The MRC Basin Development Plan

National Sector Overviews

BDP Library Volume 13

October 2004
Revised November 2005

Mekong River Commission

BDP

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Foreword

The BDP Library was compiled towards the end of Phase 1 of the BDP Programme. It provides an overview of the BDP formulation, together with information about the planning process and its knowledge base, tools and routines.

The library incorporates the essence of more than a hundred technical reports, working papers and other documents. It consists of 15 volumes:

1 The BDP planning process

2 Sub-area analysis and transboundary planning

3 Sub-area studies (including 13 sub – volumes)

4 Scenarios for strategic planning

5 Stakeholder participation

6 Data system and knowledge base

7 MRCS Decision Support Framework (DSF) and BDP applications

8 Economic valuation of water resources (RAM applications)

9 Social and environmental issues and assessments (SIA, SEA)

10 IWRM strategy for the Lower Mekong Basin

11 Monographs. March 2005

12 Project implementation and quality plan

13 National sector reviews

14 Regional sector overviews

15 Training

The work was carried out jointly by MRC and the NMCs with comprehensive support and active participation by all MRC programmes and more than 200 national line agencies. Financial and technical support was kindly granted by Australia, Denmark, Japan, Sweden and Switzerland.

The library has been produced for the purpose of the BDP and is intended for use within the BDP Programme. The work was done from 2002 to 2005, and some information may already have been superseded by new developments and new knowledge. The library does not reflect the opinions of MRC nor the NMCs.

It is hoped that the work will contribute to the sustainable development of water resources and water-related resources in support of the MRC vision of *'an economically prosperous, socially just and environmentally sound Mekong River Basin'.*

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Acronyms and abbreviations

ADB	:	Asian Development Bank
AFTA	:	Asian Free Trade Agreement
ASEAN	:	Association of Southeast Asian Nations
BDP	:	Basin Development Plan (of the Mekong River Commission)
CIAP	:	Cambodia-Australia-Irrigated Rice Research Institute Project
EIA	:	environmental impact assessment
FMM	:	flood management and mitigation
GIS	:	geographical information system
GMS	:	Greater Mekong Sub-Regional Economic Cooperation Programme (of ADB)
ha	:	hectare (=10,000 m2)
IWRM	:	integrated water resources management
LMB	:	Lower Mekong Basin (the Mekong Basin parts of Cambodia, Lao PDR, Thailand and Viet Nam)
MRC	:	Mekong River Commission
MRCS	:	Mekong River Commission Secretariat
NA, n/a	:	not applicable
NGO	:	non-governmental organization
NMC	:	National Mekong Committee
NRE	:	natural resources and environment
NTFP	:	non-timber forest products
RBC/RBO		River Basin Committee/Organization
RGC	:	Royal Government of Cambodia
RWSS	:	rural water supply and sanitation
SEA	:	strategic environmental assessment
t	:	(metric) ton
UN	:	United Nations
WSM	:	watershed management
WTO	:	World Tourism Organization, World Trade Organization
WUP	:	Water Utilisation Programme (of the Mekong River Commission)

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Executive summary

Introduction

The following water-related sectors have been identified as being particularly relevant in connection with the MRC Basin Development Plan:

Agriculture and irrigation

Fisheries

Hydropower

Navigation and waterways

Tourism

Domestic and industrial water supplies

Flood management

Watershed management

Between them, these sectors represent the in-stream and off-stream water uses that are most relevant in connection with water-related economic, social and environmental benefits, concerns and development opportunities.

Water is a key asset in the Mekong Basin, playing an important role to human life and the environment. It supports the livelihoods of the people that depend on the natural resources, including the water resources. Without water, many development sectors, including irrigated agriculture, fisheries, hydropower, navigation, transport and river works, tourism and recreation, and water supplies cannot be developed. One sector which requires a huge volume of water is irrigated agriculture, while domestic water use is the most important use in terms of value.

As human activities have increased, impacts on water resources are inevitable. Each development sector uses water in different ways and also develops different levels of direct and indirect impacts on the quantity and quality of the water. The interactions and relationships between the development sectors and social and environment impacts are complex. These linkages have become increasingly important issues in recent years.

Sector issues

Irrigated agriculture represents the predominant off-stream water utilization in the Lower Mekong Basin. It provides employment to millions of farmers, including poor rural households. Agriculture requires land and water, and is sensitive to droughts and floods.

The environmental impacts resulting from the development of irrigation systems comprise (i) effects of changes in water flow patterns and quantities resulting from the construction of reservoirs and dams; (ii) effects of changes in water quality due to over excessive pesticide and fertilizer use; (iii) changes in habitat resulting from draining of wetlands or creation of reservoirs; and (iv) salinity problems because of excessive irrigation in the dry season.

Fisheries and aquaculture are significant economic activities, for example for those who live around the Tonle Sap area. The sector contributes as much as 8-10% of Cambodia's GDP.

The relationships between fisheries and agriculture, hydropower, navigation, tourism and other economic sectors are complex. Generally, other sectors impact on fisheries more than fisheries impact on them. Both the intensity of fishing and natural environmental variability can affect the abundance of fish and the long-term sustainable yield. According to FAO, the relationships between environment and fisheries act in two directions: (i) Adverse and beneficial environmental activities which impinge on fish populations and fish communities; and (ii) the effects of fish and fisheries management practices on the environment.

Hydropower development can provide much-needed energy as well as national revenue. Also, it can lead to changes in the hydrological and ecological regimes. These effects include changes in flow patterns, impacts on ecological systems of wetlands, and impacts on aquatic ecosystems of downstream areas. The effects resulting from dam construction in upstream areas have increasingly become a major issue in the riparian countries. Irrigated agriculture, water-based recreation, fisheries, and navigation of downstream areas might all be affected by the development of big dams due to the huge volume of water that is stored in large reservoirs. A major social impact is the displacement and re-settlement of people from the reservoir areas.

Navigation on inland waterways represent an attractive supplement to other transport modalities. Development and improvement of navigation upstream can cause severe impacts on water quantity and quality downstream. The development of navigation on the Mekong mainstream may include canal dredging, reef blasting and port construction. This may in turn affect the livelihoods of people in downstream areas, particularly those who rely on activities such as agriculture, fishing and seasonal flow conditions.

Tourism offers a highly significant economic development potential. The expansion of tourism may however have positive and negative effects. The positive effects include foreign exchange earnings, government revenue, employment creation, business opportunities for service providers, improved standard of living, linkages with agriculture, fishing, stimulation of arts, promotion of recreational activities, etc. The potential negative effects on water resources management are as follows: (i) environmental degradation – destruction and depletion of endemic biodiversity; and (ii) water-related environmental impacts – sewage and solid waste disposal impacts.

Domestic and industrial water use is the most important use in terms of value. Water sources are required to be of good quality and in sufficient supply. However, whilst the extraction for domestic and industrial use does not lead to extreme impacts downstream, the discharge of wastewater from households and various kinds of industries may severely impact on the water quality of downstream waters if it is not properly treated.

Flood management is an important task with clear regional linkages. While ordinary, regular seasonal flooding is important for fishery production, maintenance of wetland ecology, replenishment of soil fertility, and supply of water for irrigation, excessive flooding can severely damage the social infrastructure, cause disruption of economic activities, loss of human lives and livestock, and destruction of cultivated crops. Flood management can be successfully achieved if the following measures are applied: Land use planning, structural measures, flood preparedness and emergency response.

Watershed management addresses the appropriate functioning of forest and wetlands ecosystems in the basin. Forests can reduce the peak runoff and can withhold water for recharge of springs, streams and aquifers. The forests can regulate the flow of water and thus soil erosion. This reduces the severity of flooding and the amount of sediment washing into the basin. In parts of the Basin, some people's livelihoods are based upon the forests through food gathering, non-timber forest products, and fuel wood collection.

Linkages between planning levels

Linkages between developments at the local level and cross-border and basin-wide levels might be characterized into the following five broad types:

1 Things that happen in a particular sub-area, planned or otherwise, that impact on the water or water-related resources and their potential use in other sub-areas, other countries, or across the whole basin.

2 The reverse of the above, things that happen in other sub-areas or countries that affect or limit what a particular sub-area can or might do with its water and related resources.

3 Things that happen to the whole basin or parts of it that are outside the control of sub-areas or the MRC countries (for example developments in the Upper Mekong, global warming leading to climate and sea level change etc.).

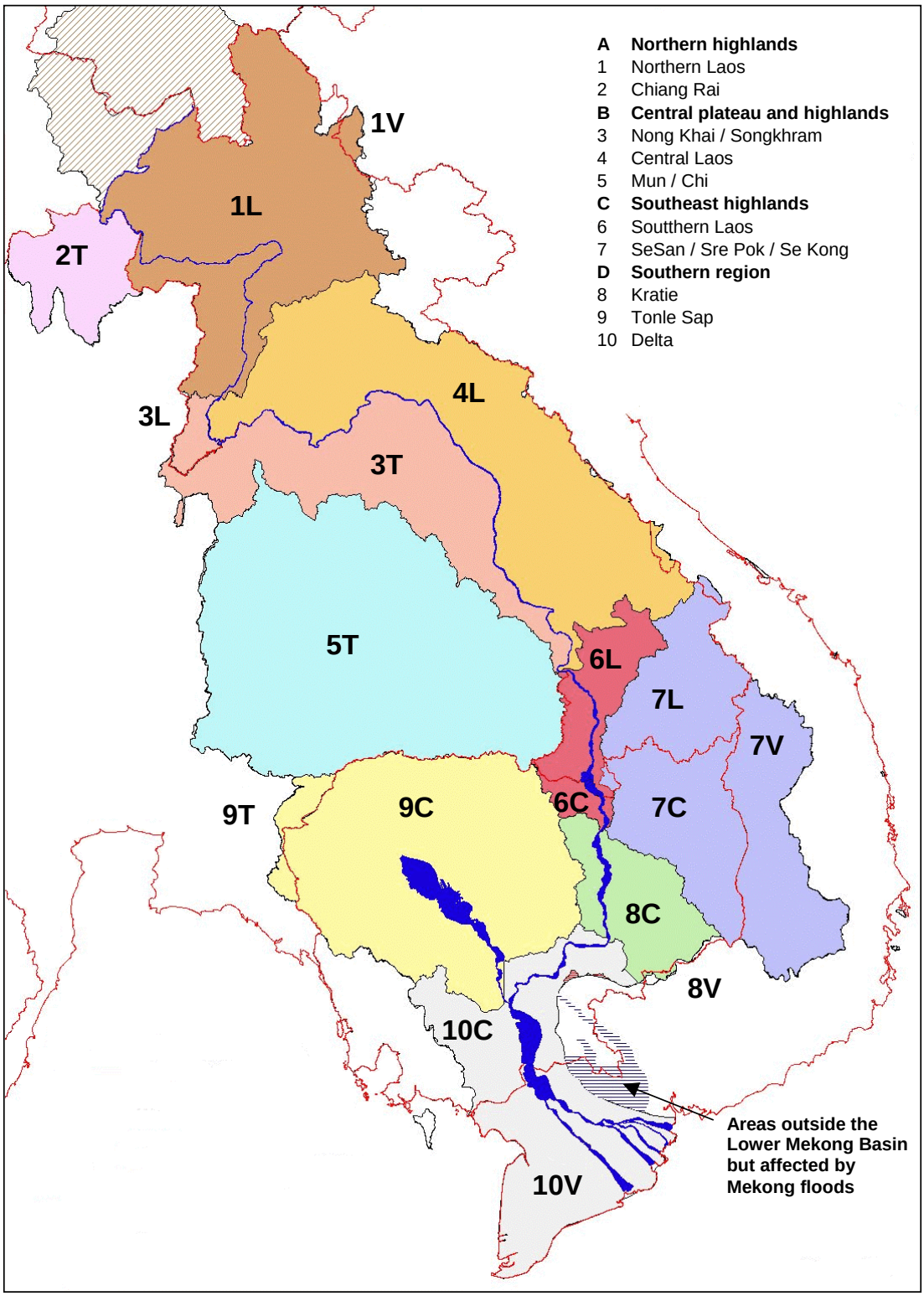
4 Common needs and ideas that have a synergy across and between sub-areas and perhaps countries (e.g. a common interest in capacity building, research, information sharing, data handling, advocacy, emergency response etc.)

5 Other initiatives that have some "added value" or advantage through being planned, financed, implemented or managed through regional rather than national or provincial mechanisms.

Acknowledgement

The present working paper has been compiled from the national sector reviews prepared by the National Mekong Committees, the national BDP Units, and the many participating national line agencies.

Map of BDP sub-areas



1 Introduction

The MRC Basin Development Plan (BDP) was instituted by the April 1995 Mekong Agreement. Following a series of preparatory studies, the BDP project document was approved by the MRC Council in October 2000. The BDP formulation (Phase 1) started in October 2001 and is scheduled for completion in July 2006.

The present report presents national sector reviews prepared by the National Mekong Committees as a part of the planning process.

1.1 Origin of document

The document is a compilation of national sector reviews prepared between May 2003 and April 2004:

CNMC (Sep 03): Integrated water resources management in Cambodia, national sector review. Basin Development Plan Programme. Phnom Penh, Cambodia

LNMC (Feb 04): Basin Development Plan, national sector overviews. Vientiane, Lao PDR

TNMC (Apr 04): National sector overview. Prepared by the BDP Unit, Thai National Mekong Committee Secretariat, Department of Water Resources, Ministry of Natural Resources and Environment

VNMC (May 2003): Basin Development Plan, national sector overviews. Hanoi, Viet Nam

1.2 Basis and context

1.2.1 Link/relationship of subject to IWRM

Integrated Water Resources Management (IWRM) is characterized by its holistic perspective, spanning across a variety of in-stream and off-stream water uses within all water-related sectors and considering the full value (or 'Total Economic Value') of water, covering short-term and long-term economic, social and environmental relations [i]. At the level of the Lower Mekong Basin, the planning covers 4 countries and a variety of transboundary implications.

Although the MRC Basin Development Plan is prepared at the basin scale, the national level remains extremely important, because a large part of the water -related policy formulation

[i] GWP-TAC4 (March 2000), p. 19

and decision-making take place at the national level, and because a large part of the initiatives identified under the Basin Development Plan relate closely to the national development in one or several member countries.

In this connection, knowledge about each sector within each country is the necessary building blocks for identification and assessment of development opportunities, demands, linkages and constraints that is an important part of IWRM.

1.2.2 Link/relationship of subject to BDP Inception Report

The BDP Inception Report (July 2002) retains the stage-wise approach to BDP formulation that had been identified during the programme formulation:

Stage 1 - analysis of the LMB and of sub-areas

Stage 2- analysis of development scenarios

Stage 3- strategy formulation

Stage 4 - compilation of long-list of programmes and projects

Stage 5 - compilation of short-list of programmes and projects

The analyses presented in the present report represent a substantial contribution to Stage 1.

1.2.3 Link/relationship of subject to other BDP reports / activities

An information needs assessment for the BDP was carried out in early 2002. It provided an initial overview of the information that was relevant in connection with the BDP formulation, mainly comprising aggregated data and analyses (for example of water availability and projected water demands), socio-economic information, and information related to sector development needs and options and regional sector strategy formulation, as well as information about related development projects and plans.

The analyses presented in the present report are closely related to the regional sector analyses that were also prepared under stage 1 of the planning process. This work has been reported in a series of working papers, and in the consolidated report

MRC-BDP (November 2002, revised September 2005): Regional sector overviews

Also, the work is related to the studies for each sub-area that were conducted in parallel.

The knowledge produced provide detailed information about the status and the development agenda for key water-related sectors in each country.

The results have provided an important part of the basis for the subsequent scenario analysis and strategy formulation.

1.2.4 Link/relationship of subject to BDP's Logical Framework Matrix

In the BDP Logical Framework, the national sector reviews contribute comprehensively to

- Output 2.1 (Sub-area studies)

The results of the work are carried forward to

- Output 2.4 (Basin-wide development & management strategies),
- Activity 2.4.2 (Management strategy components),
- Activity 2.4.3 (Formulation of basin-wide strategies), and
- Output 2.5 (long-list of programmes and projects).

1.3 Significance

1.3.1 Significance of subject for strategic planning

The national sector overviews contribute to an insight that is a necessity in connection with strategic water resources planning: Baseline conditions, trends, development opportunities, constraints, and national development policies and planned initiatives.

The compilation of such information for exchange between sectors and between countries is a precondition for analysis and dialogue in connection with the over-all, basinwide and integrated strategic planning.

1.3.2 Significance of subject for Mekong Basin

The national sector overviews have illustrated opportunities, synergies and trade-offs in connection with the present conditions and the planned development within each country and within the most important water-related sectors.

Hereby, they provide the required basis for inter-sector and transboundary analyses that are required to add value to the independent national development efforts, by identification of inter-sector linkages within each country, and inter-sector and transboundary linkages at the basin scale.

1.3.3 Significance of subject for MRCS / BDP 1

Together with the regional sector reviews and the sub-area studies, the national sector overviews have formed a platform for scenario analysis of inter-sector dependencies (synergies and constraints), as well as for the preparation of a holistic, integrated IWRM Strategy and for identification of viable development projects.

2 Summary of approach

The national sector overviews are based on (i) national social and economic development plans (5-years plans); (ii) national sector development policies and plans, as prepared by the sector ministries and line agencies; (iii) specific sector studies, as available from case to case; and (iv) data and information made available from sector ministries and line agencies.

3 Cambodia

3.1 General

3.1.1 The importance of linkages

Cross-border and basin-wide linkages

Water in the Mekong River Basin is of great importance in the regional hydrological cycle and supply of humankind with fresh water. It has been recorded that around 85 per cent of the total water use in the Basin is for agriculture. Domestic and industrial use accounts for the remaining 15 per cent (MRC, 2001). In Cambodia, the estimated total quantity used each year is 750 million cubic meters, of which 95% is used for irrigated agriculture.

The Mekong River is trans-boundary in nature, as it originates in China and traverses Lao PDR, Myanmar, Thailand, Cambodia and Viet Nam before it reaches the sea. Therefore, trans-boundary impacts are inevitable due to the nature of the river and the different economies, land cover and land use through which it flows. Critical trans-boundary impacts are both environmental and social. The environmental impacts include, amongst others: changes in water flow patterns and quantities, changes in water quality and salinity problems. Whilst the social impacts can include damage to the economies of the riparian countries and impacts on the livelihoods of people in downstream areas, particularly those who rely on activities such as agriculture and fishing depending on seasonal flow conditions.

Linkages between developments at the local level and cross-border and basin-wide levels might be characterised into the following five broad types:

1 Things that happen in a particular Sub-area, planned or otherwise, that impact on the water or water-related resources and their potential use in other Sub-areas, other countries, or across the whole basin.

2 The reverse of the above, things that happen in other Sub-areas or countries that affect or limit what a particular Sub-are can or might do with its water and related resources.

3 Things that happen to the whole Basin or parts of it that are outside the control of Sub-areas or the MRC countries (for example developments in the Upper Mekong, Global warming leading to climate and sea level change etc.).

4 Common needs and ideas that have a synergy across and between Sub-areas and perhaps countries (e.g. a common interest in capacity building, research, information sharing, data handling, advocacy, emergency response etc.)

5 Other initiatives that have some "added value" or advantage through being planned, financed, implemented or managed through regional rather than national or provincial mechanisms.

Two examples are given below to illustrate two of these potential linking mechanisms:

An example of linkage 1 or 2 (depending on the viewpoint) is flooding. Cambodia is affected by flooding almost every year. It has been reported, as an illustration, that the water released from the Yali dam project may contribute to floods in the Se San River of Cambodia. Similar effects may be felt by the construction of flood control dikes in the Mekong Delta, as construction can slow down the outflow rate of the rivers (MOWRAM, 2003). In 2000,

Cambodia was severely affected by floods. It was reported that the floods resulted in damage to some 370,000 ha of paddy rice, destruction of 6,081 houses, loss of 2,444 livestock, and affected 3.44 million people in 132 districts.

An illustration of linkage 3 is climate change. Climate change is a significant change from one climatic condition to another, and it can have profound impacts on trans-boundary resources. Climate change also impacts on human health directly through higher temperatures and increased frequency of heat waves, or indirectly, by increasing concentrations of ground-level ozone or increasing the risk of some infectious diseases. Mean annual rainfall in Cambodia is estimated to be 1,200 – 1,300 mm in the Central Plains, 2,000 – 3,500 mm in the mountains, and 3,000 – 4,000 mm in coastal areas. The rainfall has however fluctuated from year to year and from place to place. A consequence of any significant shift outside the normal variations due to climate change would greatly impact on the Cambodian economy, relying mostly as it does on agriculture.

Sector Linkages

Water is the most distributed substance in the Mekong River Basin and plays an important role in the surrounding environment and human life. It supports life in the river and the livelihoods of the people that depend on exploiting the natural resources, which are largely based upon the water resource. Without water, many development sectors, including irrigated agriculture, fisheries, hydropower, navigation, transport and river works, tourism and recreation, and water supplies cannot be developed. One sector which requires a huge volume of water is the irrigated agriculture sector, which consumes about 95% of the total withdrawal for agriculture (Nielsen, 2002). Domestic water use is the most important use in terms of value. It requires a good quality and reliable supply.

As human activities have increased, impacts on water resources are inevitable. Each development sector uses water in different ways and also develops different levels of direct and indirect impacts on the quantity and quality of the water (MRC, 2002). The interactions and relationships between the development sectors and social and environment impacts are complex. These linkages have become increasingly important issues around the world.

Some of the most important cross-sectoral linkages and impacts are discussed below, to help illustrate the range of complex interactions that need to be considered in the management of the Basin's water resources:

Irrigated agriculture is the most important economic activity within the Mekong River Basin in Cambodia. It provides employment to millions of poor farmers in a setting where opportunities for work other than farming are lacking. It contributes to approximately 26% of the total GDP. Agriculture requires a large area of land and a huge volume of water; as a result, it often eliminates wetland ecosystems and species and impacts more generally on water quantity and quality in the basin. Agricultural practices can in particular influence the water quality downstream.

The environmental impacts resulting from the development of irrigation systems are as follows: (i) effects of changes in water flow patterns and quantities resulting from the construction of reservoirs and dams; (ii) effects of changes in water quality due to over excessive pesticide and fertilizer use; (iii) changes in habitat resulting from the draining of wetlands or creation of reservoirs; and (iv) salinity problems because of excessive irrigation in the dry season.

Watershed management in term of *forests* plays an important role in the way the ecological system within the basin works. Forests act as giant sponges, slowing down runoff and holding and absorbing water that recharges springs, streams and aquifers. The forests can regulate the flow of water and thus soil erosion. This reduces the severity of flooding and the amount of sediment washing into the basin (Tyler Miller, 1992). Some Cambodians' livelihoods are based upon the forests through food gathering, non-timber forest products, and fuel wood collection. Although data and information regarding the reduction of forest have not been much referred to in the paper on Watershed Management in Part 2, it is known that deforestation does significantly impact on the water quantity and quality downstream.

Fisheries and aquaculture are significant economic activities in Cambodia, particularly for those who live around the Tonle Sap area. The sector contributes as much as 8-10% of Cambodia's GDP. The relationships between fisheries and agriculture, hydropower, navigation, tourism and other economic sectors are complex. Generally, other sectors impact on fisheries more than fisheries impact on them (MRC, 2002). Both the intensity of fishing and natural environmental variability can affect the abundance of fish and the long-term sustainable yield. According to the FAO, the relationships between environment and fisheries act in two directions: (i) Adverse and beneficial environmental activities which impinge on fish populations and fish communities; and (ii) The effects of fish and fisheries management practices on the environment.

Hydropower development can lead to the changes in hydrological and ecological consequences. These effects include changes in flow patterns, impacts on ecological systems of wetlands, impacts on aquatic ecosystem of downstream areas. The effects resulting from dam construction in upstream areas have increasingly become major issues in the riparian countries. Irrigated agriculture, water-based recreation, fisheries, and navigation of downstream areas might all be affected by the development of big dams due to the huge volume of water that is stored in large reservoirs. Major social impacts are the displacement of population from the reservoir construction areas and their resettlement (Moonasingha, 1993).

Development and improvement of *navigation* upstream can cause severe impacts on water quantity and quality downstream. The development of navigation includes canal dredging, reef blasting and port construction. This may in turn affect the livelihoods of people in downstream areas, particularly those who rely on activities such as agriculture, fishing and seasonal flow conditions.

Tourism plays an increasingly vital role in Cambodia's economy, which contributes about 10% of the GDP. The expansion of tourism may however have positive and negative effects. The positive effects include foreign exchange earnings, government revenue, employment creation, business opportunities for service providers, improved standard of living, linkages with agriculture, fishing, stimulation of arts, promotion of recreational activities, etc. The potential negative effects on water resources management are as follows: (i) environmental degradation – destruction and depletion of endemic biodiversity; and (ii) water-related environmental impacts – sewage and solid waste disposal impacts.

Domestic and industrial water use is the most important use in terms of value. Water sources are required to be of good quality and in sufficient supply. However, whilst the extraction for domestic and industrial use does not lead to extreme impacts downstream, the discharge of wastewater from households and various kinds of industries may severely impact on the water quality of downstream waters if it is not properly treated.

Cambodia has often been facing ***seasonal flooding***. Seasonal flooding is very important for increased fishery production, maintenance of wetland ecology, replenishment of soil fertility, and supply of water for irrigation. But excessive flooding can severely damage the social infrastructure, cause disruption of economic activities, loss of human lives and livestock, and destruction of cultivated crops. Flood management can be successfully achieved if the following measures are applied: land use planning, structural measures, flood preparedness and emergency response.

Planning linkages

BDP does not seek to duplicate national or provincial planning, or conflict with it in any way. It focuses instead on those aspects that have a trans-boundary or basin-wide linkage, and on developments where a multi-country approach has clear advantages.

Ideas emerging form the Sub-areas that do not fit in with the wider outlook of BDP will not be discarded however, but instead will be directed towards existing local, provincial or national planning channels. Thus involvement of national planning institutions or agencies has been important from the earliest stages to allow this filtering to progressively take place and to ensure general conformity with the national planning procedures in the riparian countries.

BDP aims in fact to provide a process for examining ideas and plans from the Sub-areas in the context of national plans, and then in a regional context, to determine their significance for neighbouring countries and to identify areas where joint initiatives could provide a regional benefit (MRC, 2003). By reviewing the national plans and policies, common and trans-boundary issues will be identified and regional strategies and initiatives formulated. Hence the importance of the National Sector Review initiative (reported on for Cambodia in this document) to this overall process.

Ideas and insights (on the current position, trends, issues, constraints, opportunities and likely development objectives) are being gathered from all levels. In the decentralised planning environment in Cambodia, Provincial inputs to the Sub-area studies and analyses should already reflect District and even Commune thinking. Sub-area ideas and insights will then feed naturally into consideration of the Cambodia national position on the BDP trans-boundary and basin-wide focus – and will in turn feed into basin-level thinking and analysis.

There are also mechanisms within BDP for drawing in shared thinking from those Sub-areas that form part of a Zone spanning more than one country – and for sharing thinking between Sub-areas that - whilst forming different catchments - interface across the Mekong mainstream.

Thus, despite BDP's trans-boundary and basin-wide focus, its de-centralised Sub-area approach demands strong linkages and understanding between all planning levels at every stage.

Process linkages

At the heart of BDP is the gathering of insights and ideas from Sub-area level and extracting trans-boundary and basin-wide aspects to be reflected in Basin level planning. This will lead to Long and Short Lists of potential projects of all shapes and sizes - Sub-area, National and Regional level – that nonetheless each have a trans-boundary or basin-wide aspect to them.

Making up this complex analysis and planning initiative, a number of interlinking processes are under way, some executed in parallel, some in series. These include (i) Regional Sector Overviews (ii) National Sector Reviews (the subject of this document) (iii) Outreach visits (to member Ministries, to the Provinces, to the External Support Agencies) (iv) Sub-area studies and analyses (v) Stakeholder Forums at Sub-area, National and Basin levels (vi) Cross-border and Interface meetings (vii) Desk studies and analysis by MRCS (vii) Development of Scenarios and Strategies at Sub-area and Basin levels and (viii) Development selection criteria for and first formulation of Long and Short project lists.

Clearly the linkages between these various processes are most important. Each must play its part in helping set the context for analysis and planning at Basin level – and the development of appropriate criteria for the selection of projects that will begin to put the Basin Development Plan into action.

3.1.2 Summaries of the eight sectors

Agriculture and irrigation

The part of Cambodia within the Mekong River basin generates 75,000 MCM/year of surface water runoff, and its aquifers contain an estimated 17,600 MCM of groundwater. This is more than 100 times the amount that is used at present. Annual rainfall varies between 1,400 mm and 3,500 mm. Each year, the Mekong River carries 475,000 MCM from Cambodia to the South China Sea.

Water in Cambodia is used for agriculture, industry, hydropower, navigation, and tourism. The estimated total quantity used each year 750 MCM/year, of which 95% (about 710 MCM/year) is used for irrigated agriculture. There is very little reliable information on the quantities used for other purposes. Groundwater potential for irrigation is an integral aspect of Cambodia's water balance, and provides a substantial natural storage of water that may be available to provide a year-round source of water.

Currently, approximately 2.7 million hectares is effectively utilized for crop production. In 2001, 2.6 million hectares was under wet and dry season rice production. Other significant crops are maize (71,500 ha), rubber (40,000 ha), soybean (33,300 ha), vegetables (33,800 ha), and mung bean (25,000 ha). In 1999, the agriculture sector contributed to approximately 26% of the total GDP, which was about 2,014 billion riel. Of this figure, rice accounted for 859 billion Riel, other crops for 591 billion Riel, and livestock for 564 billion Riel.

Different irrigation systems have been found in lowland irrigated areas along the Mekong River, around the Great Lake of Tonle Sap, and in the associated wetland and seasonally flooded areas. Lowland irrigated agriculture is generally practiced around swamps and lakes, using a combination of canals, dikes, reservoirs, small pumps and traditional lifting devices to manage and exploit waters arriving during the annual monsoon flood.

The use of surface water ponds as a source of water for farm-scale irrigation is also widespread, and newly excavated ponds can be seen in many places (no data are available on the number or rate of increase in number of ponds, however). Ponds with a surface area on the order of 400 m^2 and a depth of 2-3 meters typically can provide water for irrigation through much of the dry season, particularly for application at critical times in the growth cycle.

To address the irrigated agriculture issues, the Royal Government of Cambodia has the following strategies and policies: (i) to provide farmers with the quantity of water they need;

(ii) to promote, where justifiable on economic or social grounds; (iii) to promote the development and extension of water management technologies; and (iv) to strengthen and expand Farmer Water User Communities.

Fisheries

The Tonle Sap River is an important inland wetland in Cambodia. It is endowed by a rich natural resources base. Its area ranges from 250,000 to 300,000 ha in the dry season and 1 to 1.6 million ha in the wet season (ADB, 2002). During the dry season, the water flows out of the Great Lake into the Mekong River at Phnom Penh and is forced to flow backwards due to the greater height of water in the Mekong during the wet season. The water levels in the Great Lake consequently rise by 6–9 meters and thousands of square kilometres of land around the lake are temporarily submerged. It has been recorded that the Tonle Sap contains at least 200 species of fish, 42 species of reptiles, 225 species of birds, and 46 species of mammals. It is estimated that approximately 1.2 million people live in the area bordered by Highways No. 5 and No. 6.

Fisheries and aquaculture are significant economic activities in Cambodia, particularly those who live around the Tonle Sap areas. It is indicated that 88% of people in 170 villages around the flooded forest rely on fishing or related activities (Thouk & Sina, 1997). Inland Fisheries produce approximately 290,000 to 430,000 tones annually, with a value at landing of between US$ 150 million and US$ 250 million and retail value of up to US$ 500 million. The sector contributes as much as 8-10% of Cambodia's GDP.

The fisheries sector has been affected by continually increasing pressure from agricultural encroachment and development, deforestation, over exploitation of the fisheries resources, hunting and collecting of wildlife. Water resources development can be a severe impact on flooding, water quality, navigation, and food production in down stream countries.

The system of fisheries management has changed from stand alone to co-management. In this new system the state has empowered the local people, and people are encouraged to participate in the management of conservation activities in order to ensure better use of the natural resources. Management and governance in fisheries reform and their implementation require strengthened institutional capacity for the effective and balanced implementation of policy, legislation and laws at local level.

Reform of fisheries management should take into account proper policy, strategic planning and its implementation to place poverty reduction alongside the equitable and sustainable utilization of resources.

Hydropower

Cambodia is one of the south-east Asian countries that are rich in water resources. According to the latest preliminary study, the total hydropower potential of the country is estimated at 10,000 MW, of which 50% is in the Mekong mainstream, 40% in its tributaries and the remaining 10% in the south-western coastal area outside the Mekong River Basin. It is estimated that there are about 60 possible sites of small to large hydropower projects in the whole country.

The power demand is increasing yearly due to the increase of population. It is estimated that the demand will increase up to 991 MW and the generated power will be 3488.4 GWh in 2020, with average annual growth rates of 12% and 9.4% respectively.

The major socio-economic effects of hydropower development in Cambodia include the displacement of population living within the reservoir area of the projects and their resettlements in new areas. The flooding resulting from the impoundment of water in front of a dam will remove land that is used for other purposes such as farming and forests, and which provide various ecological as well as economic benefits. On the other hand, all economic sectors (agriculture, industry, services and trade) and private households will benefit from sufficient and reliable energy production.

The construction of dams causes ecological consequences including climatic change, influences on the water and soil quality, flora and fauna, land use, etc. social impacts and potential new health risks such as chagas disease and bilharzia.

Dam projects for power and irrigation purposes are the most sensitive issue of all water-related projects in the Mekong Basin. The benefits of hydro-electricity are as follows: (i) low operation costs; (ii) high reliability of generation; (iii) high service and economic life (compared to thermal units); (iv) stable costs; and (v) independence from fuel prices. The impacts of dam projects include modification of:

- Changes in flows downstream of reservoir, river morphology, ground water patterns;

- Impact on ecology of wetlands, flood plains and coastal habitat due to storage or diversions;

- Impact on aquatic ecosystems due to disturbance, pollution or introduction of exotic flora and fauna;

- Impact on the spawning environment of inland fish, which are the primary sources of protein for Cambodians; and

- Changes in water quality parameters due to pollution, sedimentation etc. which affects consumptive or other human uses.

Navigation

The inland waterway system has traditionally played a vital role in the Cambodian economy. The system consists of the Tonle Sap Lake, the Mekong River and the Bassac River for a total navigable length of 1,750 km, with 580 km navigable all year round. Most of the waterway traffic is on the Mekong River between Phnom Penh and Ho Chi Minh City, and from Phnom Penh upstream to Kratie province. Vessels of up to 5,000 tones can navigate along the Mekong up to Phnom Penh for most of the year.

Improvements in the efficiency of transport services will in turn create the conditions for investment in a new sector infrastructure. Rapid rehabilitation of transport capacity particularly the re-establishment of the primary road network is essential, as is the implementation of new services to ensure that future economic growth is not constrained by absence of an adequate transport infrastructure.

The transport sector was severely damaged during the period of war beginning in the early 1970s though the mid-1990s. This damage was due to the destruction brought by the war itself and caused by 25 years of neglect. The existing road network in Cambodia consisting of National (primary), provincial (secondary) and rural (tertiary) roads, has a total length of approximately 34,000 km. The primary road network comprises 4,160 km. It is the only transportation mode that has nationwide coverage and carries the bulk of the freight and

passenger movements within the country. It carries about 90% of the freight moved within the country. In the road network system, primary routes connecting to neighbouring countries such as Vietnam, Lao PDR and Thailand have not been rehabilitated and connected yet.

Only 350 km of roads were reconstructed in accordance with the international standards; while another 550 km have been rehabilitated. This is still inadequate however, with the total length of the national road network amounting to 4,165 km plus some 3,615 km of provincial roads. The National Road Rehabilitation and Reconstruction Program is presently ongoing with the aim at rehabilitating 1,400 km of National Roads by the year 2003. The Cambodian military are also contributing effort to this program, undertaking the rehabilitation of just over 900 km of road. In addition, the Emergency Flood Damage Repair Program repaired the primary road network caused by the flooding of 2000.

Financial support, technical officers, private sector participation, and compliance and enforcement of the rules and regulations are major constraints faced by the transport sector. In response to the constrains, the Royal Government of Cambodia has built on existing reforms and focused on the most pressing constraints to the rapid development of the sector. The efficiency of the sector by promoting greater private sector participation and facilitating competitive markets for transport services has also been increased. Public investment priorities will complement high priority policy actions aimed at strengthening sector institutional capacity and management, expanding transport services, particularly roads, and developing cost recovery mechanisms. The successful development of infrastructure will undoubtedly support the development of the economy and improve the quality of life for all Cambodians.

Tourism

Tourism has been playing a key role in helping resolve the past regional economic crisis, attracting foreign currency from foreign tourist to underpin the national economy. Tourism makes a significant contribution to Cambodia's Gross Domestic Product (GDP) and foreign exchange earnings and supports a correspondingly significant number of jobs in a wide range of areas. According to a consolidated report for 2002, the tourism sector has generated more than USD 576 million in state budget and in creation of about 100,000 jobs, thus contributing approximately 15% of the GDP.

It has been recorded that international tourism traffic to Cambodia has grown steadily. In 1993, 118 000 international visitors arrived in Cambodia by air, and in 2001, 408,377 by air and 196,500 by other means of transportation. Of this figure, about 60% come from the Asia and Pacific region.

Tourism in fact provides the opportunity for generating revenue and employment at the national, regional and local level. However, side effects associated with tourism have also taken place. These include social and cultural as well as biophysical aspects. The effects can be both positive and negative. The positive effects associated with tourism in Cambodia are identified as: (i) Revenue generation and contribution to diversified employment; and (ii) Economic development locally, regionally and nationally. The negative effects include (i) loss of quality of some relatively unspoilt parts of Cambodia's natural environment (both physical and intrinsic values); (ii) loss of amenity values from incremental development (in both rural and urban environments); and (iii) pressure on infrastructure, such as sewerage and roads, resulting in significant costs to small communities.

The development of a vision and strategy for the whole tourism sector, both private and public, which would set a future basis for the management of environmental effects associated with tourism, is required.

Domestic and industrial water supplies

Water supply is a crucial component for human being. Without water, life can not be sustained. Surface and ground water are the main sources for domestic water supply in urban and rural areas in Cambodia. It has been shown that groundwater is used as the major source for industrial sector.

63% of the total population living in urban areas can access to safe water supply while only 24% of the total population in rural areas can. Unprotected water sources are used by people in rural areas.

Industrial sector development has been significantly increased and improved since 1999. The garment industry is the most important sector among others. There were 25,791 companies in manufacturing. Of these, 6,257 were enterprises, 19,277 were small and medium business enterprises (SMEs) and 257 were big business enterprises (Siphana, 2003). Rapid expansion of the textile industry, based primarily on exports to the United States, contributed to double-digit growth for industrial value added in 2000. Manufacturing increasingly dominates the industrial sector, accounting for 75.0 percent of industrial value added and nearly 15.0 percent of GDP in 1999 (ADB, 2003).

In terms of water demand for the industrial sector, the demand varies depending on the size of the industry, the kind of processing, etc. It is estimated that the demand by industry ranges from 50 m^3/day to 20,000 m^3/day per industrial unit.

The water supply for domestic use must be clean and safe compared with the supply for other uses. The sources of water pollution include municipal, industrial, and agricultural. It has been indicated that the causes of major environmental issues related to the water supply include sewage, pesticides, and fertilizers. Sewage, both from municipal and industrial sources, is the most important environmental issue in water supply in most cities and provincial towns throughout Cambodia. Groundwater quality is good for most provinces. It has been reported that the groundwater for five provinces contains Arsenic, with high concentration that exceeds the WHO's standard, and this is a growing concern.

Water extraction for domestic supply does not result in trans-boundary impacts due to the small volume of water extracted. Water contamination, both surface and ground water, by sewage discharge is also not a major trans-boundary environmental effect at present. It has been demonstrated that wastewater discharge by the industrial sector is likely to have negative impacts on both surface and ground water.

Flood management

Flooding is a major problem severely affecting all the Mekong River riparian countries. Within the Mekong Delta in Cambodia and Vietnam flooding is more frequent – and the areas flooded are larger.

The Tonle Sap is filled with water from the beginning of the flood season until the main flood peak reaches Chaktomuk at Phnom Penh. For a short time at the peak, the water levels at Chaktomuk and Prek Kdam become almost the same and the flow in the Tonle Sap River is stagnant, thereafter throughout the dry season the Lake continues discharging. It has been

estimated that the Tonle Sap Lake stores approximately 20 to 30 per cent of the total discharge from Kratie during the flood season

Flooding is one of the critical issues in Cambodia. Flooding has dual effects on the country – negative and positive. Seasonal flooding is very important for increased fishery production, maintenance of wetland ecology, and replenishment of soil fertility with silt and sediment, and supply of water for irrigation. Freshwater fish production remains the most important source of livelihoods in the rural area and fish constitutes some 60% of protein intake in the Cambodia diet.

But excessive flooding can inflict damage on the social infrastructure, disruption of economic activities, loss of human lives and livestock, and destruction of cultivated crops. The 2000 floods resulted in damage to some 370,000 ha of paddy rice, destruction of 6,081 houses, loss of 2,444 livestock, and affected 3.44 million people in 132 districts. Subsequent flood in following years, though on a smaller scale, continue to disrupt the normalcy of economic activities, especially agricultural production. As a result, the rural population is exposed to unstable food security and further impoverished. Damage by the year 1996 and 2000 floods were estimated to have totalled US$ 86 million and US$ 164 million respectively.

As flooding becomes a frequent phenomenon and causes substantial social and economic damage to the country, country coordination for flood emergency relief and rehabilitation became critical. In 1995 a National Committee for Disaster Management was formed by a Sub-Decree, which was amended in 1999 to include all representation of all ministries to the committee. The committee is given a broad mandate to deal with country disaster preparedness and emergency response, information systems, public awareness and community based disaster preparedness.

A comprehensive flood management and mitigation strategy is urgently required for Cambodia, as a framework amongst others for investments in response to the major flood of 2000-2002. This must be based on an accurate assessment of the communities and assets at risk and the realistic costs (financial and social) of flood damage in the future.

Watershed management (WSM)

Planning and working toward an environmentally and economically healthy watershed that benefits those who are involved in it is a main objective of watershed management. Watersheds are used as planning and implementation entities in connection with natural resources conservation, sustainable water supply for hydropower and irrigation schemes, development and protection of upland areas and for the mitigation of up-stream cause and downstream effect relations. The total water demand is about 0.5 Bm^3/year. It is estimated that about 5% of the water is used for domestic, 1% for industrial use and 94% for agricultural use.

A large percent of the population draw a significant proportion of their livelihood from forest resources such as food gathering, Non-Timber Forest Products, and fuel wood collection. Consequently, deforestation can seriously affect the water regime and water quality as well as the livelihoods of those who are living within the catchments. The challenges include rapidly increasing population pressures and economic development that result in widespread degradation of the natural resource base. Another major issue is unsustainable and poor management of natural resources by both commercial interests and poor rural households.

The Royal Government of Cambodia has made efforts to respond to the above matters by establishing legal instruments, policies, and strategies for the management of watersheds. Those legal instruments include the forestry law, community forestry sub-decree, water resources management law, environmental law, etc. There have not many lessons learned about the impacts of WSM in Cambodia as (i) the concept of watershed management has not been clear to the policy makers and resources users; (ii) law and regulations for resources protection and conservation have not been effectively adopted; and (iii) financial resources for the management of watershed are insufficient.

Participation from the stakeholders involved in natural resources management is very crucial for watershed management development. There are 26 forestry and watershed management projects in Cambodia with a total amount of Technical Assistance funding of US$ 70 million. The main goals of the projects are to improve approaches to forest management and conservation. It is necessary to provide knowledge and skills related to watershed management to governmental staff at national and local levels.

3.2 Agriculture and irrigation

3.2.1 Introduction

The part of Mekong River basin in Cambodia generates 75,000 MCM/year of surface water runoff, and its aquifers contain an estimated 17,600 MCM of groundwater. This is more than 100 times the amount that is used at present. Annual rainfall varies between 1,400 mm and 3,500 mm. Each year, the Mekong River carries 475,000 MCM from Cambodia to the South China Sea.

Quantity of water in Cambodia is used for many purposes, such as for household, agriculture, industry, hydropower, navigation, tourism, etc. The estimate total quantity used each year is about 750 MCM/year, of which 95% (about 710 MCM/year) is used for irrigated agriculture. There is very little reliable information on the quantities used for other purposes.

Groundwater potential for irrigation is an integral aspect of Cambodia's water balance, and provides a substantial natural storage of water that may be available to provide a year-round source of water. There are insufficient data and information about the distribution, quantity, and quality of groundwater.

Based on the concept of the rehabilitation and development of water resources, water use for irrigation still remains as an active movement with the support from the RGC and external organizations. The management and development of irrigation system throughout the country is very crucial element for the reduction of poverty.

3.2.2 Economic importance of irrigated agriculture

Socio-economic development

Inability to manage water flows is likely the most serious constraint on agricultural growth in Cambodia, because of the considerable variability in rainfall (RGC, 2001). The RGC is thinking on appropriate a response has evolved rapidly. The Interim Poverty Reduction Strategy Paper presented the following proposals:

"Where technically and economically feasible, the rehabilitation of existing irrigation facilities would be carried out to provide equity in access to irrigation water and to boost agricultural production in food insecure areas. The short to medium term strategy is to encourage a private sector-led shallow tube well and low-lift pump irrigation development program. The development of medium to large scale, gravity irrigation schemes should only be resorted to after the institutional capacities at all levels is sufficiently developed for the design and implementation of such systems. The government's water policy objectives are to expand fully irrigated areas from 16 to 20 percent of the total rice cultivation areas over the period of five years to 2003 through the development of appropriate irrigation facilities, enhanced local ownership and control, increased private sector involvement in irrigation development and enhanced capability for operation and maintenance by local government units and water user communities."

The importance of human capacity was also highlighted by the draft SEDP-II (RGC, 2001):

"In parallel with the expansion of irrigation and drainage systems the emphasis will be on building capacity of Farmer Water User Communities (FWUC) to manage water for irrigation more efficiently and effectively. Expanding irrigation without simultaneously putting in place management improvement measures may create larger problems of lack of management and inefficient use of resources. Research and extension will be reoriented with an emphasis on rain-fed lowland agro-ecosystem because it comprises around 80% of the current cultivated area."

Irrigated land and agricultural production

Currently, approximately 2.7 million hectares is effectively utilized for crop production. In 2001, 2.6 million hectares was under wet and dry season rice production. Other significant crops are maize (71,500 ha), rubber (40,000 ha), soybean (33,300 ha), vegetables (33,800 ha), and mungbean (25,000 ha).

In 1999, the agriculture sector contributed to approximately 26% of the total GDP, which was about 2,014 billion Riel. Of this figure, rice accounted for 859 billion Riel, other crops for 591 billion Riel, and livestock for 564 billion Riel.

Table 3.1: Rice production and food balance (2000-2001)

Rice production and food balance	1,000 tons
Total paddy production	4,026
Seed and post-harvest losses	684
Balance: paddy available	3,342
Rice available, assuming 62% availability	2,072
Population, million persons	13.10
Total rice requirement, at 151.2 kg/person	1,981
Surplus production, rice	91

Source: RGC, 2001.

Cambodia has recently achieved surpluses of rice, and is able once more to export a portion of its production. Nevertheless, performance at provincial level varies considerably, with 13 provinces out of 24 showing food deficits in 2000/1 (RGC, 2001c). The bulk of the surplus

was generated in just a few provinces. Average yield of paddy was 2.1 tons/ha in 2000/1 (RGC, 2001c). This is a substantial increase from the 1.16 tons/ha recorded only five years earlier, and helps explain the marketable rice surplus in spite of Cambodia's growing population. The yields of other crops also increased.

Rice ecosystems and irrigation

Although Cambodia is often considered as a "water-rich" country, this is only true in aggregate, because of its location in the lower Mekong River basin. The long dry season and irregular rainfall during the wet season place considerable constraints on crop production, and on farmer confidence and ability to invest. Water resources management and control are a basic requirement for increasing agricultural productivity, reducing risk of crop failure, and reducing rural poverty.

There are four principal rice ecosystems in Cambodia. By far, the greatest proportion of rice is grown during the wet season, which is based on the natural rainfall and surface runoff, and is located in the lowland area of the country. It has been pointed out that the distribution and extent of the various rice ecosystems has changed considerably over the years, in response to agricultural technology as well as other matters such as security. In particular, the area of deep water, floating rice has diminished considerably (Nesbitt, 1997). During the wet season in 1999, 11% of the paddy land is served with supplementary irrigation water. Less than 13% of the cropland, and only about 12% of all harvested paddy land, was cultivated during the dry season. This consists mainly of irrigated lowland (fully irrigated) and flood recession rice (partially irrigated).

Table 3.2: Rice ecosystems in Cambodia, 1994-95

Ecosystem	Area ('000 ha)	Area (%)
Wet season	1,869	91.7
Rainfed lowland	1,747	85.7
Early rice	354	17.4
Medium rice	721	35.4
Late rice	671	32.9
Deepwater	84	4.1
Upland	38	1.9
Dry season	169	8.3
Total	2,038	

Source: Nesbitt, 1997.

Table 3.3: Cultivated rice by irrigation status, 1999

Season	Ecosystem	Irrigation status	Cultivated area		Type of irrigation	
			'000 ha	*%*	*Type*	*%*
Wet	Low and upland	Rain-fed	1,518	77	Gravity	10
		With supplemental irrigation	224	11	Pump	1
Dry	Lowland	Full irrigation	25	1	Gravity	11
		Recession	224	11	Pump	1
Total			1,991	100		23

Source: MAFF, 1999.

3.2.3 Land use in the Basin

Land use for irrigated agriculture

The Mekong River Commission (2002) has recently compiled a survey of irrigation systems or projects in the Lower Mekong River basin. There are approximately 1,000 systems included in the MRC inventory. However, the earlier inventory prepared by Halcrow (1994) indicated that only about 21% of the total 841 systems identified in 1994 were fully operable, and about 14% were completely inoperable. Owing to poor or no design and/or inadequate construction methods – particularly during the Khmer Rouge regime (1975-79), when many systems were constructed – many structures or entire systems are of little value, or are positively harmful to water management. The Halcrow (1994) inventory provided a useful summary of the types of irrigation system found in Cambodia. These are not all operated and maintained by smallholders, and inputs from the Royal Government are provided in many cases. Nevertheless, the farmers are, in general.

Table 3.4: Land use of irrigation systems

	MOWRAM (2000)	MRC (2002)
Number of systems	946	1,055
Area of wet season irrigation (ha)	256,120	258,908
Area of dry season irrigation* (ha)	143,490	184,566
Total irrigated area (ha)	NA	402,493

Main categories of land use for irrigated agriculture

The irrigation systems can be divided into four main categories of irrigations:

- Canals off-taking in the Mekong basin from natural lakes, rivers or streams by gravity. Level control may be provided by barrages or diversion weirs, although in many cases off-takes are uncontrolled. These systems have no storage and are used for wet season supplementary irrigation, with some limited double cropping where water is available. These systems account for 15% by number and 21% by area of the operational systems recorded.

- Canals abstracting from rivers via pump stations provided by the Government. The pumps, typically 500 l/s in capacity, are either mounted on pontoons or installed in pump houses. Systems on perennial rivers of Mekong basin have the potential for double cropping. The responsibility for operating the pumps lies with the farmers. In the event of breakdown the situation is not clear, but in practice the Provinces

generally have no funds for such work, and if the farmers cannot carry out the repairs (as is normally the case) then the pump remains broken. These systems account for 5% by number and 7% by area of the operational systems recorded.

- Reservoirs storing water from run-off, streams or rivers in the basin for supplementary wet season irrigation and, in some instances, a small dry season area. Water is abstracted from the reservoirs by gravity or mobile pumps provided by the farmers. These systems account for 45% by number and 43% by area of the operational systems recorded.

- Reservoirs storing flood waters from the Tonle Sap/Bassac/Mekong system and released by gravity or mobile pumps for a dry season recession crop only. In some cases water may be abstracted directly from the rivers without storage reservoirs. These systems accounted for 35% by number and 29% by area of t he operational systems recorded.

Canal distribution networks are usually very limited and the farmers are required to construct channels and in-field works to ensure their water supply. Furthermore many of the canals are not in command, necessitating the use of mobile pumps or traditional lifting methods.

The mobile pumps are typically of 10-30 l/s capacity and used by individual farmers or small groups of farmers to lift water from the channels to their fields. Traditional methods are commonly used by low-income farmers and include the "Rohat" (pedal pump), "Kleng" (oscillating flume), and "Snach" (tripod water shovel). These methods are time-consuming and have only a very small capacity.

Commonly, it is difficult to organise and maintain concerted management of water by the farming community. In these areas, then, agriculture is largely on a rain-fed, single land-holding basis. During the last ten years, a number of systems have been rehabilitated, most recently the ongoing Stung Chinit system (7,000 ha) at Kampong Thom province. Promotion of Farmer Water User Communities is a key element of the Royal Government Cambodia's policy on irrigated agriculture, to enhance cooperation among farmers to manage water efficiently and ensure sustainability of the systems. Further, there are many signs around the country that individual smallholders are adopting small-scale methods of irrigation, in some places with the assistance of NGOs. Hence, Cambodian agriculture is poised to recover from the setbacks of the last three decades of instability.

3.2.4 Development of irrigated agriculture

Lowland Irrigation

Very distinctive management systems for rice cropping in Cambodia are found in lowland irrigated areas along the Mekong and Tonle Sap, around the Great Lake, and in the associated wetland and seasonally flooded areas. Lowland irrigated agriculture in general is practiced around swamps and lakes, using a combination of canals, dikes, reservoirs, small pumps and traditional lifting devices to manage and exploit waters arriving during the annual monsoon flood (Pich Veasna's report, 2002). Much of the infrastructure dates from earlier decades, and there often is limited management and maintenance of the systems. Water management tends to be restricted to the use by individual farmers of lifting devices to supply water to their fields.

A particularly distinctive aspect of lowland irrigated agriculture is recession farming. As river, lake and wetland, water levels fall after the flood peak in October/November; the first

available fields along the receding water's edge are used as nurseries. From these, seedlings are transplanted to fields in succeeding recession areas, as water levels continue to fall. Water may be pumped back up to the higher fields for supplementary irrigation, using small mobile pumps or traditional lifting devices. Water is taken from the receding water or natural depressions, from behind storage bunds (which also often have a dual purpose as road embankments and storage bunds), or from ponds constructed to store water.

Cropping in the lowland areas is limited to the non-flooded period. There are two basic dry season paddy cropping patterns, namely flood recession paddy and dry season paddy with irrigation, and some upland crops also are cultivated in the early wet season before flooding.

A distinctive system of irrigated agriculture used in the central lowland of Cambodia is the so-called "colmatage" system, in which canals are constructed to lead water from the Mekong and Bassac rivers through the natural levees to the floodplain and wetlands behind. The canals supply water to the "upland" and recession fields; as floodwaters recede, the colmatage canals themselves become a source of water, which is lifted to the fields by small mobile pumps or traditional lifting devices. Colmatage farming is quite dependent on the level and duration of river flood levels, so farmers must be flexible in their operations. Small mobile pumps increasingly are used to supply water to crops.

Apart from rice growing, areas of lowland irrigated agriculture also are used extensively for other crops, particularly including corn and vegetables. Relatively high yields are obtained in such areas, due to a combination of natural fertilization by flood-borne silt (from Mekong and Bassac rivers), access to water, and dry season weather conditions that are conducive to plant growth. Indeed, the lowland irrigation systems support a diverse range of resource uses, including capture fisheries, forest conservation, and supply of firewood, maintenance of natural biodiversity, and maintenance of the rural landscape that is so much a part of Cambodia's identity (Pich Veasna, 2002).

3.2.5 Irrigated agriculture management

There are several hundred irrigation systems in varying states of operation in Cambodia, mostly small to medium (<100 ha and 100-500 ha respectively) in scale. It is difficult to generalise about system management, because management approaches and effectiveness vary widely. The relative roles of the various provincial authorities (the provincial Department of Water Resources and Meteorology, Ministry of Rural Development, Ministry of Agriculture Forestry and Fisheries), NGOs, international organisations, and the farmers themselves also vary. There is a strong push to establish Farmer Water User Communities (FWUC) to take responsibility for management of irrigation systems, and a National Policy on Participatory Irrigation Management and Development has been promulgated.

Preparatory studies for rehabilitation of the Stung Chinit Irrigation scheme (at the North) included appraisal of a number of farmer-managed irrigation systems in villages nearby (GRET, 2001). Summary descriptions of some of these are included here, to represent water management approaches in such circumstances.

The Veal Ampil irrigation system, nominally serves 1,200 to 1,300 ha in 8 villages, and is based on a dyke that diverts water from the perennial Ta Prok River, Kampong Thom province (GRET, 2001). The system makes use of some of the gates and secondary canals constructed under the Khmer Rouge regime (1975-79) for the now largely defunct in the area of Stung Chinit River. Around half the families operate a double rice cultivation system, with one short term and one medium term crop grown during the wet season. The first crop is sown and/or transplanted in mid April to early May, and harvested in late July. The second

crop is transplanted, from nurseries established in May and kept for 2 to 2½ months, during mid to late July, with harvest in late December.

Water management by the farmers appears to be functional, but with difficulties. The Veal Ampil village chief is responsible for system management, with assistance from three other villagers; none receives payment. Veal Ampil village funds most of the maintenance work, which requires around 1 million Riel/year. Funds are collected from villagers, at no fixed rate of fee (contributions range from 500 to 20,000 Riel/year), and villagers also participate voluntarily in maintenance. Other villages contribute little or nothing; as a result (or a cause), system management favours Veal Ampil villagers. However, when villages strongly disagree about water allocation, the commune chief intervenes to negotiate a resolution.

The Oh Svey system is based on a water gate constructed in 1998 on the Ta Prok River, Kampong Thom province (at the North), with funds from the World Food Programme and Social Fund for Cambodia (GRET's report 2001). A committee was established of seven members from the three communes involved, to manage the system. Unfortunately, by 2000 year, the gate was inoperable. Conflict quickly arose between villagers upstream, whose land was flooded by the gate during the wet season, and villagers downstream, who wanted to use the gate and reservoir to protect their land from flooding. The management committee met only once, to discuss water fees.

The Tuk Chhar system is located in Kampong Cham province, and provides supplementary wet season irrigation to a command area of about 3,000 ha. By 2000, total cultivated area was 320 ha. It was successively rehabilitated during 1995-98 by ADB, World Food Programme, and PRASAC. PRASAC (EU) involvement was sought in 1998 because of rapid deterioration of the system during the previous three years. The rehabilitation had been entirely structural, with no input on system and water management by the villagers themselves. GRET (2001, p. 42) observe that "the law of the strongest was prevailing, and villagers damaged water control structures in order to secure water access. There was competition between villages on the four major canals and between farmers on each of the thirty tertiary canals. This competition was materialised by payments in order to get access to water, which led to anger and equipment degradation." Difficulties were particularly evident during the fishing season (November-December) and at transplanting time (May-June).

PRASAC was requested to establish participatory management by a Farmer Water Users Committee, which progressively would take responsibility for management of the re-rehabilitated system. The organization that was developed includes:

- Water User Groups (WUG) for each of the 30 tertiary canals, with an elected leader and deputy.

- A Subsidiary Committee (SC) in each of the four major canals, of which the WUG elected members are members. The SCs elect a chairman and deputy.

- Scheme Management Committee, chosen by the SCs.

Water distribution is the responsibility of PRASAC staff and the farmer representatives; the latter do the job, with monitoring by PRASAC. The intention, according to GRET (2001) was to settle a water fee based on dry season rice cultivation area. Difficulty has been experienced in motivating farmers to get involved in the WUGs, apparently because they regard it as an external project. Farmer representatives also are not highly motivated, because they do not receive compensation. GRET comments, "The point is that Tuk Chhar reservoir (Kampong Cham province) is a difficult place to organize villagers. Some villagers still try to destroy water gate locks at night. There can be some violence, as some of them do not

respect project and local authorities. Another point is that land measurement does not get villagers' cooperation. They see it as a way to establish a fee "

This experience of a lack of cooperation among farmers is repeated in other areas, and appears to be associated with a reaction against the authoritarianism of the last three decades, and a widespread breakdown in trust. It will take time to reverse, and the RGC, NGOs and international organizations are actively promoting cooperation at the local level, particularly through the SEILA programme of community government, and establishment of Farmer Water User Communities.

Land leveling for irrigated agriculture

The Cambodia-Australia-IRRI Project (CIAP) has been developing and testing a farming system that provides an opportunity to diversify food production. It involves remodeling the land by creating paddy and "upland" cropping areas, in association with ditches (channels or canals) and dykes (banks). The ditches can be used as a water source for irrigation; the upland area provides better-drained land that is suitable for non-rice crops.

So far, five trials on areas of 0.3 to 0.5 ha have been considered by CIAP. Rice and a second non-rice crop have been grown on the lowland areas and wide ranges of vegetables, other field crops, and tree fruit crops have been trailed on the upland areas. Fish, duck and geese have been produced in the ditches. A major constraint on production in the trial areas is the infertility of the soils, particularly after land remodeling has brought sub-soils to the surface. This effect of land remodeling is greatest in the first year, and appears to decline in subsequent years. Cash income over a four-year period is three times higher from the diversified system using rice, fruit trees, subsidiary crops and livestock than from the un-remodeled land. Rice contributes only 13% of the total cash income (CIAP, 2000), but grain yields are up to 32% higher on remodeled land.

CIAP also has examined the value of land leveling to improve water control, in association with improved fertilizer application. Fields often are very uneven, due to many years of poor ploughing techniques, with the result that water depths are very variable, weed suppression is less effective, the rice crop is more prone to drought effects, and even drainage cannot be achieved. CIAP has compared rice yields on leveled and non-leveled plots, each of 0.5 ha, in six trials. A fertilizer treatment was included in the trials. Applying the CIAP recommended fertilizer rate alone increased yields by an average 17.5%, while leveling the fields but not applying fertilizer increased yields by an average of 15%. Land leveling and fertilizer application together increased average yield by 33% *(Table 6).* In another trial, of four types of land preparation (animal, 2-wheel tractor, 4-wheel tractor/back blade, 4-wheel tractor/laser leveling), average grain yield on leveled and non-leveled plots were 2.48 and 1.95 t/ha respectively; there were no significant differences in yield associated with land preparation method. In the same trial, weed biomass was significantly less on the leveled than the non-leveled fields, 0.85 and 1.46 t/ha respectively. A further CIAP trial on 19 farms in Battambang and Banteay Meanchey provinces (Northwestern) similarly show a significant increase in yield as a result of land leveling, particularly in association with improved fertilizer treatment.

Table 3.5: Mean yields (t/ha) for fertilized and un-fertilized treatments in land leveling demonstrations

Treatment	Leveled	Non-leveled	Mean yield
Fertilizer	1.99	1.79	1.89
No-fertilizer	1.76	1.46	1.60
Mean yield	1.87	1.62	1.75

Source: CIAP, 2000.

Table 3.6: Mean yields (t/ha) for fertilized and leveled treatments in land leveling demonstrations

Treatment	Leveled, CIAP fertilizer	Leveled, farmer managed	Non-leveled, farmer managed
Mean, 14 Battambang farms	2.83	2.72	2.47
Mean, 5 Banteay Meanchey farms	3.67	2.09	1.78
Mean yield	3.05	2.55	2.29

Source: CIAP, 2000.

3.2.6 Groundwater irrigation

The possibility that groundwater can provide a source of water for agriculture in Cambodia has received considerable discussion. Briese (1996) described the use of groundwater for supplementary irrigation in a number of provinces, as well as reviewing earlier groundwater studies. He reported that, in that year, up to 1,600 privately operated tube wells were being used for supplementary irrigation of rice crops – up to 3 ha per well, in Prey Veng provinces (Southeastern), as well as providing water to newly excavated fish ponds. He also reported that 3,000 treadle pumps were in operation in these two provinces, as a result of promotion by the NGO International Development Enterprises (IDE).

In Prey Kabbas District in Takeo province (Southern part), several hundred farmers had followed the example of a single farmer who in 1995 drilled a 25m depth of tube-well to enable supplementary irrigation of three crops a year. Data assembled by CARDI (Pao Sinath, personal communication, 2002) indicate that by 2001 of 1,140 pumps were being used by farmers in Takeo Province, drawing on over 3,000 open wells and over 300 tube wells (and, presumably, also open ponds).

Briese (1996), suggested that one tube-well could irrigate up to 3 ha (that is, two to three farms), but also observed that farmers generally prefer to work on an individual basis. The importance of having one or a few leaders ("early adopters"), who are copied by others around them, is indicated by the way that groundwater-based irrigation has spread in Takeo province. Most NGO interventions use demonstration farms or work with a few farmers, thereby establishing points from which new ideas can spread. For instance, in Kok Roveang village, Prey Veng province (at the South), an NGO provided one household with a treadle pump for irrigating vegetables in the 1994, dry season. By the end of 1997, after seeing the results, 91 households (78% of the village) had followed suit (Roberts, 1998).

The geology of Mekong lowland consists broadly of alluvial material overlying shale, slate and sandstone bedrock. The low hills and Plateau areas situated above the general level of the plain are generally underlain by igneous intrusion or limestone. The depth of alluvium is 70 m or more. The alluvium consists of sandy silt in the upper part and of clayey silt in the lower. There are occasional sand beds of up 1 m thickness. Two types of alluvium are

recognized, an older one and a younger one. The younger alluvium is situated under the Mekong and Tonle Sap Lake flood Plain. Except for the occasional thin sandy beds and lenses, the alluvium is low hydraulic conductivity and the rate of yield is very low, typically 0.2L/s. Yield from the sandy layer are higher, typically of the order of 1L/s. For those wells that have UNICEF records, almost 76,00 yield more than 3l/s, while less than 3% are reported as having yields in excess of 10 m^3/hr (2.7L/s).

A case study of two villages in Prey Veng province has shown that the introduction of groundwater-based irrigation in this province enables farmers to change their cropping practices significantly (Roberts, 1998). Instead of one wet-season crop using medium- and long-term varieties, farmers are able to grow a first irrigated crop in the dry-wet season transition period (mid-March to harvest in July/August) and a second irrigated crop in the wet-dry season transition period (October to harvest in January-March). Irrigation is used, in effect, to extend the length of the wet season by about three months. A short-term rain-fed crop also is squeezed in between the two irrigated crops by a significant number of farmers. In the study villages, farmers use groundwater on 17% and 41% of their total land area to grow irrigated crops; they spread their risk by growing a variety of rice crops, and also continue to use the traditional rain-fed varieties because they have a have a higher sale price.

There is still uncertainty regarding the extent of aquifers able to provide flows of water adequate for agricultural purposes, as well as concern that unregulated abstraction could over-exploit the resource. RGC (1999) suggested, "Extensive and good shallow aquifers, which span an estimated 4.8 million ha, underlie most of the arable areas of Cambodia." However, more recent experience – unfortunately anecdotal and not supported by formal surveys – indicates that the scope for groundwater-based irrigation might be more limited, and that farmers tend to prefer to develop surface water sources, particularly ponds.

IDE found few problems in obtaining groundwater in the "delta provinces" of Prey Veng, Takeo and Kandal, where aquifers are shallow and recharged by the Mekong system. However, in areas where bedrock is close to the surface or the alluvium is silt or sandy-silt and clay, so that wells yield lesser flow rates, usable groundwater is more difficult to find. More ever, there is anecdotal evidence that use of groundwater has reduced crop yields in some localities, and in extreme cases has harmed soil chemistry and structure. This is said to have been because of high concentrations of iron, salt, and other solutes in groundwater drawn from deltaic sediments or sourced from the Elephant Mountains, although data on the quality of groundwater give little reason to think that this is a significant factor.

Briese (1996) concluded, in summary, that farmers are very willing to install tube well/pump systems for irrigation, particularly if they have their own system and complete control over their own water supply. A number of NGOs and IOs have been promoting the use of groundwater, particularly through the establishment of demonstration farms, with individual farmers obtaining their own systems from private sector suppliers (well drillers, pump suppliers) when convinced. Briese suggested, however, that the Government has an essential role in defining the true extent of groundwater reserves that have adequate water quantity and quality, as well as in helping farmers to adopt new methods, inter alias by provision of credit to purchase the equipment.

3.2.7 Social and economic issues

A variety of land and water management for irrigation methods are in use by government and water user community, both at their own initiative and with the active facilitation or assistance of NGOs. A number of organizations have been carrying out researches to develop and testing some of these methods.

The principal method of water control is by the construction of bunds around the rice fields to provide the depth of water required for crop water management and weed control. There is a close relationship between the rice varieties used, field level and water depth, and soil type.

In many localities, farmers grow other crops such as vegetables, sugar palm, and various fruit. Livestock rising generally is important, with most farmers raising chickens, pigs and ducks for consumption and sale, and oxen or buffalo for draught power. For non-rice crops, a large variety of cropping systems are used, some of which involve supplementary irrigation. (Apart from vegetables, very small areas of non-rice crops are fully irrigated). For instance, maize is grown under rain-fed conditions along river floodplains, where the soil receives an annual replenishment of silt, to maintain fertility. The crop is planted at the beginning of the wet season rains, and harvested prior to the floods in September.

In the Tonle Bati area, of the total 6,900 ha of the study area, 5,100 ha (74%) are under rain-fed wet season rice. Average farm size is 1.3 ha. Farmers concentrate on rice production to attain self-sufficiency in food, and because rice cultivation is still the most reliable industry in the area. Nevertheless, most fields have no stable irrigation water supply and proper drainage. Farmers grow other crops like maize, cassava, sweet potatoes, vegetables, but the area is small – about 50 ha – in comparison with the areas allocated for rice. Bananas, coconuts, mango, guava etc are grown as home garden crops. Sugar palm harvesting is particularly significant to the local economy, with the trees generally grown along the field bunds. Livestock rising also is very important, and fishing, based entirely on capture of natural stocks, also is common.

Table 3.7: Key productions in Tonle Bati District

Items	Total	Value* (Million Riel)	Value (%)
Paddy (t)	6,570	2,628	70
Palm sugar (t)	190	152	4
Cattle (head)	1,430	372	10
Pig (head)	6,200	496	13
Poultry (head)	41,250	124	3
Total		3,772	100

Source: Nippon Koei, 1995
(*) Value in 1993 currency

The yield of rice is very low, generally in the range between 1.2 and 1.5 t/ha depending on varieties, rate of fertilizer application, year-to-year variations in growing conditions, soil types. Over 2.5 t/ha usually is obtained for fully irrigated rice during the dry season.

Table 3.8: Rice cropping in Tonle Bati district, Prek Thnot river basin

Season	Area (ha)	Production (t)
Early (transplanted May, harvested Aug-Sep, duration 110 days)	300	360
Medium (transplanted June, harvested Nov-Dec, duration 120-150 d)	4,100	4,920
Late (sown June-July, harvested Dec-Feb; duration 150-180d)	1,000	1,200
Dry Season	30	90
Total	5,430	6,570

Sources: Nippon Koei, 1995

3.2.8 Environmental impacts of irrigation

The environmental impacts resulting from the development of irrigation systems are as following:

- Effects of changes in water flow patterns and quantities resulting from the construction of reservoirs and dams;
- Effects of changes in water quality due to the over excessive pesticide and fertilizer uses;
- Changes in habitat resulting from the draining of wetlands or creation of reservoirs; and
- Salinity problems because of excessive irrigation in the dry season.

It has been indicated that the environmental impacts resulting from the development of irrigation systems in Cambodia are relatively small as many of the potential programs/projects involved have been made only for the existing irrigation schemes.

3.2.9 Institutional factors affecting irrigated agriculture

At present, many farmers are adopting methods of water delivery that rely on cheap portable pumps, drawing water from perennial watercourses and lakes, groundwater, or dug ponds. The RGC's strategy is to encourage such developments, because it provides rapid and affordable means of improving water control at the scale of the individual farm. On the other hand, there is a serious risk that uncoordinated exploitation of water resources may lead in a short time to degradation of the resource, and to conflict among users.

A draft Law on Water Resources Management, which is a basis tool for regulating use of water, is presently passing through the legislative body. However, the enforcement of this law, once it is passed, will be a major exercise. The responsible agency, the MOWRAM, is presently not well prepared for this task; as a result, institutional capacity building needs to be considered.

The followings are the classification of irrigation scales:

> *Small scale irrigation* (service area <200 ha): the system is managed by the District Office of Water Resources and Meteorology (WRAM), or by the Provincial Department of WRAM, if in more than one district; it is operated and maintained by the beneficiaries, under WRAM supervision.
>
> *Medium scale irrigation* (service area 200ha - 5,000 ha): the system is managed by the Provincial Department of WRAM, or by the MOWRAM if in more than one province. It is maintained by the Provincial Department of WRAM in cooperation with users, and is repaired by MOWRAM.
>
> *Large scale irrigation* (>5,000 ha): the system is managed and maintained by Ministry of Water Resources and Meteorology.

The RGC recognizes the need for farmers to be involved in irrigation system operation and maintenance in order to ensure the long-term sustainability of systems. FWUC is responsible for operating and maintaining agricultural water supply facilities and managing the supply of water, in compliance with Circular No. 1 of the RGC on the Implementation Policy for

Sustainable Irrigation Systems. The Circular and associated draft Irrigation Policy provide, inter alias, for FWUC constitutions, water service fees, and allocation of responsibilities and duties. About 100 FWUCs now exist in 14 provinces, covering 84,000 ha; and they are being extended as resources permit, particularly in the context of rehabilitation of irrigation systems.

To address the irrigated agriculture issues, the RGC has developed the following strategies and policies:

- To provide farmers with the quantity of water they need, when and where they need it, at a cost they and the wider community can afford, and within the limits of available water resources, technology, and financial resources for investment.

- To promote, where justifiable on economic or social grounds, the rehabilitation and construction of irrigation, drainage, and flood management infrastructure, in order to provide sufficient water for agricultural production and to alleviate the adverse consequences of excess water.

- To promote the development and extension of water management technologies that are particularly suited to rain-fed agricultural areas, such as water harvesting, improvements to the moisture-holding capacities of soils, use of farm ponds, and sustainable extraction from groundwater.

- To strengthen and expand Farmer Water User Communities, to enable them to participate in water management and allocation and to maintain irrigation infrastructure with effectiveness and sustainability.

3.3 Fisheries

3.3.1 Introduction

The seasonal dynamic of the reverse flow of Mekong River water into the Great Lake Tonle Sap via the Tonle Sap River has built up a critical inland wetland in Cambodia, with unique features in terms of ecological diversity and genetic population diversity.

The natural resources of the Tonle Sap Lake and Mekong River have proved to be essential resource for million of people. The official statistics put the number of fisher folk to about 1- 2 percent of the labor forces. The sector gives employment direct or associated activities to over 2 million Cambodians. Of this amount 9.3 percent indicated fishing as their primary occupation, 20.3 percent as their secondary occupation, and 6.3 percent as their tertiary occupation (Ahmed, 1997).

Inland fisheries produce an estimated 200, 000 to 430, 000 tones fish each year with a value up to US$ 500 million, of which about 14 percent comes from fishing lots, 4 percent from dais, 26 percent from medium scale fisheries, 35 percent comes from household fishing, and 21 percent from rice field fisheries. Cambodia's freshwater capture fisheries production of over 400, 000 tones per year is the fourth largest in the world after the People Republic of China, India, and Bangladesh.

Fishing is a vitally important issue for millions of people across Cambodia; action is needed to make sure that resources based will continue to provide food and livelihood for generation of Cambodia to come. Fish the main sources of protein and calories for

Cambodian people over 75% of animal protein consumed comes from fish and Nation-wide fish consumption range from 40- 70 kilograms per person per year.

Because of its biodiversity, economic, and cultural values, for the last 20 years the inland fishery has been characterized by breaking inequity, at time violence of resources distribution accelerating environmental degradation from unsustainable patterns of exploitation and an escalating level of conflict between stakeholders, inequity of access rights, growing population pressure, sever poverty, insufficient or nonexistent right to land tenure, and ethnic difference place the lack's ecosystem and the people who depend upon them at risk. As results, there is already evidence that certain fish stocks and species are in serious decline. Due to the poor management of fisheries sector, under resourced enforcement and implementation of existing laws have allowed illegal activities to proliferate.

The reformed fishing lots system in October 2000 holds hope for the future and is continuing for the management and administration of the natural resources are being developed. There is a general trend towards engaging local communities to manage and stewardship of the resources reflected to social and economic needed. The RGC has taken steps to alleviated hardships of the rural poor. However, problems a risk in recent years have been about the implementation of the policies as much as the policies themselves.

3.3.2 The importance of fisheries

Fish and food security

The overall contribution that Freshwater Fisheries and rice form the backbone of Cambodia's food security, most significantly a young growing population among rural households that comprised almost 90% of the country's poor.

Cambodian people in the rural areas rely very much on fisheries for their subsistence. Fish provide from 40- 60% of animal protein intake for people in the rural areas – even those who are living far from water. In the areas closed to the Great Lake, along the rivers and flooded areas, fish provides 70-75% of animal protein intake. An average of 67 Kg of fish is consumed per person/annum, compared to a national average of 151 kg of rice per annum.

The Tonle Sap alone provides around 60% of the commercial fisheries production. Estimate around 90% of Cambodia's total population live within the Mekong River catchments. Nation- wide, approximately 36% of the population lives below the poverty line, despite the vast natural wealth of the Tonle Sap Lake is classed as the poorest region with 38% of the population living below the poverty line.

The value of the fisheries to the economy

The Tonle Sap of Cambodia is a vast wetland, connected to the mainstream of the Mekong River by the Tonle Sap River, and covering 1.8 million hectares (30% of Cambodia's surface area), comprise the rivers and lakes, flooded forests, grasslands, rice fields, and swamps.

Inland Fisheries produce the estimate 290,000 to 430,000 tones annually, with a value at landing of between US$ 150 million and US$ 250 million (Vanzalinge et al, 1999) and retail value of up to US$ 500 million. The sector contributes as mush as 8-10% of Cambodia's GDP. Accurate export figures are unavailable. Freshwater fisheries collected less than US$ 3 million in fee from the fishing lots, in the year 2000.

Livelihoods and food security

The majority of Cambodian population (85 percent) living in rural areas is heavily relied upon natural resources for their livelihoods, the majority of the population, dependent mostly on agriculture including fisheries, forestry and livestock.

Fishing provides protein sources and supplementary income to ensure that families can derive sufficient income to purchase rice during the period of food shortages (shortages of rice production). Fishing also provides vital supplementary income for the Cambodian's poor, funds derived from fishing are used to purchase medicine or/and for other purposes.

Fishing could provide primary or secondary employment to more than 40% of the 2.4 million people living in eight central provinces alone. Fishing is the predominant activities. An estimate 88% of people in 170 villages around the flooded forest relies on fishing or related activities (Thouk & Sina, 1997). Employment and associated activities such as fish processing, comprised a substantial component of rural employment.

Recently, the Cambodia population is estimated at 12.2 million and is expected to be 15 million by 2010. Within the annual population growth of 2.2%, the increase of population around the Tonle Sap is highest in the country. For instance, in Battambang province, the population increased approximately 33% over the four years from 1994 to 1998. This in turn is creating new challenges for fisheries management.

3.3.3 Ecology

Wetland ecosystems

The Tonle Sap Lake, which expands to cover up to 16, 000 km^2 in the monsoon season, is of great significance to the Cambodian people, and is often described as forming the heart of the country's culture and economy. The Lake is also considered as one of the most extraordinary ecosystems.

The total wetland areas increase nearly ten folds from about 0.5 million ha in the dry season to 5 million ha in wet season in an average year. The total wetland in an average year represents nearly 28% of the total Cambodia's land area (Noelle O'Brien, 1999). This unique wetland ecosystem is driven by the annual cycle of inundation and drying of the Lake basin and its surrounding floodplain, when the direction of flow of the Tonle Sap River reverses each year. The system supports divers' habitats, particularly within the flooded zone, a highly productive fisheries and unique biodiversity.

Many communities in Cambodia depend on wetlands for their livelihoods. The seasonal rhythms of the Mekong mean that the rivers, lakes and floodplains are incredibly rich in natural resources. This river basin is an enormously complex and dynamic web of species and interacting environmental influences-linkages that are vital for the processes of life and generation that make it such a productive capture fisheries.

The maintaining of wetlands and functioning of ecosystem are important approach for the development, management and conservation of wetlands. If seriously consequences of wetland transformation, resulting losses, not only the productive capacity of the ecosystem and fisheries, but also the well being of human communities. Future management has to protect the hold eco-system if it is to safeguard the long - term interests of Cambodia's rural population.

Flooded forests

The flooded forests actually consist of a diver array of habitats including shrub lands, stunted swamp forests, gallery forests, submerged and flooding aquatic vegetation and reed beds.

About 200 plants species have been recorded, and the flora as a whole is distinct from other wetland associated with the Mekong River. Many plant species are endemic to the Mekong river basin. The size of the Tonle Sap's floodplain swamp forest – almost 400, 0000 hectares, generally surround by a broad belt of some 20 –30 km wide (Noelle O'Brien,). Moreover in Battambang the belt extends up to 65 km. The Mekong River and Tonle Sap with their associated floodplains sustains large and varied ranges of aquatic biota such as dolphin, otters, fishing cats, freshwater turtles, tortoises, crocodiles and a wide range of water birds. This means that it is of national and basin wide importance as a feeding and spawning area for both migratory and non-migratory fish.

Because flooded forests are play as breeding and spawning grounds for a number of fish species, their destruction also drastically reduces the number of fish species. The destruction of flooded forest has been occurred such as drainage and conversion to other purposes for agriculture encroachment and development, fishpond, siltation and so on.

Wetlands biodiversity

It is estimated that 500 fish species have been record in the Cambodia part of the Mekong River basin, and at least 200 species occur in the Tonle Sap (Rinboth, 1996). The main groups are cyprinids (48 species), Pangasidae (7 species), Bagridae (5 species), and Siluridae (5 species). At lease 7 fish species of global significance have been recorded, including the royal feedback *Chitala blanci,* leaping barb *Chela caeruleostigmata,* Mekong Fresh Water stingray *Dasyatis loasensis*, largetooth sawfish *pristis micodon*, Mekong giant catch fish *pangasianodon gigas*, Laotian shad *Tenualosa thibaudeaui* and julien's golden price carp *probarbus jullieni*.

A total of 42 reptile species has been recorded at the Tonle Sap, including one species of endemic water snake-the Tonle Sap water snake Enhydris longicauda- seven turtles and a crocodile. 19 species of global significance are found, including two critically-endangered (IUCN red list) species – river terrapin Batagur and Siames crocodile *Crocodylus Siamemsis* and three listed as endangered (IUCN red list)- yellow-headed temple turtle *Hieremys annadaelei*, elongated tortoise *Indotestudo elongata* and Cantor's giant softshell *Pelochelys cantorii*.

Some 225 bird species have been recorded in the Tonle Sap area (especially, the Prek Toal and Boeng Chhmar core area) since the 1960s, of which 45% - mainly large species has also been recorded in recent years. Tonle Sap floodplain is the predominant dry season breeding and feeding areas for many species, especially larger species such as ducks, jacanas, cranes, bustards, rails, herons, egrets, cormorants, darters, ibises, pelicans, and storks. Twenty-four species of global significance occur, including two critically- endangered species – white-shouldered ibis *Pseudibis davisoni* and giant ibis *Pseudisbis gigantean*- and three listed as endangered (IUCN red list) white winged wood duck *Cairina scutulata*, Bengal florican *Houbaropsis bengalensis* and greater adjutant *Leptoptilos dubius* (IUCN red list).

Although key species such as Asiatic elephant and tiger have disappeared during the pass decades, at least 15 mammal species have been recorded in the Tonle Sap Lake and floodplain during recent years, including 10 species of global significance. These include the Indochinese hog deer *Axis porcinus annamiticus*, Asiatic jackal *Canis aureus*, hairy-nosed otter *Lutra sumatrana*, smooth otter *Lutrogale perspicillata*, long-tailed macaque *Macaca*

fascicularis, Irrawaddy dolphin *Orcaella brevirostris*, fishing cat *Prionailurus viverrinus*, Lyle's flying fox *Pteropus lylei*, large flying fox *Pteropus vampyrus* and silvered langur *Semnopithecus cristatus*.

The continued survival of freshwater dolphins, globally endangered water birds, and rare turtle species are testament to the importance of Cambodia as a last refuge for many of the wetland species of Southeast Asia. Today, Cambodia is still an oasis of biodiversity in a region where wildlife has too often been crushed in the path of the destructive pressures of poorly managed human development. In addition, the Lower Mekong Basin is considered a biodiversity hotspot for molluscs, with 160 species of which 72% is endemic to the Mekong.

3.3.4 Environmental issues

Internal trans-boundary

The fisheries sector has been affected by continually increasing pressure from agricultural encroachment and development, deforestation, over exploitation of the fisheries resources, hunting and collecting of wildlife and other resources. Pressured on the living resources, especially in the Tonle Sap region is already intense to the point were some stocks are in danger.

Over the last decade, rapid human population and the associate development pressures and high demands for natural resources have results in significant ecological change in the system include, changes in water quality and hydrology, loss and degradation of flooded forests and other habitats. Decrease in fisheries resources and fish diversity, and declined in wildlife resources have led to the decline in habitat integrity and plant diversity and the loss of fauna species diversity.

The major threats driving this change are associated with:

Water Pollution and nitrification: Increasing levels of water pollution and nitrification are resulting in changes to the water quality and hydrology of the system. Especially, in Tonle Sap Lake, increase algal blooms and higher sedimentation rate are occurring.

Siltation and erratic runoff: Patterns of siltation and runoff within the Tonle Sap sub-catchment and the Mekong River basin as a whole are also changing, resulting change to hydrology and water quality. Specifically, higher levels of runoff, increased siltation, higher flood peaks and erratic flooding events are being observed. There are some factor behind these changes, include:

- Deforestation of upland areas as part of the logging process;
- Land clearance and agricultural practices in the sub-catchment;
- Mining practices;
- Construction of small scale dam and barrages; and
- Increased water extraction for irrigation.

Over-exploitation of Forest resources: Particularly, increasing around Tonle Sap is leading to widespread loss and degradation of the flooded forests, and to lesser extent, other habitats, includes the loss of mature trees and in particular the tall gallery forests as well as the loss of areas of regenerating forest. Up to 97% of households in Cambodia use fuel wood and charcoal as their main sources of energy. Moreover, the need for construction materials for houses and fishing gears, such as poles and fish traps.

Encroachment and land clearance: Encroachment and land clearance of flooded forest during dry season are increasing, due to increasing demand for agricultural land has led to high conversion pressures, where soils are suitable and the flooding regime is not too severe some areas be cleared and burn annually for dry season vegetation. Dry season burning, is also more or less traditional activity for hunting of reptiles. On the other hand, large- scale seasonal movements by migrants into system during dry season are increasing. Due to the lack of livelihood and resources available in the uplands. Few examples and incentives for managing resources sustainably exist at present.

Over-exploitation of fisheries resources: Annual catch levels have remained fairly constants, it is evident high levels of exploitation have led to a decrease in numbers; species and relative reduce in fish size of the fish being caught. Species such as the Mekong Giant catfish are also caught and the impact of this catch on the remaining populations, although known, is to be negative. Very intensive fishing pressure through the system:

- Within the fishing lot system: cover most of the fishing areas, promote maximum harvest and offered few incentives to ensure sustainability of the resources;
- By fishing villages: villagers are traditionally fishermen, there are few other livelihoods outside the fisheries sector;
- By seasonal fishers: the open access transient migrant moves to the lake for fish. Results often in direct competition with residents for access to areas outside fishing lots and often use illegal fishing techniques;
- On an industrial scale: extensive traps inside fishing lot and illegal trawling out side the lots;
- Poaching within fish sanctuaries: Eight sanctuaries have been established around the Tonle Sap but there is a widespread poaching through out this areas;
- Closed season fishing through out the Tonle Sap: fishing during this period almost certainly has knock on effects to fish recruitment rates in the following season; and
- Widespread used of illegal fishing techniques: particularly those that are quick and efficient and ensure fast economic returns.

Exotic species impacting on native flora and fauna: Although the impact is not well understood, these are includes:

- Escape of exotic fauna, which usually result from farming or culture operation; and
- Uncontrolled and unmonitored spread of exotic flora, particular the giant mimosa (*Mimosa pigra*) and water hyacinth (*Eichhornia crassipes*).

Over exploitation of wildlife resources: Over exploitation of wildlife resources is having a direct negative impact on many wildlife species, especially rarer birds, reptiles and mammals. This is leading to population declines and contributing to the loss of biodiversity. The factors contribute to this are uncontrolled hunting and collection of wildlife for food and trade. A more tangible and large-scale threat to biodiversity is the systematic hunting and collection of wildlife for local, national and international trade. In particular, many species of birds and reptiles are targeted. There is no wildlife protection in Cambodia.

External trans-boundary

According to WWF International each of the water resources development project proposed for the Mekong River Basin has the potential to damage the ecology of both river and forest ecosystems, with most of the benefits accruing to people outside of the basin a very different population from the Mekong communities who will bear the brunt of the costs. Dam and water resources projects can be a severe impact on flooding, water quality, navigation and food production in down stream countries and can affect the fisheries by preventing fish migrations. Declining in fish productivity of Cambodia's rivers and lakes will impact on basin wide, since the high productivity of the Mekong River system relies on dynamic seasonal and spatial variations – monsoon water flooding the forest and floodplains, retreating and than flooding again. On the other hand, the long distance migrant species move between Cambodia, Vietnam, Lao PDR and even China.

3.3.5 Inland fisheries management

The Department of Fisheries is responsible for the management of actual day-to-day management of the fisheries *per se* is leased out to fishing lot operators who control operations within each lot and sub-lease out to other operators. The Department of fisheries works primarily on the inspection and enforcement of the system through provincial fisheries office and at the national level, a Tonle Sap Inspection unit, various fishery Research Units and an exploitation office. The Inland fisheries management is divided into 3 categories:

- Large scale, commercial fishing - the fishing lots;
- Licensed or middle scale fishery;
- Small-scale subsistence or family fishery

Large scale, commercial fishing- the fishing lots

The most productive part of the Cambodian inland fisheries domain has been privatized for more than a century through a system of Government leases, the "fishing lots". In the recent past the lots system provided annually over US$ 2 million in tax revenues. The production of the commercial fisheries notified from 1980 until 1998 has annually fluctuated between 55, 000 and 72, 000 tones (Tana, 2003).

The commercial inland fisheries are one of the big industries in Cambodia in term of employment and production. Fishing lots are operated under two-years concessions gained via a public auction. The auction grant private lots owner exclusive rights over a particular fishing ground for large scale fishing gears. The lot owner also charged with the task of protecting the natural habitat within the lot boundaries.

According to a paper by Touch Seang Tana, 2003, there are three type of fishing lots:

- Lacustrine fishing lot: implies that the fishing ground is located at the Great Lake margin, distinguished by two types of activities:
    - Arrow-shaped production, with bamboo fencing which extends several kilometers inland from the inundated forest margin; and
    - During late March and April, when the water of the lake subsides to its lowest level, the bamboo fence installation is gradually reduced in areas, following net dragging, until a 1 or 2 hectare is formed.

- "Riverine- lacustrine fishing lot" refers to complex fishing grounds consisting of natural lakes, inundated forest, and floodplain that connected to a main streams or canals. There are two types of harvesting:
    - Fishing Barrage: used to catch retreating fish from the floodplain and inundated forest during October to February; and
    - Seine nets: operated in streams, canals, and lakes during April to May. Very commonly, even though prohibited by the fisheries law.

- "Riverine fishing lot" implies fishing ground where collection is undertaken in rivers and stream. There are four types:
    - Bag net lots, which are usually located downstream of the great Lake in the Tonle Sap River;
    - Prawn bag net lot in the Tonle Touch River of Prey Veng Province;
    - River lots: in which one or more river branches are demarcated for fishing operation; and
    - Sandy river beach lots: in which sandy beach exposed along the Mekong River. The operations take place starting in December or January and ending in May.

In line with the massive overhaul of fisheries legislation, the Department of Fisheries is itself undergoing administrative reform in late 2000 and restructuring. Part of this process has been the recent establishment of Community Fisheries and Socio-economic Office with responsibility for community fisheries extension efforts. To date it is reported that 170 areas have been developed as community and that another remaining 100 sites are targeted for development in the near future. At the mean while, the process is largely new to the Department, and the actual effectiveness of these schemes is yet to be determined. Due to the lack of human resources, partnership and fun, the organizing process of the community will take a little bit more time.

Middle-scale fishery

Open access fisheries have grown strongly in the past two decades and have contributed to the recent increase in fishing pressure. Middle Scale fishing gears (such as gillnets, seines, and arrow-shaped traps, giant push net, etc.) originally operated under a system of licensing.

Prior a 2001 change in policy, fees were formerly assessed annually according to type and size of the gear. The provincial fisheries office whose is issues and decided the criteria for obtaining a license. There were no limits to the number of licenses, to be considered as a management tool to manage the resources.

The Mekong systems are the places that are rich of biodiversity, particularly fish species. However, only less than 100 species have been caught and recorded around the Tonle Sap Lake by large and medium scales fishing gears. It has been stated that there were approximately 280 fish species gain access to the productive floodplain, which huge quantities of fish migrate from the main rivers and floodplains of Mekong River system (Nao *et al.,* 1996).

Small-scale fishery

Small-scale fisheries is fully opened-access and it is not required a license, and everybody uses smaller gears than the middle-scale fisheries. It can be operated in floodplain areas, in fishing lots during the closed season and in rice fields during rainy season.

Small-scale fisheries production excluded small-scale aquaculture production due to insufficient data for estimation, ranges from 165,000 to 215,000 tones annually. This represents from around 50 to 57 per cent of annual inland water catch in Cambodia. This shows an implication that significantly, the family-scale or subsistence-fishing component of the total inland fisheries catch is considered to be as important as the commercial component, in terms of production and distribution (Degen et al., 2000, Shams and Ahmed, 1998; Thuok and Sina, 1997; van Zalinge).

As mentioned above, small-scale fisheries resources contribute significantly to rural poor people in terms of protein sources and income generation. However, such importance of small-scale fisheries resources was overlooked and underestimated by central government and local authorities and even other institutions. The past government policy toward commercial fishing lot auction and agricultural production orientation had produced negative impacts on people-dependent on aquatic resources. The intensification and expansion of lot boundary and pressure exerted by lot owners and operators have affected increasing numbers of small-scale fishers in the local communities (Thay, 2001).

3.3.6 Fisheries sector trends

Conflict is predicated on competing claims over the Fisheries sector. According to the evolving needs of the society and natural environmental changes with the population increase, the supply from the natural resources are not enough to meet the demand of human needs. Consequently, from day to day, the natural resources have been heavily threatened and the conflicts quite often occur everywhere among user groups of natural resources. Natural resources have been consequently destroyed and the people are still poor. The long tem goal should be sustainable management and conservation of natural resources and its biodiversity. To achieve the above goal and to avoid the negative issues, the Department of Fisheries strongly determined the following strategies to implement:

Community fisheries

The unsuccessful use of methods based only on legal procedures to preserve natural resources has led to increased conflicts between family fishing and fishing lot owners and between families fishing themselves. As a result, for subsistence the poor fishing family have no way, but to use illegal fishing activities and gradually fisheries resources have been damaged.

56% of the total fishing lots were abolished in late 2000, and turned over to communities fishing to do family-scale fishing. Fishing lot reform is to ensure sustainable use of natural resources and improve the standard of living for rural poor people.

The Department of Fisheries has organized the release of areas from the fishing lots to establishment of community fisheries. The system of fisheries management has changed from state alone to co-management. In this new system the state has empowered the local people, and people are encouraged to participate in the management of conservation activities in order to ensure better use of the natural resources. This will provide a good opportunity for the local people, for employment, and income generation. Moreover, the RGC has stopped collecting hiring fee from the middle scale of fishing gears. Therefore, the fishermen are pleased to be able to increase their income.

However, the management and governance in fisheries require strengthening. The capacity of the fisheries sector should be built up not only through formal training sessions but also exposure to successful experiences in similar countries and also encouraging them to learn

from local community experience. Participatory mechanisms for monitoring, enforcement and equitable to sustainable use may also be established.

Actions to control destructive practices and phenomena should also be considered. Undesirable practices include illegal fishing, use of destructive and inappropriate fishing methods and equipment, improper and excessive use of highly toxic pesticides.

A careful review of fisheries trade is also launched by MAFF. Policies should be formulated that balance incomes of fishermen against sustainability of resources and local food requirements.

Aquaculture development

Fish supplies from nature are not enough to meet the demands of the people due to population increase, esp. who is living far from water bodies. To supplement these needs, the Department of Fisheries has identified the possibility of small-scale aquaculture development in rural areas through the coordination with financial support from FAO and many NGOs including AIT, MRC/DANIDA, PADEK and SAO. The Department of Fisheries has provided extension service and training to farmers about fishpond cultures, as well as rice-fish culture in some provinces such as Kandal, Prey Veng, Svay Rieng and Takeo province. The Department of Fisheries is pursuing assistance from the World Food Program to provide labor food to farmers to make ponds for small-scale aquaculture. Moreover, Department of Fisheries will increase small-scale aquaculture to cover other provinces.

Pond culture and rice-fish culture play important roles in providing food security and increasing their income to provide standard of living. However, besides rice farming, farmers are able to have secondary occupation in small-scale aquaculture so that farmers can get both rice and fish.

3.3.7 Fisheries conflicts and resolution

The past government policy toward commercial fishing lot auction and agricultural production orientation had produced negative impacts on people-dependent on aquatic resources. Conflict is predicated on competing claims over the fisheries resources, which is arisen from commercial interest, a rapid growing subsistence population, illegal fishing, and demands for agricultural land, water, and firewood. The intensification and expansion of lot boundary and pressure exerted by lot owners and operators have affected increasing numbers of small-scale fishers in the local communities (Thay, 2001). Gregory and Guttman (1999, cited in Gum 2000) raised concern about much effort by the Royal Government of Cambodia and development agencies to increase rice production with little appreciation of the importance of rice-field fisheries resources that are significantly utilized by rice farming families.

In consideration of how the above issues were affecting the poor people's livelihood, the government was prompted to make fast reform of fisheries management. The reform entails the reshuffle of the high level administration of the Fisheries Department and the transitional withdrawal of provincial fisheries inspection stations in all fishing lots throughout the country. Moreover, the request of local fishers to reclaim their territory for public fishing areas was partly met by returning parts or the whole fishing lots to the local communities.

The challenges for government (MAFF), Department of Fisheries, Provincial Fisheries, NGOs, IOs, local authorities, police/military and especially fishermen are to manage,

develop, use and conserve the released fishing areas from fishing lots in a sustainable manner. The concepts of community fisheries or fisheries co-management have been introduced recently.

3.4 Hydropower

3.4.1 The state of hydropower development in Cambodia

Cambodia is one of the south-east Asian country rich in water resources. According to the latest preliminary study, the total hydropower potential of the country is estimated at 10,000 MW, of which 50% in the Mekong mainstream, 40% in its tributaries and remaining 10% in the south-western coastal area outside the Mekong River Basin. In addition to the Mekong River, some 25 major tributaries and hundred of small rivers are flowing through the country. There are about 60 possible sites of small to large hydropower Projects in whole country.

Cambodia's future electricity demand (forecast done by EDC in 1998) is from 273MW and 1036 GWh in year 2004 to 991 MW and 3488.4 GWh in year 2020. Due to the increase in demand not be satisfied by the existing power system. In particular the most urgent action lies in the upgrade of existing power plants and system. This is considered critical, as a continued shortage in the electricity supply will seriously restrain the ongoing reconstruction and socio-economic development of the country.

Cambodia needs to use its hydropower potential to meet future electricity demand and to reduce its dependence on imported fuel and for the power trade with neighboring countries.

The classification of hydropower plants in regard to their size has generally been referred to a large, medium and small hydropower plant. Since there are no definite international values as to what they really refer to, and for the sake of proper understanding in this proposal the following are designated [by Hydro-Electricity Department of the Ministry of Industry, Mines and Energy (MIME)] by the rated installed capacities of hydropower plants as shown in Table 3.9.

Table 3.9: Classification of hydropower plants

Type of HPP		Installed Capacity (kW)
	- Micro	Up to 500
Small:	- Mini	501 – 5,000
	- Small	5,001 – 10,000
Medium		10,001 – 50,000
Large		More than 50,000

Hydropower generation

Evaluation of potential hydropower schemes in Cambodia has generally concentrated on schemes identified studied and constructed before 1970: Kirirom I (10MW) and Prek Thnot (18MW). Recent initiatives in hydropower generation are as follows: (i) The installation of a 1MW Mini-hydropower plant in Ratanakiri Province; (ii) The rehabilitation of Kirirom I Hydropower plant; (iii) The completion of a feasibility study of the Kamchay Hydropower

scheme by Experco International; and (iv) Two preliminary ranking studies for the Mekong River Secretariat (Lower Sre Pok II and Lower Se San II).

Recently, Cambodia has two hydropower stations:

– Chum II Hydropower Plant (1MW) in the north-east of Ratanakiri province, built in 1991 and was commissioned since 1993.

– The original Kirirom I Hydropower plant (10MW) was built with Yugoslavian technical and financial assistance commissioned in February 1968 and ceased operation due to the war in November 1970. It was linked to Phnom Penh by 120 km long, with 110 KV transmission line.

Currently, the Royal Government of Cambodia (RGC) has granted to the private company from China (CETIC) to rehabilitate with installed capacity 12 MW and to build 115 kV transmission line. It was commissioned since May 2002.

Hydropower potential

Cambodia is rich of water resources for sustainable development of hydropower projects. 86% of Cambodia lies within the Catchment of the Mekong Basin. With the drainage area of 810,000 sq. km and the total length of 4,425 km, the main annual discharge entering Cambodia is in excess of 400 billion m^3, and it is estimated that with the contribution of downstream tributaries, some 500 billion m^3 are discharge to the sea annually.

The assessment of water resources for hydropower development in the Kingdom of Cambodia indicated that Cambodia has an abundant hydropower potential. The technical hydropower potential is about 4,347MW (or 7,182MW if Sambor HPP = 3,300MW), which the Mekong mainstream 1,445MW (or 4,280MW), Mekong Tributaries 1,908MW, outside Mekong Basin 994MW. The list of Priority Hydro Power illustrates in Table 3.10.

Table 3.10: List of priority hydropower projects

No	Name	Installed capacity (MW)	Annual production (GWh/yr.)	Expected years of commission
1	Kirirom III *	13	70	2006
2	Battambang III	13	76	2008
3	Kamchay *	180	558	2010
4	Battambang II	36	187	2010
5	Battambang I	24	120	2010
6	Stung Tatay *	80	426	2010
7	Stung Atay *	110	588	2012
8	Middle Stung Russey Chrum *	125	668	2015
9	Lower Stung Russey Chrum *	125	656	2015
10	Upper Stung Russey Chrum *	32	211	2015
11	Stung Chay Areng *	260	1,358	2015
12	Sambor	467 or 3,300	2,800 or 14,870	2016
13	Lower Sre Pok II	222	1,174	2018
14	Power Se san II	207	1,065	2018

Power demand forecast

Peak power demand in Cambodia reached 542 GWh in energy production and 150 MW in generation capacity in 2001. Increase of the power demand is influenced by the increase of population, GDP, etc. Peak time in the daily load curve is observed at around 19-22 p.m.

According to the Cambodia Power Sector Strategy, it is estimated that the demand will increase up to 991 MW and the generated power will be 3488.4 GWh in 2020, with average annual growth rates of 12% and 9.4% respectively.

The majority of this growth will occur in the Phnom Penh. This increase in demand cannot be satisfied by the existing power system. This is considered critical, as continued shortage in the power supply, which will seriously restrain the ongoing reconstruction and socio-economic development of the country. The need for Cambodia will be to find the energy sources in order to meet future power demand and reduce its dependence upon imported fuel oil and to exchange of electricity with neighboring countries. The Table bellow depicts the expected power and energy output for Cambodia.

Table 3.11: Power demand forecast for Cambodia

Year	2004	2006	2008	2010	2012	2014	2016	2018	2020
Power, MW	273	331	404	477	558	651	746	860	991
Energy production, GWh	1036	1215	1454	1700	1968	2292	2634	2915	3488

Existing power generation

Present electricity supplies comprise 24 small isolated power systems and there is no National Power Grid. By far the largest power system and consumer is in Phnom Penh. About 1/3 of the total fuel-oil imported into Cambodia is used for generating power. Electricity cost is very high in the region and varies from 9-30 US Cents per kWh. The total installed capacity for the entire country is about 160 MW, of which 112 MW is used in Phnom Penh. In Phnom Penh, EDC owned 50MW installed capacity, 12 MW from hydropower generation Kirirom I and the other 50MW are owned by Independent Power Producers (IPP), one CUPL from Malaysia (35MW) and another one Jupiter Power from Canada (15MW). The total installed capacity for provincial capitals are estimated 48MW, include 1MW from hydropower generation O Chum II. The total energy production in the year 2001 is about 542 GWh, i.e. about 48 kWh per capita, is the lowest in the region. In Phnom Penh some major hotels and factories do not connect to Electricité du Cambodge (EDC) grid and use their own generators. Only 15% of households have access to electricity.

3.4.2 Planned hydropower projects

Cambodia has not included any mainstream hydropower projects in its nearest future Power Development Plan, with aims at electrification and supply to cover domestic demand.

The size of the mainstream projects and the largest scheme on the main tributaries is too large to be developed for domestic supply alone. If developed they will be built for export to southern Vietnam or Thailand where there are deficits of generating capacity.

The effect of mainstream development on fish migration and reproduction needs to be further clarified before any decision on mainstream projects in Cambodia is made.

Short and medium term hydropower development plan

The short and medium terms of hydropower development in Cambodia are as following:

- Kirirom III, with installed capacity 13 MW(1);
- Kamchay, with installed capacity 180 MW(1);
- Battambang I, II & III, with installed capacity 73 MW;
- Stung Pursat I & II, with installed capacity 92 MW;
- Stung Sva Slap, with installed capacity 4 MW;
- O Tourou Trao, with installed Capacity 1,000 kW(1);
- Upper Stung Siem Reap, with installed capacity 600 kW;
- Lower Stung Siem Reap, with installed capacity 2,000 kW;
- Prek Dakdeur, with installed capacity 200 kW;
- O Romis, with installed capacity 200 kW; and
- O Moleng, with installed capacity 150 kW.

(1) Project outside the Mekong Basin

Long term hydropower development plan

The followings are the long term development plan of hydropower in Cambodia, which will be planned to export to riparian countries:

- Stung Tatay Hydropower Project, with installed capacity 80 MW(1);
- Stung Atay Hydropower Project, with installed capacity 110 MW(1);
- Middle Stung Russey Chrum Hydropower Project, with installed capacity 125 MW(1);
- Lower Stung Russey Chrum Hydropower Project, with installed capacity 125 MW(1);
- Upper Stung Russey Chrum Hydropower Project, with installed capacity 32MW(1);
- Stung Chay Areng Hydropower Project, with installed capacity 260 MW(1);
- Sambor Hydropower Project, with installed capacity 467 MW or 3,300 MW;
- Lower Se San II Hydropower Project, with installed capacity 207 MW;
- Lower Sre Pok II Hydropower Project, with installed capacity 222 MW;
- Stung Piphot Hydropower Project, with installed capacity 25 MW(1);
- Lower Se San III Hydropower Project, with installed capacity 375 MW; and
- Lower Sre Pok III Hydropower Project, with installed capacity 330 MW.

Power sector policy and strategy

The RGC formulated a power sector development policy in October 1994, which aimed at:

- Providing an adequate supply of electricity throughout Cambodia at reasonable and affordable price;
- Ensuring a reliable, secure electricity supply at prices, which facilitate investment in Cambodia and development of the national economy;
- Encouraging exploration and environmentally and socially acceptable development of energy resources needed for supplying to all sectors of the Cambodian economy; and
- Encouraging an efficient use of energy and minimizing detrimental environmental effects resulting from energy supply and use.

To achieve the above objectives, the RGC has undertaken reform measures and rehabilitation of the power sector with the support of multilateral and bilateral agencies, which aimed at:

- Re-establishing an adequate supply of electricity nationwide through direct support of donors and private participation in generation;
- Strengthening sector managerial and implementing capability;
- Creating the environment required for sustained and efficient development of the power sector, open to competition and private participation; and
- Extending its power sector to rural areas.

Cambodia faces a major challenge to develop an adequate and reliable source of electric power in the years ahead. Based on intensive studies of the best means of providing a national electricity supply network, the RGC is formulating a power sector strategy for Cambodia to meet the growing demand for electric power over the next 15 years. The strategy consists of:

- Investment in the power sector;
- Priorities for generation and transmission;
- Establishment of the power sector's regulatory framework;
- Commercialization of EDC;
- Private sector participation; and
- Provincial and rural electrification.

Planned power generation

The Generation Development Plan has been developed on the following criteria:

- Base load thermal generation will be located at the coastal areas to give independent access to imported oil and thereby reducing the amount of oil transported on the Mekong;
- Peak load thermal generation in Phnom Penh,

- Small and medium size diesel units for base and peak load generation in the provincial towns and cities; and
- Hydropower development based initially on the easily accessible sites subsequently the export oriented projects: Stung Atay, Stung Russei Chrum, Chay Areng, Lower Se San 2, Lower Sre Pok 2 and also the three Battambang hydro sites.

The generation expansion projects have been prioritized as follows:

Stage 1 (2003 – 2008):

- Commissioning of Kirirom III 13MW hydropower plant (by private investment) in 2006;
- To develop of Battabang 3 Hydropower plant with installed capacity 13 MW and to commission in 2008;
- In order to cover the demand during this period other diesel and Heavy Fuel Oil (HFO) power plants also consider to develop such as: 10MW HFO power plant in Siem Reap (2004); 30MW HFO power plant in Phnom Penh (2005); extension of power station N^{o} 5 (C5) by 10MW (2005), additional 60MW HFO power plant in Phnom Penh (2008) and 180MW thermal power plant in coastal area (2008) connecting to National Grid.

Stage 2 (2008 – 2013):

- Construction of Kamchay hydropower plant 120MW in 2005 and expect to commission in 2010;
- By 2010, commission of Battambang 1&2 Hydropower plants total installed capacity of 60 MW;
- By 2010, commission of Stung Tatay Hydropower plant with 130 MW installed capacity;
- By 2012, commission of Stung Atay Hydropower plant with installed capacity of 110MW; and
- By 2012, commission of additional 90MW at the thermal plant in coastal area.

Stage 3 (2013 – 2020):

- By 2015, the commissioning of Middle Russey Chrum hydropower plant with an installed capacity of 125MW and Chay Areng hydropower plant with an installed capacity of 260MW;
- By 2016, commission of Sambor hydropower project;
- By 2018, commission of Lower Se San 2 hydropower plant with an install capacity of 207MW and Lower Sre Pok 2 with installed capacity 222MW; and
- By 2020, the commissioning of Stung Treng hydropower project with an install capacity of 980MW.

Existing transmission system

At present, there is a Transmission Line linking from the Kirirom I Hydropower station to Phnom Penh Grid sub-station with 120 Km of length and 115 kV of voltage. The total length of 115 kV Transmission Line is about 135 Km, 22 kV and 15 kV is about 100 Km in Phnom Penh and Provincial Town respectively.

Planned transmission system

The transmission development plan has been developed taking into account the following strategies to achieve Cambodia's electricity sector objectives:

- Reduce reliance on imported oil for energy generation (diversification of energy sources);
- Reduce reliance on the transport of oil to Phnom Penh for power generation;
- Reduce reliance on oil transport on the Mekong River through Vietnam to Phnom Penh;
- Increase operational efficiency of the system (minimize losses);
- Encourage least cost development of provincial load centers by a cost effective mix of grid expansion and local private generation;
- Increase competition in power generation by providing access to competitive sources of imported electricity from Vietnam, Thailand or Laos;
- Maintain the reliability of power supply at the level required and financially supported by customers; and
- Facilitate power trade.

The transmission system is proposed in three stages depending on the availability of the funds and the power generations plan.

Rural electrification plan

85% of the population of Cambodia is located in rural areas and can not access to the electricity. The provision of rural energy is a key factor in the rehabilitation and development of Cambodia. Electricity is very important for the improvement of living standards and an important infrastructure requirement for agricultural and small-scale industrial development in the rural areas.

In particular for the remote rural areas where located near by the stream flow which water is available whole year the micro-hydropower development is very sanctify.

The micro hydropower capability in Cambodia has not been thoroughly evaluated. Micro hydropower stations, which generate about 300W to 1 kW are quite common and require little capital. They will be ideal for small rural communities. If a micro hydropower capability exists in the vicinity of a village, it should be exploited for providing supply. As micro hydropower scheme are site specific, it is not possible to include them in a generalized rural supply strategy except, to mention that where possible they should be investigated as a source of rural supply in the first instance.

3.4.3 Socio-economic effects

The present energy supply lies below demand. Electricity supply functions mainly in the larger cities. The electricity supply for economy and for the population needs further extension. Energy supply for rural areas lies far further behind the supply of the cities.

The major socio-economic effects of hydropower development in Cambodia are the following:

– The displacement of population living in the reservoir of the projects; and

– The need for resettlement of the displaced population.

The flooding resulting from the impoundment of water in front of a dam will prohibit land that use for other purposes such as farming, forests which provide various ecological as well as economic benefits. In particular, human settlements in the flooded areas will no longer be possible. Typically, some compensation is paid to the displaced person, and provision is made for him/her to continue to make a living in alternative sites.

In addition to these large projects on the Mekong, there are further possibilities in the mountainous regions with storage power stations, which do not require massive displacement of residents. Such development could only produce energy predominantly for local use and later on connected to an electrical grid to provide service for a larger region.

The factor, which requires particular consideration, is the extent to which a given population is displaced by each project. This factor will naturally vary depending upon the size and scope of the project as well as the density of settlement in the area where the project is located. In general terms, the extent of displacement will be less if the project is located in a less densely populated area. The alternatives may be described as one of developing the Mekong River, which flows largely through the Plateau and one of the mountainous regions in the east of the country, or the smaller rivers originating from the mountains in the western part of the country, in the Costal and the Tonle Sap regions.

The Mekong River projects (more than 1,000 MW) will be the largest project type, while the other river projects tend to be smaller. The Mekong River projects are situated in areas with a relatively high population density and as a result, the socio-economic impacts will be more serious. On the other hand, the delivery of benefits to the population will require substantial investment. In contrast, the small river projects (10-100 MW) will be located in areas, which have partly low population densities. Thus, the socio-economic effects of displacement may be lower per unit of water storage involved. Due to the limitations of topography, the small river projects are likely to affect fewer numbers of people and communities in absolute terms, while the delivery of benefits to the population may be less costly.

All economic sectors (agriculture, industry, services and trade) and private households will benefit from sufficient and reliable energy production.

An improved electrical energy supply in the cities will increase the movement of rural population to the cities. Another consequence of a better energy production is an increasing or the number of plants, trade and services establishments a stimulation of economy.

3.4.4 Ecological and environmental effects

In all cases, there has to be an exact analysis of the affected area. The data, which is available, now, such as, land use, vegetation and fauna cannot give a satisfying account of the area that will be used for hydropower.

For the construction of an environmentally friendly project, it is an absolute must, to consider the ecological complexity of a scheme, the size of a dam, with all its side effects on the environment.

The construction of dams causes the ecological consequences including climatic change, influences on the water and soil quality, the life flora and fauna, land use, etc. and also social impacts and new health risks such as leishmania, chagas disease and bilharzia.

Usually hydropower projects with low to medium capacity and high head are more ecologically favorable than projects with high capacity or fossil-power stations. Nevertheless these smaller hydropower projects might require larger areas. When constructing a hydropower project in a region that is inhabited by variations of tropical rain-wood, it is often the case that the vertical differences experienced are small. To compensate it is necessary to dam up larger sections of the river. The ecological consequences are of such projects are enormous.

To be able to include the influence on the environment it is necessary to identify the affected area. Therefore a description of the actual situation and the possible qualitative and quantitative effects must be done. A check of the sustainability by the environment is necessary.

For the construction of a hydropower plant it is necessary to keep the compensation water at a steady level to reduce the negative ecological effect. To prevent this, water flow must be as steady as possible.

The planning and construction of a hydropower plant starts or intensifies the traffic with trucks and other vehicles in an area. Division and destruction of the environment are the consequences. Living spaces of animals and plants, as well as man are disturbed or destroyed, because of air-pollution, water-pollution, noise, vibration, excavation, erosion and so on. All these things will have negative after-effects and it is necessary to decrease them.

The dam projects for power and irrigation purposes are the most sensitive issue for all water-related projects in the Mekong Basin. The benefits of hydro-electricity include:

- Low operation costs;
- High reliability of generation;
- High service and economical life (compared to thermal units);
- Stability costs; and
- Independence of ups in world market fuel prices.

The construction of hydropower plants will also initiate the erection of a transmission line system in Cambodia. At the long run, this system will guarantee the possibility of coordinated operating of all plants and reduce the costs of total generation and reserve capacity. Also, benefits for the environment must be accounted.

The major benefit from using hydroelectricity is the substitution of pollution caused by emissions of thermal or diesel plants to the local environment. The greater the reliance on hydropower will result in a decreased dependence upon imported fuels.

At the same time, hydropower dam may cause social and environmental impact on large geographical area in the downstream and upstream countries, affecting a wide range of sectors and local communities. The social and environmental impacts were not much concerned and might be minimize due to low population concentration, simple land use, and intact ecosystem. As alternative energy option was not diverse at the time, cheap electricity like hydropower combined with irrigation of large agricultural areas would justify the economic viability of dam projects.

Today hydropower is still on the top agenda of all riparian states. It is considered by MRC as renewable energy, relatively clean and does not cause air pollution and global warming (MRC Annual Report, 1998). A number of pre-planned hydropower dam projects are still in the study, though the selection of the hydropower sites. Therefore prospect of hydropower development in the Mekong Basin is substantial given the pressing needs in electricity and water driven by rapid population growth. The nature of environmental impact varies from dam to dam and maybe somehow predictable.

Environmental impact associated with hydropower dam development, especially the larger dams, will be on the increase as a result of change in political and economic measures, conservation needs, human concentration and uncontrolled land use planning.

The negative effects of dam projects include modification of:

- Changes in flows downstream of reservoir, river morphology, ground water patterns;
- Impact on ecology of wetlands, flood plaints and coastal habitat due to storage or diversions;
- Impact on aquatic ecosystem due to disturbance, pollution or introduction of exotic flora and fauna;
- Impact on the spawning environment of inland fish, which are the primary sources of protein for Cambodians; and
- Changes the water quality parameters due to pollution, sedimentation etc. which affects consumptive or other human uses.

Environmental Impact Assessment (EIA) is believed to be an important regulatory instrument for the mitigation of environmental impact of any development project. In Cambodia, the EIA process is governed by the Sub-Decree on Environmental Impact Assessment Process, which provides the requirement of EIA for any hydro project with the capacity of more than 1 MW. Though EIA process is yet to be improved, this sub-decree is seen as a good step towards sustainable development with minimal social and environmental impacts. So far, only one hydro-dam has recently resumed its operation in Kirirom I where EIA was positive. Another case of hydro-dam is the Prek Thnot multiple projects, which was studied again in 1995, but because of high cost for human resettlement, the project were postponed. Nevertheless, EIA is not always properly undertaken due to the unreliable data and limited time and resources for proper review. In terms of trans-boundary impact EIA is much more difficult and some time ignored.

Some issues related to the trans-boundary environmental impacts, because of the failure to take into account environmental impacts in the upstream and downstream countries. The

case of Yali Hydropower dam construction of the 720MW Yali dam commenced in 1993 on the Se San River about 70 km upriver from the international border with Cambodia (NFTP, 2000), notably prior to the 1995 Mekong River Commission Agreement. Environmental Impact Assessment was conducted in the project area, but not including the area within the Cambodian territory. The Se San Basin has a total drainage area of 17,100 km², including 11,000 km² in Vietnam and 6,100km² in Cambodia. A study by NFTP has demonstrated that social and environmental changes in the downstream of Se San River, where is the Cambodia's territory was likely associated with the construction of the Yali hydropower dam. These findings are as follows:

- Irregular hydrological pattern;
- Social damage;
- Water quality problems;
- Change in riverine vegetation; and
- Impact on wildlife, fisheries and birds.

3.4.5 Conclusion

The predicted demand of electric energy in Cambodia can sufficiently be supplied in the short and medium future by constructing the suggested priority projects. It is necessary to properly prioritize these projects as full development.

The strategy for short-term development will meet the immediate energy needs of the country. The higher availability of electric energy will have additional benefits, such as increased employment.

The Cambodian hydropower potential gives us the optimism that the electric energy demand in the future can be supplied mainly by internal means. Further reliance on internal energy sources, such as hydropower, allow for a greater economic independence, thus enabling the economy to expand without external constraints on the energy supply. External constraints on the nation electricity supply have had deleterious effects to their economies. Considering the long term dimensions of Cambodia's electricity demand, it will be necessary to maintain studies regarding the future of the project.

3.5 Navigation and waterways

3.5.1 Introduction

An efficient transport system is vital to sustain and enhance economic growth and the quality of life. The provision of such transport facilities and services must, however, meet the essential criteria of economic efficiency. Goods and passengers must move by the mode that least costly as uneconomic services impose heavy burden on economy. The transport sector in Cambodia today is not able to efficiently respond to the increase of demand and the diversity of services provided at high cost.

Cambodia is emerging from more than 20 years of war. During that period, most of the country's basic infrastructure was badly damaged or almost completely destroyed. Within the transport sector, including roads, railways, air-transport and port was also severely damaged.

After the civil war, Cambodia is striving and starting the full course and efforts for rebuilding and the development of the nation and socio-economy of the country. Sustaining economic growth through improved efficiency of agriculture, industry and service sectors is constrained by an inadequate internal transport system and poor links to regional trading partners. Transport is critical to Cambodia's economy because of its growing regional trade and agriculture and rural development priorities. A more efficient transport infrastructure is essential to facilitate the expansion of small and medium sized export oriented enterprises.

Cambodia's geographic location offers strategic opportunities for it to become a regional transportation and trading hub within the dynamic Greater Mekong sub-region as well as a suitable location for regional institutions and administrative services. Improvements in the efficiency of transport services will in turn create the conditions for investment in new sector infrastructure. Rapid rehabilitation of transport capacity particularly the re-establishment of the primary road network is essential, as is the implementation of new services to ensure that future economic growth is not constrained by absence of an adequate transport infrastructure.

In the medium term, the Government will build on existing reforms and focus on the most pressing constraints to the rapid development of the sector. The priority will be to improve the efficient use of existing infrastructure and accelerate the sector capital program, while enhancing sector planning and financing mechanisms. The Government has the important role to play in increasing the efficiency of the sector by promoting greater private sector participation and facilitating competitive markets for transport services. Public investment priorities will complement high priority policy actions aimed at: (i) strengthening sector institutional capacity and management; (ii) expanding transport services, particularly roads; (iii) developing cost recovery mechanisms and in support of reforms to be taken at the macroeconomic level.

3.5.2 Existing river transport

As with much of the economic infrastructure, the transport sector was severely damaged during the years of war beginning in the early 1970s though the mid-1990s. This damage was due to the destruction brought by the war itself and caused by 25-years of neglect. Since the early 1990s, concerted efforts by the Government of Cambodia and the donors community has been made to reestablish the kingdom's basic infrastructure especially in transport sector. Success has been achieved in number of areas, but much still remains to be done.

A major constraint faced by the sector is the lack of financial support that ensure the long-term sustainability of the transport infrastructure. The lack of qualified personnel in the public and private sectors that are needed to implement and maintain infrastructure restricts the rate at which it can be restored and maintained. The organized structure needs further strengthening to improve efficiency and performance of the sector. The statuary requirements, which form the legal basic for many activities in the sector, have to be updated to reflect changes in the sector. The current status of each sub-sector is reviewed below.

Most of the waterway traffic is on the Mekong River between Phnom Penh and Ho Chi Minh City, and from Phnom Penh upstream to Kratie. Vessels of up to 5,000 tones can navigate along the Mekong up to Phnom Penh for most of the year. Traffic on waterways other than the Mekong is by means of small crafts, which constitute a very small volume. There is no reliable dredging needed to maintain adequate water depths in the dry season. Further reliable statistics related to the water traffic are not available.

The Inland waterway system traditionally plays a vital role in the Cambodian economy. The system consists of the Tonle Sap Lake, the Mekong River and the Bassac River for a total

navigable length of 1,750 km, with 580 km navigable all year round. In the dry season, the draft of Mekong upstream of Phnom Penh is some 3.8 m to Kampong Cham (105 km) and 1.5 m to Kratie (116 km from Kampong Cham). With dredging a draft of 2.5 m could be kept the whole year as far as Kratie with annual dredging. Between Kratie and Stung Treng, 50 ton-boat can pass easily during the rainy season, but at low water only 20 ton-boats can pass. On Tonle Sap River the draft is about 3.5 m up to Kampong Chhnang in dry season but from Kampong Chhnang to Chong Kneas (near Siem Reap) on the Lake, dry season draft is 0.8 m and reaches between 5 and 11 m in the rainy season. The Bassac River links Phnom Penh to Chau Doc, the capital of Vietnam's An Giang province. In the rainy season 100 ton-boat can be used.

The most important domestic ports are in Phnom Penh, Kampong Cham, Kratie and Stung Treng on the Mekong, Kampong Chhang, Chnok Trou and Siem Reap on the Tonle Sap River and lake. Chnok Trou and Kampong Chhang are also road-river transshipment ports. All the domestic ports suffer from insufficient or the total absence of supporting landing infrastructure. There is presently no any reliable data on domestic cargo movements on the river system. In 1994, it was estimated (in depth survey of boat operators) that about 40 to 50,000 tones could constitute the domestic cargo. Figures between 15 and 50,000 tons are usually quoted. The absence of reliable figures makes the task of designing and promoting river ports extremely difficult.

The shallower Mekong, rather than the Bassac River is the declared international channel for navigation to Phnom Penh, Kompong Cham and Kratie, restricting vessel size. Small seagoing vessels (up to 4,500 DWT) are able to serve Phnom Penh in Cambodia.

3.5.3 Ferry sites

A large number of river crossings still constitute bottlenecks. There are 10 ferry sites operated in the main rivers, which connect to the main national roads. Four main ferry sites, including Neak Loeung, Prek Kdam, Tonle Bit and Stung Treng are of important links connected to the National Road System. After the construction of Mekong Bridge at Kompong Cham, the Tonle bit Ferry was moved to the new place at Prek Tamaek on the downstream of Mekong, which is far from Phnom Penh City about 20 km.

The RGC plans to set up new ferry sites and construct the roads towards the triangle area-border point at Northeast region of the country: Cambodia, Lao and Vietnam; and across the Mekong at Stung Treng to connect the north-eastern part (Ratanakiri and Styntreng) to the North-central and North-western parts (Preah Vihear, Kampong Thom, Siem Reab and Banteay Meanchey) of the country.

3.5.4 Ports and shipping

Phnom Penh Port

The strategy for Phnom Penh Port is based on the competition and competitiveness. The urgency of a vigorous competitive strategy is required otherwise the port may be on an irreversible declining trend. Phnom Penh Port has a role to play in the future and should be in a position to be an alternative to Sihanoukville.

Competitiveness of Phnom Penh Port will be improved in the future if:

– Physical obstacles to river navigation are being removed;

- Satisfactory agreements can be reached with Vietnam; and
- Customs inspections, border and transit formalities are simplified;

Areas requiring annual dredging in Cambodia (Mekong) and Vietnam (Mekong and Bassac) are well known. Dredging is required to maintain all the year round a minimum draft of 5m. Financing dredging in Cambodia (and in Vietnam) has always been a major problem. The private sector approach has been proposed. It is proposed to turn the maintenance of the Mekong channel in Cambodia first, but ideally for Cambodia and Vietnam together, into a BOT or a BOO operation. The international company will operate in Cambodia and Vietnam; and will charge passing vessels (based on draft) a toll to recover maintenance costs. Maintenance costs will be made of dredging but could also include navigation aids (night navigation).

Some important agreements will need to be reached between Cambodia and Vietnam. These agreements are as follows:

- Authorization by international ships to PP to use the Bassac route as well as the Mekong route;
- Abolition of transit charges to international ships entering Vietnam for PP;
- Simplification of customs formalities for entering vessels; and
- Agreement on not requiring vessels to come to a complete stop to get pilots, customs and immigration officers.

In addition, Cambodian customs should agree to have customs clearance at port (PP); not at the border.

The second aspect of the strategy for PPP is the concerns of its future location in the context of the capital expansion. The location of PPP within the city poses the following problems:

- Limitations (time of operation) on trucking operations within the city affect negatively port activities;
- Any major increases in container port activities will face serious constraints in terms of stocking areas (container yard);
- Fuel pumping terminals located the Tonle Sap River present a serious hazard and there have been talks of relocating these activities further away from the city center;
- Phnom Penh Port, like Sihanoukville needs an urgent hazard emergency plan for the short term and should plan a move to another location in the next five years especially if the containers activities (by fast barges from Ho Chi Minh) materialize.

River ports

Domestic river navigation (passenger and goods) has traditionally been a crucial mean of communication in Cambodia. In the short term, the situation will remain unchanged. After 2005, when major roads are being rehabilitated, a new realignment in domestic river traffic will take place. The realignment will be along the following lines:

- For remote, rural destinations, the natural complementary will persist; roads being preferred in dry season and boats in the rainy season;

- Short haul transportation (goods and passengers) will continue to be economical especially for populations leaving along the river network; and
- River transportation will keep the long haul, bulky and low value transportation; the rest of the transport if it has not yet shifted to the road will eventually do it.

International shipments travel on the Mekong River though they may enter in Vietnam through the Bassac or the Mekong River. Vessels entering Vietnam for Cambodia using the Bassac River would need to switch to the Mekong at the Vam Nau pass in Vietnam. Continuous dredging is required in Vietnam to allow for secure passage of vessels requiring a 5m draft. There are also stretches in Cambodia that require dredging otherwise the available draft can fall to 2.5 m draft. Also the bends of the Mekong River prevent vessels of more than 110m to navigator through.

3.5.5 Policy framework

The Royal Government of Cambodia is committed to restore the condition of primary roads and highway network so that it may connect the principle urban center of the country. In the longer term, the strategy is provide all weather access between the primary road network and all provincial capitals and to all major border crossings.

The RGC realizes the benefit from keeping a well functioning railway system as an essential part of the transport system. Despite its poor condition and low levels of service, it might be possible to bring it into profitable operation through its completed operation. The involvement of the private sector is necessary. The international ports, including airports and maritime ports are required the encouragement form the RGC and the participation from private sectors. Also, the development and strengthening of regional linkages with its ASEAN neighbors have to be encouraged.

Maximizing regional links

The RGC recognizes that the country's geographic location offers strategic opportunities for establishing Cambodia as a regional transportation hub for the Greater Mekong sub-region. The RGC places high priority on further expanding trade, particularly within ASEAN and on improving cross border linkages. The budget will be used to the maximum extent possible to finance the local cost of domestic roads and railway programs either alone or in parallel with international agencies. In addition, the RGC will assess the scope for financing the regional infrastructure programs through the participation of the private sectors. Regional routes will be improved and upgraded. the cooperation and coordination among neighboring countries have also been strengthened and improved.

Rehabilitation, maintenance and expansion of infrastructure

The public investment priorities are firstly to rehabilitate the transport system with roads as the first priority and finance improvements in operations and maintenance capability, so as to pave the way for longer term sector expansion. Road rehabilitation and reconstruction can facilitate people living in remote areas to access to the areas with significant development potential The pace of improvement of secondary and tertiary road networks serving rural areas will be accelerated.

Other immediate plans include: (i) the preparation of technical studies to assess requirements and priorities for new linking roads; and (ii) the establishment of road-bridge maintenance organizations.

The RGC has to ensure that the maintenance of the road network, including bridges and ferries, is financed by vehicle registration charges, tolls, international transit fees and fuel levies or other related taxes and duties.

Strengthening institutional capacities in planning and management

Government interventions will be strictly limited to ensuring that markets work by regulating market entry and the licensing of transport systems. This will ensure that competition is promoted and monopoly situations are avoided. The aim is to safeguard consumers as well as better enforce adherence by transport operators to national safety, technical and environmental standards. Suppliers of transport services will not be constrained in tailoring their services to customers providing that they adhere to legislative and regulatory rules designed to protect consumers, worker health and safety and the environment.

The capability and skills are keys to successfully implement medium term policies. The MPWT will undertake additional identification of longer term priorities by conducting with external assistance an inter-modal transport study for the transport sector as a whole in order to formulate a comprehensive transport policy.

3.5.6 The Strategy

The recommendation strategy for the two international ports, Sihanoukville and Phnom Penh, is to ensure that they continue to compete one with the other and remain competitive, as they are like to face increasing competition in the near future. This will be facilitated by privatizing more services and giving full autonomy to the port authorities. The present autonomous port authorities should be run like private enterprises.

In the case of Phnom Penh, the Government should take all the necessary measures to make navigation on the lower Mekong easier and less costly. This means establishing appropriate international agreements with Vietnam that are enforced regarding fast custom, immigration and piloting services. This also means developing a dredging programme with the active participation of the private sector. In a 10 year horizon, if traffic peaks up in Phnom Penh port, it is suggested to build a new port along the Mekong further from the core of the city.

In the case of Sihanoukville, the development of the port has to be seen within the context of a regional development programme including the establishment of a light industry duly-free zone and the promotion of tourism activities.

Finally, the Government should support the development of the inland waterway system by providing minimum landing facilities when required, proper navigation aid and dredging. Public expenditures should be minimized however and participation of the private be reviewed with clear distinction made between ownership of assets, regulatory power and management of the port asset. Participation of the private sector should be encouraged.

Economic and social impact

The economic evaluations consider the net benefits to the economy as a whole that would result if a project were undertaken, in relation to the "do nothing" case. For most water transport projects, the main part of these benefits is derived in the form of reduced operating costs. Due to the competition between operators (at least in the long term), these benefits can be expected to be passed on to the consumers and the traveling public in the form of

reduced prices. Benefits resulting from diverted and generated traffic are also included. Savings in maintenance costs or in the operating costs are significant in some cases.

The social benefits could be a very large number of different types, all directly or indirectly related to improved accessibility and reduced transport costs (including the value of time savings). Some of these effects, such as the total cost savings to existing and diverted traffic will be considered in the economic criteria of the strategy formulation. Many others are not and these particularly concern the benefits due to new (generated) traffic. If waterway access is improved from an extremely poor to a reasonable level, this can be expected to result in more social benefits.

Water transport development and poverty reduction

Water transport sector in directly contributing to poverty reduction has received little attention so far. By and large, the navigation projects were assessed in terms of improving efficiency and promoting economic growth. The contribution of transport operations to poverty alleviation is seen, in general, as indirect and stemming from broadly based economic development. Yet, most direct poverty-targeted interventions (schools, health clinics, nutrition programs, and social services) depend on transport as a complementary input for their effective delivery. It is desirable and timely to assess prevailing views of the role of transport projects in poverty alleviation and to take stock of the treatment of poverty issues. Room has to be allowed to establish a sound conceptual framework for identifying, examining, and shaping the potential role of waterborne transport operations in reducing poverty.

Minimal infrastructure services are one of the essential components of personal welfare and provide more convenient access to a broad range of socio-economic opportunities. This can be best assessed by examining how navigation affects people's daily activities. Many villages along the Mekong River and its tributaries are geographically isolated; the river is the only access. Convenient and safe access to the schools, hospitals, markets and to other villages is therefore paramount; lack of affordable and safe access deprives them of the ability to take advantage of job opportunities and even very basic social services.

In general, a transport project is expected to contribute to poverty reduction through its indirect impacts on economic growth or its direct impact on personal welfare of the poor. What exact impact the project would have on poverty reduction hinges on both the type of infrastructure or services and the areas and people the project serve. In general, local waterways or canals in poor rural areas make only a modest contribution to national income growth, but they are likely to have a direct significant impact on the daily life of the poor. On the other hand, shipping is of strategic significance to a national economy. It is provided with the objective to stimulate and facilitate national income growth; their impacts on poverty reduction are indirect.

Transport investment reduces the cost of assembling intermediate inputs for production (raw materials, energy, labor, other intermediate products, and information) from different locations, directly reducing the cost of production. Reduced cost and improved quality in transport services also reduces the market price of products and hence promotes regional and international trade, making it possible for agriculture to commercialize, for industry to specialize, and for production and employment to expand by exploiting scale economies. In a multitude of ways through these mechanisms, transport contributes to economic growth. In addition to improving accessibility, navigation investment affects employment. The provision of the transport services, including the construction and maintenance of transport infrastructure, generates demand for labor (often unskilled labor) and provides income-

earning opportunities for the poor. If a transport project generates jobs for the poor who are otherwise unemployed or under-employed, it contributes to the reduction of poverty.

On the Mekong, the great navigation potential has not been addressed yet to the core although lots of small scale projects could primarily help farmers and the agriculture sector in its transportation needs of agricultural goods from production to consumption centers. Indeed, the access provided by waterborne transport to remote areas where the river offers the only possibility for communication and can have an optimum return on interventions in other sectors. For farmers, improved river transport can also ease the introduction of improved farming practices and the transition from subsistence farming to cash crops and a market economy.

Transport development may also have an adverse impact on the poor. The infrastructure works or the navigation operations, if not monitored or regulated well, may cause negative environmental impact. In this case, the poor are the least able to respond, adjust or compensate; they may be the most vulnerable and the most "at risk". This has to be taken duly into account when drafting the strategy.

In many cases navigation on the Mekong River, due to the hazardous nature of the river, is limited to an association of well experienced pilots and skippers, who restrict their skills and knowledge to their association and family. It is the MRC intention to assist primarily the poorer communities, by facilitating the use of the river through channel marking and training, so this group can safely have access to this mode as well. The natural navigation potential is there and whilst preserving the ecological balance, the long tradition of using boats should be promoted and facilitated.

In summary, in the navigation strategy elements have to be formulated for poverty reduction in terms of a two-pronged approach: broadly based economic growth to generate income-earning opportunities for the poor, and targeted interventions to meet the basic needs of the poor.

3.5.7 Conclusion

The development of physical infrastructure and utilities is crucial for the economic growth of Cambodia. Concerted efforts will be needed by all agencies, stakeholders and the local community to upgrade, rehabilitate and repair the existing infrastructure network. The projects will have to be implemented according to priority. The required laws and regulations will have to be enacted and implemented. The successful development of infrastructure will undoubtedly support the development of economy and improve the quality of life all Cambodians.

3.6 Tourism

3.6.1 Introduction

Based on the world and regional trend, tourism has emerged to play a role as a fastest growing industry and become a driving force to boost the world economy at present and in the future.

The direct and indirect income from tourism greatly contribute to the national economy such as earning foreign currency, creating job opportunity to the people, resolving economic and social crisis and alleviating poverty.

Tourism has been playing a key role in helping resolve the past regional economic crisis, attracting foreign currency from foreign tourist to underpin the national economy.

A report made by the world tourism organization (WTO) illustrates that tourists traveling worldwide were 698 millions in the year 2000, increasing by 7.4% if compared with the year 1999; and the income from this sector was 475 billions, augmenting by 45%.

On the other hand, East Asia and Pacific region received more 111.7 million tourists, which accounts for 16% of the world total member, and increased by 14.5%.

In the Kingdom of Cambodia, the Royal government is actively endeavoring to rehabilitate and develop the national economy in which tourism is given a priority and the locomotive to accelerate economic growth.

With our enriched culture and natural potential, the Royal government considers Cambodia tourism as a cultural Nature tourism, and this policy is producing its positive outcome in line with the world tourism development trend at present.

Asia and the Pacific is a sanctuary and a tremendous cultural asset of many nationalities and tribes, who have a diversity of language, custom, tradition, traditional dance, cooking recipe and separate history, that have their comparative advantage for tourists in Asia.

A study made by the WTO shows that the member of International Tourist will increase by 1.5 billion in the year 2020. Asia and the Pacific will become to most popular tourism destination in 2020. Asia and the Pacific will become the world second tourism destination.

3.6.2 Economic and social value of tourism

GDP contribution

The Tourism Sector has experienced uneven and modest growth since 1994, averaging about 2.8 percent annually. The share of the Tourism Sector in GDP has remained broadly stable since 1994 at around 35 percent of GDP, ranking slightly behind agriculture in recent years. Trade is the predominant sub sector (10% of GDP) followed by transport and communications (7%). The contribution of tourism to GDP remain low (4%) despite high growth since 1999, implying that thus far the domestic value added in the sector has been limited.

Tourist arrivals by air totaled 408,377 in 2001, compared with 118,000 tourists in 1993, and 260,000 in 1996, and reached an all-time high of 786,524 in 2002. Although about 70 percent of tourists arrive in Cambodia by air, an increasing number of foreign tourists visit the country by road from neighboring countries or by ship. About 60 percent of foreign tourists coming by air are from the Asia and Pacific region, with the largest share (12%) from Japan, while Europeans and North and South Americans account for about 25 and 15 % of air arrivals, respectively. While tourism receipts have increased dramatically, the average spending per tourist and length of stay are much lower than in Thailand and Malaysia. Hotel accommodation seems adequate in the sort term. There is significant potential for further development of tourism in Cambodia, as many temples are still inaccessible, and the infrastructure for eco-tourism is underdeveloped. Domestic tourism would also likely develop rapidly if roads were rehabilitated.

Table 3.12: Cambodia main indicators of tourism, 1994 – 2001

Year	1994	1995	1996	1997	1998	1999	2000	2001
Total visitor arrivals								
(In thousands)	...	...	...	...	...	367.7	466.4	604.9
Of which:								
By air	176.6	219.7	260.5	218.8	186.3	262.9	351.7	408.4
(Percent change)	...	(24.4)	(18.6)	(-16.0)	(-14.9)	(41.1)	(33.8)	(16.1)
Other	...	...	...	...	...	104.8	114.7	196.5
Share by regional origin								
(In percent)*	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Asia and Pacific	64.6	71.5	68.4	68.7	61.1	58.5	58.7	59.3
Europe	20.7	17.3	20.6	19.8	26.2	25.6	24.8	24.1
Americas	13.6	9.8	10.7	11.2	12.4	15.5	15.9	16.0
Other	1.1	1.4	0.3	0.3	0.3	0.4	0.6	0.6
Tourism receipts								
In million US dollars	...	53	82	68	66	133	199	235
In percent in GDP	...	1.7	2.6	2.2	2.2	4.0	5.9	6.9
Average receipt per tourist (US$)	...	327	422	417	465	666	950	701

Source: Ministry of Economy and Finance, 2002.
* Based on arrivals at Phnom Penh airport only.

Revenue

Tourist expenditures in Cambodia represent a major injection of new money into the economy, stimulating a variety of economic activities. Because the economy is a relatively open one, there is no measure available from the banking system as to the amount of foreign exchange being earned from tourism. In fact, much of the urban economy is operating in US dollars. Also to be considered is that many of these activities are fueled not only by tourists but also by the large number of expatriates working long-term in the country. Therefore, tourism earnings must be calculated based on the count of the number of tourists was compiled for 2001 (MOT, 2001). These figures provided the basis for estimating total expenditures, as shown in table 3.13. Total tourist expenditure was estimated to be about US$ 304.3 millions in 2001.

Table 3.13: Estimate of tourist expenditures in Cambodia in 2001 in US Dollars

Item of expenditure	Individual	Group tours
Accommodation/day	26.2	Included in package
Food and beverage/day	11.8	Included in package
Local transport/day	9.5	Included in package
Shopping/day	10.5	16.1
Other spending/day	9.6	16.4
Total average expenditure/day	67.7	138.3
Average length of stay in days	6.8	4.2
Average expenditure per trip	460.9	538.8
Number of foreign tourists in 2001	390,354	214,565
Total number of tourist days	2,654,407	901,173
Total tourist expenditure (rounded)	179,703,354	124,632,226

Source: Ministry of Tourism, 2003.

Based on the analysis of economic tourism experts, it is calculated that revenue from tourism contributes to 15% of GDP. A report by MOT in 2002 indicated that:

- By the year 2006 the number of international visitors to Cambodia will be 1,505,200, generating revenue of US$ 1,119 million
- By the year 2008 the number of international visitors to Cambodia will be 2,167,200, generating revenue of US$ 1,611 million
- By the year 2010 the number of international visitors to Cambodia will be 3,121,000; generating revenue of US$ 2,302 million.

Poverty alleviation

Poverty alleviation is one of the key outcomes for the strategic policy in tourism development. The objective is to raise the living standards of the poor people, especially those who are living in local tourist destinations such as in cities, towns and rural areas.

The exponential growth of tourist numbers to Cambodia has resulted in an average annual increase of 25-30% to national revenue. In 2002, the total revenue was approximately 576 million and created employment opportunities for 100,000 people. In addition, millions of local tourists have made revenues and job opportunities for the poor at local tourist destinations by providing services and local products.

Economic leakage of tourism

It has been estimated that the economic leakage of tourism is to be ranked from 25% to 30% (source).

The main leakage is related to imports of goods and services:

- Fuel to serve the local transport
- Construction material, such as steel, cement and other equipments for hotels, restaurants, airports and tourist resorts.
- Foreign foods and beverages, beers and wines for instance, using particularly in luxury hotels and restaurants.
- Repatriation of profit to service the foreign capital investment in tourism sectors and repatriation of salaries by foreign employees.

Lessening tourism economic leakages

In many developing economies, around 55% of tourism expenditures do not remain in the destination country (OECD, 2001). The figure for Cambodia might be somewhat less but it still represents a significant issue related to the economic benefits of tourism. Leakage occurs due to use of imported skilled labor and luxury products, repatriation of profits by owners, and the considerable amount of money spent on the marketing, transport and other services based in the originating country. What is important from a poverty perspective is not simply how much remains in the country but how much stays within a particular destination and is spent on goods and services provided by the less advantaged residents of the destination.

It is hoped that the import of products and services at the initial stages of tourism development may trigger the entrepreneurial spirit of local people to provide locally produced goods and services. This has not only economic benefits but also helps to ensure a unique visitor experience. It is clear that increasing the local content of goods and services will not occur without the support and encouragement of government policy.

In Cambodia, domestic policies attempting to lessen the level of leakage from international tourism should include:

- The provision of incentives to reinvest profits and potential cash transfers that would otherwise be invested abroad.
- The enhancement of the capacity of tourism destinations for intensifying the production of goods and services required by the tourism sector.
- The provision of incentives to domestic investors to expand participation in tourism (OECD, 2001).

Employment opportunities

- Tourism is a service industry which demands a huge labor force;
- Tourism's role as a job provider was clearly recognized and promoted;

According to WTO, there are 4 main types of job created by tourism and related business:

Direct Employment: person who works in the tourism enterprises, such as tour operators, hotels;

Indirect Employment: the jobs in the tourism related sectors, mainly the suppliers to the tourism industry such as agriculture and manufacturing;

Induced Employment: people who do not involve in the two above categories, but any person who support by the spending of revenue made by the direct and indirect employees; and

Construction Employment: the kinds of jobs generated in the construction of tourism infrastructure and facilities such as roads, airport, ports, hotels, etc.

According to the ADB, the direct employment was estimated at 30,000 in 2000, and will increase up to 50,000 by 2003. There are many jobs related to the kinds of indirect, induced and construction employment.

3.6.3 Characteristics and impacts of water use

One of the most important requirements for the development of tourism facilities is an adequate and continuous supply of safe water for drinking purpose and for domestic and recreational use. In some developing countries, the responsibility for the supply and treatment of water lies with the tourism development project. In other cases, it is a responsibility accepted by the government in the interests of both the visiting and the residential communities.

For some countries, there is an uneven quality and quantity of water in the major townships, smaller townships, and rural areas. Upgrading the various aspects of the water systems then becomes a responsibility of the tourism developer, and there may be a benefit to the adjoining local community.

Water needs are diverse and increasing. Supply requirements for tourism developments include water for:

- Domestic purposes;
- Hotels and restaurants;
- Laundries;
- Swimming pools and other recreation uses (such as for watering golf courses);
- Street cleaning;
- Irrigation; and
- Fire fighting.

There are basic quantitative measurements which, while useful, do not take into account the special demands generated by particular factors. These factors can include such things as:

- Climatic conditions;
- The tendency towards extravagance in water use by holiday-makers;
- The increased levels of water use in food and drink preparation in remote locations; and
- The tendency for corporate and government agencies to be more lavish in their use of water in the maintenance of sites in areas which experience high levels of tourist visitation.

Assessment of the capacity of systems is sometimes frustrated by acts of vandalism, by leakage and breakdown of inefficient systems leading to production in water pressure, and failures.

Water use per capita for tourism

Tourism activity demands a high per capita consumption of water. A general standard used in the Cambodia is about 6,000 liters per hotel room per day (for 2 or 3-star hotels) and 12,000 liters per hotel room per day (for 4 or 5-star hotels), including water needs for restaurants, swimming pools, hotel site irrigation and direct visitor usage. Most areas in locations with particularly humid climates and higher-grade hotels may experience higher water demand levels. Areas with many golf courses may experience a demand level that is up to 2.5 million liters per day.

The demand for water is not constant regarding quality. Treatment of water for drinking purpose produces a different quality then water necessary for the purpose of irrigation, site cleaning, recreation area watering, or fire fighting. Some of the various quality requirements include:

- For drinking, cooking and dishwashing, sterilized water free from contamination is required;
- For other domestic uses, including personal washing and laundry, water must be free from contaminants but treated underground supplies may be acceptable in some circumstances;
- Swimming requires clean, sterilized, filtered water, including filtered sea water; and
- Irrigation needs can be met with recycled and filtered wastewater.

Siem Reap: Only the old central area of Siem Reap is served with a central water supply system, with raw water taken from the Siem Reap River. The treatment plant is not operating because of damaged equipment and lack of chemicals therefore consumers are supplied with the untreated water. Limited intake capacity and lack of power means the service reservoirs, elevated tanks and piped distribution network are either inoperable or in a poor state of repair. These deficiencies result in the system being only 40% operational. Water delivery is limited to a few hours each day. Most of the population draws water from individual wells. A vast majority of hotels and guesthouses depend on their own wells, which are 25 to 75 meters deep. Many hotels filter the groundwater, without chemical treatment, making the water suitable for bathing but not for drinking.

In Phnom Penh: The quality of the water supplied by the Phnom Penh Municipality is suited for drinking, but a risk remains of contamination during distribution and de-central storage.

Water sources

Principal water sources include rainfall, underground aquifers, and river systems. The sources can very considerably. Water supply is dependent on rainfall, catchment and aquifer recharge, and storage capacity.

If weather patterns are variable, good storage and treatment becomes critical. It may be that due to the variable nature of the sources, new tourism developments may need to be self-reliant in terms of sources, catchment, and treatment.

If major tourism developments such as hotels and integrated resorts are required to become self-reliant in their sources, a number of planning and design safeguards need to be introduced, including:

- Protection of the water source;
- Assurance of supply from the source; and
- Appropriate treatment of water from the source, careful maintenance of water storage facilities, selection of sources well away from waste discharge and built-up areas.

In general, there is a preference for centralized water systems that draw on a public supply system in which the protective measures listed above may be pursued consistently and monitored.

Resort locations may be determined by the proximity of clean and reliable water supplies, with augmentation of the supply from streams, underground aquifer, and innovative solutions for catching and storing rainwater (such as using zinc-aluminum roofs rather than traditional leaf roofs).

3.6.4 Environmental, social and socio-economic issues

Environmental effects in Cambodia

Tourism can generate either positive or negative environmental effects depending on how well its development is planned and managed. In its best form, tourism can provide the justification and help pay for conservation of national parks, wildlife sanctuaries and other protected areas and scenic landscapes in Cambodia because these are attractions for tourists. Cambodia has designated several protected areas which constitute the basis for nature tourism and can help be conserved by tourism. As emphasized in the preceding section on socio-culture considerations, important archaeological and historic sites can also help be conserved by tourism. Improvements in infrastructure, including infrastructure serving tourism, can greatly assist in controlling environmental impacts of air, water and other types of pollution and congestion. Overall environmental quality of an area including maintaining an attractive, clean environment can be improved by tourism because tourists prefer to visit areas that have a high level of environmental quality. All these environmental benefits of tourism could be realized in Cambodia if appropriate measures are carried out.

Environmental problems resulting from tourism development at the present time include the likely possibility of some pollution of surface and underground water resulting from improper sewage waste disposal from tourists facilities, some poorly designed hotels and other tourist facilities that are not attractive additions to the landscape, and some land use problem resulting from unsuitably located hotels and limited amount of parking spaces development for the hotels. More generally, the overall environmental quality of tourism areas is deficient. Some tourism areas exhibit littering of the landscape and solid waste disposal problem, limited maintenance of urban park and public space, traffic congestion and drainage problems after heavy rains.

A serious environmental problem that is facing the country is apparently uncontrolled logging operations that are leading to deforestation in some areas including potential nature tourism areas. Management plans need to be prepared and implemented for forest areas. These plans should be aimed at prohibiting logging in the designated protected areas and

achieving sustainable logging practices in the areas suitable for this activity. Additional protected areas should be designated where warranted.

Water-related environmental impacts

The potential detrimental impact of tourism development and activity includes water pollution as a result of waste disposal, swimming, boating, and oil spills (from small boats). In addition to the reduction in the quality of the water, repercussions may include contamination of fish and reef life, and eutrophication, leading to weed growth that stifles oxygen levels.

Besides the detrimental impacts of some tourism activity on the natural environment of water areas, there may be health hazards to users in these areas.

Sewage: The sewage system in Phnom Penh is in disrepair and is exposed above the ground in some parts of the city. Storm drainage is insufficient and unable to control flooding during the rainy season.

Siem Reap has an acute lack of wastewater treatment facilities. If no action is taken, this constraint will lead to a major restriction of tourism growth. The hotel situated on the riverbank use the river as a sewer outlet. Other developments have septic tanks but, with no regulations on the installation of these, there is danger of ground water pollution. A satisfactory sewage system must be installed for the development of tourism as well as general urban growth.

The Natural Environments: The river system, lake and climate are discussed below because of their direct impact on tourist activities, facilities and development of tourism products.

- *River Systems:* The Mekong and the Tonle Sap rivers form important tourism features of the city. These rivers are used to a limited extent for tourism based activities. Flooding during the rainy season remains an important issue that needs to be addressed which is partly caused by water level rise in the river and the inability of the storm drainage to flush out the water. The Tonle Sap lake forms an important drainage and navigation channel connecting Siem Reap to Phnom Penh, and the floating houses and villages along the banks and in the middle of the lake are tourist attractions. The lake is now experiencing considerable siltation, resulting from deforestation of its watershed, making navigation more difficult during the dry season. The Siem Reap River and the Rolous River provide important transportation links and a source of water supply to Siem Reap. Pollution of the rivers due to dumping of waste and poor water works facility is making it difficult to use the water for domestic purposes. Also the fluctuation in the level of water makes river navigation difficult year round. The extensive riverbank has not been utilized as a recreation area.

- *Seasonal Variations:* Tourism is a seasonal activity in Phnom Penh and Siem Reap with large number of visitors during the dry season. The amount of tourist normally decreases during the rainy season.

Social and socio-economic benefits of tourism

Social: The influx of international travelers to the town has the potential to conflict with the existing value system inherent in the culture. The combination of the new economic regime with the sudden increase in exposure to international ideas and concept may adversely affect

traditional value systems. The beginning of this is evident in the imitation of western dress, practices and food preparation.

Socio-economics Benefits: Several approaches should be used to increase the economic benefits of tourism. Several of these have already been recommended in this plan but are repeated here to reinforce their importance for economic reasons. These approaches include the following:

- Promote the expansion of quality of tourism which will attract higher spending and longing staying tourists (even though the import leakage may be somewhat higher for this type of tourism). Quality tourism is also more culturally and environmentally beneficial as is explained in subsequent sections of this chapter.
- Encourage longer average length of stay of tourists through providing more tourist attractions and activities as has been recommended. Improving interpretation facilities and services at attraction features will increase tourist length of stay and expenditures.
- Provide more opportunities for tourists to spend more money through developing additional tourist attractions and activities and expending the amount and variety of good quality craft items and craft sales outlets, including developing integrated craft markets as was previously recommended.
- Encourage greater linkages with other economic sectors, for example, producing higher quality beef in the country instead of importing quality beef. However, it must be accepted that some types of manufacture items used in tourism will always need to be imported.
- Develop tourism in other parts of the country, outside of the Phnom Penh-Siem Reap-Sihanoukville area, in order to spread the economic benefits of tourism more widely, broaden the tourist markets and increase their length of stay. This will include developing special interest tourism in remote places, such as eco-tourism in Ratanakiri and other areas in eastern Cambodia.
- Develop conference and meeting tourism to attract more 'business' tourists who will also visit tourist attraction features.
- Improve collection and accounting procedures for sources of government revenue from tourism, so that the revenue is in fact received by the government.
- Maintain the present policy of maximizing local employment in tourism, including at the higher technical and managerial levels, through employment policies and training programmes.
- Encourage local and joint venture ownership of tourist facilities and services to the extent local financial resources are available, realizing that considerable
- External investment will be needed for major project during the foreseeable future.
- Encourage involvement of local communities in tourism development in their areas so that they can receive direct and indirect economic benefits from tourism.

Social impacts

The improvements to tourism-related infrastructure will bring major social benefits to resident in and around urban areas, local and international tourists, and the tourism industry. Upgraded road will facilitate the movement of population and goods, as will rehabilitate airports and river facilities that encourage a greater tourist throughput. Economic activity in

the sub-region will increase with increased employment and higher incomes. The provision of efficient wastewater treatment and sewage disposal systems will similarly improve the health and general quality of life of resident populations. The burden on women in particular, on whom many childcare and household activities depend, will be relieved with improved child health resulting from more efficient sewage and waste disposal. Better facilities at border crossings will facilitate movement of migrant workers and local tourists, and contribute to the development of the wider regional economy.

3.6.5 Trends and issues

Ministry of Tourism collaborates with the ASEAN and continues to actively embark on the agreement of ASEAN Tourism, which was brilliantly initiated by Samdech Hun Sen, Prime Minister, which has been recently signed by the ASEAN Heads of State and Heads of Governments in the ASEAN Summit and unilateral, bilateral and multi-lateral cooperation. The RGC has cooperated and collaborated with such governments as Japanese, Chinese, and Korean Government.

Based on these fundamentals, RGC has strived and achieved political stability, social security and safety; and decently influenced the confidence of national and international public sentiments. International tourists place reliance on the stability of these factors when assessing the status of Cambodia's tourism. Also, the RGC issued key policies in order to rehabilitate and develop tourism as follows:

- Open Skies Policy for travel by air, Overland and Water;
- Visa on Arrival; and
- Visa Exemption for Cambodians living abroad policy (Visa K), which has been appreciated by the national and international Cambodian community.

3.6.6 Hot spots and transboundary issues

Ecotourism is to travel with responsibility together with sustaining uniqueness of each natural site and cultural site. Meanwhile learning process for relating people is important. Public participation is needed to maintain sustainable ecology. The following activities are suggested for ecotourism in Rattanakiri and Mondulkiri:

- Trekking along natural sites;
- Elephant trekking along Pichada-Phnom, namely Wildlife route;
- Following elephant precession between Sen Monorom and Pichada;
- Touring to grassland on the plateau of Mondulkiri with the elephant, motor cycle and other vehicles;
- Wildlife/bird watching in highland areas of Rattanakiri and Mondulkiri;
- Participation of local cultural activities; and
- Rafting on rivers and streams.

Ecotourism can have a number of positive and negative effects. The positive effects include:

- Generating different kinds of employment;
- Creation of local small- and medium-sized enterprises;

- Sustainable nature-based tourism must ensure that the profits from the tourism activity are at least in the part reinvested into the local economy. It is equally important that some of the proceeds are directly used to maintain the conservation activities of either governments or NGOs;
- Very often more remote areas suffer from significant infrastructure gaps and nature-based tourism can help to provide financing or the rationale of investment infrastructure. While the infrastructure may be necessary to meet the needs of tourists it can also have beneficial impacts on the local community;
- Depending on the nature of the surrounding communities the handicraft industries and local traditions can be either revitalized or maintained. How to do this must be the subject of another paper but it is essential to think about how the cultural dimensions of an ecosystem can also be enhanced and maintained; and
- Sensitive and well developed interpretive programs can help to develop a conservation ethnic not only within tourists but also with the local community. This is especially true if the local population can be convinced that their well being in part depends on a healthy ecological setting.

Examples of negative effects are as follows:

- Visitors contribute to various forms of pollution whether they are air, water, visual or sound related;
- Traffic congestion, depending on the scale of the attraction, can be an issue;
- How to dial with solid waste as well as wastewater is a constant challenge especially in natural areas;
- The form of tourism development that surround nature-based tourism can at times in the fact lead to the reduction in the value of traditional lifestyle and concerns; and
- Without proper interpretation we see that the co modification of both natural and cultural heritage can occur.

3.6.7 The role of public/private partnerships

The RGC has recently demonstrated political will to build partnerships with non-government sectors and a more open process in the drafting of a new land law. Partnerships are seen as an essential strategic and priority action for the development and encouragement of structures and delivery mechanisms that involve both the public as well as the private sectors. There are obvious cases where either the private or public sectors may be best suited to delivering various aspects of tourism activity. There are also many instances where public and private partnerships could be seen as the most effective tools for sustainable tourism development that reduces poverty and maintain heritage in Cambodia. There are a number of successful international models where countries (e.g. Singapore, Hong Kong, Canada, and Malaysia) have adopted partnerships as a part of their tourism development approach.

In support of the role of partnerships the creation of the following partnerships are recommended in Cambodia:

- The creation of the Cambodia Tourism Marketing and Promotion Board made up of representatives of the public and private sectors. This Board would be responsible in a large part for marketing Cambodian tourism and for helping guide decisions on product development. The Board will be independent and will be financed from both the public and private sectors. Initially it is recommended that

the Marketing and Promotion Department of the Ministry of Tourism serve as the secretariat.

– The creation of public/private Cambodia Tourism Human Resource Development Commission. The nature of this board is explored in the 2001-2005 Cambodia Tourism Human Resource Development Strategy.

3.6.8 National tourism initiatives in Cambodia

The Royal Government has agreement with others neighboring countries to improve tourism sectors as follows:

– The ASEAN Tourism Agreement Calls for tourism cooperation in the region. The objectives of this Agreement are:

- To cooperate in facilitating travel into and within ASEAN;
- To enhance cooperation in the tourism industry among ASEAN Member States in order to improve its efficiency and competitiveness;
- To substantially reduce restrictions to trade in tourism and travel services among ASEAN Member States;
- To establish an integrate network of tourism and travel services in order to maximize the complementary nature of the region's tourist attractions;
- To enhance the development and promotion of ASEAN as a single tourism destination with world-class standards, facilities and attractions;
- To enhance mutual assistance in human resource development and strengthen cooperation develop, upgrade and expend tourism and travel facilities and services in ASEAN; and
- To create favorable conditions for the public and private sectors to engage more deeply in tourism development, intra-ASEAN travel and investment in tourism services and facilities.

– Besides, the collaboration with the ASEAN Association, Government had engaged in cooperation with the WTO and other international tourism organizations. Also, there has been cooperate with the Greater Mekong Sub-region countries and the Mekong Ganga Cooperation, which consists of five countries plus one (India). In addition, there has been continual collaboration with Japan, China and Korea.

3.7 Domestic and industrial water supplies

3.7.1 Domestic water and sanitation

Overview

Domestic water supply and sanitation is the most important field for rural and urban areas in Cambodia. Cambodia is, based on the country geography, a country with large freshwater resources (surface water, groundwater and rainy water, etc.), which gives the advantage of a great potential to supply water for many purposes. The rehabilitation and development of rural/urban water supply is a priority area among others.

The quality of drinking water is importance to human health and the provision of a safe drinking water supply is one of the main objectives of Cambodian national policy. Therefore, to gain a better understanding of levels of drinking water quality surveillance, the Royal Government of Cambodia has initiated to identify potential threats to human health from low quality of drinking water throughout a significant area of Cambodia.

Demand, access and sources

Domestic water supply is a crucial component for human being. Without water, life can not be sustained. Surface and ground water are the main sources for urban and rural areas in Cambodia.

Table 3.14: Domestic water supply sources in Cambodia

No.	Location/ stations	Water sources	Structures	Pump capacity (m^3/day)
1	Banlung	Groundwater	Well borehole	150
2	Battambang	Sangker River	Intake towers	3,300
3	Kg. Thom	Stung Sen River	Intake towers	375
4	Prey Veng	Groundwater	Well borehole	227
5	Pursat	Pursat River	Infiltration gallery; Intake pump	577
6	Koh Kong	Open reservoir	Floating Intake	91
7	Sisophon	Sisophon River	Floating Intake	130
8	Stung Treng	Sekong River	Floating Intake	253
9	Takeo	Open reservoir	Intake tower	138
10	Kampong Cham	Groundwater	Well borehole	1,500
11	Kampong Chnnang	Tonle Sap River	Floating Intake	394
12	Kampot	Waterfall	Floating Intake	2,305
13	Takhmao	Bassac River	Floating Intake	788
14	Kratie	Mekong River	Floating Intake	842
15	Siem Reap	Groundwater	Well borehole	1,055
16	Sihanoukville	Open reservoir	Floating Intake	2,799
17	Svay Rieng	Groundwater	Well borehole	420
18	Kean Svay	Mekong River	Floating Intake	600
19	Odong	Open reservoir	Floating Intake	236

Source: Water Supply Sector, MIME, 2001.

As of the 1999, 54.3% of the total population have access to safe water supply services.

Table 3.15: Access to safe water supply services

Sources	All country %	Phnom Penh %	Rural %	Other %
Piped in dwelling	5.1	45.4	0.7	7.2
Public Tap	1.3	2.9	1.1	1.6
Tube/piped well of borehole	19.0	8.0	19.4	24.8
Protected dug well	22.1	6.4	24.2	18.1
Rainwater	0.7	-	0.6	2.0
Tanker, truck or otherwise bought	6.1	31.5	2.6	12.8
Subtotal for protected sources	54.3	94.2	48.6	66.5
Unprotected dug well	15.5	0.4	17.8	9.7
Pond, river or stream	28.3	5.0	31.5	22.3
Other	1.9	0.4	2.0	1.5
Subtotal for unprotected sources	45.7	5.8	51.4	33.5
Total:	100	100	100	100
Number of households in (000)	2,093	174	1,705	214

Source: (i) MRD, 2002. (ii) Institutional Development Plan, 2003-2012.

Surface water is the main source for domestic consumption in rural areas surrounding the Mekong River, while groundwater is used by those who are living in remote areas where are far away from the Mekong River. It is indicated that about 69% of the total households uses dug-wells, rivers, streams, and springs as the main sources for drinking water. In rural areas, about 73% of the total populations are exposed to poor water quality. It has been shown that about 25-30% of the population can access to safe drinking water.

Table 3.16: Sources of domestic water supply

Source of water supply	Total	Phnom Penh	Other urban areas	Rural
Piped Water	5.8	29.7	25.0	2.5
Tube/Pipe Well	14.9	3.9	13.8	15.1
Dug Well	40.3	12.2	22.4	43.4
Spring/River/Stream, Rain	28.2	10.6	15.1	30.4
Bought	8.3	43.6	21.5	6.1
Other	2.5	-	2.2	2.5

Source: NIS, 2002.

Social and Economic issues

Of the total urban population of 1.79 million (1998 census), nearly a million live in the capital city of Phnom Penh while the balance 0.8 million are distributed across the remaining 23 urban centers (20 provincial towns and 3 municipalities). The coverage of the water supply by piped line in the provincial/municipal towns is as low as 15%, with service restricted to the central core areas of the town.

The percentages of rural and urban water supply with access to safe water supplies are 24% and 63% respectively. In both rural and urban areas, many people take advantage of the rainwater collected in large water jars during the wet season, and for the rest of the year use whatever source is most readily available and for many households this may entail a long wall for women and children to fetch water. Over 30% of household expenditure in the poorest sector of the population is on water. Pipe water supplies rest is restricted to part of Phnom Penh and eighteen towns. Piped water supply coverage is by far the best in Phnom Penh, as the result of a considerable amount of investment since 1993 to rehabilitate water treatment plants and the distribution system. In none of the provincial towns does coverage exceed 18% of households.

Investments are continuing that will enable the PPWSA to supply drinking water that meets WHO standards to the whole population of the four central city districts and to consumers in the three suburban districts that can be economically supplies. The Authority is now a financially self-sustaining entity. There has been an extensive program to meter connections and remove illegal connections. Metering of 95.5% of connections has been achieved, with 61% billing of consumers and 39% collection.

In rural areas, some 6.4 million people are depended on unprotected water resources, from ponds and streams. There have been significant efforts by the Ministry of Rural Development, international organizations such as UNICEF, OXFAM and NGOs to install wells for water supply and introduce sanitary latrines to reduce pollution of water sources.

Groundwater demand was used remains more popular in rural areas and some in smaller urban centers. More than 81% of the population is rural, and close to 60% of this use groundwater. In contract, only 15% of Phnom Penh consumes well water. Hand dug wells (or open wells) are widely used throughout the country, but the trend towards drilled wells with hand pumps will continue as the rural development efforts succeed.

Environment issues

The environment issues is the major sources of chemical pollution that are from the agrochemicals including pesticides extensively used in middle basin area of Mekong River, e.g. Thailand, and the urbanization and industrial establishment on riverbanks or close to rivers, discharging the untreated wastes into the river system, directly or indirectly.

Human induced activities are on increase of households/industrials in settlement areas and so are the uses of agrochemicals including pesticides in crop farming. During rainy season, dilution in the river is very high, but in dry season, poor water quality such as lower dissolved oxygen and the presence of toxic substances could have killing effects to aquatic species particularly fish and it also impacts to water supply resources/reservoirs. Only few species, which could cope with the contamination water could survive and breed. Some of the species could even carry toxic substances in contamination with polluted water sources.

Any water supply project increases the domestic wastewater. If not disposed properly, benefits from safe water supply may disappear and may constitute a threat to public health. The maximum water supply volume estimation in 2010s is about 13,440 m^3/day in Siem Reap province. Considering typical tropical country value of 80% for the conversation to wastewater, the maximum amount of wastewater generation in 2010 is 10,752 m^3/day. Per capita BOD load depends on geographic location, climate, social and food habit, personal hygiene, local custom, and economic properness. A BOD load generation value of 40gm/capita/day can be estimated for Siem Reap Town for the persons served with water supply facility. For a target service area population of 53,151 in the year of 2010 and a target

service ratio of 75% the total domestic wastewater pollution load is estimated as 1,860 kg-BOD/day.

In term of environment issues are the water quality and water pollution issues. The most consumers complain on the aesthetic effects like taste, smell and color. Hard water is frequently cited for its damage to hair after bathing and calcium is widely believed to cause the formation of kidney stones. People concern the turbidity of the river water for insufficient treatment, and chlorine smell. Toxics algae in Phnom Penh's raw water and sedimentation tanks were reported in 2000. A number of toxic algae growths were detected, especially in the late dry season from April to May in the Tonle Sap River. These can produce toxins and release them into drinking water supply.

Pathogens are commonly found in surface water, however, and arsenic has recently been detected in concentrations that exceed WHO guideline values in five provinces. In August 2000, MRD and MIME completed a nationwide survey in provinces at along Mekong River and around Tonle Sap Lake, on the chemical qualities of urban and rural drinking water sources with technical and financial support from WHO. Over drinking water sources representing thirteen provinces were sampled and analyzed for more than 80 chemicals and pesticide compounds by a certified lab in Australia.

The survey reported that the chemical quality of most urban and rural drinking water sources was generally good. Not pesticides were detected in any of the samples. Although not the subject of the survey, bacteriological quality was emphasized as the priority for the safe drinking water. Nitrites and nitrates were detected at levels in several locations. Contaminants such as barium, chromium, fluoride, lead, manganese, molybdenum, and selenium were also found bit appeared to be exceptions to the general trend. On the other hand, iron and other aesthetic concerns like hardness proved a significant issue for many rural consumers of groundwater.

3.7.2 Industrial water use

Almost water uses in Cambodia for industries are surface water (Streams and Rivers), but groundwater sources there are most use in many factories/plants at the present. Thus some kind of water treatment beyond simple disinfections would be necessary for the water to be even aesthetically acceptable. The biggest problem of water quality use is the need to remove suspended solid load.

Overview

As yet Cambodia has few industries because of the lack of power and raw materials. In the rural areas, there are number of rice processing mills. In urban areas, several state owned factories such as plastic items, hand tools, soft drinks, cigarettes, textiles, soup and basic needs. Most of those factories are using the groundwater use by their own drilling deep wells.

Water demand, withdrawal and sources

The industrial water demand varies widely from enterprise to enterprise and from country to country base upon location conditions. Water demand is often considered under the following heads:

– Cooling water demand: usually abstracted directly from rivers and returned to the same with little overall loss.

– Major industrial demand: factories using 1,000-20,000 m^3/day or more for such industries as paper making, chemical manufacture, iron and steel production, oil refining etc. Such supplies are often obtained from private sources.

– Large industrial demand: factories using 100-500 m^3/day for food processing, vegetable washing, drinks bottling, ice making, chemical products etc. These supplies are frequently drawn from the public supply.

– Medium to small industrial demand: factories are using less than 50 m^3/day comprising many types are making a wide range of products. The majority will take their water from the public supply.

In 2001, Cambodian major industry is associated with the garments in the region of Phnom Penh city; about 200 factories are employing about 150,000 people. The water use requirements are estimated at 75,000m^3/day or about 27 MCM/year.

Table 3.17: Estimation of water demand for industrial and other institutions

No.	Description	Consumption allowance
1	Basic factory requirement for cleaning and sanitation	0.05 m^3/day/worker
2	Average consumption in light industrial estates	0.25-50 m^3/day/worker
3	Average consumption in light industrial estates that include a proportion of factories engaged in food-processing, soft drink manufacture, ice making	0.90-1.10 m/day/worker
4	Requirements for specific industries:	
	dyeing fabric and leather production	70-85 m^3/tone
	paper production	150 m^3/tone
	plastics	30-80 m^3/tone
	chemicals	10-20 m^3/tone
	soft drinks and breweries	7 m^3/tone
	meat production/slaughtering	5 m^3/tone livestock
	concrete products	1 m^3/tone
	terrazzo tiles	1 m^3/10-20 m^2 of tiles
5	Small shops and traders, offices	25 liters/head/day
6	Large offices	65 liters/head/day
7	Hospitals and Hotels	350-500 liters/bed/day
8	Schools	25-75 liters/persons/day

Source: MOWRAM , 2001.

Freshwater requirements for industrial purposes were estimated in 1996 about 47-55 MCM/year for Phnom Penh, and up to 2 MCM/year for each provincial town. Phnom Penh and the provincial towns are near to ample water sources, and per capita demands should be supportable at all times of year from surface and/or groundwater. Withdrawals are more likely to be constrained by plant capacity than by size of the sources.

Environment issues

Data are available for wastewater disposal in Phnom Penh city, but not in general for other towns. Commercial and industrial discharges in Phnom Penh were estimated about 3.4 MCM/year (2000), and discharges from houses and public institutions were estimated to be

32 MCM/year. However, sewers carry both storm water and foul water, while on the other hand many properties (particularly industrial sites located along water courses) are not connected to the sewer network and discharge directly into the natural drainage system. Therefore, it is difficult to determine exactly what the wastewater component is.

Loading from both point-source contaminations, principally by untreated sewage from all industries in Phnom Penh and some other urban areas, non-point-source contamination by human waste and chemicals, and accidental pollution from events such as oil spills can be expected to grow in the future. Concern has also been expressed regarding the possible effects of grow up industries in the upland areas, and settled human activities near by industrial areas.

Transboundary issues

The wastewater treatment of household sewage is designed to be via septic tanks into the sewer network. Many of Phnom Penh's sewers discharge directly to Tonle Sap, Bassac rivers or other water courses and others discharge also directly to holding ponds such as Buong Trabek, Buong Tumpon and Buong Samyab Lakes, which provide a measure of natural treatment before the water is pumped to the river.

In Phnom Penh, about of 194 factories (assessment in December 2000), only 8 have on-site primary treatment and their effluents generally exceed Cambodia's water quality standards. The transboundary issues for wastewater can transfer to Mekong River will distribute to inside country and they will also impact to downstream in future. But now Cambodia's industry is not so much developed and by the government policy, Cambodia is an agricultural country, so for wastewater impact out let from industries are not so very much to effect in water flow patterns downstream side.

The transboundary issues that may need to be considered in connection with industrial water supply/use development in Mekong basin of Cambodia with include:

- Effects of changes in water flow patterns and quantities; for example, on groundwater drawdown, existing water supply for industries practices;
- Effects of changes in water quality; for instance, increased risk of sanitation due to wastewater discharge return flows and evaporation from reservoirs; and
- Changes in habitat resulting from the draining of industrial wastewater treatment.

3.7.3 Sector analysis

Institutional Development Issues (1989-2002)

The institutional development plan relates directly to the rural water supply sector investment plan, of which it constitutes a key component. It describes overall sector financing requirements on the basis of existing levels of coverage, projected increase in rural population over the 2003-2012 ten years plan period and expected levels of coverage by 2012.

There has been large-scale investment in the sector since 1989, with the putting in place of projects assisted by UNICEF and OXFAM, and a number of other UN and bilateral agencies and NGOs. At the initial stages, from 1989 to 1999, assistance was primarily of an emergency relief nature, focusing on water supply sector, and it was not until later that attention began to be paid to sanitation as well. It is estimated that a total of $76.9 million

was invested in the sector over the 1989-2002 periods, of which $59.9 million was provided from external sources.

The Ministry of Rural Development has gained valuable experience in the sector and government efforts at decentralization have provided scope for greater end-user involvement in rural water supply sector planning and management but the sector related institutional environment nevertheless remains weak. Service delivery is not sufficiently demand responsive and sector legislation and regulation either does not exist or is not enforced. Vulnerable and disadvantaged groups do not adequately benefit and methodologies used are not adequate for addressing the needs of the poorest communities. The extent to which decentralization will actually occur now that the commune councils are in place is not clear. Women are underrepresented in the sector and Government's ability to monitor and evaluate sector performance is low. Villager literacy and education is low, making it difficult for them to be meaningfully involved in project planning and management.

Table 3.18: External investment by sector 1989-2002

No.	Name of project	Direct beneficiaries ($ x '000)	Duration (year start-year end)	External funding ($ x '000)	Funding source
1	Water Supply in 15 Provinces	400.0	1989-1994	8,400.0	UNICEF
2	Water Supply in 4 Provinces	100.0	1989-1995	2,200.0	OXFAM
3	Water Supply in 4 Provinces	100.0	1989-1996	1,800.0	CARE
4	Water and Sanitation in 4 Provinces	180.0	1992-1995	3,800.0	CARERE-1
5	Water and Sanitation in 2 Provinces	50.0	1992-1996	1,100.0	IRC
6	Water and Sanitation in 2 Provinces	80.0	1992-1996	1,700.0	CONCERN
7	Water and Sanitation in 2 Provinces	170.0	1993-2002	5,000.0	PFD
8	Water and Sanitation in 8 Provinces	100.0	1995-2000	2,200.0	UNICEF/ CASD
9	Water Supply in 6 Provinces	350.0	1995-2000	7,400.0	PRASAC-1
10	Local Structures in 4 Provinces	120.0	1995-2000	2,500.0	AFD
11	Water Supply in 6 Provinces	100.0	1995-2000	4,660.0	China Gov't
12	SEILA Program in 4 Provinces	100.0	1996-2001	2,100.0	CARERE-2
13	Hydro geological Research Project in 4 Provinces	234.0	1996-2000	4,100.0	JICA
14	Planning and Capacity Building Project (National Level)	65.0	1999-2001	1,400.0	Sida/AFD
15	Pumped-piped Systems in 1 Province	20.0	1999-2002	341.0	MIREP
16	SEILA Program in 17 Provinces	68.0	2002	1,500.0	PFLG + Other
17	Water and Sanitation in 6 Provinces	40.0	2001-2002	880.0	UNICEF/ CARC
18	Water Supply in 6 Provinces	86.0	2001-2002	1,800.0	PRASAC-2
19	Phnom Penh Peri-Urban Water Supply	10.0	2002	240.0	JICA
20	RWSS Policy Testing in 4 Provinces	25.0	2001-2002	525.0	APSER
21	Multiple Small Scale RWSS	300.0	1989-2002	6,200.0	Various
Total		2,698.0		59,846.0	

Source: Ministry of Rural Development, 2002.

The capacity of the government staff, both at the local and national level, is also limited, particularly at the planning level. Financial resources are limited and prospects for increased resource allocation to the sector from local sources are not good. In appropriate choice of technology, poor workmanship and low quality of materials lead to low level of performance and durability for rural water supply sector installations, and water quality is not sufficiently monitored and controlled. A low level of private sector involvement leads to excessive demand for limited government resources.

The information management issue of rural water supply (RWS) sector planning, implementation, monitoring and evaluation require quality data that can only be collected, processed, stored and retrieved through an efficient, up-to-date information management system. Database already exist at the MRD/RWSD and MOWRAM/DWSS, but the information they contain is not up to date, and; in many case, is not sufficiently accurate to enable sound sector data management. The reasons of capacity of the Government to monitor and evaluate RWSS sector performance is low, and arrangements for disseminating sector related information to stakeholders are inadequate.

Investment in Institutional Development Plan (2003-2012)

The Institutional Development Plan was prepared with assistance from the ADB/RWSS project PPTA, to address institution-related requirements. The plan is based on the understanding that water resource management, including water supply and sanitation, is a priority for the development of Cambodia. Particular emphasis is given to sector reform and to the financing of sustainable, equitable and gender balanced sector services. Competition for water in rural areas is limited, considering that use is a fraction of resource size, but the high incidence of water-related morbidity and mortality are indicative of a serious weakness in Cambodia's ability sustainable to manage its water resources in general, and the institutional and financial aspects of the sector in particular.

The GDC is committed to promoting the role of private enterprise in the economy. As a result, the scope for increased involvement of entrepreneurs in rural water supply is growing, for instance in the installation of private tube wells. In support of capacity building within the private sector, the expertise of private local operators, such as consulting engineers and we drillers will be developed. Training will include such topics as production techniques and labor management, based at least in part on training programs developed by ILO and the ADB-funded Rural Infrastructure Improvement Project (RIIP), supplemented by additional technical input.

The sector investment indicates that a total of $85.4 million in external investment will be required over the next decade to attain sector goals (Table 3.19). An amount of $53.0 million has already been identified from ongoing or pipeline project, and 5 new projects worth $32.4 million in total are being proposed.

Table 3.19: Investment in the Institutional Development Plan (2003-2012)

No.	Name of project	Funding source	Duration	Total external funding ($ x '000)	Institutional development component ($ x '000)
1	RWSS in 6 Provinces	UNICEF/CARC	2003-2005	1,320.0	264.0
2	RWSS in 6 Provinces	PRASAC-2	2003	900.0	180.0
3	RWSS Policy Testing in 4 Provinces	APSER	2003	175.0	35.0
4	Pumped-Piped Systems in 1 Province	MIREP	2003-2004	341.0	68.0
5	Water Supply in 1 Province	JICA	2003-2004	520.0	104.0
6	RWSS in 3 Provinces	ADB	2003-2007	15,000.0	3,000.0
7	RWSS in 17 Provinces	Seila	2003-2012	30,000.0	6,000.0
8	Multiple Small Scale RWSS Projects	Various	2003-2012	4,700.0	940.0
	Sub-total			52,956.0	10,591.0
Projects for which investment resources have not yet been identified					
1	RWSS in 2 North-Centre Provinces	Not yet identified	2004-2008	4,991.9	998.4
2	RWSS in 3 North-West Provinces	NYI	2005-2009	6,051.5	1,210.3
3	RWSS in 5 North-East Provinces	NYI	2006-2010	8,025.7	1,605.1
4	RWSS in 3 South-West Provinces	NYI	2007-2011	4,322.6	864.5
5	RWSS in 4 South-East Provinces	NYI	2008-2012	9,015.4	1,803.1
	Sub-total			32,407.1	6,481.4
	Grand Total			85,363.1	17,072.4

Source: Ministry of Rural Development, 2002.

A total of summary of planned external investment 2003-2012 of $85.5 million will be required from external sources, of which $53.0 million (62%) have already been identified, leaving an unidentified balance of $32.4 million (38%) (Table 3.19).

76% of the total resources requirement (i.e. $65.0 million), will be allocated to rural water supply, while 24% of resources (i.e. $19.6 million) will be allocated to sanitation.

Table 3.20: Planned external investment 2003-2012

Sub-sector	Planned external investment ($ x '000)		
	Resources already identified	*Resources not yet identified*	*Total*
Rural Water Supply	40,625.0	24,374.6	64,999.6
Sanitation	12,375.0	8,032.5	20,407.5
TOTAL	53,000.0	32,407.1	85,407.1

Source: Ministry of Rural Development, 2002.

Water quality development

The development of domestic water supply in urban are most people contributed, but in the rural area the people are poor, so that, there are some contributed. Due to the lack of a national standard for drinking water quality, individual laboratories (PPWSA; Ministries of

MIME; MOWRAM; MOE and others) in Cambodia use individual standards for drinking water quality.

The water quality standard of the Pollution Control Department (PCD) of the Ministry of Environment shows higher values for the parameters. This is because of its purpose to control the pollution of the natural water sources.

The internally adopted drinking water quality standards in Cambodia are mainly adopted from international standards or guideline values, partly due to the donor driven, with no reference to the actual situation in the country. Since Cambodia was under French colonial rule for nearly 100 years, French standards are still popular figures to use. During the UNTAC, when the multinational experts started their missions in Cambodia, water quality was nominated according to their recommendations. The WB/UNDP technical team adopted WHO guideline values and referenced EU Guideline value for drinking water for Phnom Penh water Supply. Health sector education in Cambodia is based mostly on the French system, and thus the National Laboratory (of MOH) favors French standards for drinking water quality. However, during 1998 and 1999, the laboratory made changes in the numbers of parameters and the values of these standards by adopting values from WHO, Germany, Malaysia and Thailand.

The water quality standards are seen to differ according to their differing applications. PPWSA standard value is presented under two headings: the highest desirable level and the maximum permissible level. This was done because the values reflected existing international standards, but allowance was still needed to guide authorities faced with an inefficient treatment plant. Most of the PPWSA value is similar to the WHO Guideline values. The National Laboratory (of the MOH) relies more upon microbiological parameters because bacteriological quality is much more the domain of the health sector than the chemical constituents. The higher values of some chemical parameters found in the water quality standards of the Ministry of Environment are typical for use in monitoring untreated surface water and groundwater. These are not yet strictly aimed at drinking water quality monitoring.

Wastewater treatment development

Phnom Penh water supply is undertaken by Phnom Penh Water Supply Authority (PPWSA), that supply treated water to the Phnom Penh city. Its three treatment plants are the following:

- The first oldest water treatment plant in Phnom Penh is location of Chrouy Changwar. It is in the eastern of Phnom Penh city and was constructed in 1859 by French company CEEI with the original capacity 35,000 m3/day. In 1959 the plant was expended to 45,000 m3/day by on of Japanese reparation with the time of World War II. However, it has not been operated from 1983, because of out-of-older of submerged transmission on mains and deteriorated plant facilities. Until 1999 this treatment plant was rehabilitation and interim operated since 2001. The Mekong River is the main water resource on this water treatment plant.

- The second is Chamkar Mon water treatment plant that was constructed since 1957 with capacity 10,000 m3/day. During the civil war (Pol Pot regime), the plant has been abandoned and heavy damaged due to no operation. After finishing the civil war, the plant was repaired temporally by the water supply authority, and rehabilitated during 1985 to 1988 by the assistance of Soviet Union (USSR) to cover the original capacity 10,000 m3/day. After 1988, the water treatment plant was

rehabilitation and extension the capacity up to 20,000 m3/day. The treatment plant takes raw water from Bassac River through pipeline with 600mm diameter.

– The third water treatment plant was built in 1966, in Phum Prek of Phnom Penh water supply system with capacity 100,000 m3/day in original plan as 200,000 m3/day. Since 1979 to 1993 the plant was operated only 50,000 m3/day due to lacks of operation and maintenance. At the present, the treatment plant was rehabilitation and extension the capacity to 100,000 m3/day and will increase to capacity 150,000 m3/day in 2004 by the plan. Phum Prek water treatment plant takes raw water from Tonle Sap River through three pumps that located in front of Cambodia Development Council (CDC). The process of water treatment system consists of 2 Coagulation, 12 Flocculation basins, 6 Sedimentation basins and 12 rapid sand filters. The Aluminum Sulfate, Chlorine and Lime are the based chemical for treated water process in water supply activities of PPWSA.

Transboundary issues

The reasonable and equitable share shall be done without prejudice to the principle of Cambodian sovereignty. Cambodia has the right to develop and mange international river basin on her territory within her reasonable and equitable share, consistent with national environment and development policies and with the obligations stemming from the international agreements to which Cambodia is a Party.

The procedures for water quality transboundary issues are monitoring in the national institution as difference from one department to other depending on their purposes. Among these laboratories engaged in water quality monitoring in Cambodia, the PPWSA and MOWRAM laboratories engaged in water quality monitoring in Cambodia, the PPWSA and MOWRAM laboratories are more efficient and well experienced.

In Cambodia, arsenic is a big problem, that transboundary from groundwater by exploitation mines activities to the surface water. In the wet season the capacity of arsenic can transfer from Mekong River and then flow to supply in the area near by to the bank side and they also can also trance in to neighboring country in South Viet Nam. Mekong River is the main rivers that can be transfer to and from upstream-downstream crossed Cambodia by the value of arsenic contained.

The most significant finding of the survey was that the naturally occurring arsenic in groundwater from certain areas in Cambodia. The element was detected at levels above the WHO guideline value of 10µg/L in live of thirteen surveyed provinces. Some 9% of the randomly selected groundwater sources were affected with arsenic. The MRD hosted an inter-ministerial meeting to share the survey results, and the arsenic finding in particular, which called for inter-ministerial efforts towards developing national drinking water standards and a national monitoring capacity. The finding was submitted to the Council of Ministers recommending a national arsenic response to be led by the MRD. Meanwhile the MRD has begun further field surveys with NGO partners to delineate the extent of the arsenic occurrence in three provinces with WHO and UNICEF Support.

Inter-sectoral/ institutional issues

It is mandate of the Ministries to improve access to safe water supply with both services in urban and rural areas and in collaboration with other key line ministries. MRD has issue in rural water supply and sanitation guidelines, MIME has guideline issue in urban and

MOWRAM has a water supply sources management issue and the policy framework for domestic water supply and sanitation sector.

Contributions from other ministries include a "draft on water resources management law" that is now in the final stages of preparation under the overall guideline of MOWRAM, while legislation on an appropriate water sector regulatory framework and water tariff reform is being drafted by MIME.

A sub-decree on water pollution control was issued in April 1999 to support the authority of the Ministry of Environment on water pollution control. The MOE is committed to developing a national action plan for prevention of pollution of water sources. It consists of the establishment national standards for pollution sources, including wastewater discharges to public areas or sewers. Collection and evaluation of data and the analysis of the results are part of the development of the national action plan planned to be completed within a three years.

3.7.4 Conclusion

With many purposes of domestic water supply in both urban and rural areas of the Mekong Basin in Cambodia are increasing water demand and population of the country, the Cambodia Government recognized the importance for quality of water, particularly; safe drinking water affects the life of the people. Therefore, the Government has tried to assign a high priority to the improvement of water supply facilities and new technologies.

Most of rural populations are used shallow groundwater and rainwater for domestic water supply in their life. The data on sustainable groundwater yields are not available for the country. Therefore, the potential of groundwater resources is not estimated yet. Urban water supply is used for domestic, hotels and restaurants, etc. The types of industry are leaders in industrial development at present; the garment industries and tourism/hotel are not heavy users of water work supply. They are able to provide for their own requirements of water for groundwater resources, where public supplies of sustainable quality and reliabilities are not available.

The types of industry that are leaders in industrial development at present, notably the garment industries and tourism/hotels are not heavy users of water. They can provide for their own requirements from surface or groundwater resources, where public supplies of sustainable quality and reliability are not available. They are, however, significant potential polluters of water, and intensification of these industries will require that this matter is addressed effectively. Industrial water use similarly receives little mention in the Socio-Economic Development Requirement and Proposals, although the uses of water could make a significant contribution to Cambodia's industries and commercial buildings.

3.8 Flood management

3.8.1 Flood characteristics and extent within the country

Cambodia is a predominantly rural and forested tropical country, bordered by Thailand to the west, Lao PDR to the north, Vietnam to the south and east, and the Gulf of Thailand to the southwest. About 14% of the country drains directly to the Gulf; the remainder is in the catchment of the Mekong River, which Cambodia shares with Vietnam, Lao, Thailand, Myanmar, and China. The cultivable area is approximately 21% of the total land area; more

than 60% is forested, but the average rate of loss of forest cover is estimated at 0.5% per annum.

With a population of nearly 12 million and a total land area of 181,035 Km^2, Cambodia has a relatively low average population density, by Southeast Asian standards. Nearly 84% of the population still resides in rural areas, and is engaged in agriculture. The Socio-economic Survey of 1997 estimated that 36% of all households are under the poverty line, with 90% of these in rural areas.

The country is hilly to mountainous around its periphery, but the dominant feature of its landscape is the extensive flood plains of the Mekong, Tonle Sap Rivers, and the Tonle Sap Lake (Great Lake). These water bodies are a unique hydrological system. From May to October, when the Mekong level is high, water flows upstream along the Tonle Sap into the Lake, which increases in size from 3,000 Km^2 to 10,000 Km^2. In November, the flow reverses, and water drains from the Lake to the Mekong and thence to the South China Sea - around 475 billion m^3/annum. The Mekong system represents a valuable resource for Cambodia, particularly in terms of fish production, and a future potential for hydropower.

Mean annual rainfall in Cambodia is estimates to be 1,200 – 1,300 mm/year in the Central Plains, 2,000 – 3,500 mm/year in the mountains, and 3,000 – 4,000 mm/year in coastal areas.

The Mekong River discharges more than 432 billion m^3 of water yearly on average through Kratie with an average of 13,700 m^3/s. Flood season is from June to November, with 80% of the annual flow volume and dry season from November to May. At Kratie, the recorded maximum flood discharge is 66,700 m^3/s, and the minimum discharge is 1,250 m^3/s. the historical peak and cumulative peak discharge volume at Kratie has been shown in Table 3.21.

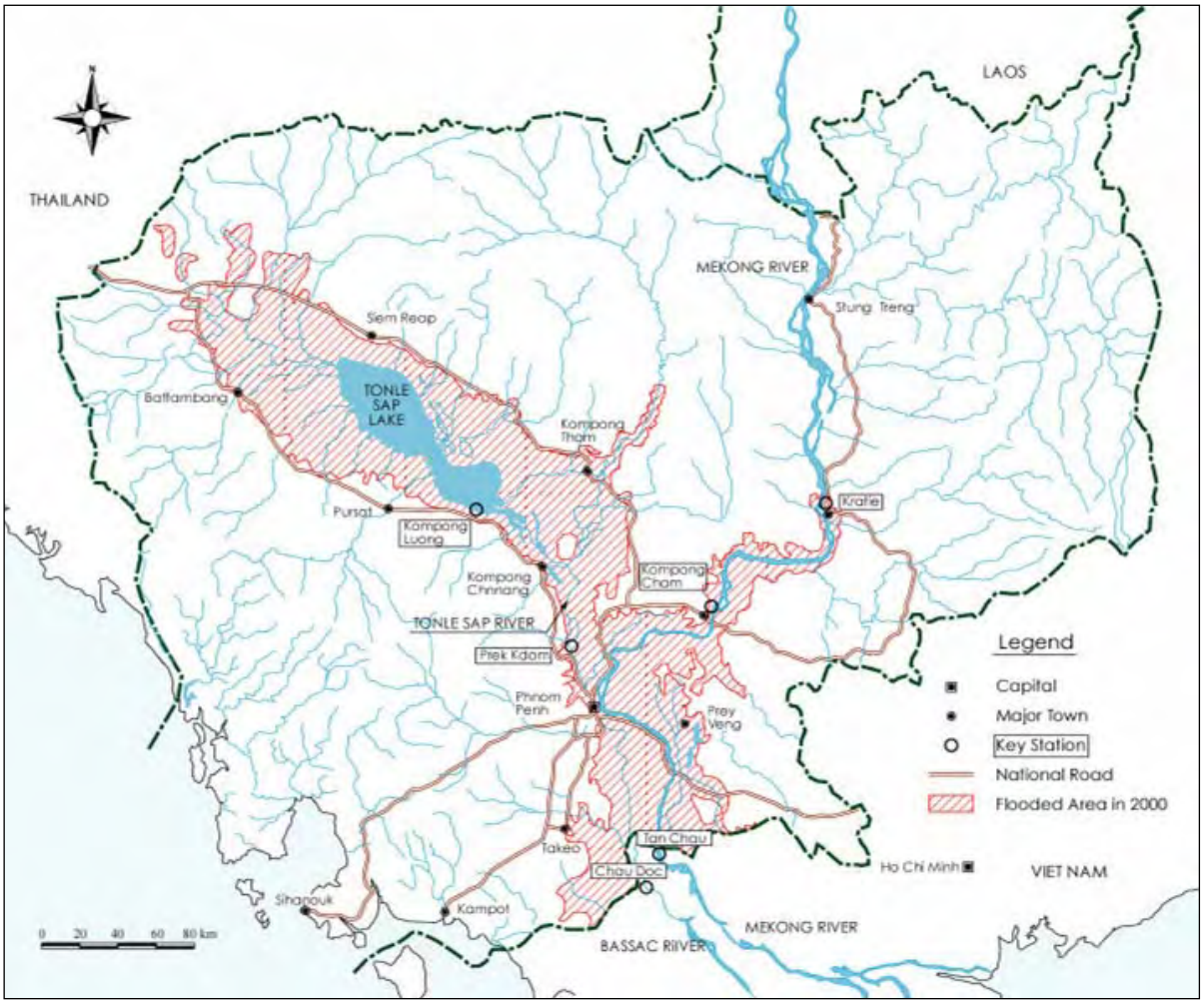
Table 3.21: Historical and Cumulative Peak Discharge Volume at Kratie

Year	Peak discharge	Cumulative peak discharge ($.10^9$ m^3)				
	(m^3/s)	*15 days*	*30 days*	*60 days*	*90 days*	*120 days*
1937	64,400	80.4	146.4	276.2	366.3	423.2
1939	66,700	81.2	143.5	247.5	341.3	396.8
1961	62,400	71.8	135.6	262.7	338.5	411.4
1966	58,600	72.0	130.0	232.7	304.7	353.6
1991	60,800	74.8	138.5	232.2	314.7	356.2
1994	54,400	64.6	122.3	233.5	329.5	387.1
1996	64,600	78.4	130.2	222.9	303.0	366.2

Source: MRC-KOICA, 2000.

The flood traveling downstream from Kratie spread over the riverbanks and the tributaries along the left bank of the Mekong. As water level in the Mekong rises, the water runs through the ungated colmatages to fill the back swamps behind of the colmatage-irrigated areas. The river bank are lower around the diversion to the Tonle Toch and near Roka Kaong, over which the first flood peak in August fills into the back swamps along both sides of the Mekong River in between Kampong Cham and Phnom Penh. When the water level near Roka Kaong rises over 8 m, large volume of flood, over 2,000 CMS at the peak flow rate, traverse from the Mekong to the Tonle Sap through the natural meandering depressions and under a few bridges of National Road no. 6A and 6.

Map 3.1: River network in Cambodia with areas flooded in 2000



During the historical floods, the riverbanks along both sides of the Mekong and the Bassac in Cambodia were overtopped except National Road no.1 and 5. Flood flow inundates all over the low land area over the left bank of the Mekong upstream of National Road no. 1 forming a huge inundation plain leaving the hilly area. In the low land area in between the Mekong and the Bassac rivers, much of the floodwater entering through the colmatages and over the left bank of the Bassac River flows down overland until discharging into the rivers near the border.

The Tonle Sap is filled with water from the beginning of the flood season until the main flood peak reaches at Chaktomuk. For a short time at the peak, the water levels at Chaktomuk and Prek Kdam become almost same and the flow in the Tonle Sap River is stagnant, thereafter until the dry season the Lake continues discharging. It has been estimated that the Tonle Sap Lake reserves approximately 20 to 30 per cent to the total discharge from Kratie during the flood season.

In the flood season the discharge capacity of the rivers in the Cambodian Mekong delta is insufficient and large scale flooding occurs yearly. The flood storage and overland flows start at Kampong Cham. The floods in the Mekong River basin result from a variety of causes occurring from its tributaries and the main rivers as follows:

- Carrying discharge very much in excess of their capacities due to large concentration of runoff caused by heavy rains/or swift movement of waters;
- Backing-up of tributaries by the main rivers at their outfalls;
- Heavy local rainfall synchronizing with spill of rivers;
- Inadequate drainage of low-lying and flat areas;
- Inadequate water passages in roads and railways;
- Silting up of river beds with large amounts of sediment and detritus brought down by the rivers during the monsoon as result of erosion;
- Changes in the courses of rivers which flood in the reaches because of heavy silting up;
- Synchronizing of high tides and upland floods.

The number of hectares inundated land in dry, flood and post-flood period is provided in Table 3.22 below.

Table 3.22: Extent of inundation (ha) in selected provinces of Cambodia in 2000 derived from RADARSAT-1 ScanSAR imagery.

Province	Number of hectares inundated				
(total area in ha)	Dry season (March 16 - 19, 1999)	Cyclone (Oct. 25 – Sept. 4, 2000)	Peak flood (Sept. 23-Oct. 5, 2000)	Post flood (Oct. 19-29, 2000)	Maximum difference from dry season
Stung Treng (1,201,513)	19,308	42,310	41,961	41,427	23,002
Kratie (1,197,280)	24,544	72,950	71,434	55,645	48,406
Kg. Cham (947,392)	25,458	231,665	251,388	236,882	225,930
Prey Veng (476,749)	11,560	263,780	263,136	278,052	266,492
Kandal (356,784)	27,798	244,909	255,655	279,360	251,562
Takeo (349,174)	3,263	162,049	188,498	205,528	202,265
Kg. Speu (696,470)	290	536	471	1,706	1,470
Kg. Chhnang (528,421)	14,544	182,109	185,470	185,060	170,926
Pursat (1,158,839)	287	130,871	142,628	154,667	154,380
Battambang (1,245,111)	2,709	295,248	310,783	324,651	321,942
Siem Reap (1,196,390)	6,744	259,539	229,995	231,316	252,795
Kg. Thom (1,244,673)	12,273	333,138	341,865	349,621	337,348
Total	148,778	2,219,104	2,283,295	2,343,913	2,195,135

Source: MRC, 2001

3.8.2 Socio-economic and environmental issues

Flooding is a major problem severely affects all the Mekong River riparian countries. With the Mekong Delta in Cambodia and Vietnam flooding is more frequent – and the areas flooded are larger.

The most densely settled part of Cambodia is on the floodplain of the Mekong, Tonle Sap, Bassac and Tonle Sap Lake, and Cambodia experiences flooding every year, during August-November monsoon when the Mekong carries flows of up to 70,000 m^3/s at Kratie. The Tonle Sap Lake extends in area from about 3,000 km^2 to 10,000 km^2, storing some 70 billion m^3 of water, and other parts of the floodplain also are inundated and provide, in effect, natural detention storage. Such inundation is an accept part of life in Cambodia, to which the population has adjusted. However, the extent of flooding varies from year to year, in extreme years can impact areas that are settled and developed.

Flooding is one of the critical issues in Cambodia. Flooding has dual effects on the country – negative and positive. Seasonal flooding is very important for increased fishery production, maintenance of wetland ecology, and replenishment of soil fertility with silt and sediment, and supply of water for irrigation. Freshwater fish productivity remains the important source of livelihoods in the rural area and fish constitutes some 60% of protein intake in the Cambodia diet. Large agricultural land around Tonle Sap Lake and in the low Mekong areas has been cultivated with seasonal flooding of the Mekong waters.

The floodplain is essential for fish breeding, feeding and growing. Large fishes utilize flooded forest as shelter for spawning. Fry and fingerling depend on flooded forest for nursing and feeding. Fisheries and aquatic environment in the floodplain are gradually deteriorating due to the development activities leading to a decline in total fish production as a whole. Destruction or degradation of the flooded forest has been linked to declining catches. Since 1973 flooded forest coverage has decreased by 30%. It is reported that the loss of 10% of inundated forest resulted in the loss of 10% of fish production from the floodplain.

The primary productive of the floodplain is mostly associated with higher vegetation in various types of rooted or floating, submerged or emerged plants. A succession of plants develops throughout the flood season with the free-floating, high water plants playing a dominant role in most floodplain. The principal species, water hyacinth, can double every 8-10 days in optimal conditions to clog lake output and induce deoxygenate conditions under the vegetation mat.

Other sources of primary production in floodplain habitats include epiphytic algae growing on the submerged surfaces of higher plants. The densities of these smaller plant, more important as fish foods, reach a maximum in the low water period, but due to the greater available of substrates in the expanded floodplain, total abundance are maximal during the flood. Autochthonous nutrient inputs include plants and other materials falling into waters from above and are most important in inundated swamp forests, particularly around the Great Lake areas and lakes located along the side of Mekong rover bank.

But excessive flooding can inflict damage to the social infrastructure, disruption of economic activities, loss of human lives and livestock, and destruction of cultivated crops. The 2000 floods resulted in damage to some 370,000 ha of paddy rice, destruction of 6,081 houses, loss of 2,444 livestock, and affected 3.44 million people in 132 districts. Subsequent flood in the following years, though in a smaller scale, continue to disrupt the normalcy of economic activities, especially agricultural production. As a result, the rural population is exposed to unstable food security and further impoverished.

Flood hazard is an unavoidable aspect of life in the Central Plains of Cambodia. Some communities, such as the residents of the floating villages on Tonle Sap Lake, have accommodated themselves to flooding. Others, often the poorest people with the last choice of where to live, settle in inherently flood-prone locations, and suffer severe loss when floods eventuate. Phnom Penh and surrounding townships was at risk of flooding during extreme Mekong flows, although embankments protected much of the city in the year 2000 flood, which had no previously been exceeded for over 70 years. Damage by the year 1996 and 2000 floods were estimated to have totaled US$ 86 million and US$164 million respectively.

Floods also create a climate of insecurity and instability to socio-economic systems. In such an environment sustainable development, which builds on long term planning and future-oriented investments, becomes difficult. Better flood preparedness would help to reduce people's susceptibility to floods by providing necessary data on flood hazards and flood occurrences as well as measures to cope with such natural hazards. It would contribute to stabilization of socio-economic systems and allow for a long-term development perspective.

As flooding becomes a frequent phenomenon and causes substantial social and economic damage to the country, country coordination for flood emergency relief and rehabilitation appeared critical. In 1995 a National Committee for Disaster Management was formed by a Sub-Decree, which was amended in 1999 to include all ministries as representative of the committee. The committee is given a broad mandate to deal with country disaster preparedness and emergency response, information system, public awareness and community based disaster preparedness.

Ministry of Water Resources and Meteorology provides a flood warning service based on near real time transmission of observations at seven keys stations, and a Flood Forecasting Model. Forecasts are provided to the Mekong River Commission, Cambodian National Mekong Committee, National Committee for Disaster Management, the Royal Government ministries, and the publics, via news media.

A flood forecasting system is provided by the Ministry of Water Resources and Meteorology that supports emergency response in the Mekong/Tonle Sap floodplains, but not in tributaries that are subject to flash flooding. Few other measures, structural or non-structural, are taken to mitigate the effects of floods. The cost of providing structural flood control for a river the size of the Mekong, the near-impossibility of enforcing land use zoning regulations to prevent settlement of flood-prone area, and the low value of improvement are major impediments to any concerted efforts to mitigate flood impacts.

3.8.3 Trans-boundary issues and opportunities related to other MRC member countries

While the flooding consequences appear obvious, the causal factors linking with flooding do not always have a clear-cut explanation. The reason is due to the limited knowledge and capacity to quantify and qualify the proportion of the effects of several projects according to a spatial and time change. Flooding is believed to stem from deforestation, high rainfall and storms, siltation, hydropower dam, human settlement and modification of natural rivers.

The magnitudes of flooding impact in Cambodia is sometimes higher than the effects of several combined projects as Cambodia does not have enough capacity and contingency plan to deal with annual floods. Besides, floods in Cambodia may be partly induced by flood control projects outside its national boundary. The water release from Yali dam project (and the near future Sesan 3A on Sesan and Dai Link 2 Dams on Sre Pok) is supposed to

contribute to floods in Se San River of Cambodia. Similar effects may be felt by the construction of flood control dikes in the Mekong Delta, as construction can slow down the outflow rate of the rivers.

Specific land-use activities or structural measures in one country frequently impact on flooding in another country. If such issues cannot be solved bilaterally there is a need for a neutral institution to assist member countries in resolving trans-boundary issues. The existing MRC Agreement doest not include any detailed instructions for the Commission and/or the Joint Committee by which processes trans-boundary flood differences should be addressed. There is also lack of continuity and technical expertise to assess aggregated cause-and-effect relationship at the regional level as to provide the decision-making process with essential information for joint and timely actions.

Article 8 of the 1995 Mekong Agreement instructs member states to resolve differences and disputes in the use or discharge of water in an amicable and timely manner and by peaceful means. The parties involved are instructed to determine all relevant facts caused by the state in conformity with the principles of international law relating to state responsibility. Article 18 C further informs that the MRC Council is to entertain, address and resolve issues, differences and disputes referred to it by any Council member, The Joint Committee, or any member State on matters arising under the Agreement.

Article 24 describes the functions of the Joint Committee. Its role in trans-boundary water management is multifold: (i) to implement policies and decisions taken by the Council, (ii) to formulate a basin development plan and identify adjoined projects/programs to be submitted to the Council, (iii) to regularly exchange data and information necessary to implement the Agreement and maintain database, (iv) to conduct studies to protect the environment and the ecological balance of the Mekong River Basin, (v) to "address and make every effort to resolve issues and differences that may arise between regular sessions of the Council", and (vi) to "review and approve studies and training for the personnel of the riparian member countries involved in Mekong River Basin activities as appropriate and necessary to strengthen the capability to implement this Agreement".

It is already identified by the MRC that prevention and resolution of potential conflicts arising from increasing pressure on resources in the Basin is a key task. Likewise, the Water Utilization Program has taken initiatives to establish technical drafting groups where cross-border teams of technical staff and legal experts draft compromises acceptable to all member states and thereby preventing potential contentious issues from becoming real contentious issues.

The draft version of the Law on Water Resources Management in Cambodia in its Articles states that *'Without prejudice to the principle of Cambodia sovereignty, Cambodia has the right to use, develop and manage international river basin on her territory within her reasonable and equitable share, consistent with national environment and development policies and with the obligations stemming from the international agreements to which Cambodia is a Party'.*

The draft version of the National Water Resources Strategy is clearly defined the strategies related to trans-boundary issues to prevent the damage that may occur as a result of floods, droughts, watershed degradation, erosion and sedimentation; to protect aquatic and fish resources. It states that to cooperate and exchange of information with the other Mekong Basin countries, in order to prevent the harmful effects of floods, watershed degradation, erosion, sedimentation and drought that might originate in activities carried out in these countries.

3.8.4 Trends and likely development prospects

The funding for development projects related to water resources has increased in the last 5 years in conjunction with the establishment of the Ministry of Water Resources and Meteorology by the Royal Decree No. 0699/08 on 23 May 1999 with its mandate to overall manage and develop the national water resources. In addition to the projects funded by the Government of Cambodia, several major donors' agencies are focusing on the management and development of water resources sector in Cambodia such as ADB, WB, AFD, Italy, Japan, PRASAC and other NGOs.

Table 3.23 shows the summary of water resources development and management funding status in Cambodia.

Table 3.23: Summary of water resources development funding during 1996-2000

Description	1996	2002	Increase
Government budget (riel)	3,412,274,855	9,119,262,208	5,706,987,353
Loan (US$)	0	49,943,000	49,943,000
Grant aid (US$)	18,200,000	52,459,000	34,259,000
Heavy equipment (unit)	61	125	64
Light equipment (unit)	23	64	41
Irrigated area (ha)	407,000	514,863	107,863
Flood control (ha)	750	13,500	12,750
Inshore water protection (ha)	560	15,390	14,830
Human resource trained (prs.)	190	387	197

Source: MOWRAM, 2002.

The on-going major projects related to water resources development and management is as follows:

- Rehabilitation of irrigation systems destroyed by 2000 flood (ADB&WB),
- Rehabilitation of the Stung Chinit Irrigation Development Project (ADB),
- Construction of the drainage canal to divert the direction of Prek Thnot flood from Phnom Penh (Government & ADB),
- Strengthening of the TSC and Agro-meteorology (Japan),Construction of the Prey Nup Polder dikes (AFD),
- Construction of Kamping Pouy Irrigation system (APS/Italy, FAO),
- Implementation of the Northwest Irrigation Development Project (ADB).

3.8.5 Related plans and policies

The Kingdom of Cambodia is a country that is considered to have abundant water, and has relatively small population and undeveloped economy, but in future years we expect that population growth and economic development will place rapidly increasing demands on water resources. Before these demands become unmanageable, it is essential that the Nation mapped out its vision and policy for the role of water in the society.The National Water Resources Policy has stated its vision for Water for Cambodia as follows:

- Access for all to safe, adequate, and affordable drinking water, hygiene, and sanitation;
- Freedom for all from the threat of loss of life and livelihood as a result of floods and droughts;
- Sufficient water where it is needed, to provide for food security and industrial activity;
- A water environment that is unpolluted, and supports healthy fisheries and aquatic ecosystem.

The fundamental principles for policy formulation based on the constitution of the Kingdom of Cambodia and the draft law on Water Resources Management in Cambodia.The national water resources policy well stated about the management of water-related hazards. Regarding the policies for measures for hazard mitigation:

- Phnom Penh and other localities in which there are very high concentrations of people and/or economic assets will be fully protected against flooding. Other urban or industrial centers with lesser concentrations of people and assets will be provided with levels of protection that are economically justifiable.
- All people and institutions will be encouraged and enabled, by means such as education and demonstration of technology, to adopt flood mitigation measures appropriate to their circumstances.
- All public facilities will be constructed above the estimated 50-year flood level in the particular locality, and will provide for unimpeded drainage.

The National Policy regarding the monitoring, forecasting and warning issues is as follows:

- To ensure that all people and institutions at risk receive early warnings of droughts, floods and storms. It will do this by providing nation-wide meteorological monitoring, forecasting and warning; nation-wide droughts; and hydrological monitoring, forecasting and warning in area at risk.
- To build and extend the hydrological and meteorological databases needed to support appropriate measures for mitigation of water-related hazards, such as delimitation and zoning of flood-prone areas, definition of the frequencies of hazardous weather patterns, etc.

The Water Resources Strategic Plan formulation (2001-2005) is based on principles laid down in the Water Vision for Cambodia and the National Water Resources Policy.The Objective of the Strategic Plan (2001-2005) is to manage and develop water resources with effectiveness, equity and sustainability to assure the healthy ecosystem and minimize the water related hazards to the livelihoods and public property.The draft National Water Resources Strategy is clearly defined the strategies to prevent the damage that may occur as a result of floods, droughts, watershed degradation, erosion and sedimentation; to protect aquatic and fish resources:

- Control of floods and abatement/reduction of the effects thereof,
- Improvement of weather forecasts to ensure timely warning of natural occurrences such as typhoons, floods and droughts,
- Prevention of watershed degradation, erosion and sedimentation,

- Cooperation and exchange of information with the other Mekong Basin countries, in order to prevent the harmful effects of floods, watershed degradation, erosion, sedimentation and drought that might originate in activities carried out in these countries.

The draft Law on Water Resources Management stipulated regarding the flood control and management that:

- *'The Ministry of Water Resources and Meteorology, together with the other institutions concerned, may designate any flood-prone area in Cambodia as Flood Control Area';*
- *'Within Flood Control Area, the Ministry of Water Resources and Meteorology, together with the other institutions and the local authorities, shall plan flood control measures and may impose such limitations as may be necessary to ensure the safety of persons, animals and property';*
- *'The Ministry of Water Resources and Meteorology has the right to prohibit activities that are likely to damage flood protection works or to obstruct the natural flow of rivers'.*
- *'In the event of floods, the Ministry of Water Resources and Meteorology directs, on behalf of the Government, the execution of emergency works'.*

Flood control planning

The project entitled *"Flood control planning for development of the Mekong Delta"* covering Cambodia and Vietnam, which was implemented in 2000 and was undertaken by the Korea Water Resources Corporation (KOWACO) in association with the Korea Agricultural and Rural Infrastructure Corporation (KARICO). The objectives of the project were:

- To determine immediate action plans for flood control,
- To determine long term flood control measures to ensure an appropriate solution for development of the Mekong delta and
- To strengthen the capability of the national agencies concerned in flood control planning.

The short term flood control plans were recommended by the project for Cambodia as follows.

The main philosophy of the flood control plan was *"living with flood and keeping the environment natural"*. It was aimed to 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. The specific recommendations under the short terms flood control plan were as follows:

- Rehabilitation of 42 colmatage canals with gates on the left of the Mekong River from Kampong Cham to Neak Luong.
- Rehabilitation of other additional 14 colmatage canals with gates along the Mekong River and Bassac River.
- Close off the gates until 1st August to protect human lives, infrastructures and crops from early flood.

The long term flood control plan

The key concepts in developing the long term flood control plan for the Mekong Delta is how to allocate or distribute the hue 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 project recommended 5 alternatives of long terms flood control plan for the Delta.

The Poverty Reduction Strategy Plan (2002-2005) has underlined the objectives and strategies related to flood control and management. The main objectives are:

- To reduce the flood-related loss and damage to assets and productive capacity;
- To enable increased production by reducing the flood risk;
- To implement a set of flood mitigation measures.The outlines of flood control strategy for the poverty reduction are:
- Inventories of assets at risk and flood-prone areas,
- Regulation of construction (through licensing),
- Building of flood protection and drainage infrastructure in priority areas both urban and agriculture land (10,000 ha protected by 2005),
- Improve flood warning system in order to reach the vulnerable groups.

The long term flood control strategy:

- Appraise the opportunities for multipurpose dam development and their implications for water resources management and socio-economic matters
- Plan, implement major flood control, and assess the impacts of structural measures
- Implement flood management and mitigation

Table 3.24: Alternatives for a long-term flood control plan in the Mekong Delta

No.	Alternatives	Objectives	Flood situation	Purpose of flood protection	Alignment
1	Diversion canal with dikes from Takeo to the Gulf of Thailand (west Bassac River area in Cambodia)	Flood control Development of agricultural production Navigation Industrial center Tourism	Heavy rainfall in the mountainous area of western Cambodia Bassac River flooding caused by high water level of Mekong River Long duration of inundation	August & October flood of Bassac River Flood by highland rain Drainage	Kandal – Takeo – Gulf of Thailand
2	Diversion canal with dikes from Kampong Cham to Tonle Sap River (Tonle Sap area)	Flood control Development of agricultural production Navigation Fish migration	Serious flooding caused by high water level of Mekong River Long duration of inundation	August flood of Mekong River Drainage	Kampong Cham – Tonle Sap River
3	Diversion canal with dikes from Neak Luong to West Vaico River (East Mekong River area in Cambodia)	Flood control Development of agricultural production Irrigation water supply	Serious flooding caused by high water level of Mekong River Long duration of inundation	August & October flood of Mekong River Drainage	Neak Luong – Prek Trabek River- West Vaico River
4	Gated colmatage canal system in Cambodian Delta	Flood control Development of agricultural production Irrigation water supply	Serious flooding caused by high water level of Mekong and Bassac rivers Long duration of inundation	August & October flood of Mekong and Bassac Rivers	Along Mekong and Bassac rivers
5	Main canal with dikes from Sarai to Thanh Hung in Vietnam	Flood control Development of agricultural production Irrigation water supply	Serious flooding of plain of Reeds caused by overland flow from Cambodia Long duration of inundation	August & October flood of Mekong River Drainage	Sarai – Tram Chin-Thanh Hung

Source: MRC-KOICA, 2000.

3.8.6 Conclusion

The water sector as well as flood control and management sub-sector is unique, because the so many sectors of the Nation's economy and society depend on water. Successful implementation of the national water resources policy, strategy and other water related laws and regulations would require active involvement of many organizations, as well as the many millions of people who direct use of and get impacts from water. In particular, there must be:

– Commitment from line ministries and provincial departments to taking the actions needed to achieve the aims of the policy, strategy which related to flood control and management.

– Support from international organization of investments that will achieve water resources development and management that achieves the nation's goals for socio-economic development.

A comprehensive flood management and mitigation strategy is urgently required for Cambodia, as a framework inter alia for investments in response to the major flood of 2000-2002. This must be based on an accurate assessment of the communities and assets at risk and the realistic (financial and social) costs of flood damage in the future. The strategy should include the full range of measures (i.e. structural such as flood embankments and non-structural such as flood plain zoning) that might be realistic for Cambodian circumstances, and necessarily will be long term in nature. The strategy will need to address a range of related matters, including land drainage, regulation of construction and other activities on river/lake beds and banks, and the regulation of obstruction and infilling of water courses that might cause flooding upstream. Road and railway embankments have an important influence on flood flows and inundation.

3.9 Watershed management

3.9.1 Introduction

The majority of Cambodian economy depends on agriculture and the natural resources based fisheries and forestry for their livelihoods and economic growth. The water resources used for hydropower production have yet developed so much, but the water resources are highly important for agriculture and fisheries.

Recent studies indicated that the severity of the forest situation about 70 000 ha per year were deforested during the period from 1973 to 1993 and it increased up to 180 000 ha per year in the period from 1993 to 1997. There will be increasing severe impact on biodiversity and watershed control, if the situation continuing. The multiple use of forest in the form of fuel wood collection, agricultural encroachment development land conversion, is also important cause of deforestation in the watershed areas.

The resulting reduction in crop yields because of soil erosion and increased flooding may dramatically increase poverty in the rural areas. A related problem is that the fish catches, a vital sources of protein un the diet are plummeting because of combine effects of habitat loss in the inundated zone of the Tonle Sap, over exploitation, destructive fishing practices and agrochemical pollution. Moreover, the environmental impact of industrial and infrastructure investments would bring more concerns.

Watershed management is very crucial component for improving the natural resources as well as with intention of improving people's livelihood. This paper provides an overview of the watershed and its management in the Cambodian context. It discusses briefly the country profile, the overall situation of the watershed management including concept, classification, natural resources and status, policy, legal framework and involved institutions, and how projects/programmes are implemented. Finally, an analysis is done on challenges, opportunities and constraints for a sustainable management of the natural resources, and ways for improvement.

Definition

A watershed is a topographically delineated area from which rainwater drains as surface run-off via a specific river or stream to a common outlet point (e.g. a large river, lake or the sea).

Depending on their location and size, various types of watersheds can be distinguished, ranging from micro-catchments and sub-catchments to larger watersheds and river basins.

Watersheds are used as planning and implementation entities in connection with natural resources conservation, sustainable water supply for hydropower and irrigation schemes, development and protection of upland areas and for the mitigation of up-stream cause and downstream effect relations.

Watershed management is defined as a coordination process of natural resources management in the area of catchments, in which:

- The resource utilization is based on participatory planning, implementation and monitoring;
- Involving multi-stakeholders;
- Recognizing decentralized decision making, transparency, and good governance as guiding principles; and
- Aims at poverty alleviation by maintaining ecological balance.

The overarching goal of government is to promote sustainable use of natural resources and sound environmental management. The challenges include rapidly increasing population pressures and economic development that result in widespread degradation of the natural resource based. Another major issue is unsustainable and poorly managed of natural resources, by both commercial interests and poor rural households.

Watershed classification

Watershed classification in the LMB derived from to slope, landform and elevation (MRC, 1997). It reflects suitability of different land uses.

Table 3.25: Watershed classification

Class	Type of surface	Area (ha)	Percentage
1	Protection forest	84,300	1
2	Commercial forests	538 887	3
3	Agro-forestry	889 325	6
4	Upland farming	2 731 437	17
5	Lowland farming	11 373 956	73
Total		15 618 563	100

Source: MRC, 2000.

Class 1: is the area with very sleep slopes and rugged landforms, commonly upland and headwater areas. There are critical watersheds, at risk of erosion and degradation. The existing land uses based on traditional right and practices should be considered with regards to their impact on water and soil erosion.

Class 2: is the area with the steel slopes, usually at higher elevation. Landforms are in general less susceptible to water and soil degradation than under class 1.

Class 3: is the area with moderate the steep slopes and less erosion landforms, including upland and foot zones of slopes. Wider range of land use tolerable than in WSC class 1 and 2 from point of view of water and soil conservation. May be used for commercial forest, grazing and combinations of trees and agricultural crops.

Class 4: is generally slopping lands. There are moderate needs for water and soil conservation depending on local conditions. Wide range of land used possible from point of view of water and soil conservation of agriculture and forest.

Class 5: Are generally slopping lands and flat areas. Suitable for wide rage of land use for paddy rice, other agricultural uses and forest.

In Cambodia, there are four regions of watershed:

- The upper Mekong region with nine catchments;
- The western Tonle Sap Lake with eleven catchments;
- The northern Tonle Sap Lake with 15 catchments; and
- The costal area with ten catchments.

The priority catchments in Cambodia are Se San, Sre Pok, Se Kong, Stung Pursat, Stung Mongkul Borey, Stung Sreng, and Stung Sen catchments. Several important watersheds have outlets in Cambodia and their headwater in other countries (e.g. Se San, Sre Pok, Se Kong, Stung Mongkol Borey and Stung Sreng), while many others are wholly within Cambodia (e.g. Stung Pursat and Stung Sen). The Royal Government of Cambodia has been working with MRC and other organizations in promoting watershed management projects and programs to manage and protect these watersheds.

3.9.2 Status for watersheds

Land tenure and land use

The land covered by forest accounts for 59% of the total Cambodia's land of 181, 035 square kilometers. The woodland/grassland is 15%, agricultural land covers about 23% and wetland/water is 5%. Soil types vary from catchments to catchments. Up to now, more than 20 soil types have been identified. The expanding of agricultural land has recorded an 8.14% increased over the 1990s; this presents an average growth rate of 1.63%, which is considerably less than preceding years. Land used regulations is not permitted yet in many up land areas by the Government.

Water and water use

The total Cambodia's catchments area is 155,000 km, which is 86% of the area of Cambodia, and 19% of the area of the Mekong Basin. The average flow from area is 2,860 m^3 per second, about 18% of the total flow. The renewable internal water is 88 Bm3/year, and the river inflow is 410 Bm^3/year.

The total water demand is 0.5 Bm^3/year and the internal water supply is 1,004 m^3/person. Water for domestic use is 5%, industrial use 1% and agricultural use 94%. These figures will change due to future development in the LMB that bring about changes in the river hydrology. Groundwater is another potential resource for domestic use in crop irrigation.

The Ministry of Water Resources and Meteorology (MOWRAM) has established policies as follows:

- The increase in the area and intensity of irrigated agriculture;
- The development of drainage systems and protection dykes;
- Data collection and studies to ensure integrated management of surface and groundwater quantity and quality;
- Improved weather and hydrological forecasts related to disaster management; and
- Rehabilitation and construction of small, medium and large-scale irrigation schemes.

Forests and forest use

Lower Mekong Basin forest covers 22 million ha (36% of the LMB) (FCMP, 1999). In Cambodia with population density of 21/km^2, about 40% to 60% covered by forest, which is better than Thailand and Vietnam, with the population density of 128 and 224 person/ km^2 and have only 16%, and 25% forest cover respectively.

According to the ecosystem of the watersheds, there are different types of forests with different categories of wood. For examples, evergreen forest accounts for the largest portion of forest which covers about 13 million ha (59%). The other kinds of forests include deciduous forest, mixed forest, secondary forest, flooded forest, and flooded secondary forest, which are found in the western Tonle Sap Lake catchment.

According to the MRC/GTZ forest cover Monitoring Project, deforestation rate in the lower Mekong Basin declined to 0.5% per annum between 1993 and 1997, except Cambodia where it has been increased by 13% (FCMP, 1999). A large percent of the people draw a significant proportion of their livelihood from forest resources, such as food gathering, Non-Timber Forest Products, and fuel wood collection.

Deforestation can therefore seriously affect the water regime and water quality as well as the livelihoods of the people living within the catchments. Forests are also of enormous indirect value by virtue of the role they play in averting environmental degradation of landforms and watersheds.

Another important component of the forestry industry is NTFP harvesting. The NTFP category encompasses a wide range of forest resources including wildlife, wild fruits, medicinal plants, resins, gums, precious woods, rattan, and bamboo. Demand for these products is growing throughout the LMB and in China, leading to increased income earning opportunities for forest dwellers, but also creating a danger of unsustainable resource use. While such products are not included in official forest valuations, they comprise important primary and secondary earners of income for large numbers of people, as well as back-up food and cash-income sources for farmers during poor harvest years.

Socio-economic and cultural forest function

The forest in Cambodia as well as in the lower Mekong Basin is classified into three broad categories according to their principle function. Classification is based on geophysical factors: elevation, slope, and landform, and its ecological and environmental value. Generally forests with unique ecological, habitat of recreational value (caves, waterfalls, saltlicks, cloud forests or remnant lowland dipterocarp forest) are classified as conservation forests or protected areas. Generally, forest productions are located on steep slopes or at the head of

important watersheds, where watershed production values exceed their value as sources of forest products.

Rural residents regularly use the forest to obtain food and medicine as well as households uses the forest to obtain cash income. Forest conversion, logging and watershed degradation on a wide scale can endanger food production and foraging off-takes. This will cause negative impacts on woman of upland ethnic minorities, as well as those of low land agricultural who practices irrigate paddy production in their rice fields and supplement their diet with forest foraging.

Other resources found in the Cambodian watersheds are wetland products such as fish, vertebrate, plants, birds, animals, insects, and mines. These resources provide sources of food and income generation to large population of Cambodia, particularly the rural poor and maintain the function and balance of the ecosystem.

Environmental aspects

Deforestation, is causing increasing water runoff, soil erosion, siltation of rivers and wetlands, increasing rates of occurrence and severity of floods, landslides and droughts, loss of bio-diversity, fisheries depletion, and damage to agricultural and irrigation systems.

Deforestation is of particular concern in vulnerable watershed areas – those with land on steep or very steep slopes at high elevations in the headwater areas of the river system. A recent MRC study found that deforested critical watershed areas covered 3.5 percent of Cambodia.

Other manmade factors that impact on watershed are the hydropower development in the upper stream, the problems of irrigation systems, and the chemicals use in agriculture. These actions resulted in loss of biodiversity, runoff and the sedimentation, soil salivation, bank erosion, flood and affect the water quantity and quality.

3.9.3 Institutional framework

Policy and legal framework

A Royal Decree on watershed management was established in January 1999. The Ministry of Agriculture, Forestry and Fisheries (MAFF) is an institution carried out on forest management activities in all watershed catchments. This intention is to ensure the forest resources to be managed in a sustainable way in order to protect soil erosion, flood, landslide, etc.

According to the data of watershed classification above, it has shown that slope bigger than 30 degree covers the areas of 61,015 ha (0.3% of total area of Cambodia) and watershed class 1 and class 2 cover only about 5.8%. Most of the headwaters are covered by evergreen forest, semi-evergreen forest, deciduous forest or wood and scrubland. It is estimated that only 7.8% of people are living in the vicinity of the headwaters and more than 90% lives in the floodplain.

The Department of Water Resource Management and Conservation in the Ministry of Water Resources and Meteorology has drafted a Sub-decree on watershed management, which is focusing on the water supply function of watersheds. The Department of Forestry and Wildlife, on the other hand, planned to prepare another Sub-decree on WSM. Other legal

instruments regarding the water resources and watershed management are being prepared by the MOWRAM and MAFF.

Major legal and policy documents

The major legal and policy frameworks regarding the watershed management are as following:

- Land Law (endorsed in August 2001);
- Law on Commune Administration Management (endorsed in August 2000);
- Law on environmental protection and natural resource management (endorsed in November 1996);
- Forestry law (already submitted to Council of Ministers in July 2001, but has not yet passed);
- Sub-decree on Community Forest Management (final draft elaborated February 2002);
- Sub-decree on forest concession management (signed by the Prime Minister in February 2002);
- Law on water resources management – exists in draft form;
- Decentralization and Devolution Policy of the Ministry of Interior;
- Five-year Socio-Economic Development Plan (2001-2005); particularly relevant on 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 Peoples' Development, also called "Highland Policy" (Sept. 1997) (not yet ratified by the Council of Ministers); and
- Forest Policy – currently being drafted by a national working group.

Decentralization

The Government of Cambodia has started to implement its policy of decentralization with the establishment of village and commune development councils. Major tasks of these councils will be the establishment and implementation of participatory development plans that are supposed to be aggregated with district and provincial plans. This planning process and the institutions involved will be of critical importance in watershed management and planning.

Institutions involved in watershed management

There is a multitude of government institutions in Cambodia that are relevant to WSM. The major ones are MAFF, MOWRAM, and MLMUPC.

The Government institutions that are involved in WSM include:

- Department of Forestry and Wildlife (DFW), Ministry of Agriculture, Forestry and Fisheries (MAFF);
- Department of Agronomy and Agricultural Land Improvement (DAALI), MAFF;
- Planning and International Co-operation Division, MAFF;
- General Department of Land Management and Urban Planning and General Department of Cadastre and Geography, MLMUPC;
- Department of Water Resources Management and Conservation, MOWRAM;
- Department of Nature Conservation and Protection, MOE;
- SEILA Program;
- Ministry of Rural Development;
- Cambodian National Mekong Committee;
- Council for the Development of Cambodia; and
- Inter-ministerial council to oversee ethnic minority development.

There are supports from multi-lateral and bi-lateral donors such as ADB, Belgian Government, DANIDA, EU, German Government, Swiss Government, UNDP/UNOPS and WB; non-governmental organizations including CIDSE, Concern Worldwide, NGO Forum, OXFAM GB, RECOFT, World Wide Fund for Nature; Research Organizations such as DFW/Research Institute for Forest and wildlife, the Royal University of Agriculture, Royal University of Phnom Penh, Cambodian Development Research Institute, and IDRC; and Networks active in the NRM sector such as the Community Forestry Networking Group, Sub-Group in Natural Resources, and Environment Working Group of the NGO Forum.

Priorities and long-term objectives

The National Environmental Action Plan of Cambodia has identified objectives for the period of 2001-2005, including strengthened protected areas management, and enhanced forest concession management and improved management of the Tonle Sap ecosystem.

Priority investments include:

- Protection and management of critical wetlands;
- Forest monitoring and reporting; management of protected areas;
- Preparation of a biodiversity strategy and action plan; and,
- Tonle Sap biodiversity conservation.

Longer-term objectives include:

- Protection of surface water quality from point source and non-point source pollution;
- Minimization of changes in hydrological regimes from planned hydropower and water diversion schemes;

- Increased forest area cover and plant species in protected areas; rehabilitation of aquatic ecosystems;
- Rehabilitation and sustainable management of wetlands; and
- Prevention of biodiversity degradation and protection of rare and endangered species.

Programmes and projects

There is a multitude of projects or programmes in Cambodia promoting participatory planning approaches, which attempt to integrate natural resources management (NRM) issues in a local planning process. There are numerous examples of community-based NRM, such as community forests and fishery schemes managed by local committees, while participatory land use planning and land allocation according to the new land law has just started. As many of these projects are supported by international and local NGOs, most of them are on a small scale, covering from 5 to 20 villages. More widespread and more holistic approaches to NRM can only be found in Siem Reap (FAO-supported), in Ratanakiri (SIDA-supported) and in Kampong Thom (GTZ-supported). Yet, none of these projects has a watershed perspective.

In November 2001, the national SEILA Task Force prepared a project proposal to DANIDA for a watershed management project in the Stung Pursat and Mongkol Borey areas (Provinces of Pursat, Battambang and Banthey Meanchey). The idea behind this proposal is to combine watershed management activities with the existing decentralized planning and implementation mechanisms created by the SEILA programme in line with the NRM mainstreaming strategy of SEILA. The expected outputs and activities of this project have numerous similarities to the output 3 (WSM planning and implementation on the local level) of the AIFP WSM component of the MRC, but within the framework of a bilateral project. Due to present budget restrictions it is doubtful whether DANIDA will be in a position to start funding the bilateral WSM project within the coming 2 years.

3.9.4 Issues and challenges

Poverty and environmental degradation

The development objective of watershed management is to increase participation of all relevant stakeholders in natural resources management for economic growth. There are compromised by unsustainable and exploitative forest used and unconsidered conservation activities, example unsustainable land use, changes in land availability. These force lead to intensified use of remaining land and decreasing fallow periods by the lack of in cooperation of local needs to break the poverty. Generally, there are outmoded to effective enforce sustainable management of natural resources in watershed areas. Due to the low priority accorded to watershed management in National development agendas.

Inadequate benefit sharing

The cost of watershed deterioration should be evaluated in terms of benefit to public and private sector downstream interests. Increase watershed protection ensure a regularity and predictability of water flow that is vital for the continuance of agriculture and aquaculture activities development downstream to ensure certainly of local livelihoods and present conditions for improvement in crop production.

Severe limitations have been discovered regarding studies on the downstream effects of alterations in water regimes. There is a dearth of research on the topic and such studies as do exist arise from impact assessments associate with hydropower projects. Therefore, a pressing needs to studies of down stream effects on deforestation.

Attempts to value forest benefits, generally fail to capture non-market benefits such as soil and water conservation. The failure to value the external benefits of forest, and to distribution market benefits to local people, adds to the pressure to clear forest and convert them to agricultural purposes, which is benefit directly to local communities. To combat this trend, efforts are being made to increase local return for interest in protecting and managing forest. These include: (i) secure land tenure and resources rights for local populations; and (ii) allowing for controlling and sustainable harvest of wood and non wood products from forest (including those signaled as watershed protection forest).

Land use planning and conflict resolution

The Royal Government of Cambodia has over rights and responsibility for managing land. Traditionally, the local people are free to use the land. As result, the forest become more vulnerable to open-access, common property problems, due to tribal heads no longer have any strong reason to try and limit shifting cultivation or timber operations

Problems often arise in identifying the current extent of forests, due to the unreliability of survey data, owing to problems of data collection and collation. The fact that there are often several sources of land used data further complicates interpretation of land use. Accelerate some forms of maps and data should be available to ensure transparency in the land use planning and other stakeholders to participate and joint input. There should be the mechanism to ensure access to appropriate data.

Recently, Government has identified forest from land use/agricultural capability maps; the boundary is indistinct and subject to dispute, unless the detail ground surveys are conducted. Furthermore, the extent of village land demand increased. Local community based land use planning is often not clear and subject to change over time as the village land demand increased.

Local community based land use planning often facilitates conflict resolution among villages. The highly centralized, remote and often inappropriate nature of policies and institution which government natural resources exploitation and rural development lead to risk difficulties and number of failed rural development project the result were not imbalance in wealth and opportunities between rural and urban areas, and increase tensions between and within different groups.

The establishment system of predictable land use planning and land market role focus on the provision of information, jurisdiction of border disputes, enforcement of property rights and valuation and assessment of land for tax purposes. The Government's role in land use decision should be set in a wide range of policy and guidelines. On the other hand, the responsibility for forest resources administration has been devolved and the role of the Government function should be limited to policy setting, research and other higher level function.

Participation in forestry and watershed development

- Resettlement migration is increasing. New village are formed with a heterogeneous population, which has an impact on participation approaches;

- Mistrust of people (based on experience) that forest authorities, police, powerful leaders and other will reap the benefits from selling the trees and/or forest products grown by the community;
- People will only be interested in participation of long term improved resources management if they believe that any short term sacrifices and change to their current land management practices will be ultimately justified in terms of better lives for themselves;
- Lack in PRA methodology and gender assessment studies (GAS) by the Government staffs; and
- Change of fundamental staff attitude in decision making and planning and awareness rising.

Hydropower and irrigation development

The 4,800 km long Mekong River has a vast hitherto largely untapped potential for hydropower development. So far 11 projects have been completed with a total distal led capacity of 450 MW, which among of less than 5% of the hydropower potential (MRC, 1997). While the majority of dams have been built on tributaries of the Mekong, two dams are currently contributed on the Mekong proper (Manwan and Daochaoshan built on the upper Mekong in Yunan Province, PR of China). With approximately 18% of the Mekong annual flow originating from China, these two dams could seriously affect the hydrological and ecological conditions of the Lower Mekong.

In 1970 the interim Mekong Committee presented its indicative plan by the water resources planners estimated the hydropower potential of the lower basin alone up to 37,000 MW, of which 51% in Lao PDR, 33% in Cambodia and the other in Thailand and Vietnam. The plan called for a cascade of 7 dams to be constructed on the Mekong River main stream. Due to years of geo-political instabilities, implementation of this plan was severely disrupted. The Asian development Bank (ADB) is currently funding a feasibility study for 6 large hydroelectric dams in the Se Kong – Se San River Basin.

Environmental management and monitoring plans for reservoirs generally call for strict protection of watersheds to prevent rapid salutation of reservoirs, which could threaten the economic feasibility of the dam. Storage reservoirs attract local community to settle along the reservoir's shore in pursuit of their fishing activities. In up land farming in areas which are often classified as WSC I or II areas, with all the negative ramifications on soil erosion and increase sedimentation load build buildup, thereby reducing water flow and lower electricity generation.

Challenges

The concept of watershed management in Cambodia is new, and the policy and strategy are just emerging. The water resource is available, but has not been made usable to satisfy the demand of the population and development. While at the same time, the water quality is increasingly affected by the development in the upper stream and unsustainable practices and management within the country.

There are not much lessons learned about the impacts of WSM in Cambodia. However, it is possible to comment that the watershed management is suitable strategy for resource conservation and economic growth, because it is a system wise management, it is planned

and implemented through participatory approach, and involve important stakeholders, particularly, direct users.

The main problems encountered are that the concept of watershed management has not been clear to the policy makers and resources users. Laws and regulations for resources protection and conservation have not been effectively adopted. However, opportunities for project implementation are provided. For example, the integration of WSM in the development planning of SEILA program, the policy of decentralization, the networking through ADB/GMS, and the supports of many donors and international organizations.

Donor support

There are 26 forestry and watershed management projects in Cambodia with a total amount of TA funding of US$ 70 million. The main focus of international funds projects in Cambodia as well as LMB region is to improve approaches to forest management and conservation, which include:

- Review and consolidation and monitoring of forest resources;
- Formulation and implementation of an appropriate institutional and regulatory framework for implementation of forestry and watershed management policy;
- Implementation of national program in: (i) forest inventory; (ii) monitoring and sustainable of forest resources; (iii) monitoring and enforcement of forest operations; and (iv) community forest based rural development; and
- Human resources development program for the successful implementation.

3.9.5 Conclusion

Catchment management as a concept is some what understood at local level, but its meaning becomes more varied and is more difficult to clarify at the large watershed and trans-boundary watershed levels. At present, there are many activities that are promoting local-based planning which integrate NRM issues into the planning process, and the government has plans to spread such activities nationwide. Nevertheless, as the scale of planning increases, political planning boundaries dominate those of watersheds.

When development activities are community-based, it needs watershed management that focuses on more than the management of natural resources. Other aspects such as non-formal and formal education, health, income generation and so on are interrelated with the community-based resource management. Therefore, there is need to establish linkage and support from other sectors of development.

Given limited capacity and resources at the government and community levels, greater skills and knowledge are needed for all to support the development. This is especially true regarding newer planning approaches such as catchment-based planning, and management. At the same time, there are lessons from the community-based natural resource management to be learned for these new approaches.

4 Lao PDR

4.1 General

The longest river in Southeast Asia, a geographic spine for the subregion, the Mekong, over a total of 4,800 km, with its length of 1,760 km is winding throughout the Lao People's Democratic Republic. Its tributaries contribute the biggest share of some 5,270 m3/s equivalent to 35% of the whole river runoff . The 202,000 km2 catchment area covers nearly 90% of the national territory or one quarter of the entire Mekong basin. These mere figures show the significance of the Mekong River to the country and its population.

The Mekong is considered as one of the most important resources of the country to harness in order to achieve the target that has been set since 1996 when the 6th Party Congress defined long-term development objective as freeing the country from the status of least developed country by the year 2020. This will be achieved by transferring the nation from a natural resource based economy to an intensive economy, a goal re-emphasized and strengthened in 2001 by the 7th Party Congress and the Government's Fifth Socio-Economic Development Plan (2001-2005). This has the following objectives:

- 7-7.5% annual GDP growth
- 4-5% annual growth for agriculture
- 10-11% annual growth for industry
- 8-9% annual growth for the service sector
- Agriculture and forestry products cover 47% of GDP
- Industrial products covers 27% of GDP
- Single digit annual inflation
- Stable exchange rate
- Increased annual budget revenue: the budget revenue should be 18% of GDP by 2004-2005. The budget deficit should be around 5% of GDP
- Reduced trade deficit to 6% of GDP
- Public investment covers 12-14% of GDP and saving should be about 12% of GDP in 2005
- In 2005, the population would be around 5.9 million, and the GDP per capita should be US$ 500 to 550.

For the development in Lao PDR, the basic principles adhered to poverty alleviation such as: social equity, gender equality, environmental sustainability, technical feasibility, economic viability and good governance.

All these targets and principles are translated directly or indirectly in the eight sectors to be reviewed in this study.

4.2 Agriculture and irrigation

As the agriculture and forestry sector provides the economic livelihood, the social and cultural base for more than 80 per cent of the population, and accounts for about 53 per cent of GDP, it constitutes the highest priority for the Government of the Lao People's Democratic Republic. The challenge facing the Government is that subsistence farming

remains widespread, characterized by low inputs and low outputs, with the result that farming incomes are very low, especially in the poorest districts.

The Government is earnestly striving to modernize this sector to fully meet sustainable practice, and that achieves food security and better livelihood for all Lao people, while respecting and protecting the traditions of the Lao way of life and the rich diversity of its ethnic minorities. The goal of poverty eradication and graduation from Less Developed Country status depends on a more productive agriculture and forestry sector.

The Government's Strategic Vision for the Agricultural and Forestry Sector includes seven key themes as follows:

1 Participatory planning, as to ensure sensitivity to local needs and circumstances. Village and district level action is the main catalyst for growth of the agricultural sector.

2 Lowland transformation to help expand commodity export.

3 Sustainable development of sloping lands and environmental management.

4 Stabilization of shifting cultivation.

5 Expansion of irrigation; schemes are being managed more effectively and new projects are expanding the area under irrigation.

6 Human resource development to improve participatory planning, extension techniques as well as understanding of the market system and role of the private sector.

7 An enabling environment for business development promoting economic growth with equity.

Within the overall context of the Government's policy in the agricultural and forestry sector in general, the development of irrigation constitutes one of the essential components of this Strategic Vision. However, this sector has its own constraints.

To accommodate the agricultural development envisaged by the socio-economic development programs, the Ministry of Agriculture and Forestry has formulated six programs to be translated into specific plans, projects and activities. The six programs can be summarized as follows:

1 **Food production program.** The Government considers achieving food self-sufficiency to be an important prerequisite for improving the living standards of the people. Food self-sufficiency will improve both the quantity and quality of food consumption and reduce the instability of availability.

2 **Commodity production support program.** The purpose of this program is to develop the agro-processing sector to provide income opportunities at the local level and increase the value-added of export commodities. The commercial crops to be included are: rice, maize, soybean, groundnut, sugar cane, vegetables, tobacco, cotton, coffee, and fruits.

3 **Stabilization of slash and burn cultivation.** One of main priorities of the government is to stabilize slash and burn cultivation because of the serious negative

environmental effects of these farming systems. These farmers will be encouraged to take up alternative economic activities such as planting trees, animal husbandry, food and/or cash crop production in the mountain plains, wage in processing factories, or trading. To facilitate the resettlement, the Government must guarantee farmers access to the necessary financial and technical support in area such as land clearing and construction of irrigation schemes.

4 **Irrigation development schemes.** This program is aiming at: to increase rural incomes and stabilize rice availability by expanding irrigated area in both the wet and dry season, and to improve the operation and maintenance of the existing irrigation schemes. Construction of small-scale community based irrigation schemes and water wells for households will be emphasized. These can limit the effect of droughts, can be used for domestic consumption and horticulture production, and solve the problem of seedbed preparation. Effects will also be made to mobilize loans and grants to invest in medium and large-scale irrigation schemes in high potential area. Reaching the targets is thus a joint effort between the State and the communities.

5 Agriculture and forestry research program. The objectives of this program are: to conduct survey of agriculture and forest land, the water resources in order to prepare master plans for land use and agricultural development. Especially in the northern provinces, to rehabilitate existing research stations or centers and expand research activities to new area, and to cooperate with research institutes abroad especially in the field of improved seed varieties and their multiplication, and in the sector of meteorology and hydrology.

6 Human resources development program. The objective of this program is to upgrade the technical and political skills of the staff in the Ministry of Agriculture and Forestry. The development of an effective extension service at the district and provincial level is particularly important. Extension staff should be trained in a technical field and be able to transfer information and technology to the farmers. Lack of sufficient skilled staff is an important constraint in all sectors of the Lao economy.

4.2.1 Constraints on irrigation works

Physical constraints

Laos is an essentially mountainous country with 80% of its areas situated above 200 m, while the remaining is made up of plains along the Mekong River and its tributaries. Heights are improper to agriculture with its excessive humidity causing a general deficit in rice; this is different from plains along the Mekong River and its tributaries where irrigation can be conveniently be built up and soil is most favorable to cultivation.

Climatic constraints

Two seasons alternate with variation of temperature between 18 and 21 degree Celsius in the dry season and 25 to 28 degrees Celsius during the rainy season between June and October. This is accompanied by a change in the humidity from 30% to 98% and rainfall from 1300 mm in the northern area to 3700 mm in the southern plain. The maximum rainfall would intervene from July to August.

However, in some years with uneven rainfall, the need for irrigation to supplement insufficient rainfall varies from 5000 m3 to 7000 m3 per hectare depending on areas. When drought strikes, irrigation becomes the only means to sustain the rice cultivation as well as the cultivation of other crops that would require water from the river around 17,000 m3 to 20,000 m3 per hectare.

Plains are watered by the Mekong River as well as other rivers such as Nam Ngum, Nam Ngiep, Nam San, Se Bang Fay, Se Bang Hieng, Se Don, Se Kong. It is not unusual that drought strikes these areas at the beginning and at the end of the cultivation season. While during the rainy season, the river water level is rising rapidly, specially between July and September causing severe floods such as in 1966, 1968, 1970, 1971, 1974, 1978, 1990, 1991, 1995, 1996, 1998, 2000, and 2002 with loss of live and materials as shown the following available figures:

Table 4.1: Floods in Laos

Year	Damages (in US$ millions)	Areas damaged
1966	13.80	Central Laos
1976	9.00	North Laos
1978	5.70	Central and South Laos
1993	21.00	Central and South Laos
1994	21.15	Central and South Laos
1995	35.50	Vientiane Plain, Central and South Laos
1996	21	Central and South Laos
1998	3.50	Central and South Laos
2000	5	Central and South Laos
2002	3.50	North, Central, South Laos

Single cropping per year, and dependency on rainfall.

The Lao People's Democratic Republic has invested in building-up irrigation schemes aiming at meeting needs in water for agriculture as well as household use. However, the efficiency of irrigation projects carried out is still low. The designing, the preparation, the maintenance and management are not up to standard causing the agriculture to still be of one harvest and essentially dependant of erratic rainfall.

4.2.2 Governmental policy

Irrigation within the Government policy to lift the country off the less developed status in 2020

In order to achieve this goal, the Government has adopted five working plans regarding food production as the Government set the year 2000 to bring the country into food self-sufficiency. Such an ambitious target can be attained only through the consolidation, expansion, maintenance, and efficient use of irrigation. Such a target will be more difficult to be attained in the remote provinces of Laos' upland. The four other working plans are about commodity production, limitation and eradication of shifting cultivation and environment protection, comprehensive rural development and human resource development.

In the main, the development of water resources, particularly irrigation has the following roles:

- To expand the development of irrigation to the rural areas.
- To change natural economy, semi-natural into commodity production.
- To protect the environment by stabilizing the areas of production and to create new settlements for people practicing previously slash and burn cultivation, as well as to avert all setbacks linked to the irrigation works.
- To build new irrigation projects, to rehabilitate and to improve existing irrigation projects, to strengthen facilities for the implementation of the development of irrigation.
- To develop human resources, especially at managerial level.

Specialization of geographical areas

Relying on realities, the Government has set a strategic vision in 1999 to specialize the plains along the Mekong River as production base for commodity production, and to develop agriculture in mountainous areas as factor to decrease poverty. Practically, food security has to be insured in one hand, while on the other, goods for exportation have to be produced; in the same time slash and burn cultivation has to be stopped by the year 2010.

Progression in irrigated areas

Consequently, the last few years, especially since the 1996 flood, the Government has given a great importance to the irrigation issue translated by the leap forward of the irrigated area during the dry season from 24,000 ha in 1996 to 214,000 in 2002. By 2002, this policy is translated by investing in pumping stations and individual pumps (amounting to 3,828), building dams, weirs (totaling 786), constructing reservoirs (numbering 184) to retain water, 69 water gates of canals and dykes, 17,604 traditional weirs, 116 gabions with the result that the irrigated areas in 2003 reach 307,000 ha in the rainy season, and 214,000 ha in the dry season.

Table 4.2: Irrigated area by various techniques in 2002 and 2003

Techniques	Number of schemes		Irrigated area in the rainy season (hectares)		Irrigated area in the dry season (hectares)	
	2002	2003	2002	2003	2002	2003
Dams	786	867	56,882	53,449	25,873	25,809
Reservoirs	184	222	22,896	24,474	11,131	10,681
Pumps	3828	4568	166,459	168,891	144,630	145,942
Water gates of canals and dykes	69	69	9,749	9,864	2,614	2,469
Traditional weirs	17604	18794	47,945	49,676	29,261	28,452
Gabions	116	157	3,168	3,817	1,117	1,479
TOTAL	22,857	24,677	307,097	310,171	214,625	214,832

Comparing to the past, the irrigated surface has significantly increased as shown the following table:

Table 4.3: Irrigated area 1991-2003

Year	Rainy season (hectares)	Dry season (hectares)	Flood prevention (hectares)
1991	136,000	16,000	7,000
1992	138,000	18,000	10,000
1993	140,000	20,000	12,000
1994	145,000	22,000	20,000
1995	150,000	26,000	25,000
1996	156,000	28,000	27,000
1997	164,000	45,000	29,000
1998	216,890	75,000	35,000
1999	258,200	124,234	40,000
2000	295,535	197,131	N/A
2001	300,054	214,131	45,000
2002	307,097	214,625	50,000
2003	310,171	214,832	60,000

It results that about 65% of agricultural production of the country, as well as 20% of rural population benefit from irrigation. Details about irrigated agriculture in the 18 provinces are as follows:

Table 4.4: Irrigated area by province, 2002-2003

Provinces	Irrigated surface (hectares) 2002		Irrigated surface (hectares) 2003	
	Wet season	Dry season	Wet season	Dry season
I.	Northern Laos			
1.Phongsali	4,079	1,330	4,092	1,339
2.Luang Namtha	7,353	3,515	7,378	3,519
3.Oudomsay	7,608	3,939	9,052	3,942
4.Bokeo	7,239	3,069	7,874	3,102
5.Luang Prabang	7,632	5,145	7,891	5,154
6.Huaphan	10,157	3,785	10,169	3,789
7.Sayabouly	13,710	8,550	13,737	8,557
II.	Central Laos			
8.Vientiane Capital	42,480	36,729	42,510	36,732
9.Xieng Khuang	12,226	2,698	12,229	2,701
10.Vientiane	36,698	28,881	36,438	28,838
11.Bolikhamsay	20,812	15,630	20,807	15,625
12.Khammouan	23,435	15,431	23,420	15,431
13.Savannakhet	48,644	15,431	49,726	35,777
14.Saysomboun	2,547	355	2,514	375
III.	Southern Laos			
15.Saravane	18,166	11,365	18,168	11,367
16.Sekong	2,668	1,491	2,538	1,493
17.Champassak	37,854	34,795	37,857	34,798

Provinces	Irrigated surface (hectares) 2002		Irrigated surface (hectares) 2003	
18.Attapeu	3,790	2,298	3,770	2,293
TOTAL	307,097	214,625	310,171	214,832

Features of irrigation schemes

Most of the irrigation schemes located in the upland and mountainous areas are of small size (less than 100 ha), and are not made in concrete, but with natural materials. They are temporary and last one year, and subjected to erosion, embankment.

Of the 800,000 ha cultivated, only a small portion is benefiting of irrigation and mostly located along the Mekong River and its tributaries (Vientiane Capital, Provinces of Vientiane, Bolikhamsay, Khammouan, Savannakhet, Saravane, Champassak, Sekong, Attapeu) with water provided by individual pumps or pumping stations using electricity or petrol. Medium (101 to 1,000 ha) or huge (more than 1,000 ha) scale irrigation schemes can be found in these provinces. The pumping stations needs to be maintained, improved, and even canals and ditches need to be under constant maintenance. Potentialities remain vast, but to exploit them fully, old problems have to be solved first such as the pumping stations or individual pumps.

In mountainous areas (Northern provinces: Phongsali, Bokeo, Luang Namtha, Oudomsay, Huaphan, Sayabouly, Luang Prabang, Xieng Khuang, and Special Zone Saysomboun), characterized by small scale irrigation schemes (irrigated area of less than 100 ha) approximately 18,150 temporary traditional irrigation works have been carried out by the population using woods, logs, or rocks, thus the name of "primitive weirs" or "people's community's weirs".

4.2.3 Strategic vision of the Government for 2005-2010

Irrigation policy for 2005-2010

As the Government sets the target to produce 2.5 millions tons in 2005, 3.5 millions tons of rice in 2010 and 5.2 millions in 2020, priority in expanding irrigation and surface irrigated is significant. Furthermore, irrigation is needed to help decreasing the slash and burn cultivation which has to be ended by 2010, to cease opium cultivation, and to make central and southern Laos as base for commodity production. This two-fold policy regarding irrigation in the main would provide the following projection:

Table 4.5: Cultivated areas (2005-2020)

Farming systems	Year 2005 (hectares)	Year 2010 (hectares)	Year 2020 (hectares)
Area cultivated in the rainy season	350,000	540,000	800,000
Area cultivated in the dry season	250,000	300,000	400,000
Irrigated rice-field	130,000	180,000	250,000

Especially in the seven major plains lying along the Mekong River as well as its tributaries, and which are to be devoted to the commodity production, the breakdown of the above figures would be as follows:

Table 4.6: Cultivated areas along the Mekong River and its tributaries (2005-2010)

Plains along the Mekong River and its tributaries	Year 2005 (ha)		Year 2010 (ha)	
Vientiane	Irrigated ricefield	85,604	Irrigated ricefield	45,175
	Regular ricefield	72,889	Regular ricefield	86,090
	Non-rice crops	13,055	Non-rice crops	16,365
Bolikhamsai	Irrigated ricefield	25,000	Irrigated ricefield	30,000
	Regular ricefield	30,000	Regular ricefield	40,000
	Non-rice crops	8,500	Non-rice crops	8,500
Khammouan	Irrigated ricefield	8,200	Irrigated ricefield	14,000
	Regular ricefield	20,800	Regular ricefield	22,500
	Non-rice crops	2,500	Non-rice crops	4,700
Savannakkhet	Irrigated ricefield	37,700	Irrigated ricefield	49,000
	Regular ricefield	99,320	Regular ricefield	104,000
	Non-rice crops	16,350	Non-rice crops	20,650
Saravane	Irrigated ricefield	8,900	Irrigated ricefield	15,000
	Regular ricefield	35,000	Regular ricefield	54,000
	Non-rice crops	6,500	Non-rice crops	10,500
Champassak	Irrigated ricefield	25,000	Irrigated ricefield	35,000
	Regular ricefield	50,000	Regular ricefield	75,000
	Non-rice crops	18,000	Non-rice crops	25,000
Attapeu	Irrigated ricefield	14,500	Irrigated ricefield	34,200
	Regular ricefield	29,000	Regular ricefield	43,000
	Non-rice crops	4,000	Non-rice crops	6,500

In the meantime, the Government has to promote and to support small-scale irrigation project initiated or practiced by families or communities, to foster the participation of farmers and private sector in the irrigation development, and to secure the socio-economic development as well as the protection of the environment.

Strategy in the development and the practice/ organization of irrigation

This strategy needs:

1 To focus on the development of irrigation in northern Laos where slash and burn as well as opium cultivation are practiced, and in central and southern Laos to promote commodity production.

2 To survey and to gather data on potentialities of water resources.

3 To edict laws, regulations and rules for expansion and implementation of irrigation such as: technical standards, regulations to be carried out strictly.

4 To train officials dealing with irrigation within the provinces and districts.

5 To conduct feasibility study of prioritized projects, to design in detail and to implement.

6 To promote investment in irrigation by private sector, community, and foreign financial organization through direct assistance and short and medium term loan.

7 To mobilize rural population to participate in the development of irrigation.

8 To build rural road connecting irrigation network to the markets, and to create facilities for the promotion of commodity production.

9 To salvage and modernize the whole of traditional irrigation works to insure high efficiency and to expand the irrigated surface.

Working plan to reach the assigned goals embedded in the projection figures

A working plan was elaborated:

1 To survey and estimate natural resources such as soil, water, seeds, as well as the living conditions of the population.

2 To survey and to evaluate the situation, needs and the strength of the socio-economic development.

3 To survey and to forecast natural cataclysms such as drought, flood, as well as the potentiality to meet requirement in water for various uses.

4 To determine the use and needs of water by factories, and to strike the balance in the projected figures of the development plan up to 2010.

5 To analyze options in the development of water resources to support the socio-economic development: to meet requirement in water for drinking and individual use, agricultural and industrial production, and to concentrate on averting and eradicating damages resulting from floods.

6 To determine methods or steps of investment capable in the implementation of economic development suitable with the technical capabilities and economic potentialities in the areas.

7 To rely on existing methods to supply irrigation water such as reservoirs, dams, pumping stations and individual pumps, and water gates of canals in plains. While traditional weirs and gabions will be used in mountainous areas.

Maintenance and sustainability of irrigation system

Past experience reveals the importance of these issues such as:

1 To organize associations of users of irrigation water, with adopted statute and rules to operate the association.

2 To train administrative officers of the associations of users of irrigation water for them to be knowledgeable about Water Law and Environment Protection Law, the management as well as the calculation of the servicing of water, the business management, as well as the loan which was granted.

3 To train groups of irrigation system users to be aware of management work and the use of water such as plan to cultivate according to season, the opening and closure of water, plan to maintain the system and the implementation.

4 To train members of associations of users of irrigation water to be knowledgeable about allocating water, the maintenance and strengthening of the system, and the implementation.

5 To hand-over projects to the associations of users of irrigation water.

6 Irrigation officials as well as officials assisting the authorities of the provinces, and districts must follow-up and provide advice about the management of the irrigation system to the associations of users of irrigation water as well as its members.

7 To promote and to encourage intensive agriculture by spreading technology among the farmers.

4.3 Fisheries

While the Lao are living mostly along rivers, and have their life intertwined with it, fish is one of the main food for the population accounting for about 42% of animal protein consumed. However, comparing to the neighboring countries, with fish protein intake per head per year is about 14 kg in 2001 for Laos, while the figure is 20 kg for Cambodia, 20 kg for Vietnam, and 25 kg for Thailand, it is expected that the demand will increase in the near future.

Table 4.7: Current fish availability and estimated future requirements

	1996	2001	2005	2010	2020
Estimated national population (millions)	4,7	5,2	5,7	6,4	8,2
Demand of animal aquatic products (kg/head/year)	10,2	14,0	16,0	18,0	23,0
Total amount (tones)	48,000	73,000	91,200	115,200	188,600

To meet this demand, increase in production from capture fisheries may not be possible in the spirit of sustainable use, appropriate management and protection of natural resources including aquatic biodiversities, and the only way is the augmentation in fish production from aquaculture or enhanced fisheries that are still in infancy.

4.3.1 Present situation

In 2001, fish production amounts to 73,100 tons and contributes as 7 to 8 % of GDP. The trend is progressing over the years as from 1996 to 2001 capture fisheries as well as aquaculture increased 152% with the production of fish from aquaculture totaling 18,000 tons in 1996 up to 43,100 in 2001.

These figures reflect areas, locations, and types of fish production within the 18 provinces mainly from capture as follows:

Table 4.8: Types of national inland fisheries and its production from 2000 to 2002

Type of fisheries	Water resources	Total area (ha)	Estimated total production (t/year)	Total area (ha)	Estimated total production (t/ year)	Total area (ha)	Estimated total production (t/year)
		2000		2001		2002	
Capture fisheries	Mekong River and its 14 tributaries	254,150	17,790	254,150	17,790	254,150	19,060
	Reservoirs	57,025	3,421	57,025	3,421	57,025	4,562
	Shallow irrigation and small reservoirs	34,460	5,169	34,460	5,169	34,460	5,513
	Swamps and wetlands	95,686	2,870	95,686	2,870	95,686	4,784
Aquaculture	Fish ponds	10,300	10,300	11,845	12,081	15,300	15,759
	Fish production cum rice culture	3,050	475	3,355	513	3,500	530
	Rain-fed rice-fields and irrigated rice-fields	477,176	23,850	477,176	23,850	477,176	23,850
	Small natural pools oxbows and irrigation weirs	1 2,934	7,441	12,934	7,441	12,934	7,440
	Cage culture	NA	NA	NA	NA	1,616	1950
TOTAL		944,781	71,316	946,631	73,135	955,331	83,455

Details about total areas devoted to fishery by province are as follows:

Table 4.9: Total fish production area by province (2002)

Provinces	Mekong and tributa-ries	Reser-voirs	Irrigation canals	Swamps and wetlands	Rain-fed ricefields	Fish production cum rice culture	Fish ponds	Dykes	Cage	Total
I		NORTHERN LAOS								
Phongsali	-	0	103	500	650	45	100	60	0	1458
Luang Namtha	x	0	381	1390	8750	15	250	35	0	10821
Oudomsay	x	0	250	1950	8500	35	1032	20	0	11778
Bokeo	x	0	180	12750	7000	10	230	140	0	20310
Luang Prabang	x	2000	120	1000	9000	180	1147	100	0	14400
Huaphan	-	0	123	790	7996	917	982	150	0	10958
Sayabouly	x	50	730	2900	30000	55	275	465	0	34475
II		CENTRAL LAOS								
Vientiane Capital	x	1600	1500	8700	51155	170	3288	2600	1150	70163
Xieng Khuang	-	0	283	810	28000	1475	1183	130	0	31881
Vientiane	x	57025	1453	1665	41655	220	1537	1800	1020	106375
Bolikhamsay	x	1050	1233	15850	25055	40	150	3271	950	47599
Khammoua n	x	6770	1500	8250	56155	50	100	400	1000	74225
Savannakhet	x	2060	3500	12150	101155	150	2225	1200	870	123310
Saysomboun	-	0	270	101	450	30	20	520	0	1391
III					SOUTHERN LAOS					
Saravane	-	3700	800	1150	40000	50	400	500	0	46600
Sekong	-	0	100	4470	5500	10	50	393	0	10523
Champassak	x	3763	841	11660	51155	40	2261	1000	110	70794
Attapeu	-	0	100	9600	5000	8	70	150	0	14928
TOTAL	254150									254150
	254150	78018	13476	95686	477176	3500	15300	12934	5100	955331

4.3.2 Legal and regulatory framework

Up till recently, policy and information relating to fisheries were sketchy, and limited to directives sent to administrative authorities to protect natural fauna, to disseminate to the population information on setbacks resulting from the use of dangerous and illegal devices to catch fishes. It was only in 1989 that a decree no. 118, dated 5/10/1989, regarding the Management, and Protection of Fauna was passed. However, it is only within the area of Nam Ngum that management of fisheries has been organized with the assistance of the Mekong River Commission, The Netherlands, Switzerland, and Denmark. During 1990-2000, development in cooperation on this issue is noticeable with assistance from international organizations, particular countries, as well as neighboring countries. This assistance allowed the listing, the synthesis, the physio-biological study of resources, the

survey, the socio-economic study, extension of relevant information to communities, and the setting up of Living Aquatic Resource Research Center (LARReC). Since then, the focus on the issue of fisheries has grown in importance with a supporting policy, market demand, as well as the transfer of technology, especially in fingerling production.

Table 4.10: Fingerling production (2001)

Hatchery type	Production (million seeds)	Percentage
State (17)	62.7	33.9
Private (13)	70	37.8
Private and small group of farmers	52.3	28.3
TOTAL	185	100

4.3.3 Policy framework

The Lao People's Democratic Republic adheres to the principle of equitable and fair utilization of the water resources of the Mekong River, and that environmental consideration should be integrated into planning and implementation of major development projects in each catchment area to make sure that those projects have no serious adverse environmental effect on the Basin.

The Lao Government since 1989 attached priority to develop its fishery resources by seeking funds and know-how to develop technical manpower, fishery infrastructure, credit schemes, processing and cold chain including marketing avenues and by cooperation with regional and international ventures for the sound exploitation and management of its resources in accordance to the "FAO Code of Conduct for Responsible Fisheries."

The overall government targets regarding fishery products will center on:

- The contribution to food security with emphasis in supplying more animal protein to the rural area particularly the rural farming communities.
- The contribution to poverty reduction in the sense of getting a complementary source of income.
- Gradual integration of sustainable aquaculture farming into agricultural mixed farming, generating new employment in the sub-sector.
- Supplementary food supplies to the growing urban population by promoting peri-urban semi-intensive aquaculture (pond, cage, pen…) with attention to aquatic animal health and good management practices.

4.3.4 Strategic framework

This strategic framework is two fold.

Capture fisheries

While aware of the existing international instruments pertaining the fisheries management, there still needs more study and better management practices.

There is a need for a more in-depth understanding of the physical and socio-economical settings of present endowment of aquatic resources, specifically on riverine ecology, taxonomy, fish life cycle, fish habitats and breeding grounds. Aquatic plants, aquatic animals, the wetland values and community management dynamism need to be identified and reassessed.

As for the best management practices, some key factors should be considered such as:

- The decentralization of fisheries management functions to empower local communities and call for its participation on co-management measures including the promotion of the use of local knowledge and effective management system.
- The need to take measures aiming at eliminating the use of illegal and destructive fishing gear and practice by building awareness of adverse impacts, enforcing regulations and encouraging alternative means of livelihood.
- The introduction of right-based fisheries in some important reservoirs and fishing grounds.
- The promotion of awareness regarding the importance of fresh-water fisheries for local food security (e.g. developing guidelines), rehabilitation and restoration of habitats for migratory fish, restocking indigenous fish species and encouraging culture based-fresh-water fisheries where appropriate.
- The building-up and maximizing of the use of national statistical systems by focusing on clear objectives and results directly related to fishery management decision-making and planning process.
- The development of national statistical mechanisms and technical development framework on inland fisheries and aquaculture in order to provide a basis for the exchange in information with particular emphasis on the catchments approach especially in international river basins.

Aquaculture

Among the key development idea identified during the conference on "Aquaculture in the Third Millennium: the Bangkok Declaration and Strategy" (February 2000) were the following:

- Investing in aquaculture development.
- Integrating aquaculture into rural development.
- Improving culture-based fisheries.
- Managing aquaculture health.
- Applying genetics to aquaculture.
- Improving nutrition in aquaculture.
- Improving fish quality and safety for consumption.
- Promoting market development and trade.
- Strengthening institutional support.
- Strengthening linkage with regional and interregional cooperation.

Those are general principles the Lao People's Democratic Republic should, at this stage of its aquaculture development, incorporate into the development strategies. Following the master plan proposed by JICA, the development of aquaculture in the Lao People's Democratic Republic should focus on some of the following projects/activities:

- Rehabilitation of fish hatcheries and expansion of fish production and distribution.
- Development of small scale breeding facilities at local level.
- Rural aquaculture development.
- Fish feed improvement.

Possible investment opportunities resulting from the increasing demands in fish food of the growing urban population and export are enumerated as following:

- The investment of Pangasias production and farming (especially in Champassak Province)
- The research and development of ornamental indigenous fish for export.
- Establishment of a fish sauce plant; the operation is to include fish preservation and fish meat preservation;
- The establishment of fish feed mill to support the expansion of semi-intensive fish culture and especially the cage culture of some important fish species.

4.4 Hydropower

The Lao People's Democratic Republic with 87% of its land area considered as hilly and mountainous is thus endowed with more than 60 "promising" sites for hydropower generation that have been identified on the tributaries of the Mekong River. It has been estimated that the country has a generating potential of 12,000 MW, of which only 930 MW has been developed so far. As it did and does already up to now, in the long-term, hydropower can contribute, among other priority development interventions, to socio-economic development of the country.

The recent international environment has been relatively favorable for the exploitation and development of water resources, particularly of hydropower for internal use as well as for export. Hydropower becomes the strength as well as the focus for development plans in the short-term, medium and long range.

4.4.1 Present situation

Steady progression of electricity use among the Lao population

From 33 MW produced in 1975, the figure reaches 627 MW in 2000. Families benefiting of the use of electricity expand from 5,000 to 293,495 during the same period of time, meaning that 35.8% of the population in the Lao People's Democratic Republic have access to electricity.

Table 4.11: Electricity servicing in Lao PDR

Year	Total population			Electricity supplied					
	Districts	Villages	Families	Districts	%	Villages	%	Families	%
1995	133	11,640	752,105	45	33.8	879	7.5	110,229	14.6
1996	134	11,453	750,843	78	58.2	1,191	10.4	136,280	18.2
1997	139	11,047	752,554	82	58.9	1,545	13.9	196,998	26.2
1998	141	11,053	754,265	102	72.3	1,884	17.0	226,004	30.0
1999	141	11,058	768,142	109	77.3	2,507	22.7	254,610	33.1
2000	142	11,263	818,668	119	83.8	2,651	23.5	293,495	35.8

While projection for future use of energy is increasing, it is obvious that the use of energy per capita and per year which is around 124.23 KWH/per capita/per year is the lowest one among ASEAN countries.

Sources of production of electricity

If the bulk of electricity originates from hydropower (98%), and only the remaining 2% from other sources such as petrol or solar energy, the State alone is however not the main producer as illustrates the following figures:

Electricité du Laos (EDL)	42%
Joint ventures	56%
Local producer of electricity	2%

The number of joint ventures as well as independent power producers is expected to grow in the near future with the opening of the country. It was expected that the signing the Memorandum of Understanding (MOU) for at least twenty hydropower projects (see the following table) would result in projects capable of producing 1,500 MW by the year 2000. However only two (Theun-Hinboun and Houay Ho) were able to be built and to produce 360 MW. The cause was essentially the 1997 Asian Crisis and the subsequent shrinking of the market.

Table 4.12: Status of hydropower projects

Province	Projects	Energy to be produced (MW)	Year of signature of MOU	Status
I	Northern Laos			
1.Phongsali	Nam Ou 2	630	1994	Cancelled
2.Luang Namtha	Nam Fa	150	2002	Australian company
3.Luang Namtha	Nam Sim	7.8	2003	Norwegian company
4.Oudomsay	Nam Beng	30	2002	Thai company
5.Luang Prabang	Nam Khan 2	145	1994	Cancelled
6.Luang Prabang	Nam Khan 3	237	1994	Cancelled
7.Luang Prabang	Nam Seuang 2	195	1994	Cancelled
II.	Central Laos			
8.Xieng Khuang	Nam Ngiep2-3	495	1995	Cancelled
9.Xieng Khuang	Nam Ngiu	30	2003	Lao private company
10.Vientiane Province	Nam Ngum 2	615	1991	Postponed
11.Vientiane Province	Nam Mang 3	40	1994	In construction by EDL
12.Vientiane Province	Nam Lik	100	1994	Cancelled
13.Bolikhamsay	Nam Ngiep 1	440	1991	Reconsidered with a new MOU signed on 9/5/2003
14.Bolikhamsay	Theun-Hinboun	210	1993	In operation
15.Bolikhamsay	Nam Theun 1	540	1994	Postponed
16.Khammouan	Nam Theun 2	681	1994	In construction
17.Saysomboun	Nam Ja 1	115	1994	Cancelled
18.Saysomboun	Nam Ja 2	70	1994	Cancelled
19.Saysomboun	Nam Bak 2B	150	2002	Replace Nam Ja 1 and 2
III	Southern Laos			
20.Sekong	Sekong 4	450	1994	Cancelled
21.Champassak	Se Katam	100	1994	Postponed
22.Attapeu	Houay Ho	150	1993	In operation
23.Attapeu	Se Kaman 1	460	1994	Postponed
24.Attapeu	Se Pien-Se Nam Noy	339	1994	Postponed

4.4.2 Planned development

Development policy

Regarding the hydropower sector, the Government's aims are:

- To reduce imported fuel.
- To support rural development.
- To reduce regional power imbalance.
- To encourage private investment in hydropower investment.
- To earn foreign currency for socio-economic development.
- To minimize environmental impacts.
- To develop watershed management.

Strategy

The production of electricity for internal use is the focus of the efforts. This requires diverting part of the electricity produced for export as well as to build new hydropower schemes including new lines of transmission, and meet needs especially in remote areas to sustain livelihoods.

Table 4.13: Projection of the number of families using electricity (2000 to 2020)

Year	2000	2005	2010	2020
Families in Laos	852,900	960,449	1,071,383	1,295,799
Families using electricity	286,454	427,399	588,652	1,163,591
Electricity use as percentage	34%	44.5%	55%	90%
Inhabitants	5,200,000	5,900,000	6,700,000	8,300,000

The electrification of this magnitude in this pace of time would requires an investment of US$ 70 million per year, or US$ 350 within the next five years after the year 2000. If large hydropower schemes are more cost-effective than medium or small size, especially for export of energy, as well as having the advantage of providing one part of the produced energy for the local market alongside the export market. However, medium size hydropower schemes are the most appropriate for domestic market, moreover they required less difficulties to mobilize capital for investment.

At the same time, the transmission line network has to be nationally interconnected in order to spread energy as far as possible within the whole country to meet internal needs as well as to balance the import of electricity. At present, three separate networks do exist. The first one is linked to Nam Ngum 1 and Nam Leuk hydropower plants. The second one focuses on the import of electricity in Central Laos (Khammouan and Savannakhet Provinces). The third one runs from Seset1 and Selabam dams. The connection of the three existing networks will require the building of high tension line transmission of 115KV from Paksane

to Savannakhet, from Savannakhet to Kengkok and Sepon, from Savannakhet to Pakse, and from Pakse to the Lao-Cambodian border.

The Government attaches a great importance to rural electrification as well as servicing electricity to remote areas. Thus the need to construct small hydropower schemes, to promote solar power, especially in the northern provinces of Laos, as well as small fuel powered generators. As foreign assistance (JICA, World Bank) on this issue is limited, investments have to come from the Lao Government's budget, while private investments are encouraged and promoted in the meantime.

The export of hydropower energy is said to require foreign capital. The focus is to carry out projects that have been already decided upon in cooperation with the governments of Thailand, Vietnam and Cambodia, as well as to cooperate with the Greater Mekong Sub-region countries and the ASEAN countries.

4.5 Navigation and waterways

With the Mekong River forming the natural artery of Laos and flowing through more Lao territory than other countries in the region, it was a convenient communication facility for peoples living on its shores using traditional means to transport small volume of merchandise and limited passenger number. The river continues to foster hopes that it can alleviate problems of transports.

4.5.1 Navigation

Present situation

As the Mekong River in its Lao section is marred with dangerous rocks, plagued with numerous shoals in parts, in most cases barely identified, if not with poor aids to navigation, water traffic is challenging. The solution to this issue requires trans-boundary cooperation to pool efforts to harness and exploit the potentialities of the Mekong River for the socio-economic development of the region. In order to understand this feature, technically, the Mekong River in Laos is divided from the upstream end to the downstream end into six reaches. The following table shows the characteristics of the six reaches.

Table 4.14: Status of navigation on the Mekong in Lao PDR

		Houakhong-Houaysai	Houaysay-Luang Prabang	Luang Prabang-Vientiane	Vientiane-Savannakhet	Savannakhet-Pakse	Pakse-Voeun Kham
Managed by International Convention		Four riparian countries Agreement on Commercial Navigation on 20 April 2000 (China, Laos, Myanmar, Thailand)	Four riparian Agreement on Commercial Navigation on 20 April 2000(China, Laos, Myanmar, Thailand)				
Mekong length (kilometers)		301	304	426	459	256	170
Mekong tributaries on the left bank				1.Nam Ou 2.Nam Khane 3.Nam Seuang 4.Nam Ngum	1.Nam Ngum 2.Nam Ngiep 3.Nam San 4.Nam Kading 5.Se Bang Fay 6.Se Bang Hieng	1.Se Don	1.Se Kong
Mekong width (meters)		50-700	50-700	150-1600		90-2100	
Current (meter/second)		3.5 to >6					
# Important ports		1.Huakhong 2.Xieng Kok 3.Ban Mom 4.Houaysai			1.Port Km4 2.Thakhek 3.Keng Kabao 4.Savannakhet	1.Savannakhet 2.Pakse	1.Voeunkham
# Obstacles (rocks and islands)		20	14	8 with some rocks of 10-12 m height harming the navigation in dry and wet seasons	6	11	6
Boat capacity (tons)	Dry season	50	30	30	30		30
	Rainy season	100	50	80	300	50	100
Annual variation in the level of the Mekong (meters)		27.8	35 at Pakbeng 22 at Luang Prabang	30 at Ban Kok			

With the achievement of Phase 1 in the improvement of the navigational channel and the installation of navigation aids from China's border to the Golden Triangle, the Upper Mekong River section is increasingly busy. This improvement results from the signature of Agreement on Commercial Navigation between Laos and China; this agreement is superseded by the Agreement on Commercial Navigation on Lancang/Mekong River Among the Governments of China, Laos, Myanmar and Thailand on 20 April 2000. Environmental problems are expanding with the rapid increase of the traffic on the Mekong River, but they are still under control; in contrary to the southern section of the Mekong River, this northern section will be increasingly used as the road no. 13 is far from the

Mekong River, thus the competition between land transport and river transport will not be detrimental to the navigation as it is for the section between Vientiane and Savannakhet.

The Vientiane-Savannakhet section was the busiest before the strengthening of the road linking the two cities, particularly during the rainy season. Even with this road, the transport of bulk commodities on the Mekong River on this section is still significant as the dealt volume to-fro Vientiane and Savannakhet covers 52 to 71% of the total volume carried on boats in Laos. However, the volume is steadily decreasing with the roads constructed along the Mekong River and bridges in Vientiane and Pakse. This decreases the environmental impact of the navigation too.

The Savannakhet-Pakse section is unusable in the dry season as the shallow water averts any navigation. During the rainy season, the capacity to transport is the lowest comparing to others sections of the Mekong River.

The navigation on the Mekong River's tributaries is inconvenient, and the volume transported varies from 0.5 to 3.5 tons on Nam Ou River or from 0.5 to 3.0 tons on Se Kong River. On other tributaries, small volume can be transported within the fifty kilometers from the junction with the Mekong River.

Servicing the navigation are 15 ports, while the construction of seven new ports, all in the north of the country (Ban Say and Xieng Kok in Luang Namtha Province; Ban Mom, Ton Pheung and Houaysay in Bokeo Province; Pak Beng in Oudomsay Province, and Tha Suang in Sayabouly Province), is planned.

The future in perspective

The Government's strategy regarding navigation is mainly focusing on:

- To maintain and improve current transport capability by river.
- To improve navigation aids and information for travel safety.
- To encourage the use of river transport in the wet season instead of poor roads.
- To protect the riverbanks from erosion.

To implement such a strategy, work-plans have to be detailed and implemented.

- Needs required are expertise, logistics, as well as organization. This has been carried out in 2002-2003. Organization strengthening (facilities, and organization of river transport offices) is implemented for 2002 to 2004 in Luang Namtha, Bokeo, Oudomsay, Phongsali, Luang Prabang, Sayabouly, Vientiane, and Champassak Provinces as well as Vientiane Capital.
- Associations of river transport have to be established or those existing have to be improved.
- Companies of river transport have to be upgraded in order to meet international standards aiming at applying to transportation between the four members of the Agreement on Commercial Navigation of 20 April 2000.
- The completion of efforts in collecting statistics regarding river transportation; these efforts started since 2002.

- The implementation of the cooperation starting since 2002 to reach consensus with riparian countries about navigation signalization, and to complete the installation of aids to navigation (2002-2004).
- For 2002-2005, a set of actions has to be brought to completion as follows:
  - To implement the decisions taken by the four parties regarding the Lancang/Mekong River, and to prepare the opening of navigation between the four countries for the second phase from Simao to Vientiane.
  - To study the cooperation plan for the regional development of the Mekong-Ganges Rivers.
  - To study the navigability on the Mekong River in the south from Voeun Kham to Stung Treng, and Kratie.
  - To conduct the feasibility study of the expansion of existing ship yard in Vientiane set up with Vietnamese technical assistance, and the eventuality to construct one in Luang Prabang. Another shipyard does exist in Pakse, but of modest capacity.
  - To promote and monitor the implementation of regulations and rules on navigation by local authorities.
  - To set up a boat unit to patrol for checking along the Mekong at diverse spots such as: Bokeo, Luang Prabang, Vientiane, Thakhek, Savannakhet, and Pakse.
  - To study the project of setting up inland clearing centers at ports related to the Asian road system such as: area of Ban Mom (Bokeo Province) and Road A12, Pak Beng (Oudomsay Province) and Road A13, Luang Prabang and Road A12, Vientiane and Road A12, Khammouan and Road A15, Savannakhet and Road A16, and Champassak and Road A14.
  - Regulations and rules have to be drafted and adopted.

4.5.2 River transport

While contributing in the past to the economic development of the country, river transports reveal to be a relatively low-cost investment and secure infrastructure investment, energy saving with minor pollution, to decrease heavy land traffic. Despite that resources are limited (28 Associations of River Transports and six Companies of River Transport with eight focusing on merchandise and 26 on passenger transport) (see Annex), river transport is increasing steadily. The policy of the Government is to improve and develop this sector according to its plan up to 2020, particularly to construct and to strengthen ports, to improve navigational channels, and to adopt relevant regulatory framework to sustain the economic development.

Table 4.15: Water traffic in Lao PDR (1976-2001)

Year	Cargo vessels (inland water transport)		Carried passengers (inland water transport)		Marine transport		Fleet
	1000 t	*1000 t-km*	*1000 persons*	*1000 person-km*	*1000 t*	*1000 t-km*	
1976	22.00	6,009	134	8,330			109
1977	25.00	6,242	149	8,953			
1978	28.00	7,415	167	9,701			
1979	33.00	8,700	169	9,884			
1980	34.20	9,387	179	10,195			
1981	38.80	11,069	187	11,482			
1982	41.30	12,507	211	12,526			228
1983	44.90	13,804	250	14,142			
1984	47.00	15,277	280	18,202			
1985	50.00	15,492	320	22,346			
1986	54.00	18,826	367	14,589			
1987	70.00	22,565	390	15,529			
1988	79.00	26,039	415	16,672			475
1989	92.00	29,532	441	17,836			
1990	106.00	32,987	469	19,091	10	18,590	
1991	275.00	15,000	387	21,000	17	33,808	633
1992	114.00	12,000	745	46,000	6	146,746	659
1993	202.57	12,006	675	13,239	20	397,760	717
1994	613.56	10,094	727	22,379	22	748,317	789
1995	476.39	7,097	436	18,451	43	75,130	1042
1996	537.00	22,527	1,252	27,298	37	84,649	1125
1997	604.00	26,573	1,599	45,702	29	69,957	1132
1998	533.20	21,542	1,127	30,584	22	46,480	1101
1999	602.00	25,872	1,603	47,833			
2000	681.00	21,013	1,832	37,196			
2001	459.00	25,032	1,180	26,246			
Total	5862.92	433,60	15,693	545,469	205	1,621,437	

Future action of the Government regarding the river transport is similar to the navigation with especially the focus on searching to set up joint venture or to secure special loans, as well as to organize with Yunnan Province (People's Republic of China) common business, to introduce the use of electronics to the company of river transport for servicing customers.

Efforts have been concentrated for 2002 to 2005 to create or improve existing ports along the length of the Mekong River such as: (1) Ban Sai, (2) Xieng Kok, (3) Ban Mom, (4) Houaysay where existing port has to be upgraded, (5) Pak Beng, (6) Tha Suang, (7) Luang Prabang, (8) Tha Deua, (9) Vientiane, (10) Bolikhamsay, (11) Savannakhet, (12) Pakse, and (13) Voeunkham.

4.5.3 River works

Trends during the past ten years

The improvement of the road linking Vientiane to the Lao-Cambodian border, as well as the construction of bridges over the Mekong, brought to a standstill river works and the navigation on this section of the Mekong River.

At present, river works are concentrated on a few projects. In the past five years, embankments have been built at Ton Pheung District (Bokeo Province), Dong Phosi, Chomcheng and Sibounheuang Villages (Vientiane Capital), as well as further down at Paksan and Pak Kadan (Bolikhamsay Province), Thakhek (Khammouan Province), Savannakhet (Savannakhet Province) and Pakse (Champassak Province). Government's budget, provinces' budget, and private funds as well as foreign assistance have been used for these works. The share of provinces' budget and private funds is increasing in this regard.

Construction of ports has been undertaken at Ban Say and Xieng Kok (Luang Namtha Province), Ban Mom (Bokeo Province), Ban Vang (Vientiane Province), port servicing ferry boat at Ban Hat-Ban Na, Done Khong (Champassak Province).

Signalization devices as aids to navigation had been installed from Vientiane up to Paklay.

With the financial assistance of the People's Republic of China, navigation channel has been improved recently from the three border zone between China, Laos, and Myanmar down to Bokeo Province (Laos). The preparation had been initiated since 1993.

Trans-boundary effects of some river works

Particular effects regarding river works are to be noticed.

The river bank protection made on the Thai side along the Mekong River creates severe erosion on the Lao shore, as illustrated in the following table.

Table 4.16: Severe river bank erosion

Province	Location of severe erosion
Bokeo	Ban Sibounheuang Muang Tonpheung Ban Donesavan Ban Kuan Ban Donekhoun Had Vang Ban Huaisay Tai Ban Tin That Ban Vieng May Ban Dan Had Khay Nok
Vientiane Province	Ban Phalad Ban Sanakham
Vientiane Capital	Ban Samphanna Ban May

Province	Location of severe erosion
	Ban Nonkeo
	Ban Suanmon-Chomcheng
	Ban Thakhek
	Ban Nahay
	Ban Pak Peng
	Ban Maknao
	Ban Nonsay
Bolikhamsay	Northern Paksan
	Southern Paksan
	Ban Pak Kadan
	Ban Sod
Khammouan	Ban Hadsay Kham
	Ban Kava Neua
	Ban Kava Tai
	Ban Khao Min Yai
	Ban Thakhek

Construction of ports on Thai side (Chiangkhong and Chiangsaen) as well as the construction of roads to exploit sand in the Mekong River have deep effects by changing the flow direction.

The setting of some navigation buoys may cause misunderstanding as some are misplaced regarding the border of the riparian countries.

Construction of navigation channel on the Upper Mekong River by removing 11 rocks and 10 shoals aims at allowing during the first phase to a 150 tonne capacity boats to navigate, and 300 tons for the second phase. However, the consequences of these efforts would be the ebbing in the water level, the changing of the flow direction, and the difficulty to retain water.

Plans

For the coming years, efforts will focus on:

- Completing the construction work regarding the protection of the river banks at Houaysay, Luang Prabang, Vientiane, Paksan, Thakhek, Savannakhet, and Pakse..
- Constructing or improving landings and ports.
- Strengthening the management system of ports according to international standards.
- Completing the navigational channel between the Lao-Chinese border down to Savannakhet.
- Completing the installation of navigation aids between the Lao-Chinese border to Savannakhet.
- Completing the enhancing of skills of the human resources at professional and managerial level.

– Completing the construction of dykes against floods at major cities and towns prone to flooding.

– Completing the construction of water gates to protect at cities and towns along the Mekong River.

4.6 Tourism

Sharing a similar cultural mold as its neighbors, Laos is one of the strongly growing tourism destination with its unspoiled nature, from spectacular limestone mountain karsts housing thousands of caves to river gorges, rural villages lost in time, mountain plateau and fragile cave ecosystem.

With the growing attraction of tourists, the government has taken measures to enhance the trend as well as to preserve the natural environment and the culture of the multiethnic people of the country.

4.6.1 Growing importance of tourism and recreation

There has been very strong growth in the Lao tourism sector, from only 14,400 international arrivals in 1990 to 735,662 arrivals in 2002. Tourism is now a major contributor to national income (7 to 9 per cent of GDP) and employment.

Table 4.17: Number of tourist arrivals, average length of stay, and revenue generated (1992-2002)

Year	Number of tourist arrivals	Change (%)	Average length of stay (days)	Revenue from tourism (dollars)
1990	14,400	NA	NA	NA
1991	37,613	+161.2	NA	2,250,000
1992	87,571	+132.82	NA	4,510,000
1993	102,946	+17.56	3,50	6,280,000
1994	146,155	+41.97	5.07	7,557,600
1995	346,460	+137.05	4.25	24,738,480
1996	403,000	+16.32	4.12	43,592,263
1997	463,200	+14.94	5.00	73,276,904
1998	500,200	+7.98	5.00	79,960,145
1999	614,278	+22.81	5.50	97,265,324
2000	737,208	+20.01	5.50	113,898,285
2001	673,823	-8.6	8.00	103,786,323
2002	735,662	+9.18	6.50	113,409,883

Table 4.18: Revenue from tourism and major exports (1997-2002) ($ millions)

Product	2002	2000	1999	1998	1997
Tourism	113.4	113.8	97.3	79.9	73.3
Garments	99.9	100.1	94.4	76.5	72.6
Electricity	92.7	91.3	107.0	49.6	20
Wood products	77.8	80.2	71.3	41.2	79.3
Coffee	9.8	15.3	29.0	19.3	26.2
Agricultural products	25.6	5.7	5.0	NA	16.5
Minerals	3.9	4.9	6.0	29.4	NA
Handicrafts	2.7	3.8	5.1	3.0	1.6
Other industries	19.9	NA	NA	14.4	83.2

However, not all provinces are to evenly benefiting from tourism.

Table 4.19: Visitors by province (1997-2002)

Province	1997	1998	1999	2000	2001	2002
Vientiane Capital	277,292	312,640	482,199	486,613	429,420	506,677
Champassak	23,260	28,019	29,019	34,796	55,142	45,635
Khammouan	22,718	24,360	11,455	13,712	20,317	19,596
Bokeo	16,543	19,002	21,120	25,286	42,561	65,045
Luang Namtha	18,032	18,600	20,700	24,770	41,704	19,319
Savannakhet	140,412	144,840	90,910	109,033	113,287	98,962
Luang Prabang	30,769	44,538	61,034	165,222	51,207	94,846
Bolikhamsay	14,900	13,388	29,734	35,681	23,900	30,758
Xieng Khuang	1,771	4,500	NA	NA	35,744	16,223
Saravane	1,266	NA	NA	NA	NA	4,823
Oudomsay	5,438	NA	NA	NA	18,654	36,000
Huaphan	943	732	NA	NA	398	2,819
Sayabouly	NA	8,300	6,200	7,446	9,014	10,840
Vientiane	NA	NA	NA	NA	NA	30,480
Phongsaly	NA	NA	NA	NA	NA	8,500
Attapeu	NA	NA	NA	NA	NA	6,831
Sekong	NA	NA	NA	NA	NA	574

Tourism is a labor intensive industry and contributes directly to poverty reduction. Since the opening of t he country, this service sector has expanding tremendously as shows the following table:

Table 4.20: Number of accommodation establishments and rooms (1997-2002)

Province	Number of establishments						Number of rooms					
	1997	1998	1999	2000	2001	2002	1997	1998	1999	2000	2001	2002
Attapeu	4	3	3	4	4	4	43	37	41	94	74	74
Bokeo	5	5	6	16	21	22	88	88	143	307	254	267
Bolikhamsay	3	8	8	16	23	23	61	96	115	200	331	331
Champassak	14	18	18	56	65	65	246	306	374	759	889	925
Huaphan	6	8	8	10	10	10	60	83	83	106	119	124
Khammouan	4	11	11	13	16	17	124	196	236	281	320	295
Luang Namtha	14	26	26	25	31	30	113	246	269	263	312	287
Luang Prabang	33	45	67	100	116	116	462	539	864	1048	1173	1275
Oudomsay	18	21	22	31	31	26	187	203	279	568	568	316
Phongsaly	11	11	11	11	20	19	66	70	77	77	203	192
Saravane	3	4	4	8	11	11	23	33	45	66	96	96
Savannakhet	18	22	22	25	29	30	338	424	399	512	479	504
Sayabouly	5	16	16	15	7	7	68	220	220	196	99	99
Sekong	1	1	1	1	1	1	16	15	15	15	16	15
Vientiane Capital	68	81	81	98	119	113	1884	2099	2033	2351	2782	2739
Vientiane Province	10	10	14	14	53	52	157	165	184	184	899	900
Xieng Khuang	16	16	16	24	13	13	172	179	147	286	163	166
Saysomboun	NA	1	1	1	1	1	NA	20	20	20	20	20
TOTAL	233	307	335	468	571	560	4108	5019	5544	7333	8797	8625

There is considerable potential for greatly expanding the sector, drawing on visitors to the region and highlighting their interest in Laos' natural environment, its history, cultural heritage and rich ethnic diversity. However, the tourism industry faces constant challenges because of changing customer preferences, travel patterns, and unpredictable events such as SARS.

4.6.2 Government's tourism strategy

The Lao People's Democratic Republic's tourism strategy favors pro-poor, community-based tourism development, the enhancement of specific tourism-related infrastructure improvements, and sub-regional tourism cooperation. Current activities include: awareness initiatives focusing on tourism benefits and environmental and cultural conservation and enhancement; awareness programmes on prevention of HIV/AIDS, sexual exploitation and trafficking of women, and information on successful regional experiences.

Other elements of the national tourism strategy include:

- Identification and development of tourism products (i.e., possibilities for community-based tourism, etc.).
- Development of small-scale tourism-related infrastructure (such as information centers, community lodges, viewing points, walking trails).
- Capacity building for tourism-related local micro-enterprises and communities.

- Gender specific programmes (training for women to develop and to run micro-enterprises).
- Participation programmes for ethnic minorities.
- Training in marketing and eco-tourism, and identification of eco-tourism ventures.
- Promotion of community-based tourism networks in-country and in the sub-region.

Sub-regional co-operation for sustainable tourism is an important aspect of the Government's tourism strategy. The establishment of tourism marketing and promotion boards within the Greater Mekong Sub-region and the ASEAN framework will promote and facilitate tourism. In this spirit, the Government will seek co-operation with neighboring countries to improve tourist facilities at border posts and to streamline immigration and customs regulations. From 30 January to 7 February 2004, Laos has hosted the ASEAN Tourism Forum.

Human resources development related to tourism is necessary as there is an acute shortage of appropriately trained people. Human resources development includes language training as well as training in all matters related to tourism development (e.g., hotel and guesthouse management, tourism guide work, housekeeping services, and site management). Training activities will be decentralized to some provinces that are experiencing an increased tourism inflow (Champassak, Oudomsay, Luang Prabang). The Government envisages the establishment of a national committee for tourism education and training.

4.6.3 National development priorities for the tourism sector

Based on the importance the Lao Government places on tourism as a tool for poverty alleviation, cultural and natural heritage protection, and the use of tourism as an impetus for sub-regional cooperation, the Government has prioritized tourism-related development assistance as follows:

- Human resource and capacity building initiatives, especially those that focus on improving the managerial and regulatory capabilities of tourism-related public sector entities;
- Assistance in the creation of tourism law, guidelines and regulatory frameworks that underpin the conservation and protection of the country's cultural and natural heritage;
- Initiatives that foster international cooperation, especially within the Greater Mekong sub-region;
- Tourism-related infrastructure improvements;
- Private sector tourism service and skills development;
- Development of a National Tourism Training Center or Bachelor Degree level course curriculum at the National University.

4.7 Domestic and industrial water supplies

Domestic water and sanitation are essentials for the life, health and productivity of the population. The issue is dealt with by two line ministries with the National Centre for Environmental Health and Water Supply, Hygiene and Prevention Department, Ministry of Health, focusing on delivering clean water, sanitation and hygiene to the rural areas, and Lao

Water Supply Enterprise, Ministry of Communication, Transport, Post and Construction, servicing clean water for urban centers.

4.7.1 Water supply in cities and towns

Water supplying people in towns and cities originates mostly – about 85% - from the Mekong River and its tributaries, with the remaining from ground water, springs, and small streams.

The national capacity of the existing 36 water treatment plants to produce drinkable water is 188,380 m3/per day. But the average production is only 157,340 m3/per day supplying water to 525,395 people or 37.67% of the urban population. This means that only 300 liters/per day/per person is provided by these plants.

However, water resources from the Mekong River is hardly exhausted as the production of tap water is only 0.04% of the 140,000 million m3/per year of the Mekong River discharges.

At most, the installed capacity can meet the wants of only 629,000 people, while more than 765,800 city dwellers are outside the network of water supply in 2002.

Drinkable water produced in Vientiane by Nam Papa Lao covers 53.7% of the total produced in the country, while lesser production occurred in Luang Prabang, Pakse, and Khanthabouly.

The construction of new water treatment plants as well as the expansion of the existing ones are required to meet the needs of those who are left-out of this basic amenity. Based on the figure of 158 liters/per day/per person, approximately 195,480 m3/per day has to be produced to meet the needs of 80% of city dwellers. In 2020, the demand will require a production of 383,860 m3/per day.

To attain such a goal, the Government has sought a wide range of finance including loans and financial assistance. It has also encouraged private sector to contribute to the development in this field in order to insure that water is supplied in adequate volume and quality to all those in need of it.

The thrust of the Government's development policy is to increase amenity of life in urban areas by providing affordable, reliable and quality services in commercial water supply and in sanitation.

4.7.2 Water supply in rural areas

It is estimated that in 2002, about 60% of the population in rural areas has drinkable water from a public tap, or hand pump or spring; no houses have been connected by piped water. The goal is to reach the figure of 90% by 2020. The average need would be 35 liters/per person/per day and the total need of water in rural area would be 204,900 m3/per day; this is based on an estimated increase of 2.5% of the rural population totaling 6,505,500 persons in the year 2020.

The Government's development policy is:

- To improve water supply and environmental health in rural areas;
- To focus on inaccessible, poverty-ridden areas; and

– To encourage private supply and sanitation ventures in easy-to-reach areas.

4.7.3 Sanitation

Meeting needs for adequate domestic water and sanitation services for each province is a great challenge as they are related problems as shown in the following table:

Table 4.21: Access to clean water and sanitation in each province (2002)

Province	Clean water (% of population served)	Sanitation coverage (%)
Attapeu	59.89	28.29
Bokeo	64.01	50.92
Bolikhamsay	57.16	23.98
Champassak	77.67	32.27
Huaphan	65.50	23.43
Khammouan	52.37	47.59
Luang Namtha	66.72	40.12
Luang Prabang	55.60	30.72
Phongsaly	43.69	13.13
Oudomsay	38.34	18.11
Saravane	54.62	15.09
Savannakhet	79.20	33.40
Sayabouly	59.50	50.01
Saysomboun	37.33	21.00
Sekong	48.09	18.89
Vientiane Capital	86.19	74.57
Vientiane Province	64.00	41.00
Xieng Khuang	62.00	51.00
Total for the whole Country	58.09	41.56

Presently, the percentage of population having access to sanitation is relatively low. With the targets set to bring piped water to the population in the whole country by 20% in 2005, and 50% in 2020, the access to sanitation in 2020 will significantly improve as follows:

Table 4.22: Access to sanitation

	2002	2020
City dwellers	67%	80%
Rural population	41.56%	80%

As there is a recognized need to close the gap between people who have adequate water and sanitation services and those who do not, access to clean water and sanitation has been planned to progress up to 2020 as follows:

Table 4.23: Access to clean water and sanitation 1999-2020 (% total population)

Programme	1999-00	2001	2002	2005	2010	2015	2020
Clean water	52	55.1	58	66	75	82	90
Domestic sanitation	37.6	39.7	41	45	60	69	80
Sanitation in school	6.7	8.3	11	21	35	50	60

4.7.4 Wastewater

Wastewater is an issue as the drainage of urban wastewater to discharging upstream of water supply pumping stations raw water such as at Pakse and Saravane. In other towns, erosion and flooding in the rainy season by raising the level of water at the pumping stations caused water pollution, and required more chemicals to clean the raw water, thus increasing financial cost.

Wastewater is mainly from domestic usage, as only 2.5% of the piped water is used in industrial activities. This is consistent with the limited number of factories as well as the water volume allocated to them.

Table 4.24: Number of factories (2001)

Province	Large scale factory >99 workers	Medium scale factory with 10 to 99 workers	Small scale factory <10 workers
Attapeu		5	239
Bokeo		23	486
Bolikhamsay	5	34	1520
Champassak	10	57	2316
Huaphan		4	400
Khammuan	19	25	1809
Luang Namtha	3	9	423
Luang Prabang	1	29	2259
Phongsaly			1548
Oudomsay		12	1492
Saravane	1	16	1401
Savannakhet	10	57	2316
Sayabouly	1	37	1213
Saysomboun		2	161
Sekong		9	380
Vientiane Capital	62	157	1750
Vientiane Province	2	65	2675
Xieng Khuang		11	1030
Total for the whole country	116	542	23651

As the range of economic activities of these factories is limited, the quantity of water required is low as shown the following table:

Table 4.25: Water used for industrial activities

Industrial activity	Quantity produced	Unit	Unit demand of water	Water demand (m3)
Food processing				
Slaughterhouse and sale of meat	4,400	Tonne	20,000 liter/tonne	94,000
Bread, cake	850	Tonne	3,500 liter/tonne	4,270
Fish sauce, soy sauce	350,000	Liter	1.50 liter/liter	525
Noodle	550	Tonne	3,000 liter/tonne	2,022
Salt	18,800	Tonne	10,000 liter/tonne	210,000
Fermented fish	500	Tonne	15,000 liter/tonne	7,950
Sugar	300	Tonne	15,000 liter/tonne	3,975
Drinks				
Ice	65,000	Tonne	1,200 liter/tonne	98,400
Bottled water	160	Million liter	1.20 liter/liter	222,000
Alcohol	310,000	Liter	7.50 liter/liter	2,475
Beer	50.89	Million liter	15 liter/liter	864,750
Soft drink	14.39	Million liter	1.50 liter/liter	21,330
Cleansing				
Alcohol 90 degrees for medicine use	50,000	Liter	10 liter/liter	550
Washing powder	850	Tonne	1,750 liter/tonne	1,138
Soap	300,000	Block	0.125 liter/block	38
Construction				
Paint	590	Tonne	1,500 liter/tonne	1,020
Brick	66.5	Million block	0.25liter/block	21,750
Cement block	700,000	Block	1 liter/block	950
Water required for all industrial purpose in 2001				1,557,142

Regarding the situation in Vientiane capital, the open drainage network is made up of three portions that are all discharging into the That Luang-Salakham Marsh. These drains are directed first to Nong Chan, and wastewater is treated to oxygen at six ponds with each pond to treat wastewater originating from about 30,000 persons. Water treated is sent to the 13 km length of the That Luang Marsh. From That Luang Marsh, the water will run off to the Mekong River along 50 km of many camlets. Since 1990, no wastewater was let running directly to the Mekong River as in the past.

With the low maintenance of the canal drainage as well as increasing waste around the That Luang Marsh, the system is beginning to break down.

It is estimated that rain water and wastewater discharging by this way into the Mekong River average 120 million m3 per year, and comparing to the Mekong River volume which is 140,000 million m3 a year, the average of the dilution of rain and wastewater into the Mekong, in Vientiane, will be 1000:1. The figure of dilution would be 800:1 during the dry season. With urbanization increasing as well as the expansion of tourism and industry, waste problem will soon become an issue.

4.8 Flood management

Most of cities and towns of the Lao People's Democratic Republic lies along the Mekong River and its tributaries, thus prone to flooding during the rainy season. Floods may, as in 2000, result in loss of life and property, and disrupt the social and economic life of the people.

4.8.1 Occurrence of severe floods

It is noticed that flooding is very much influenced by tributary flows. The combined effects of large runoff in the tributaries and the mainstream of the Mekong River cause serious damage, including flash floods on tributaries and bank overflow in lowland area. About 80 percent of the rural flooding and 20 percent of the urban flooding is caused by tributaries. The four major flood prone areas are situated along the mainstream near large tributaries: Vientiane Plain, Thakhek, Savannakhet, and Pakse.

During the rainy season, the water level rises rapidly, specially between July and September causing severe flood such as in 1966, 1968, 1970, 1971, 1974, 1978, 1990, 1991, 1995, 1996, 1998, 2000, and 2002 with loss of live and property as shown the following available figures:

Table 4.26: Damage caused by floods (1996-2002)

Year	Damages (in $ millions)	Areas damaged
1966	13.80	Central Laos
1976	9.00	North Laos
1978	5.70	Central and South Laos
1993	21.00	Central and South Laos
1994	21.15	Central and South Laos
1995	35.50	Vientiane Plain, Central and South Laos
1996	21	Central and South Laos
1998	3.50	Central and South Laos
2000	5	Central and South Laos
2002	3.50	North, Central, South Laos

Plains of central and southern Laos along the Mekong River are flooded more often than northern Laos as shown the previous table and the following table.

Table 4.27: Damage caused by floods in each province (1999-2002)

Province	Inundated area (hectares)			
	1999	*2000*	*2001*	*2002*
Northern Laos	0	20	240	1,810
1. Phongsaly		20		962
2. Luang Namtha				157
3. Oudomsay				110
4. Bokeo				377
5. Luang Prabang			10	64
7. Sayabouly			230	
Central Laos	4,965	8,350	20,193	24,151
8. Vientiane Capital	395	1,290	5,080	5,493
9. Xieng Khuang	160		50	57
10. Vientiane Province	70	350	1,100	761
11. Bolikhamsay		250	8,370	5,644
12. Khammouan		4,000	4,440	7,040
13. Savannakhet	4,340	2,460	1,153	5,156
14. Saysomboun				
Southern Laos	3,935	4,530	1,790	8,103
15. Saravane	1,575	1,400		222
16. Sekong				
17. Champassak	995	2,060	1,790	7,432
18. Attapeu	1,365	1,070		449
TOTAL	8,900	12,900	22,223	34,064

The flood occurring in 2000 was severe and encompassed many provinces.

Table 4.28: Damage caused by floods in the year 2000

Province	Persons affected	Ricefield inundated (hectares)	Ricefield damaged (hectares)
Phongsaly	670	30	20
Vientiane Province		960	350
Vientiane Capital	10,350	3,650	1,290
Bolikhamsay	19,400	3,710	250
Khammouan	125,360	23,640	14,000
Savannakhet	96,460	23,640	14,000
Saravane	16,500	4,740	1,400
Champassak	117,940	22,730	12,060
Attapeu	12,080	1,930	1,070

The causes are:

- Climate change,
- Deforestation,
- Land degradation,
- Lack of timely and appropriate warning
- Poor organization,
- Lack of responsibility for water level observation,
- Lack of equipments,
- Lack of mobilization and of money.

4.8.2 Data collection and dissemination

Since 1990, the Government has provided data to the Mekong River Commission, and cooperated closely with the relevant international organization in providing information about the level of the Mekong River and its tributaries in order to forecast flooding. These data are dispatched regularly by the Department of Roads from its various observation stations.

Table 4.29: Hydrological stations supplying data to Mekong River Commission

	Station location	River
1	Pak Beng	Mekong
2	Muang Ngoi	Nam Ou
3	Ban Moud	Nam Khan
4	Paklay	Mekong
5	Port at Km 4	Mekong
6	Thakhek	Mekong
7	Savannakhet	Mekong
8	Paktaphan	Mekong
9	Keng Don	Se Bang Hieng
10	Pakse	Mekong

Information is also supplied by the Department of Meteorology and Hydrology; this Department monitors rain gauge stations located at Xieng Kok (Mekong River), and Paksan (Mekong River).

4.8.3 Flood control

Based on the Prime Minister's Decree 204/PM, on 9 October 2001, dykes to protect against floods, water gates, and drainage canals had been built in major cities and towns located along the Mekong River.

Supported by the Government's budget, loans and foreign assistance, works carried out in Vientiane Capital, Bolikhamsay, Khammouan, Savannakhet, and Champassak are as follows:

Table 4.30: Construction of dykes and water gates against floods

Location	Length of dyke against floods (meters)	Height of dyke against floods (meters)	Level of flood (meters)	Number of water gates against floods
Vientiane Capital	72,000	172	12.50	2
Paksan, at Pakpeung	2,500		14.50	3
Thakkhek, at Huay Nang Li			13.50	4
Savannakhet			13.00	2
Pakse	2,500		12.00	3

Vientiane Capital was flooded in 1966, 1978, 2000, and 2001. The causes of the flooding are multiple such as:

- Insufficient dykes;
- Where these dykes do exist, they are not high enough at some places;
- Lack of pumping stations or mobile pumps when inundation occurs;
- Natural canals to drain flood water are small and shallow;
- Land development is poorly organized; and lack of flood management standards, etc.

The building of diversion canals to discharge water from floods first took place in 1997 with a loan from Asian Development Bank, and is divided into two phases. During Phase I (1997-2000), the following works have been achieved:

- Hong Kae 3400 m
- Hong Khua Khao 2546 m
- Hong Thong 1790 m
- Hong Uai Luai 2751 m
- Hong Kai Keo 1356 m
- Hong Sak 2 1678 m
- Hong Thong Sang Nang 1275 m
- Hong Sak 1 558 m
- Hong Thong 1 258 m

Further downstream, Paksan is often subjected to flooding, north of Paksan, from tributary, Nam San, and southern side of the town, from Pak Peung. In 2002, a 2,500 meter length dyke and water gates were constructed at Nam San (Huai Nang Ni), and along the Mekong River (Huai Song Mae Luk, and Huai Pak Peung).

With an Asian Development Bank's loan, water gates against floods have been built at Thakkhek (Khammuan Province) in 2002-2003 at Pak Huai Sakham, Huai Nang Li, Huai Nang Sod, and Ban Chomcheng.

As Khanthabuli (Savannakhet Province) has been subjected to severe floods, particularly in 2002, water gates have been constructed at two locations: Huai Long and Huai Khi Lamang.

Located just downstream of Se Don River, Pakse (Champassak Province) is subjected to frequent flooding from the Mekong River rise, particularly in 1975, 1978, and 2001. In 2003, with an Asian Development Bank's loan, a system against flood has been constructed with 2,500 meter length of dykes, water gates, canals to discharge flooding water and three pumping stations.

4.8.4 Outline of a development plan

The development plan mainly is to:

1 Complete the construction and the restructuration of hydro-meteorological stations along the Mekong River and its tributaries.

2 Achieve the automatic collecting and dispatching of data at the 13 existing stations.

3 Complete the forecast of flooding through GSM mobile phone at Luang Prabang and Pakse.

4 Ensure a nation-wide system of floods warning.

5 Compile the hydrological and meteorological databases.

6 Continue the water drainage construction plan in Vientiane Capital (2003-2005):

- Hong Seng 4,200 meters
- Hong Wattay 1,650 meters
- Hong Kao Yod-Simuang-Pha Pho 957 meters
- Hong Khua Luang 163 meters
- Hong Suan Mon-Chomcheng-Khoknin 1,650 meters
- Hong Phon Papao 2,450 meters
- Hong Thong Sang Nang 500 meters
- Hong Huai Luai 985 meters
- Hong Sisavang Kang 683 meters
- Hong Kha Tai 780 meters

7 Carry out, in Bolikhamsay Province, the construction of water gates aiming at preventing inundation, with two more water gates to be installed at Nam Sa and Nam Kadan.

4.9 Watershed management

4.9.1 Government policies and programmes

Laos is a resource-rich country, in terms of natural resources in proportion to the population, with high potential for future economic growth. It is one of only three Southeast Asian countries (Indonesia and Malaysia) that are considered resource-rich countries.

However, unsustainable resource management practices are beginning to reverse this favorable situation; the fragile mountain ecosystems are severely at risk. For instance, forest cover has declined from 70% to 47% over the last 50 years due to clearing of low land forest

for permanent agriculture, logging, construction of reservoirs, shifting cultivation, and the use of defoliants during the Indochina war.

In order to preserve the natural resources as a basis for the Lao People's Democratic Republic's sustainable development and maintenance of the overall system of the natural resources, a number of laws and regulations have been adopted such as the Forestry Law (1996), Water and Water Resources Law (1997), Land Law (1997), Electricity Law (1997), Law on Agriculture (1998), Environment Protection Law (1999). In 1999, the Government issued its Strategic Vision for the Agricultural Sector embodying the seven thematic approaches (see Part I. Irrigated Agriculture). For a number of years, the Government has implemented the policy of area-based development.

The Integrated Watershed Management approach was fully endorsed in 2002 by the National Agriculture and Forestry Conference. The Prime Minister stated that: "Our development strategy has to follow an area-based approach. Development in the lowlands and on the major plains shall emphasize an integrated and decentralized agriculture and forestry programme. Development in the uplands shall follow a watershed approach to develop sustainable agro-forestry systems and conservation in the context of sustainable use of the natural resources and decentralization. We believe that the development strategy will lead to realize our goal in alleviating poverty in most upland areas using an environmental friendly livelihood system."

Currently the Ministry of Agriculture and Forestry is applying the Integrated Watershed Management approach with the aim of sustainable management of natural resources. The Integrated Watershed Management approach is a holistic area-based planning process, which extends the government's policy on natural resources management and development activities; it complements the national planning framework by improving the understanding of the natural resource base and socio-economic situation in a given watershed and agreeing upon among the key stakeholders at the local level to more effectively address poverty alleviation, and future conservation and development of upland watersheds.

Particularly, as part of the Vision 2020, adequate land use zoning receives high priority with the aim of increasing the agricultural and forest production. Zoning includes plans where intensive lowland agriculture should be undertaken, sloping areas where mixed agro-forestry system should be prevailing, and finally, upland steep slopes, which mainly should be used for forest conservation and protection.

4.9.2 Status for watersheds in Lao PDR

The country is divided into 64 watersheds with 53 watersheds or 91% of the land area drained into the Mekong River, and the remaining into Vietnam from Xieng Khuang and Huaphan provinces. The Mekong River Commission has developed a watershed directory, which specifies the boundaries for first order watersheds and provides basic information on the physical characteristics of each watershed.

Some first order watersheds, catchments, or sub-basins such as Nam Ou are large, covering more than one province, where as some are very small and cover only a small part of the district. Therefore, it is important to distinguish between different levels of watersheds in relation to the administrative boundaries and sectors involved in these areas that are fully in line with the Government's policy on decentralization.

Table 4.31: Watershed management levels in Lao PDR

Level	Indicative area	Administrative coverage	Key agencies
Mekong River	International		Governments of the Mekong riparian countries
			Mekong River Commission
	National	Whole country	Government of Lao PDR
			Water Resources Coordinating Committee
			Lao National Mekong Committee
			Ministry of Agriculture and Forestry
River basin or large watershed	> 1,600 km2	Province(s)	Provincial authorities
			Provincial Agriculture and Forestry Services
Medium watershed	< 1,600 km2	District(s)	District authorities
			District Agricultural and Forestry Office
Micro watershed	< 100 km2	Village	Village Development Committee

The Mekong River aside, watersheds in the Lao People's Democratic Republic are equally divided into 32 river basins and large watersheds and 32 watersheds with area below 1,600 km2.

The provincial level plays an important role in laying out overall strategic considerations for the utilization of natural resources based on area potential and priorities, e.g. where to establish infrastructure, specific development actions, biodiversity conservation areas or link areas with market opportunities.

The district is the key level for developing an integrated watershed management plan, since this is the budgeting and planning unit. The district level integrated watershed management plan can be aggregated into provincial level watershed plans.

In order for the district to develop an integrated watershed management plan, the river basins or big watersheds should be broken down to smaller manageable watershed units appropriate to promote and support more specific activities in close collaboration with the villages. The village is the implementing unit. It is suggested that the maximum manageable size would not exceed the average size of the district, which is about 1,600 km2.

The size of the managerial watershed unit should be agreed on a case-by-case basis, by assessing factors such as:

- Number of villages and their distribution in the area
- Infrastructure
- Available resources (forest, land, and water)
- Economical development potential
- Biodiversity conservation areas

- Hydropower potential
- Biophysical features

In Lao PDR there are 32 first order watersheds with areas below 1,600 km2. The remaining 32 river basins and large watersheds above 1,600 km2 preferably need to be split into smaller manageable units for planning and management purposes at the district level.

4.9.3 Case studies

Integrated watershed management plans

In accordance with its very diverse biophysical and socio-economic features, development models for different watershed categories are required. It should be noted that models should include the planning process, but also implementation with appropriate feedback mechanisms to learn from experiences.

A number of case studies or model development representing district and provincial level integrated watershed management plans have been developed for the Nam Tong (an area of 556 km2 with 27 villages) and Nam Tin (an area of 220 km2 with 23 villages) watersheds in Vientiane and Bokeo Provinces respectively. More significantly, a model has been initiated in the Nam Et Phou Loei National Biodiversity Conservation Area encompassing two provinces (Huaphan and Luang Prabang); it covers a mountain range with an area of 4,200 km2 with high biodiversity being headwaters for four main watersheds. The area has about 110 villages located in the buffer zone and about 35 villages located inside the conservation area mainly practicing shifting cultivation. The area also produces some opium. The Nam Neun watershed in Xieng Khuang and Huaphan Provinces embeds another ongoing case study as it represents a mountainous area of about 6,881km2 with about 400 villages mainly practicing shifting cultivation, upland rice farming, livestock raising and collection of non-timber forest products. The area also produces some opium. In addition to the above-mentioned cases, a number of planning exercises have been undertaken, such as investment plans for Nakai Nam Theun 2 and Nam Ou river basins and forest management in Vang Vieng.

As a lead agency, the Ministry of Agriculture and Forestry is currently preparing the Nam Ngum River Basin sector Project which will develop and implement integrated watershed management plans for the entire Nam Ngum River Basin covering 16 sub-watersheds in an area of 16,906 km2.

Increased awareness

The increased awareness about the integrated watershed management has resulted in a significant demand from provinces and districts throughout the country for assistance and support to develop integrated watershed management plan. Vientiane Province, for instance, has allocated 250 million kip for watershed planning in the province. The increased attention has also resulted in the augmentation of governmental financial support to develop Integrated Watershed Management as well as of foreign assistance (Nam Ngum River Basin Development Sector Project is supported by Asian Development Bank, the French and the Japanese Governments for a total amount of about US$ 22 million).

Coordination and integration

A Natural Resources Information Center is also established by the Ministry to coordinate all data within the integrated watershed management planning.

The case studies and models embody the fact that effective watershed management needs to be holistic and interdisciplinary in coverage and scope. It involves the planning and implementation of both technical and policy initiatives to enable the natural and human resources of individual watersheds to contribute to one or more of the following development objectives:

- Poverty alleviation and improved standard of living, through the maintenance and enhancement of existing, and development of new sustainable livelihood opportunities for those individual households and communities whose needs are met fully or in part from the utilization of the watershed natural resources;
- Improved conservation and protection of forest areas that are important for the preservation of biodiversity and for protecting water resources;
- Improved conservation and management of the natural resources within individual watershed/river basin areas thereby enabling them to be used for economically productive purposes (water, forestry, agriculture, tourism, power generation, etc.) on a sustainable basis while maintaining and enhancing their social and environmental service functions;
- Improved water resource management (rainwater and ground water) management within individual watershed/river basin areas, for provision of water with the quality and quantity required, and at the time wanted, to meet the needs of different water users within, and downstream of the watershed;
- Provision of power generation and transport infrastructure, and increased protection from damage by floods and sedimentation;
- Increased marginal productivity values of natural resources (land, water and forests).

The challenge of Integrated Watershed Management in the Lao People's Democratic Republic is to find ways in which the above multi-criteria objectives can be met simultaneously. Variations among individual watersheds are numerous and complex. Some areas call for total protection for e.g. biodiversity preservation, wildlife or headwater protection. For most watersheds in Lao People's Democratic Republic, the ultimate goal of any watershed program or project should be to promote the sustainable and suitable use of natural resources (soil, vegetation, fauna, water, etc.). This will require the establishment of a mechanism based on assigned land use and water rights for allocating and enforcing these rights among competing sectors (e.g. fisheries, tourism, irrigation, hydropower, domestic, industrial). This will request the development and adoption of improved forest, crop and/or livestock management practices that are not only productive but also conservation effective. Such practices should enable the users of the watershed resources to increase tree, crop, and/or livestock production in ways that would enhance and sustain, rather than degrade, their natural resource base.

4.9.4 The next steps and challenges

The Government has the vision that resource allocation to upland development should be based on Integrated Watershed Management plans. Mechanisms and procedures for incorporating the Integrated Watershed Management approach into the national planning framework will be developed in close collaboration with the Committee for Planning. All

provinces should develop overall strategies and priorities for sub-watersheds covered by the province. All districts should develop watershed plans either by themselves or together with neighboring districts depending on the biophysical boundaries of the watershed.

By 2010 integrated water management should have been developed for the whole country at district and provincial levels.

Within the present five-year plan 2001-2005, focus will be on developing watershed plans in all the eight northern provinces, which are home for the priority watersheds of the country because of the existence of important water resources and the high incidence of shifting cultivation and poverty. This will support the Government's plan to significantly reduce shifting cultivation and poverty by 70% and alleviate poverty in northern Laos, the poorest provinces of the country.

The challenge is now to develop staff capacities in basic, technical and facilitation skills to support nationwide Integrated Watershed Management.

5 Thailand

5.1 General

5.1.1 Background and some important policies

Mekong River and Mekong River Commission

Mekong is an International River; the source of river is born in China and flow through Myanmar, Thailand, Lao PDR, Cambodia and Vietnam before flowing to the sea in the delta in Vietnam. The total length of the river is 4,173 km, approximately half of the river (2,373 km) located in the area so-called "Lower Mekong Basin" that flows through the Lao PDR, Thailand, Cambodia and Vietnam. The total area, where 62 million people of 4 countries are living, is 606,000 km2 and this number is equal to the total population of Thailand at the present.

The Lower Mekong Development works has started since 2500 (1957) under support of UNDP and implemented by Mekong Committee, which composed the representatives who have the sole right from the 4 countries. During 2518-2538 (1975-1995), the committee is well known in the name of Interim Mekong Committee. Due to the war and the political changing in some country and that made Cambodia could not join the committee as regularly, so there are merely 3 country members left in the committee. However, the Interim Mekong Committee still continued there working regarding to the Indicative Basin Plan (IBP) of the year 2513 (1970) and the Annual Work Programme of the committee under the financial support from UNDP and more than 10 donor countries, and the International Financial Institute/organization such as World Bank, Asian Development Bank and so on.

In April 2538 (1995), four riparian country members of the Interim Mekong Committee signed the new Mekong Agreement, which was the point to establish Mekong River Commission (MRC), to replace the old committee.

The Mekong Agreement has defined the framework and principles for using water resources from Mekong system in the form of management organization and specific in cooperation between the member countries in order to protect the environment and sustainable development, to equalize the member countries in terms of development opportunity in using the existing shared resources for promoting people's quality of living and the well being. Mekong Agreement has been realized as very important basis that make the regional cooperation to be more realistic.

Planning of Mekong Basin Development in Thailand

As a country that has joined the Mekong collaboration (the previous Mekong Committee and the current MRC) since the beginning, Thailand, represented by Thailand National Mekong Committee and concerned government authorities, has closely participated in developing this plan so far, the main benefit is the occurrence of many development projects in the Mekong Basin area in the part of Thailand those have been implemented under financial and technical support from international communities through the committee/MRC which is an important international organization in this region, an organization which is now joining in developing current BDP is TNMC, and TNMC now is organizing a provisional BDP unit to be responsible for planning. In addition, the National Working Group and Sub-Area Working Groups have been established with many

representatives from the units and/or private sectors in order to work and study together that promotes the closely and widely participatory working as the main concept of BDP.

However, as realizing that the River Basin Planning process is using the Public Participation, Thailand has already implemented widely not only in Sub-areas but also other areas as defined in BDP (mentioned in heading 2.2). So, it is necessary to closely coordinate with the related agencies that may have already organized in every level in order to study more data and/or to avoid the overlap works for creating the optimum benefits.

5.1.2 Important development policies and plans

The necessary factor which makes the participation successfully affect into the projects consideration and defining for BDP is to know the related development policies and plans within the regional and national level such as National Social-Economic Development Plan, Basin Management Policy, Ministerial Agreement, Development Strategies of Provinces and Group of Provinces which are formulated in Thailand.

National Socio-Economic Development Plan and Long-Term Development Plan

Thailand has had the National Social-Economic Development Plan (five years plan) since 2504 (1961), and we are now using the 9th development plan, which put the most attention in development of the forest and soil environment. Before that, the 4th and 5th plans had included some policies on natural resources conservation, while the 6th plan focused on management and development of the remaining resources to be more systematic and concretely, the 8th plan had adjusted the economic development policies to be centralized by improving every sector to be integrated, that included the sector of natural resources, community and environment.

The evaluation of development results during the past 4 decades shows that the development which based on mainly the natural resources can generate only success in the economic sector but lacking of balancing in natural resources, the environment deterioration and inappropriate managing, the results of development are for particular only the society, but most of people rely on natural resources for surviving and they are still poor.

Due to above reasons, the 9th development plan has defined the development strategies which are the tasks for all in the nation, there are 3 main missions as following:

- To focus on eradicating the poverty within the country
- To strengthen the root of society and to make the vast proportion of people in the country have the well being
- To adjust the country's economy to be more competitive and self-reliant, together with consolidating the cooperation among all sectors to reform the management to be better in all level of Thai society.

Apart from above missions, there are also defining of 7 strategies for sustainable development as following:

1 Good governance

2 Quality Development of people and society

3 Sustainable rural and urban development, to promote the income generating, community and urban development for better living quality.

4 Sustainable management of natural resources and environment, to raise awareness and the participation of the community in appropriately conserving, renewing and utilizing the natural resources.

5 To manage and strengthen the country's economy and building of the economic base for its qualitative economic growing in the long term.

6 To increase the country's competitiveness, to develop the production's quality and productivity, to process the agricultural products by developing the labor's skill, developing the basic infrastructure, skill in commercial bargaining and so on.

7 To strengthen the development in sciences and technology and promote Research and development etc.

It has been recognized that: in the long term Thai social and economic development plan pays attention in sustainable development, which means the existing of sufficient participation, conservation of natural resources and environment in order to create the well being of the people.

Related policies, measures and management of the Basin

The management of the River Basin is different, and it depends on the size of area, physical condition of the natural resources, and the social and economic situation of the people. Therefore, the management of particular river basin may need a period of time for study and planning, however the initial and important principles are presented following:

1 The reforestation in the basin area: to plant or reforest to be abundant and sufficient by selecting the planting area and the appropriate variety of trees.

2 The water management: it may be done by constructing of water reservoir to store the water from the rainy season, it can be used in the dry season and it also needs to improve the water management and allocation system such as controlling of the reservoir, managing of water diversion system and maintenance of irrigation to be more efficient.

3 The development of ground water and to utilize it in many purposes, this case needs to consider the emerging of the unbalancing changes such as the level of salt water that may be higher and dangerous for environment in the future. So, the installment of motor for pumping water from the ground in some areas needs to be aware also to keep the balancing between the fresh water and the salt water.

4 In addition, in particular area the management of water the basin should be performed along with the water conservation due to the water resources is very limited. And at the moment, the using of water per production unit is higher than the necessary level (especially for the agriculture production). Therefore, it is necessary to motivate the awareness and the participation from the people and to bring the modern technology into the production process, changing of category and type of the plants and so on.

5 The water diversion from the nearby basin: this last measurement for management of the river basin is the water diversion from the nearby basin to use (this includes the diversion of water from Mekong River) that needs to aware on the physical possibility of the basin within 2 areas that will have many water diversion, in case that it is not possible to do physically, it needs vast amount of budget and may also create environment problems.

Related resolutions of the Cabinet Council

Some important examples of ministerial agreement relating to the management of the River Basin especially for the basin in the north and southeast which are related to the development of Mekong Basin are following:

1 Ministerial agreement dated in 27 July, 2525 (1982) on study projects for defining the quality level of the basin of the country based on the principles and standard of using natural resources in each level of basin by study and research on the basins in the north (Ping, Vang, Yom and Nan) in 2525-2528 (1982-1985) and basins in the northeast (Chi and Mun) in 2528-2530 (1985-1987).

2 Ministerial agreement dated 2 June, 2530 (1987) on Principles and conditions in defining the deteriorated forest which is excluded the basin area in level 1A and 1B and level 2 and the defining of deteriorated forest according to the decree on National Conservation Forest in 2507 (1964). It would not affect to people who are gaining benefits in and it has the characteristics as defined in the regulation of Forestry Department.

3 Ministerial agreement dated 12 July, 2531 (1988) on the defining of quality level of the basin and some recommendation on the measurement in using land in Nam Mun and Nam Chi areas, that Ministry of ScienceTechnology and Energy supervised and prepared the Action Plan complying to the measurements recommended to use for the land in the area of Vang, Ping Yom and Nan.

4 Ministerial Agreements dated 27 June, 2532 (1989) on the direction for implementation regarding to measurements recommended for using land in the areas of Nam Mun and Nam Chi, to use it as a frame for conserving and utilizing the natural resource in the basin area appropriately in technical terms.

5 Ministry Agreements dated 10 March, 2535 (1992) on the classification of area using natural resource and forest land in the national conservation forest and additional agreement dated 17 March, 2535 (1992) on the classification of area using natural resource and forest land in the national conservation forest by dividing the national conservation forest into 3 zones e.g. conservation forest, forest for economic purposes and forest area that is appropriate for agriculture, the conservation forest area has been divided into 2 types e.g.:

   i. The official conservation forest according to the laws and MA means area for conserving wildlife, national conservation forest and the basin area in level 1.

   ii. The additional conservation forest means area that conserved for protecting the environment, the ecology and the natural sources that should be conserved including the local symbolic area and so on.

6 Ministerial Agreement dated 4 May, 2536 (1993) on the implementing direction for the land reform in the national conservation forest and permanent forest, it indicated that in case of people engaged in that area before the government's announcement they will get the right in using that land and get the related documents according to the Land Laws, but in case people trespassed in the land after government's announcement they will get the right and official documents through the reform system.

7 Ministerial Agreement dated 28 February, 2537 (1994) on the land reform for agriculture purposes in the national protected areas for economic purpose which is deteriorated.

8 Ministerial Agreement dated 21 February, 2538 (1995) agreed with National Environment Committee on the classification of quality level of water in the west,

central and NamPaSak basin and the classification of quality level of water in the north and other northeast basins (river basin in the border zone)

9 Ministerial Agreement dated 22 August, 2538 (1995) on canceling of Ministerial Agreement dated 4 May, 2536 (1993) on solving the land relating problems in the forest in case of people engaged in the land before the government announce it to be the conservation forest by issuing the right approving documents according to the land laws and in case people trespassed in the land after announcement for conservation forest that they will get the right to use through the land reforming process.

10 Ministerial Agreement dated 22 April, 2540 (1997) in the traveling ministerial meeting in VangNamKhiew, Nakhonrasima. The agreement on the measurements and ways to solve problems related to the forest area which can be divided into 5 types.

11 Ministerial Agreement dated 30 June, 2541 (1998) on the solution of land problems, it is the defining in addition to the Ministerial Agreement in VangNamKhiew which is very important for the forestry department in coordinating with the related parties in order to check and implement the allocation of the responsibility for the area of forest, public usage and the area that are under responsible of government that is the duty of forestry department to carefully consider to allocate the land for public usage and other facilities in the area that people are engaging in.

12 Ministerial Agreement dated 1 September, 2541 (1998) on the principles of reducing the restriction based on Ministerial Agreement dated 21 February, 2538 (1995) on defining of principles on the area that should reduce the restriction and allow people to live in and use the area if they can prove that their community or their village engaged permanently or the village was established officially by using photos taken from the air during each period of time in each area or any documents that shows evidences that indicates people or community have right to engage in that area officially.

Another good example is Ministerial Agreement dated 22 February, 2547 (2004) that approved 5 strategies in developing the competitiveness in order to reengineer the economy of southeast of Thailand, those are following:

- Strategy 1: To upgrade the production base of the region.
- Strategy 2: To cooperate with the Indochina group to expand the industrial base and border economy of the region.
- Strategy 3: To empower and create the opportunity for the poor.
- Strategy 4: To manage the natural resources and environment in sustainable way and to bring the balancing back to the nature, and
- Strategy 5: To develop the human resources for the sustainable development

Strategic development plans for provinces/groups of provinces

In addition, the development event happened recently during the last 1-2 years in Thailand are assigning the provincial governors to be totally the Chief Executive Officers: CEO in their provincial areas, and the provinces where locate nearby and have similar physically potential will be in the same group of province, the groups of provinces can despotically define the visions, missions and strategies such as:

- Vision of ChiengRai Province is "Golden Door of LaneNa Culture and the Trading to International Community"
- Vision of the Group of Upper Northeast Provinces which includes UDonThaNi, NongKhai, NongBuaLamPhou and Leuy is "Second Residence for the Investor and Tourists"
- Vision of the Group of provinces e.g. SaKonNaKhone, NaKhonPhaNom, MoukDaHan and KaLaSinh is " Indochina Commercial and Tourism Bridge"
- Vision of the Group of provinces e.g. KhonKean and MaHaSaLaKham is "The Center of Trading, Investment and Service within the Region to the World"
- Vision of the Group of provinces e.g. OuBoLaSaThaNi, SiSaKet, YaSoThon and AmNadChaLeun is "The Business Partner of Neighboring Countries"
- Vision of the Group of provinces e.g. NaKhonLaSiMa, SouLinh, SaYaPhoum and Buriram is "ISan Door to International Community"

We could see that above visions of groups of provinces and province are long term visions which need to set up the strategies and many supported programmes, and it could not avoid the using of water resources for supporting those developments. The way to define the BDP to be consistent with the needs of many aspects showing in above visions and/or the strategies of each province (group of provinces) will make clearer role of BDP for participating in the development of the Lower Mekong Basin in Thailand.

5.1.3 The conditions of the Lower Mekong Basin in Thailand

Climate and geography

The total catchment areas of the lower Mekong River Basin in Thailand is 188,645 sq km which can be divides into three parts namely the north, the northeast and the eastern Thailand. The conditions of its geography and areas have been briefly sumarized as the following:

The northern area

The northern area is the area where the lower Kok River, Ing River are located, or in the territory of Chiang Mai, Chiang Rai and Phayao Province. The catchment of Kok River has about 8,160 sq km, it flows a distance of 285 km, the first flow distance (approximately 128 km) flows through the Rathsan, Myanmar, it rises about +1500 metres above mean sea level. It flows to the Mekong River at the level of +350 metres. Almost at the northern Thai territory is mountainous areas where there are many sources, but the suitable areas for agriculture are mainly in the Chiang Rai province. As for the Ing River locates in the Phayao and Chiang Rai province, it flows a distance of 300 km, its source locates at the high mountain about +500 to +450 metres. the main water resources of Ing River is Phayao and Lengsai lake at Phayao province. At the tail end of the Ing River where it flows to the Mekong River always causes the flood in the rainy season because of the Mekong River at this time rises at the high level.

Sub-area 2T is deleneated by Basin Development Plan (BDP) mentioning above covers the lower Kok, Ing River and the Mekong River basin at the northern part which has the total areas about 18,859 sq km.

The north-eastern area

This area totally covers the north-east consisting 19 provinces, about 168,854 sq km or 105,533,750 Rai [1]. The area consists mostly of a plateau which includes many small hills, has the slope from the west to the east. It locates at higher than sea level about 100-300 metres. it has the Phoupan mountain range which divides the area into 2 parts for instance: the south korat plateau and the provinces along the Mekong River, the main rivers flowing through this area are the Mekong River, the Songkham River at the north, and the Chi River and Mun River in the middle, the BDP has divided this area into sub 3 sub-area such as:

- Sub-area 3T convers 8 provinces namely the provinces along the Mekong River-Isan; Udon Thani; Sakon Nakon; loei; Nong Bua Lam phu; Nongkhai; Nakhon phanom; Mukdahanand Amnat Charoen province. Among these are, Udon Thani, Sakon Nakon, Nongkhai, Amnat Charoen and Mukdahan province, important economical provinces having the total area of 46,460 sq km.
- Sub-area 5T consists 11 provinces in the north-eastern thailand having total area of 119,000 sq km. For the sake of convenience of study and implementation, Sub-area 5T could divide into 2 main parts:
    i. Sub-area 5T-1 is in the lower Chi River having total area approximately 49,476 sq km, consists 6 provinces for instance: Chaiyaphum, Khon kean, Maha Sarakham, Roiet, and Yasothone province. As for Khon kean province is the business center of the sub-area and the region as well.
    ii. Sub-area 5T-2 is in the lower Mun River having the total area of 69,700 sq km, consists 5 provinces in which are Nakhon Ratchasima, Buri Ram, Surin, Si Sa ket and Ubon Ratchathani, among these provinces are, Nakhon Ratchasima and Ubon Ratchathani, the business centre.

The eastern area

This area is in the Sa kaew and Chanthaburi province, one part of this area locates in the lower Cambodian lake (Cambodian called the lake and main rivers who link this lake to the Mekong River as Tônlé Sap), the other is under the Thai territory is at the west of the lower river. This area mostly is on high mountainous areas which slope from the west to the east. Any water courses flowing through Cambodian so called the lower Tônlé Sap River or sub-area 9T which has the area about 4, 150 sq km.

The climate in the Thai territory at the lower Mekong River basin is commonly the same. At the north-eastern area where covers the largest area including sub-area 3T, 5T-1 and 5T-2 have the average annual rainfall between 800-2,000 mm, the rainfall occurs between May - October or the average annual rainfall is 1,400 mm which is not less than the rainfall in the north and the east, but the soils at this area mostly are lateric that could not be water-bearing soils and have a short rainfall period, this causes the problem of tremenous drought more than other area along the Mekong River till the western areas.

An overview of BDP sub-areas in Thai territory is given in Table 5.1.

[1] 1 rai = 1,600 m2

Table 5.1: Sub-areas of the Lower Mekong Basin in Thailand

Sub-area	Size of area (sq km)	Location
2T	18,859	Kok River, Ing River and some part of the Mekong River, The north
3T	46,460	The lower Mekong river basin, the northeast
5T-1	49,476	Chi River, the northeast
5T-2	69,700	Mun River, the northeast
9T	4,150	The lower Tônlé Sap River, the east

Soil resources

The topic would refer to the soil resources having the potential of agricultural development and irrigation works.

Sub-area 2T

Among the total of 5.10 million rai of Kok basin, in which about 0.61 million rai have a fertility soil for agricultural production and appropriate for agricultural development and irrigation works, and another area of high or relatively high soil quality for agriculture is about 0.92 million rai. Besides, the basin of Kok River still has the wide area of sloping hills about 3.16 million rai (approximately 62% of total lower river area) which should conserve as the evergreen forests better than using as agricultural aspects. The rest of the lower river area is mountainous areas and some already used as public area.

As for the lower Mekong and Ing River whose soil resouces have the relatively high capacity of agricultural and irrigation development are about 2.50 million rai (approximately 40% of lower area).

Sub-area 3T 5T-1 and 5T-2

The high quality soil resources for agriculture at this area are about 58 million rai, but most of the soil quality at this area is lateritic soil which has a fairely low fertile soil such as saline soil about 17.80 million rai (approximately 30.7% of overall agricultural areas) among this is the severe saline soil which could not use for any cultivation about million rai, moderate saline soil about 3.70 million rai and low saline soil about 12.60 million rai. Furthermore, the potential areas which could be saline soil about 19.60 million rai, most of them locate at Nakhon Ratchasima, Maha Sarakham and Udom Thani province in which divide into 4 groups:

1 Upland covering approximately 43%, mostly locates at the east along the way to the south and some part at the central region.

2 Paddy field covering approximately 27%, mostly locates at the central part and south part of the region.

3 Lateric soil covers approximately 18%, mostly locates at the east along the way to the south and pass some parts of the central region.

4 Mountainous soil covers approximately 12%, mostly locates at the west.

Sub-area 9T

By dividing this small lower river area, it indicates that it is appropriated for upland crops, the total area is approximately 2.60 million rai in which about 1.05 million rai is appropriated for cultivation and fruits and then about 0.78 million is appropriated for rice field (about 29.9%). This plantation area mostly locates on the low-lying land at both side of river bank. The rest area is the forests, small stream sources and some already used as public area.

Land use

Sub-area 2T

The rice field at the Kok River basin covers 0.82 million rai, the rest is the plantation area for planting industrial crop namely, corn, pea-nut, soybean, green gram, fruits, and various vegetables. The main fruits including mango, longan, lichi, coconut, Tamarind and banana. The main vegetable is garlic, onion, ginger, chili and leafy vegetable and also includes winter fruits and vegetables which have just been bringing to plant. As for the lower Ing River has the similar area because the area for rice cultivation is about 1.31 million rai, the rest is the area for dry crops and forests which locates in the sloping area with complicated geographical feature of place.

Sub-area 3T 5T-1 and 5T-2

Actual land use of the northeast is approximately 105.5 million rai, in which the area for local community and towns are about 5.0 million rai, forests are about 13.1 million, the irrigation areas are 4.9 million, rural areas are 60.0 million, mountainous area, road and other are about 20.8 million rai.

This lower area gives the greatest yield of rice cultivation of the country about 9.6 million Ton or 37.1% of rice cultivation in the country but the yield per rai is only 300 kilogram, it is still less if compared to the central part of the country which produces about 500 kilogram per rai. The area where there is much rice cultivation is sub-area 5T (Central Isan) or about 40% of the total cultivation in the region in which Ubon Ratchathani has (3.4 million rai) Nakhon Ratchasima (3.2 million rai) Burirum (2.7 million rai) and Si Sa Ket (2.3 million rai).

Sub-area 9T

The land use of the lower Tônlé Sap River shows that most of the area is forests about 1.0 million rai (47.6%) of total areas, normally at the upstream river areas. Another land use of this river is agricultural area which locates on the alluvial plains of both side of the river bank about 0.9 million rai (42.7%), inhabitant around 0.082 million rai and the rest is used as public area. The most cultivating crops of this Tônlé Sap River is crops and rice, among this 47% of total agricultural area is crops which locates on the plain but far away from river for example: Pong Nam Hon District and Soi Dao mountain, Chanthabuli Province. As for the rice cultivation area is about 45.0% locating on the low-lying land of Tônlé Sap's upstream river such as Tha kieng and Promhoad creek, the other area is used to plant the fruit trees and perennial.

Surface water

Sub-area 2T

The total annually runoff of two mains river namely Kok and Ing River are equally about 5,200 mm/ year and 2,350 mm/year respectively.

Sub-area 3T 5T-1 and 5T-2

The annual average flowing water through the northeast around 61,513 mm per year coming from the three main rivers (1) the lower Mekong River basin at the northeast about 30,769 million cubic metres per year (2) Chi River around 11,244 mm per year and Mun River is flowing about 19,500 mm per year.

Sub-area 9T

The natural annual average river water of Tônlé Sap is about 2,394 mm, in which 83.65 % is from the rainy season, this could calculate the annual average river water as 18.30 litres/second/sq km.

Groundwater

Thailand has a plenty of ground water resources which make use of consumption and industrial aspects at some places. At the northeastern areas there had been excavated the ground for water quantity study and used as consumption for people in the rural area since 1953, among these excavating projects there were many organizations coming from state sectors and international institutes. Since 1958 the government has been developing the ground water for consumption. However, the use of ground water for irrigation works still has a limitation because of the fairly low potential development both water quality and quantity.

Forest resources

The forests in the lower Mekong River basin area in the Thai territory is relatively fertile at the sub-area 2T and 9T, but the overall forests of sub-area 3T and 5T at the northest had continously declined during this 4 decades. In 1960, the forests area at this region had approximately 44.3 million rai or 42% of the region, currently there is only 13.1 million rai or 12.4 %, as result of illegal wood cutting and slash and burn cultivation.

5.1.4 Socio-economic situation

The social situation of local communities at the lower Mekong River basin in Thai territory is rural and agricultural society relying on the rainfall to do their cultivation, they mostly stay together in group at any villages, like peace and conserving their tradition, but their existing problems are the lack of knowledge to protect the soils, water. In addition to the soil and water quality does not permit them to do agriculture (as mentioned above) caused of poverty more than any other areas.

The statistic 2002 indicated that the total population of the northeast was 21.5 million, the population densities were 127.3 people per sq km, among this was children 5.5 million, young people 14.2 million and old people 1.8 million or 25.6%, 66.0 % and 8.4 % respectively. 83.2% of total population (17.9 million) lived in the rural area, among this 5.2

million people recorded as poor or 24.2 % of the total population in the region. The average income was about 5,000 baht a person per year which lower than the annual average income of the country.

Most of population at this region finished primary school espcially the young people have the average educating duration 6.3 years.

This regional economy depends on the 4 mains production namely the agriculture, trade, industries and services, the statistic 2003 showed that gross national products of the region was agriculture 1.15 hundred thousand million baht, trading 1.23 hundred thousand million baht, industries 1.05 hundred thousand million baht and services 1.19 hundred thousand million baht.

The industries products including foods and beverage, machinary, transportion and electronics respectively. Most of the factories are processing factory producing foods and beverages such as ricemill, tapioca flour, noodle and sugar.

Almost 97.7% of factories at this region are small scale factories investing not more than 10 million baht, medium factories investing not more than 100 million baht have only 2.1%, the rest is the large scale factories with total investment more than 100 million baht locates in the Nakhon Ratchasima, Khon kaen, Ubon Ratchathani, Surin and Roiet province.

The border trade between Thai and Lao in the year 2002 was 19,006.6 million baht in which exporting values was 15,260.8 million baht and importing 3,745.8 million. The main exporting products were consumption products for example: electronic appliances, fuel, cars, motocycles, spare parts and constructing material as for importing products were lumbers, mineral reserves, and metals.

The border trade with Cambodian through the Suline and Si Sa ket province had the total values of 315.5 million baht (the statistic: 2002) in which 295.0 million baht was exporting and 20.5 million baht was importing. The main exporting products were industrial producst, agriculture, vehicles and equipments, fuel, constructing materials, beverages and household equipments.

Tourism and services of the region have graduately significant role, the main regional tourist spotsare about archaeological significance for example: Prasat Hin Phimai, Phanom Rung and Ban Chiang Village. The natural tourist sites are: Khao yai national park, Phouluang, Phoureua, Phu Kradueng National Park. The traditional tourist spots are: rocket festival and Candle Festival, Besides, tourism could link with other Mekong sub-region countries. The statistic 2001 indicated that the number of visitors were 13.6 million among these were tourists 8.6 million, travellers 5 million, foreigners 6.8 hundred thousand or 5.0% of total visitors. And the income from the tourism about 19,678 million baht.

The positive expansion of services have been influened by tourism, therefore, it makes the boom of hotels, restaurants and other service sectors, especially in some big provinces of the regions such as Na khon Ratchasima, Khon kaen , Udon Thani and Ubon Ratchathani province.

5.1.5 Cross sectoral issues

The projects under the frameworks of BDP have one main issue concerning «Water resources in the Lower Mekong River Basin», thereby the performance of one project might have an effect to other sectors or cross sectoral. Therefore, the project development plans

should give consideration to the effects which are interrelated to other sectors, not analysis the feasibility and impacts that might happen only.

The impact of the projects might occur from socail, economical and environmental factors, all of these impacts are the main issues which have to be considered altogether in all projects, especially the impacts from upstream to tail end river occured by the result of project performances from the upstream river creating the changes of water quality and quantity to tail end river. Nowsaday, Thailand has been using the socio-economic development plan, volume 9 as a framework for development of human resources, communities, economic reform, natural and environmental preservation with a good management that concentrate to the protection of natural resources and environment. Therefore, any projects development plans should be interrelated and integrated approach in all aspects and equally link to each others.

The below table indicates the relationship and feasibility of one sector to others (the colum is the main sector showing the effect to one another)

Table 5.2: Inter-sector relationships

Sector	Forest management	Irrigation works	Water consumption	Hydro-power	Flood management	Fisheries	Water transportation	Tourism
Forest management		+	+	+	+			+
Irrigation works			+	+	+	+	+	
Water consumption		+		+				+
Hydropower	+	+			+		+	+
Flood management		+		+		+	+	+
Fisheries							+	+
Water transportation						+		+
Tourism	+					+	+	

The impacts which occured from the (projects) management of «water and other resources» among sectors including water quality and quantity could be briefly explained as follows:

Projects of lower river management/upstream forest management

This type of project involve the management of water allocation, economical activities to other sectors for instance: determining and controlling the water quality at the lower river. This means that the project has to have measurements and effectively follow up program to make sure that the people live at these lower river areas would receive the advantage from this water and resources management for sustainable use. However, the short meaning of the management and deforestation framework at upstream river of BDP still have a direct advantage to all sectors for example: Improving the soil quality at the upstream river, Being the watershed conserved areas for other developments including ecotourism.

Irrigation projects

Generally, there are many potential irrigation projects for intensified withdrawal of water and supply water to agricultural areas. However, among the water supply might include the water for consumption and industrial use. The research found out that the development framework of the sub-areas at the lower Mekong River Basin ,where there is the high volume of water flowing more than 2,200 million cubic metres still has various potential irrigation with more than 640 projects and the new irrigation areas about 4,6 sq km. Hence, the future irrigation projects will have a significant role and an effect to the development of other sectors such as: Hydroelectric projects (the projects which are not needed high level dam), reduce the negative effect of floods, fisheries and tourism. Therefore, these projects should be considered as the integrated approach and involved by all sectors.

Projects for water consumption and industrial use

These projects have an effect to other projects in water quality and quantity, espcially water allocation, waste water from consumption. However, the future demands of water use in 10-20 years later may not over 30% of total water volume. But the existing problem of these projects might be the water quality which has an effect to related sectors for instance: Industries and tourism.

Hydropower projects

The development of these projects are the critical matters because they could have an effect to overall sectors namely forestry, rivers, water use for agriculture, flood relief, shipping and tourism. Nevertheless, the projects still have both positive and negative impacts, therefore, it is necessary to have an impact assessment for quality and quantity before taking the projects into action. However, these potentail hydroelectric projects are mostly located at the sub-area 2T, as for 3T and 5T might have some projects such as the existing project of installation of electric generator at Ram Pao Dam.

Flood management projects

These projects have an objective to solve and reduce the negative effect of flood, most of the projects are the large scale, huge budget usage and involved with large population or areas, Eventhough the projects would not directly involve with water, but the projects have fairly effects to agriculture, fisheries, shipping and tourism. Therefore, the project studies should be carefully analysis the advantage and disavantage.

Fishery projects

These projects have widely advantage for society, especially for the people and grass-root of the national economy. However, the projects still have the problem of water quality and resources management which needed the cooperation among sectors.

Water transportation projects

A future number of these projects might not have many in Thailand, But the regional developments with the Mekong sub-region countries force Thai government to cooperate in many development projects for instance: the ports improvement, the installation of navigating instruments and others, concerning about water transportation, mainly during 6

waterways on the Mekong River as mentioned at topic 4.8.3. However, the projects might have negative impacts on tourism and fishery sectors.

Tourism development projects

Thailand's tourism projects are under the framework of the lower Mekong River basin development plans. Therfore, the projects still have a further stage of development with private sectors and international organizations along the lower Mekong River basin which is interrelated with each other for example: forest management, shipping and fisheries.

Cross-cutting issues

As mentioned, the main issues of projects development are economical, social and environmental sectors which are the target policy of the government under the development plans (volume 9). The plans have been determined the development activities of Thailand into 3 main tasks: 1) Poverty reduction, 2) Creating the fundamental strength of society and standard of living, 3) Creating the potentail economic competition and self-reliance. As for environmental matters, the government policies have put the significant emphasis on making the participatory of local communities and environmental protection which are the fundamental of «sustainable development», core development plan along the lower Mekong River Basin or BDP as follows:

1) Poverty reduction

If considering to the sectoral strategy of the lower Mekong River basin development frameworks, the sectors which are committed to the poverty reduction are the irrigation, fisheries, and tourism sectors, especially the development of the two first sectors which have directly an emphasis to the development of the people's production in the areas where most of the poor could do the transaction to generate their income.

The tourism sector could be the additional sector in both rural and urban area where the people could have an opportunitties to earn more income, expand their businesses and services for example: Creating the local products demands, generating income, and up to reduce the poverty. The tourism development still need the fundamental factors such as water supply and public ultilities as electricity, social security and water transportation.

2) Creating the fundamental strength of society and standard of living

The meaning of the fundamental strength of society and standard of living are to make the good well being of the people, to have a good health and spirits, a good security by using the measurement of fundamental development for example: Public ultilities, the measurement of administration namely public management, making law, rules and regulation, performand guidelines, maintenance, the management of information technology and the enhance of public participatory among the people in the areas and with government. All sectors of development and preservation at the Mekong River Basin have the same main reason and sub-reason to strengthen the grassroot of society under the framework of BDP as follows:

Water supply is the main fundamental development of the people that is to say the daily facilities for the people will also make them healthy, increase their working capacity.

The lower river management includes the preservation of rivers, forestry and soils. The management at the tail end river will also have a positive effect to people's lives, protect the

environment, relief the flood and drounght and it could conserve the balance between the projects development and capacity building such as: the reservoir for agriculture or hydroelectric, flood protection and the natural and environment preservation.

Hydroelectric development will facilitate the standard of living of the people in both external and internal areas, besides the reservoir areas could use as the tourism spots as well.

Flood Management and Mitigation the protecting measurement could be done as physical works as:Dam constructions, weirs and non-physical works like administrations such as flood forecasting operation, the adjustment of land use, town plan. This flood management will also force a good effect to economy and social in the lower river where there used to have disatous floods. It will also increase the confident and security of the people's lives and property, decreasing the local residends imgration, the intrusion of new areas and social problems.

Water transportation This also reinforces the society by increasing the facilities and security for travelling and water transportation, including tourism. But the projects should consider to the effect of environment and have the measurements to follow up, check, and solve the problems which include the quality study, aquactic ecosystem, fisheries, bank erosion, sedimentation, morphology , watercourse.

3) The economic adaptation in competitive and sustainable market

The main strategy of economic adaption is the performance of good administration, the intergated developing approach, the natural and environmental protection, the effective and transpanrently administration, and the participatory among state and the people.

The development schemes of 8 sectors at the lower Mekong River Basin which support and promote "the participatory of involved people", this supports the government policies, if the projects have been carefully showed to reduce the negative impacts to the society, natural resources, environment and have effectively or transparently administrations, it will be sucessfully as its targets.

4) Sustainable development

Any activities and projects could create the positive and negative impacts. Therefore, the negative impacts of sustainable development should be reduced as much as possible. The negative impacts might include socio-economic and environmental matters. Generally, the negative impacts caused by water use/water resources, which have impacts to water quality and quantity and have an effect to people's lives, environment as the following example of negative impacts of socio-economics,and environment below.

The development projects at upstream rivers and water use mentioned above for instance, the irrigation projects for agriculture, the water supply for industial use, fishery projects, shipping and tourism in the lower Mekong River basin are the projects reinforce the fundamental frameworks, job creation and generating more income to local people. These would be poverty reduction, local communities development and prevention of changes one's residence to urban area and other social problem. However, these development may have conversed effects for example the effect of aquactic ecology at the river mouth causes the decreasing of aquactic animals, increasing the expenditure for water improvement, water supply to agriculture and etc.

The other development projects for improving the water supply and sanitation are: Hydroelectric projects, water supply, flood management, lower river basin management, water transportation and tourism, but these projects might cause the negative impacts as well:

Water supply: caused the damatic rise in domestic sewage and hazardous wastes, therefore, it is necessary to clean up damage for the tail end river residents.

Flood control and management: this project might have a negative effect to fishery areas where there used to have floods for example:a declinning number of fishes caused by water decreasing. Moreover, the flood control at the lower river basin might change the soil ultilization or cause the conflicts among local communities.

Hydropower: espcially the construction of large scale dams caused negative effects to ecosystem in both water and forests, including imgration, compensation and finding new location for local people at reservoir areas which is the huge problem causing the high budgets and will directly charge of end users.

Water transportation: the development of this project will create the demands of high volume water for the shipping of big ships which will cause the effect to the people's lives for instance: fisheries and creating the conflicts among the local communities as well.

In addition to the above matters, any development projects along the Mekong River basin might cause the biggest problem for example: the water contracdictory could be a source of upstream and downstream residents conflicts. Therefore, it causes many projects not be success. In the future, it should have the intergated water managment by putting significant emphasis on making the local communities participatory to consider, determind and participate in the project management which might include the following points:

- Having the watershed management organization, nowadays there is sub-river commssion and water use groups.
- Having organizational rules and regulation for water use.
- Having an effective administration.
- Raising the level of public participation approach in the organization's management, improvement of the Mekong Basin, water allocation, water usage management, management of environment and natural resources and organizational management.

The future sustainable development, there should overhaul and consolidate the working methods especially the participatory expansion of key stakeholders who directly receive or lose their benefits in project areas for example: the outsiders of the project areas. The projects should put this local people to participate in appropriated project planning such as the participation in decision-making of measurements for reducing or decreasing the potential conflicts, the money collection measurement from the benefits recipients to compensate the affected people, the setting up the water management organization or the right of water use and waste water treatment. For this case, any expenditure on the projects should not only come from the government's budget but the involved people who make the water pollution should also pay the fee for the waste water treatment.

5.1.6 Trans-boundary issues

The Basin Development Plan Project is combined with various regional projects related to water use or water allocation in the Mekong River Basin, also related to main watercoureses

and has more than one country member. Therefore, it is interesting that co-issues mentioned in topic 5.2 especially in part of «the impacts among areas that have significant trans-boundary issues» such as the impacts from using and releasing waste water of one country to socio-economic and environment other countries at the downstream.

The volume of water use at the areas may be caused the change of water level especially in the Mekong River in dry season, which will have an effect to agriculture, water transportation at the tail end river, water quality and change the aquactic ecosystem caused the impacts to fisheries, drinking water, and the areas of involved countries about water resources in the lower Mekong River Basin as follows:

Water

The quantity development projects in one country (water course of the Mekong River) might cause the change of water flowing and quantity «in every season». Even if the average of water quantity per year may not change (except the case of inter-basin diversion). such changes may have an effect to change aquactic ecosystem and other development such as: the construction of reservoir or weirs for irrigation works, hydroelectric, flood protection, water supply, water transportation. But the things which should be considered is what the level of significant problem is if compared to the benefits, the capacity of problem solving and problem alleviation.

The quality development projects may cause the water degeneration to water quality both surface and riverbed, because of the sidement from fertilizer, insecticile in the agricultural areas. Besides, it may effect from industrial's waste, household's water use, ship's fuel and etc. This impacts have an effect to aquactic ecosystem and morphology. There are development activities concerns about these issues are: irrigation development, hydroelectric development, water supply, water transportation and tourism. Furthermore, some development such as irrigation development and water transportation may cause the problem of salty in water because of the mix between the chemical and waste water flowing to river. Especially in the dry season, which the development makes the level of water change or water flow into the Mekong River and its tributaries have changes and also makes the aquactic ecosystem change.

In order to protect both water quality and quantity, there are once more general measurements mentioned at 4.1 of this document known as the water utilization programme (WUP) and environmental plan of MRC will be a a concept for consideration and implementation of new development projects in the future.

Other resources related to water

The important resources here is «Soil». People's living activities in the basin and some developments might have an effect to the soil quality such as slash and burn cultivation, irrigation, dam constructions, flood protection, water transportation and etc. These cause the erosion of surface, Changes in the flow and reduction of water levels through increasing sedimentation. Therefore, the development projects that have medium scale, should be considered about soil protection.

Data of development plans of a whole 8 sectors mentioned above indicated that the sectors having the large scale project had high capacity in development and these concerned with water use in the lower Mekong River basin and riparian countries of MRC such as: agriculture and irrigation, consumption and water transportation for example: Kong-Chi-Mun projects, Kok-Ing-Nan projects, Kam River project, Songkham River project, Inter-

basin diversion project at Nongkhai Province (Regional water supply), Chiangsaen and Chiangkong development ports at Chiang Rai Province.

Consideration of these development in different sectors of integrated approach and public participation will make the development projects protentially increase the development capacity in various sectors, make the project be useful, create value and benefits in both money and non-money type to economy and society of the people along the Mekong basin or among sub-region and countries. And these also increase the overall benefits of projects under BDP. But the development projects may cause the negative effect to many sectors as mentioned, therefore, the projects should plan as the integrated approach which will be able to find the solution in order to set up the protection or reduction of the impacts. This integrated plans will also alleviate the protential impacts and stop the problem of tran-boundery issues

Project consideration guidelines/activities

For the benefits of project considerations and studies of 8 sectors under the framework of the development projects at the Mekong River basin, have main points to be considered as follows:

- Development should not be violently negative impacts on economy, society, environment and politics of neigboring countries areas and downstream areas.
- Developing project areas should not be natural preservative areas such as the quality areas (1A), where there is the conservative areas and rare animals conservation.
- Projects that cause to negative impacts of environment and social-economic, should have monitoring measurement, checking, protective ways or impact reduction.
- Key stakeholder's participation in the projects should include the key stakeholders' participation since the beginning of the project till the end.
- Basin areas should gain benefits or be more important areas than other.
- The intensified withdrawal of water to outside the river basin should not have any tremendous impacts to the water use at the tail end river or socio-economic and environmental factors.

In Thailand, any development projects had already been conducted the feasibility study, but not totally the integrated projects. Therefore, some data available are not up to date information. Hereafter, the feasible development projects should be studied and conformed to actual situation.

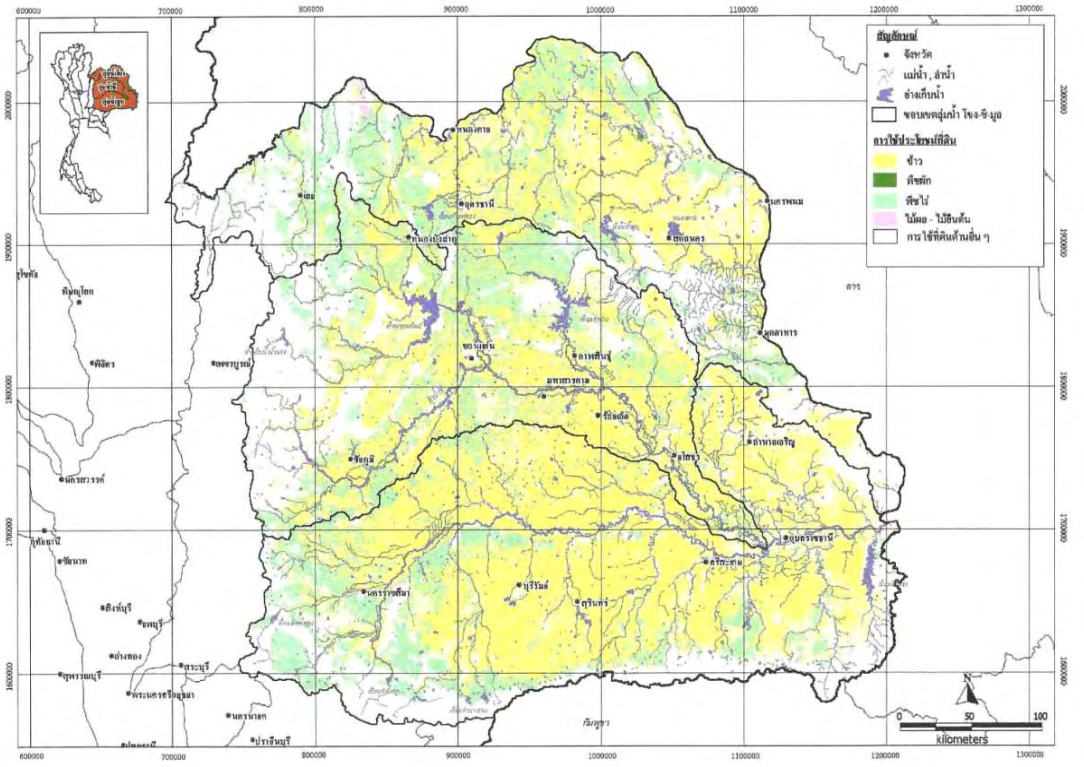
5.2 Agriculture and irrigation

5.2.1 General

Irrigated agriculture is a business sector which is the most water consumer especially the water from the source that was already developed "Irrigation Projects", the Royal Irrigation Department plays an important role for developing many type of agriculture such as Crop Diversification, Crop Intensification and Increased Crop Yield which comes from getting water in appropriate and sufficient level. The irrigation is the heart of agriculture development, in case of Thailand that in average 70% of the water from irrigation project is used for agricultural purposes and the rest will be used for consumption and industry

respectively. At the present, there is the development of more than 20 thousand projects in the Mekong Basin Thailand, which can provide the water to the irrigated area in approximately 8.84 million Rai. But this figure is still low in comparing with the agriculture land and the real demand for using water. Figure 5.1 shows the example of land use in the Sub-Area 3T which reflects the irrigating agriculture area that needs to be more developed.

Figure 5.1: Land use in Nong Khai / Songkhram (sub-area 3T)



The data of irrigation presented in this document mostly compiles from the Royal Irrigation Department which is a main responsible authority especially for the medium and large scale projects, with head-works, water delivery system and certainly irrigated area. The small scale projects, there are mostly head-works and irrigated area but do not have the water delivery system. These projects are not only implemented under the Royal irrigation department but some may be under the responsibility of other authorities such as Rural Development Department (it is now changed to another department and it has been moved to other working unit especially for the water development work that has been moved to be under the Water Resources Department) and Energy Development and Promotion Department is now implementing the Water Pumping Project by using electricity (now the water pumping work has been moved to be under Royal Irrigation Department), currently there are more than 40 state authorities who have roles and responsibilities relating to the water management, those are under supervision of the line ministries.

The development of irrigation in the Mekong Basin in Thailand is changing in many aspects from the policy level such as official system reform, up to the working direction that would be the power decentralization and other businesses from the central level to the regional level, there are now more than 4 million Rai is the potential irrigated areas while the natural water sources are limited, this will lead to be a big problem for the development of irrigation project in the future. So, it needs to be diversified the projects e.g. to do not only develop the

new projects but also improve and expand the existing projects to be more efficient in transferring and using water including the development concept in using the increased water from Mekong in the sustainable ways.

5.2.2 Policy framework for water and irrigation management

Unified water management

Following the restructuring, the Water Resources Department is now under Ministry of Natural Resources and Environment. This department gradually plays a role in the management work "in the policy level" regarding to the water resources which is used to be main duty of the irrigation department. Therefore, it is necessary to have the Unified Water Management System, issuing the related laws and improving of the existing regulations related to the water resources by having the participation from all stakeholders (Decree on Water Resources) in order to make an efficient management of the water resources in the future.

Water resources management

The successes from implementing the water resources management is the concept of water management decentralization from the central to the regional level in the form of "Water Basin Sub-Committee", even the committees were just organized and are being in the beginning step of implementation when the capacity of the committees have been built up, these sub-committees can manage and take care their responsible area more efficiently and equally.

Water delivery service

This includes the measurements which relate to the Irrigation Department and many other mandates of the department as following:

- The measurements for the water transportation that has been implemented under Irrigation Department, if these measurements can be implemented it means the water irrigating system is reformed, since the part this used to serve people according to the roles and responsibilities of Irrigation Department only but now it changes to serve people according to the community's participation e.g. Participatory Irrigation Management – PIM in every big project.
- The measurements in organizing the PIM unit in the central level and in the regional irrigation office, the recruitment of Irrigation Community Organizer-ICO and the implementation of action guideline in order to make Irrigation Department can work more closely to the water users.
- The measurements which relate to the sub-contracting with the private sector or transferring of the responsibilities regarding to the water Operation and Maintenance-O&M that the government has already planed to transfer the responsibility on O&M to the sub-district authority. As for the medium and big projects, Irrigation Department planned to hire the private sector for doing O&M as the pilot projects (there are 8 projects).

- The government measurements for recovering the cost that invested in the irrigation system, Ministry of Agriculture and Cooperative now agrees with the action plan in terms of procedure and time period which the concept of this plan is participatory cost sharing for irrigation system instead of the cost recovery which encourage the participation from local people in taking care and responsible for the government irrigation by introducing the regulation for using water, allocating of the irrigated water and sharing in water service payment and the maintenance cost of the irrigation system, those will be a way to use the existing and limited water resource more efficient and fairly.

5.2.3 Current problems and solutions

Existing irrigation projects

Sub-Area 2T

Kok River Basin is a potential and appropriate area for doing agriculture activity and developing the irrigation for about 1,164,000 Rai or 17% of the total basin area. At the present, a number of the big, medium and small irrigation projects are constructing including the electric water pumping project and of these 270 projects are already finished, the total benefit area is 650,000 Rai and the demand for irrigated water is 330 million m^3 per year. In NamInk Basin, the potential area that is appropriate for developing irrigation is about 900,000 Rai or 21% of the total basin area, many sizes of projects now are finished (in the number of 340 projects), the benefit area is 590,000 Rai and the irrigated water demand is 250 m^3 per year.

We could say that this sub-area still has many potential for irrigation development in the future.

Sub-Area 3T, 5T-1 and 5T-2

There are many projects for water source development whether in the big size (its volume is more than 100 million m^3 or the irrigated area is more than 80,000 Rai), medium and small sizes which are implement under the responsibility of many working units such as Irrigation Department, Electricity Production Sector of Thailand, Energy Replacement and Conservation Department (the former of Energy Development and Promotion Department) and Rural Development Department.

Many sizes of projects that already developed in this part is more then 20 thousand projects and the benefit area is approximately 7.48 million Rai, in which there are 11 big water reservoirs that can put the water in volume of 7,341 million m^3 or 11.9% of total volume of the water per year.

Oubonrath Water Reservoir	2,263 million m3
Sirinthorn Water Reservoir	1,966 million m3
Lampao Water Reservoir	1,430 million m3
NamOun Water Reservoir	520 million m3
Lamtakhong Water Reservoir	324 million m3
Choulaporn Water Reservoir	188 million m3
Namphoung Water Reservoir	165 million m3

Upper NamMoun Water Reservoir	141 million m3
Lamnanglong Water Reservoir	121 million m3
Houyluang Water Reservoir	113 million m3
LamPhraPreung Water Reservoir	110 million m3

Many river bank and water source areas receive the water from the water pumping projects which are now implemented by the Irrigation Department, it composes the electric water pumping project which is a permanent water pumping project that people sharing expend for the electricity fee for water pumping, each project comprises water pumping station and the water transferring system that mostly is the concrete channel system, currently there are in total 992 electric water pumping projects in the bank area of Mekong, Chi and Mun River, about 1.44 million Rai total area that can receive water from the projects. Apart from these, Irrigation Department also has the water pumping projects to help people who faced the drought problems due to the rain does not fall regularly during the production season and in the dry season in many area as people's requirements. There are about 22,370 medium and small water sources that can fill 1,616 million m^3 of water, the total irrigated area is 7.48 million Rai, it is divided into the sub-area 3T, 5T-1 and 5T-2 which are equal to 1.88 million Rai, 2.62 million Rai and 2.98 million Rai respectively, as mentioned above that the objectives of using water from these projects e.g. mainly for irrigating/agriculture.

In considering with the water volume reserved by the projects compared by the natural water in each main basin, the proportion between the capacity of reservoir to the volume of the natural water in the sub-area 3T, 5T-1 and 5T-2 in percentage are about 5.6%, 43.6% and 24.6% respectively, the average percentage of the basin in this part is 19.5%. It shows that there is now the cost-water source in the low proportion.

Sub-Area 9T

In the sub-area in TonleSap River , there are many types of 98 projects which have capacity in filling water about 75.97 million m^3 and the total benefit area (irrigated area) is 0.117 million Rai, the water demand in this area is about 0.10 million m^3 per year, the details are as follows:

Table 5.3: Existing irrigation projects in the Tonle Sap catchment (sub-Area 9T)

Type of project	Number of projects	Filling capacity (million m3)	Benefit area (million Rai)
1. Big and Medium Size projects	6	66.50	0.046
2. Small size project	86	8.35	0.060
3. Projects implemented by ERCD	6	1.12	0.011
4. Electric Water Pumping projects	-	-	-
Total number of all project types	98	75.97	0.117

In sum, the developments of water sources for irrigation in the Mekong Basin in Thailand, which are implementing in a number of project, but it seems to be small number in comparing with its potential and the water demand in this area, however there are many important issues need to be considered in order to make the development to be more efficient and productive in the future.

2) Problems

The problems related to the irrigation development that is the effects from the nature or problems that created by human such as the drought, flood, soil quality (salty soil), problems from cutting the trees which affects to the water ecology on the ground level (the soil erosion and the sedimentation), problems of water quality due to the mixture of the waste water from community and so on. In addition, there are still problems on water management even there are the laws and many authorities who manage the water, but there are still many conflicts. The reasons for those problems can be summarized as following:

(1) Open access regime and lack water allocation Rules

Even if Thailand has many laws relating to the water management but the water on the ground is still be in Open Access Regime and there is no policy to prioritize or define the right of the users of this regime, it does not only create the luxurious water using with no efficient and unfair, but it also creates the conflicts in using water for different purposes.

(2) Coordination problems

Before the official system reform in Thailand, more than 40 government agencies in many ministries who have authority relating to the water management which comprises the units were assigned to define the national policies and plans such as National Water Resources Committee Office which is now restructured to be Water Resource Department, National Social and Economic Development Committee and other units who are working under the scope of the laws, they have their own-roles and responsibilities and their managements are freely separated, that makes this working lacks of the integration, there are many cases that leads to the conflicts or repetition in this work. In addition, to have many organizations responsible for the water management leads to use the limited resources and budget in inefficient and non-necessary way.

Since official system reform in 2544 (2001), most of above problems have been solved even there are still some problems in practice including the problems regarding to the decentralization of the decision making power from central government to the regional working units, this is because of the lacking of experiences or the ready in implementing all new mandates.

(3) Demand management measures

The management of resource in Thailand so far concentrated in water procurement or supply management such as the construction of water reservoir or dam which is the activity that wastes high environmental and social cost. At the present, it is starting to be refused by the general people and society, the existing water resources management institutes seem could not answer the questions and/or the demand requested from the people, the measurements on supply management seems to be gradually needed such as to use the economics instruments in managing water that is very limited now, even the **Decree on The Royal Irrigation in 2485** handed the right to the ministers can ask for the fees from the irrigated water users in the rate that indicated in the law which is very comparatively low. Importantly, the collection of water fee so far is not so active especially for the water using for agriculture this makes the water using in this sector have no efficiency.

(4) Lack of necessary knowledge about basin ecology and socio-economics

Similarly, the water management in Thailand does not give any priority to the overall ecologic system especially the consideration of the effects of development to the using of many types of land and forest ecology, the effects to the water flow, the water conservation and the water recycling, the forecasting of water consumed by the plants, the water using in any activities that is out of agriculture sector. This makes the previous evaluation of water using was not consistent with the reality.

(5) Lack of appropriate management and lack of participation by water users

So far, the water management in the irrigated area mostly characterized as project-based rather than basin-based which could not see the integrated and systematic picture. Recently, there are many affords in planning based on the basin as mentioned earlier that the water management in the basin level was just started, therefore the problems on lacking of management in the basin system are clearly appeared when there are some arguments within the basin and the water user groups have to solve the problems by themselves, the appropriate approach in the future need to use more knowledge and the cooperation from the water users in defining the rules and making agreement that is recognized by the society in that basin and it also should be the monitoring and checking the enforcement of the rules in the basin by the water users themselves.

5.2.4 Planned projects

To understand the problems mentioned above would help in considering the irrigation projects in the basin in the future to be more physical and reasonable. In the development of the new projects in order to supply the demand on water for many purposes in the future, the Irrigation Department has studied some potentials and directions as follows:

Sub-Area 2T

Plans for study, survey and design 21 potential projects in the Kok and Ing Basins:

- Nam Kok Basin: 10 projects, total benefit area is 230,400 Rai
- Nam Ing Basin: 11 projects, total benefit area is 184,700 rai

Table 5.4: Planned large and medium irrigating projects of Kok and Ing Rivers

No	Project name	District	Province	Capacity (Mm3)	Benefited area (rai)	Project value (million Baht)	Duration of construction
	Kok Basin						
1	Maesaluay Water Reservoir	Maesaluay	Chieng Rai	73.00	7,000 (64,000)	906.0	2542-46
2	Maethalopluang Water Reservoir	Chaiprakarn	Chieng Mai	15.30		475.0	2545-49
3	Nongluang Water Reservoir	Meuang	Chieng Rai	15.00	9,300	268.0	2547-50
4	Saysombat Dam	Meuang	Chieng Rai	-	12,000	25.0	2548-51
5	Maepounluang Water Reservoir	Viengpapao	Chieng Rai	53.00	13,000	865.0	2549-53
6	Maeyangmin Water Reservoir	Maesaluay	Chieng Rai	32.00	55,000	690.0	2550-54
7	Maechedeeluang Water Reservoir	Viengpahao	Chieng Rai	35.00	39,000	676.0	2551-55
8	Maenavang Water Reservoir	Fang	Chieng Mai	36.20	36,000	615.0	2552-56
9	Huay Khray Water Reservoir	Chaiprakarn	Chieng Mai	48.50	13,000	767.0	2553-57
10	Upper Fang River Reservoir	Chaiprakarn	Chieng Mai	50.00	28,000	758.0	2554-58
	Total				230,425		
	Ing Basin						
1	Maechai Water Reservoir	Mae Chai	Pha Yao	3.00	2,700	78.0	2543-45
2	MaeTak irrigating system	Vieng say	Chieng Rai	9.00	17,000	95.0	2543-45
3	Rathsaphon Irrigating Dam Improvement	Meuang, Dokkhamtay	Pha Yao	-	22,960	248.0	2547-51
4	Nonglengsai	Mae Chai	Pha Yao	6.50	10,000	125.0	2548-51
5	Suan Water Reservoir	Siengkham	Pha Yao	36.00	20,000	326.0	2546-50
6	Mae Ing Dam	Therng	Chieng Rai	-	15,000	540.0	2551-55
7	Ang Thong Dam	Therng	Chieng Rai	-	37,000	804.0	2552-56
8	Lao Basin Development	Siengkham, Phousang	Pha Yao	-	-	-	2552-57
9	Ing Watergate	Siengkong	Chieng Rai	-	48,000	996.0	2552-56
10	Dam over Therng District	Therng	Chieng Rai	-	12,000	445.0	2553-57
11	Phayao Lake Improvement	Meuang	Pha Yao	33.20	-	50.0	2555-59

Sub-Area 3T and 5T

The potential projects for developing the water sources and irrigation systems in the future comprise:

- There are 290 projects in Sub-Area 3T which have potential and need to be studied and it is expected that those have capacity to fill the water in volume of 801 million m3 and it can be increased the irrigated area more 1.67 million Rai.
- There are 143 projects which need to be developed in full potential in the Sub-Area 5T-1, the expected capacity for filling water is 536 million m3 and it can increase the irrigated area more about 1.0 million Rai.
- There are 184 projects which need to be developed in full potential in the Sub-Area 5T-2, the expected capacity for filling water is 887 million m3 and it can increase the irrigated area more about 1.44 million Rai.

In addition, the Energy Development and Promotion Department conducted the project study in Mekong, Si River, and Mun River in 2532 (1989) those were built for reserving the water in HouiLuang River, PhonPhiSai district, Nongkhai province, the project's work is to construct the water controlling building on the mouth of HouiLuang and to construct the water pumping station that use electricity in Ban Doung, Oudonethany province that pumps the water from Houiluang down to Saipathan channel which length 67 km. and make it flowing down to the reservoir in NamLampao in Kalasinh province, then let it down to Si River and Mun River. To dig 4 channels between Si River and Mun River along with the direction of the main channel that can let the water flow or pump it to keep in the existing reservoir for using in irrigating purpose, the volume of water that is diversified from Mekong to Houiluang is 1,870 million m^3, the speed of diversifying is not more than 100 m^3 per second, the benefit area is 2 million Rai and the investment cost 18,100 million Bt. That is very big and high potential project in the basin which needs to be considered in the future.

Information about location and basic characteristics is given in the tables below.

Table 5.5a: Irrigation projects in the Northeast (a): Isan and total for the Northeast

Project	Mekong River Basin in Isan			Sum of the Northeast		
	Number of projects	*Capacity (million m3)*	*Area (million rai)*	*Number of projects*	*Capacity (million m3)*	*Area (million rai)*
Current Water Source Development Projects						
Large-medium Irrigating System	91	917.22	0.688	270	9,195.83	3.140
Small Irrigating System	972	250.07	0.608	4,224	815.48	2.304
Electric Water Pumping	304	-	0.421	992	-	1.437
Water Source Development	198	156.98	0.163	610	321.45	0.602
Total current projects (With water canals)	395	917	1.109	1,262	9,195	4.576
Total current projects (No water canals)	1,170	407.05	0.771	4,834	1,136	2.906
Total current projects	1,565	1,324.27	1.880	6,096	10,332.77	7.482
Current Water Source Development Projects						
Large-medium projects	64	652.14	0.860	113	1,885.09	1.708
Irrigating canal system projects	64	-	0.259	147	-	0.704
Developing effectiveness of water use				330	340.01	1.397
- Water source development	151	149.52	0.506	27	-	0.143
- Water deviation of sectoral rivers	11	-	0.010	-	-	0.164
- Water deviation of Mekong sectoral rivers	-	-	0.039			
Kong-Chi-Mun Project	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Sum of development projects	290	801.66	1.674	617	2,225.10	9.096
Sum of full potential development (With water canal system)	685	1,718.88	2.783	1,879	11,420.93	13.673

Table 5.5b: Irrigation projects in the Northeast (b): Chi and Mun River Basins

Project	Chi River Basin			Mun River Basin		
	Number of projects	*Capacity (million m3)*	*Area (million r ai)*	*Number of projects*	*Capacity (million m3)*	*Area (million rai)*
Current Water Source Development Projects						
Large-medium Irrigating System	72	4,636.29	1.122	107	3,642.32	1.330
Small Irrigating System	1,349	227.44	0.637	1,903	337.97	1.059
Electric Water Pumping	445	-	0.688	243	-	0.327
Water Source Development	181	90.54	0.172	231	73.94	0.267
Total current projects (With water canals)	517	4,636.29	1.810	350	3,642.32	1.657
Total current projects (No water canals)	1,530	317.98	0.808	2,134	411.91	1.327
Total current projects	2,047	4,954.27	2.618	2,484	4,054.23	2.984
Current Water Source Development Projects						
Large-medium projects	44	416.30	0.400	5	816.65	0.488
Irrigating canal system projects	40	-	0.149	43	-	0.297
Developing effectiveness of water use						
- Water source development	53	120.48	0.393	126	70.01	0.498
- Water deviation of sectoral rivers	6	-	0.017	10	-	0.115
- Water deviation of Mekong sectoral rivers	-	-	0.043	-	-	0.082
Kong-Chi-Mun Project	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Sum of development projects	143	536.78	1.003	184	886.66	1.440
Sum of full potential development (With water canal system)	660	5,173.07	2.812	534	4,528.98	4,528.98

Sub-Area 9T

The potential projects in NamTonleSap which are in the development plan of Irrigation Department comprise:

Projects in the Short Term Construction Plan (2547-2551) (2004-08)

There are 4 medium construction projects as presenting in Table 5.6.

Table 5.6: Potential projects in sub-area 9T, short term

Project	Types of project	Filling capacity (million m3)	Irrigated area (rai)
1. Water reservoir project in Houisatone, Sakeo province	Medium size	22.32	8,000
2. Water reservoir project in KhrongPhrasatheung, Sakeo province	Medium size	-	-
3. Project in KhrongPraphouthorn, Chanthabuly province	Medium size	69.50	52,400
4. Water transferring system project in Khrongpraphouthorn, Chanthabuly province	Medium size	-	-
Total		91.82	60,400

Projects in the Long Term Construction Plan

There are 2 medium construction projects as presenting in the Table 5.7.

Table 5.7: Potential projects in sub-area 9T, long term

Project	Types of project	Filling capacity (million m3)	Irrigated area (rai)
1. Project in Prongnamlorn, Chanthabuly province	Medium size	18.16	11,800
2. Water reservoir project in Rattanakosinh, Tapthai sub-district, Taphaya district	Medium size	-	-
Total		18.16	11,800

5.3 Fisheries

5.3.1 General

Fishery is important to both the country economics and consumption lives of people in general information collected in the year 2538-2542 (1995-99) specified that Thailand fishery production result was between 3.4 to 3.6 million tons per annum listed in one of countries of the first of the world with high fishery production results.

Fishery production result was 2.9 per cent of Gross Domestic Product of Thailand (figures of the year 2541 (1998)). Majority was sea fishery both quantity and values were higher than fresh water fishery, the year 2543 (2000) information specified that fresh water animal fishery production result from the country's tributaries was about 201,000 tons valued 2,200 million Baht, however, the production of this field is likely to be declining.

The area of Mekong down stream, the part belongs to Thailand, fresh water fishes is one of the important food and protein sources of the country in which more than 20 million people have lived their lives on fishery, is regarded as one of the important jobs of Mekong River Committee with continual development activities since the establishment of Mekong Down Stream Development Area in the year 2500 (1957), the Mekong River and its tributaries are important fishery and food sources for the people in the area, and deserve to be sustain ably developed and maintained.

5.3.2 Relevant important policies and laws

National policy on fisheries (2545-2549) (2002-06)

Setting of time frame of action plans was in accordance with national socio-economic development plans during the period of plan implementation between the year 2545-2549 (2002-06).

As well as the Kingdom of Thailand's Constitution from 2540 (1997) caused many important reforms specifically the local development, decentralization of power to take care of natural resources and environment including people's participation in development making people, community and different organizations self aware and realize in participation in service, management and development of various fields in having their says and expression of their opinion, and joint implementation resulting in sustainable development. National fishery development policy of the year 2545-2549 (2002-06) has established policies in 5 areas in accordance with national economic development as follows:

- Policy on development of fishery areas and relevant organizations.
- Policy on provision of services and management of fishery resources and environment.
- Policy on breeding/farming of water animals.
- Policy on fishery development outside water boundary.
- Policy on industrial development and fishery business.

Specifically the policy on provision of services and management of fishery resources and environment with the following important subject matters:

- Improvement of services and management of fishery resources and environment.
- Making people value of fishery resources and environment.
- Giving support to organizations and communities of all levels to participate in management of fishery resources and environment.
- Rehabilitation of weak fishery resources and environment.
- Giving support to administration and preservation of biodiversity and
- Giving support to technology and human resources development in management of fishery resources and environment.

Law on fishery

There are 5 laws on fishery, however, there are 2 laws that directly relate to fresh water fishery such as law on fishery enacted the year 2490 (1947) and the law on preservation and administration of wild animal enacted the year 2535 (1992).

The law on fishery enacted the year 2490 (1947) has been applied as the law on supervising the fresh water fishery and was amended twice the year 2496 and 2528 (1953 and 1985). The law consist of 6 chapters and 73 articles covers the management of fishery and preservation of breeding, registration, and asking for permission to supervise fishery statistics and law on punishment covers both fresh water and sea fisheries, which has been made to be equivalent to fresh water fishery before the laws has divided water resources into 4 types such area for protecting species, area for bidding, permitted area and the area for utilization.

In general the law on fishery widely covers and is sufficient to administer and manage of fresh water fishery, however, majority of fresh water fishermen carry out fishery from hand to mouth with little income and education, therefore, they have other options for making living, hence, are often in breach of their registration and will continue doing so if poor villagers still catch water animal for living.

On the other hand, law on fishery that has been applied for years is out of date and cannot catch up with fishery method that has been fast developed and advancement of technologies making officers difficult in carrying out their jobs with inefficiency, the law has been being amended and revised by fishery department.

The law on preservation and management of wild animals enacted in 2535 (1992) the Fishery Department has authority and functions to manage all types of water animals specified in the list of preservation and management animals which cover water mammals such as dolphins, barrier reefs, sea turtles and many fish species that are nearly extinct. This law bans hunting, catching, being ownership, breeding, trading, exporting and importing of all types of water animals listed, in addition, the law supervises international trades on animals and tree species that are nearly extinct, is in accordance with CITES subcontracts.

Relevant organizations

Services and management of fishery resources partly relate to other organizations as follows:

- Department of Forestry is responsible for forest areas such as which are areas for laying eggs and nursing of young animals.
- Water Transport and Navigational Commercial Departments are responsible for registering fishery boats.
- Irrigational Department and Thailand's Electrical Production Department are the two organizations that have important roles on fishery in catchments or reservoir and rivers.
- Water Resources Department is a newly established organization from restructuring of state organizations in 2545 (2002) has important roles in establishment and management of the use of water in general of the country, specifically focusing on management of downstream system, supervision of pollution, prevention of and solving problems of water and water sources pollutions due to urbanization, industrial and agricultural development that release waste water without treatment into water sources.

Activities relating to fishery such as water animal breeding farms, attention has been paid for not directly releasing water from breeding farms into natural rivers, serious practical measures have been carried out for sea farming industries nationwide and efforts have been made in trying to get concerned people understood and devoted for society in paying for treatment of water from the breeding farms before releasing it into the natural water rivers.

5.3.3 Current situation

The need of food made of water animals

Information collected in the year 2543 (2000) specified that water animal production from the Mekong downstream areas, the part belongs to Thailand including natural fish catching and breeding were 153,798 tons calculated from population of 24.87 million sheltering in the

area will receive an average consumption rate of water animal of 6.18 kg per person per year. When comparing with analysis results which found out that the consumption of water animals of northeastern part habitants is equivalent to 33.8 kg per person per year that is understood that the habitants sheltering in the Mekong downstream area have to depend on importing of water animal products for their consumption from other source of big quantity per annum.

Initial production calculated in catching portions in the area such as 2T, 3T, 5T-1 and 5T-2 which equal to 5.4%, 13.58%, 13.31% and 67.70% accordingly and similarly the said production results can be divided into reservoir areas and natural water sources and fish lake in the portions of 31, 59 and 10 per cent accordingly.

Although practical measures have been put in place in preserving water sources to enable the sources of water animal production, invasion of water sources have been practized making the production results from the areas is not much, together with fast increasing of population and number of tourists resulting the demand for consumption increasing and more than normal production can supply.

Production sources

The production sources or important water animal catching sources in the Mekong downstream areas, specifically in the northeastern part consist of public water and breeding sources as follows:

Public water sources

Statistical information collected by Department of Fishery categorized the public water sources into 3 types as follows:

- Reservoirs including bays.
- Natural sources such as streams, rivers, ponds, lakes and fish ponds.
- Fish lakes such as village water sources and other water sources made for benefits of water animal farming.

Information of the same sources shown that numbers and areas of public water sources of different types in the northeastern part are more than other parts of the country as shown in Table 5.8.

Table 5.8: Numbers and areas of public water sources (by region) (2543) (2000)

Region	Total		Public water sources					
			Reservoirs		*Natural water sources*		*Lake fish farming*	
	Number	*Area (rai)*	*Number*	*Area (rai)*	*Number*	*Area (rai)*	*Number*	*Area (rai)*
North	9,179	850,988	1,237	520,204	5,159	299,246	2,779	31,538
North eastern	20,001	1,918,296	1,905	1,036,238	14,490	777,487	3,060	104,571
Central	1,440	64,450	134	22,176	1,151	40,408	155	1,865
East	985	111,844	98	75,867	668	29,877	219	6,099
West	865	180,735	121	116,499	325	61,715	328	2,520

Source: Selected from fresh water animal production results from natural water sources of the year 2543 (2000) Department of Fishery.

Breeding/farming

Fresh water animal farming can be categorized into 4 types as follows:

- Pond fish farming refers to location for water animal farming dug by human labor or machinery, in general the location is rectangular including lime ponds.
- Fish farming in rice field refers to rice field fish farming similar to rice farming and including fish farming in the rice field with water level of not more than 1 meter.
- Fish farming in garden canals refers to the use of the canals in garden for water animal farming. The canal is less than 5 meters wide. The canal is long connecting with one another and the water animal can conveniently travel from one location to another. The area is regarded as one location.
- Net fish farming refers water animal farming in cages or big net and foams floating or it is similar to big net with big forms attaching to the sides of net, the net rim is high up from the water level to prevent water animal escape away.

In the northeastern part, production results from the water animal farming was 7, 928.92 tons dividing production results from ponds, rice fields, garden canals, nets in the portions of 83.3%, 9.3%, 0.03% and 2.37% accordingly, from the statistics found out that breeding and farming of fresh water animals in the area is likely to increase 12% per annum (during 2539-2543) (1996-2000) due to high quality water sources for breeding and farming in the Mekong downstream areas.

Water animal species production

In the area of Northeastern part, there are analysis and fresh water development centers, and fresh water fishery station of more than 20 locations in total producing species of 500 million young fish per annum with the purpose of releasing them into water sources in order to increase quantity of water animals in the natural water sources on average of 300-400 million young fish which are equivalent to 62-77% in order to replace natural water animals that have been decreased.

5.3.4 Problems and threats to fishery resources

Factors causing problems and threatens to the fishery resources are many and important as follows:

Industrial waste

The problem of digesting oxygen decreasing has been occurring in Phong River starting from ponds, rivers to Nong Wai Dike, Nam Phong District, Khonkaen Province. Rotten resulted from releasing waste water of Khonkaen Paper Mill and Sugar Mill causing the death of net fish in big quantity along the Phong River. The said problem is often occurring during the period that hydropower dams releases less water into the river that is not enough in digesting the waste.

Salinity

It is the specific problem of the Northeastern part, water testing found that water from many sources have electrical carried values in between 500-1, 250 microsimen per centimeter which is higher than normal level, this occurs during the dry season, the cause is from the

salt melting from land with high level of saltiness into water sources. The areas that have the said problem are Moon River starting from Phimai District, Nakonrachasima Province to Thatoum District, Surin Province. The Chi River starting from Kaengsamannang, Nakonrachasima Province to Meuang District, Mahasarakham Province and the problem has occurred throughout the Slongkham River, however, electric current measured is not higher than standard set for general crop growing or not more than 2,000 microsimen per centimeter, except in the area of Syo River Dike, Meuang District, Mahasalkham Province, the electric current measured is twice higher than set standard (information collected by Toxic Supervision Department in the year 2539) (1996).

Soil was washed and eroded away

The soil surface is destroyed that occurs during the rainy season in the forest area that illegal logging is practiced and agricultural areas when it rains, the soil surface is washed causing the river water brown colors along the river or flooded areas. The washing of soil surface causing 2 damages such as loosing fertility of the soil, making the crop growing depend on more fertilizer in order to increase production results causing high production cost. The soil was away by water current get stuck along water sources causing changes of ecological system and shallowness along the river that is difficult for water transportation and causing the reduction of water sources capacity.

Construction of dams or dikes to obstruct water current

Because Northeastern part is drought constructing dams to store water is the only way to solve the problem, however, the dam construction causing fishery problem, which barriers traveling routes of water animals, specifically during the rainy season in which the fish looking for place to mate and lay eggs. Although the dam construction creates big reservoir like fish farming pond consequently water animal products will be made

Available, however, when looking at water animal production statistics is clearly that the products decreasing continually due to fishery effort made is more than production efficiency as well as the changes of ecological system in the reservoir further to reduction of the products, diversity of water animals also decreases, the breeding and releasing young fish into the reservoir cannot compensate the products from natural water animals.

Overfishing and illegal fishing

In addition to the said threatens, the over and illegal fishery are other factors causing the decreasing of water animal products. The fishery with high efficient equipment are illegal equipment or with cleansing method is important cause that causes water animal products from natural water decreasing.

Pollution of migrants fish species

Many foreign fish species have been imported into Thailand for the purposes of breeding and be beautiful water animals (pets). The types of water animals were imported for the successful breeding and have been done so till present, those fish groups are Chinese (Chinese Carps)fishes are carps, Russian king fish, in addition to production result of breeding, it is found that the said group of fishes, are quite high in production results in natural water sources, listed in group 10, the first level of high production results. It is shown that the said foreign fish species are capable in adapting themselves into Thailand's

environmental situation. The said capacity will affect on reduction of traditional fish species with less competition capacity.

The reduction fresh water animal products resulting from previous fresh water fishery carried out in the main rivers and the areas below the flooded areas. Building dams create multipurpose reservoir with irrigational, use and consumption purposes making the flooded areas where water animals mate and lay eggs, decrease or disappear. In addition to the shallowness of water sources including cooperative activities of community cause affects and environmental deterioration, and reduction of water animal populations.

5.3.5 Policy for development

To sufficiently increase future water resources meeting the demand, measures to be used to tackle the said problems may consist of:

- Rehabilitation of available water resources.
- Release more water animal species into rivers.
- Establishment of plant species protection areas.
- Supervision of fishery.

The production result, is to promote breeding and farming of water animal is of important measure as previously mentioned that water animals are important protein sources of habitants sheltering the Mekong Downstream areas, specifically the people of rural areas. Fresh water animals in the past mainly obtained from the natural water sources in which the estimation of water animals in the main rivers during the year 2510-2512 (1967-69) was 14 kilograms per Rai, however, the current water animal products from natural water sources are likely to decrease in quantity and not enough for consumption demand in the areas whereas the breeding and farming are not developed in full scales for example the farming areas of the northeastern part is only 16% of the nation wide areas (Phongkaphan and Nouanpid, 2540(1997)) mainly the farming are mix of rice field and garden methods and are also in irrigational areas, the famous types of farming fish are carps and nin.

The fish farming has been developed after serious promotion has been made under the northeastern part development project aiming to be protein food source from consumption of water animals and to increase income for poor rural habitants, promotion of multi-method activities such as just enough fish farming, village method fish farming and school fish farming. Fish farming products in the northeastern part for the period of 10 years (2525-2535) (1982-92) has been fast increased, despite the farming product increase to 185% in that period, however, the product per Rai was only 10%, that shown that the increase of water animal product was mainly from traditional method of farming and there is lots of development work needs to be done in order to increase the products both quantity and quality.

Action plan on fishery under the Mekong River Committee has important area such as joint operation of the fishery resources management in reservoir, the first phase was (2539-2542) (1996-99) already completed and now being in the second phase of the project that commenced since the year 2543 (2000) with the following important subject matters:

First period operation, the project emphasizes on scientific analysis and socio-economic status of fishery of many targeted reservoirs in the region that gives knowledge and understanding of resources in the reservoirs, and information on fishery career activities in those reservoirs.

The action plan for the second phase has been adjusted in project methods in order to test fishery resources management procedures with co-management of the reservoirs with smaller scales which are useful work and will continue to be carried out.

5.4 Hydropower

5.4.1 General

Hydropower is the country's one of the most important power source because of the use of water resources, with low cost, is clean and can be reused forever to produce power again (Electricity Generation Authorities of Thailand) (EGAT). Regional Power Replacement Promotion and Preservation Department, Irrigation Department and etc are the main organizations in water resources development to produce electric current, so far 1,022 projects in total have been developed, scattered around in downstream of This River and generators have been installed to produce electricity which results 12 hydropower dams have been developed with production capacity of 241 megawatts or is equivalent to 18% of nationwide hydropower plants (2,939 megawatts), but is equivalent to 1% of every installed machinery of the whole county (25,638 megawatts).

It is said that the development of hydropower in the Lower Mekong Basin, the part belongs to Thailand have already been carried out and efficiency to be developed and used in future is still available specifically on the basis of cooperation of member countries of the Mekong River Committee.

In the past Thailand promoted to study the efficiency of the region in producing hydropower of the country's every region and specifically the downstream areas the Mekong River, the most important river in southeast Asia attended as member of the country who established Mekong downstream development committee under the support of the United Nations in 2500 (1957) and the Interim Mekong River Committee in 2521 (1978) under the international operation, many project efficiency has been studied and development has also completed, and many projects have been being studied and to be developed next.

In addition to hydropower, Thailand has emphasized the use of power sources by mixed methods that consist of petrol, coal, and natural gas. At present by means of installation transmission lines across borders, Thailand has policy in producing and exchanging power with its neighboring countries in Mekong basin that promotes the use of resources suitable to each country's characteristics, it also reduces resource shortage circumstance, specifically water resource which is gradually limited. An important thing is opportunity to develop hydropower in the Mekong basin is little available to Thailand due to geographical composition is not favorable in constructing reservoirs of big scale and hydropower dam construction resistance of domestic private and overseas organizations which raise environmental affects as an excuse however, Thailand's new constitution enacted in 2540 (1997) creates opportunity for local people to participate in project development in every steps that means the development organization will have more activities than they used to in order to successfully complete the projects.

5.4.2 Current situation

The nationwide installed power production capacity is equivalent to 25,638.2 megawatts (information collected on the 7 January 2546 (2003)), of figure, hydropower takes 11% or 2,939.3 megawatts, of this figure, the Mekong River group production capacity is 24 megawatts or is equivalent to 8% of the total hydropower capacity, by dividing into groups

as Kok River 8.175 megawatts, See River 66.7 megawatts, Mun River 160.35 megawatts and other rivers 6.1 megawatts.

The available transmission system, it is said that Thai electricity consumers are 95% of the total population. Those who are in short of or lack of electricity to use because they live far away from transmission line system. These people are 5% of the total population.

Categorized by electric producers, it is found that producing capacity by EGAT is only 58%, private and foreign producers consist of 42%. The total Thailand's need for electricity is 18,121 megawatts (information collected on the 7th of May 2546 (2003)) or is equivalent to 70% approximately of the nationwide production capacity and with the use values of electricity 116,743 million units per annum Gigawatts hour/year of the population 6.3 million in total, therefore, on the total population's average maximum need of power consumption is 0.288 kilowatts per person and average se of electric current is 1,853 kilowatts hour per person per year.

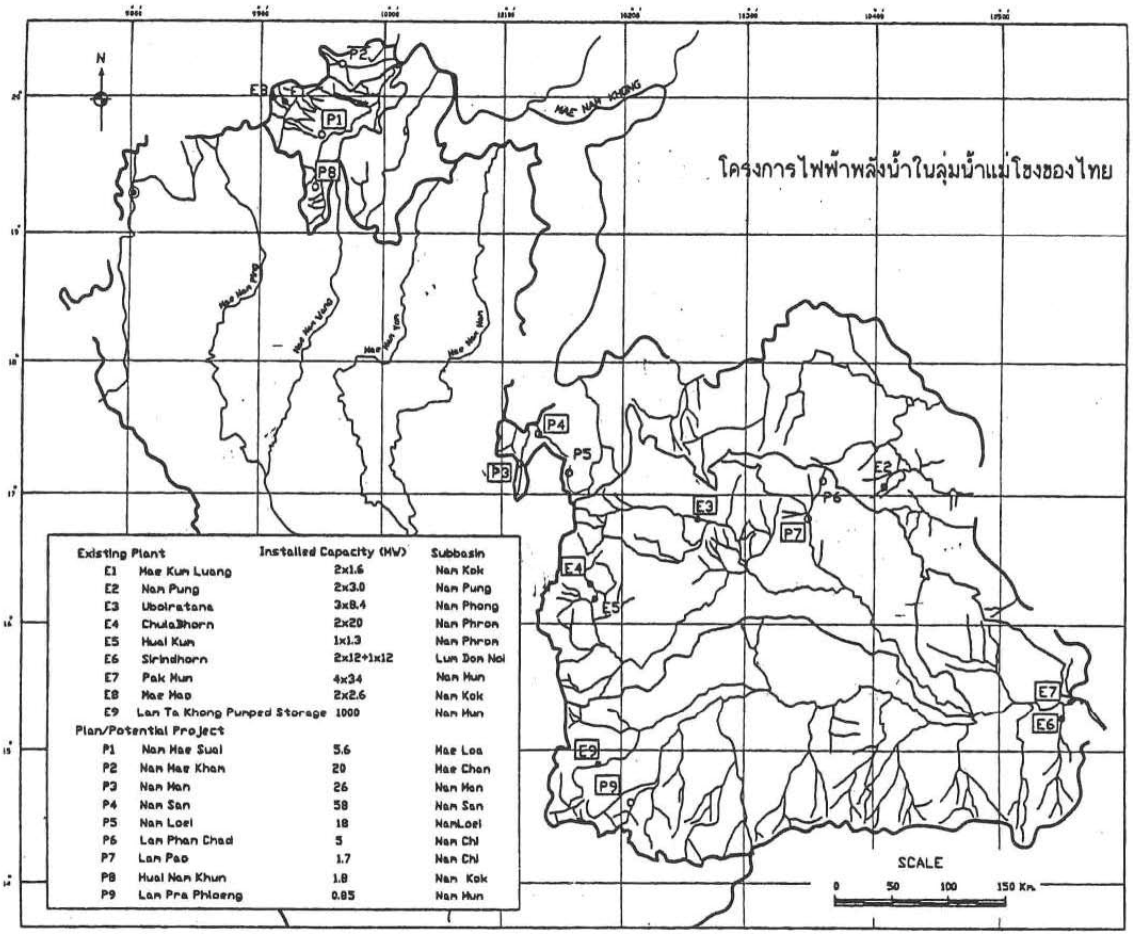
North eastern part, the need for power production capacity is 2,006 megawatts or 7.82% of the nationwide production capacity and the total use of power is 10,387 million units per year or 8.90% of the country total use of power from average population 22 million, hence, north eastern part population need to use power maximum of 0.091 kilowatts per person and average power use 472 kilowatts hour per person per year which is equivalent to 31 and 25% accordingly on average of the maximum of power and the average use of power of total population accordingly.

Table 5.9: Hydropower projects

Downstream	Hydropower projects	Responsible organization	Location	Reservoir area in km2	Capacity Mil. m3	Produc-tion capacity kw	Electric current Gwh	Completed year
Houay Kok	Mae Kim Luang	Res.org	Mae Sao, Maesai, Chiangmai	56		2 x 1,600	15.62	2524 (1981)
	Mae Mao	Res.org	Santrai, Farng, Chiangmai	61	20.6	1 x 2,300	9.14	
	Mar Chai	EGAT	Monpin, Farng, Chiangmai			1 x 875	4.8	2528 (1985)
	Namsoom River	Res.org	Maesroai, Chiangmai	36.4		1 x 1,800	8.988	
	14 electricity water pumping projects	Res.org						
Kong Isarn	Phoong Hydropower Dam	Res.org	Khokpoo, Koodbard, Sakonakon	297	156.8	2 x 3,050	15.45	2508 (1965)
	326 electricity water pumping projects	Res.org						2544 (2001)
Houay See	Jupakal	EGAT	Khornsarn, Saipoomee	545	188	1 x 20,000	94.84	2525 (1982)
	Koom River	EGAT	Setakitsomboon, Saipoomee	262	22.8	1 x 1,300	2.91	
	Ubonratch	EGAT	Ooplat, Khonkaen	12,000	2,263	1 x 8,400	54.73	2530 (1987)

Downstream	Hydropower projects	Responsible organization	Location	Reservoir area in km2	Capacity Mil. m3	Produc-tion capacity kw	Electric current Gwh	Completed year
	438 electricity water pumping projects	EGAT						
Mun Stream	Lamtakong	Res.org	Sikyu, Nakonratchasima	1,430	310	1 x 250,000		2524 (1981)
	Lampraperng	Res.org	Nakonratchasima			2 x 175	1	2541 (1998)
	Lankomnoi	EGAT	Piboolmangsaharn, Ubonratchathanee	2,097	1966	1 x 12,000	84.927	2514
	Park mool	EGAT	Soongjiam, Ubonratchathanee	117,000	225	1 x 34,000	280	2537
	244 electricity water pumping projects	Res.org						

Figure 5.2: Thailand's hydropower house



5.4.3 Current problems and solutions

From the facts previously mentioned, it is concluded that the general electric production and consumption at present is not a big problem. It is observed that hydropower production rate is not high and the consumption rate of people living downstream of the Mekong River is below average of Thailand in general. On the other hand it is shown that development efficiency of the sector is still a lot to do and at the meantime it is shown that it is necessary to establish measures in order to cope with the need of consumption which is double increased.

Future needs

Statistical information of Thailand's maximum electric production from the year 2536 to 2545 (1993-2003) shown that the average growing rate increased to 6.5% per annum whereas the average production rate increased to 6.8% per annum, however, the subcommittee on electricity need appraisal has estimated the need of electric current and power of Thailand in 10 years up to the year 2557 (2014) at 34,743 megawatts or 223, 437 million units accordingly if the maximum consumption portions have been used and electric current of the northeastern part versus the whole country's current rate, the maximum need of electric current can be estimated and the electric current of the northeastern part can be estimated that it will be reaching 2,717 megawatts and 19,886 million units accordingly.

Solutions

Analysis of the Mekong downstream the part that belongs to Thailand, there are many ways to consider as follows:

Improvement of hydropower plants

EGAT has planned to improve hydropower plants of Phoong and Ubonratchathani Rivers from 2548 (2003) and to be completed in 2550 (2005), Sirinon and Jupakol hydropower plants from 2549 (2004) and to be completed in 2551 (2006), this to get the maximum utilization after the power plants and their equipments have been used for a long period of time.

Installation of hydropower generators into dams of Department of Irrigation

In response to the government policy in utilize the recycle power in order to minimize the environmental affects and prevent foreign currencies leaking out of the country in importing fuel for consumption, EGAT has planned to install the hydropower generators of small scale into the dams of Department of Irrigation whose construction already completed such as Lampang Dam, Karasin Province (to be completed in 2547) (2004).

New hydropower dam development projects

(1) Man and Sarn River Projects

EGAT has studied the projects of Mekong downstream areas of Thailand, which are the big projects such as Man River project with production capacity of 2x16 megawatts and electric current of 67 million units, Sarn River project with production capacity of 52 megawatts and electric current of 113 million units from 2530 (1987), however, the projects have been terminated due to affects of many populations have to be resettled and wild animal

conservation areas, later on EGAT has studied and minimize the scale of the projects to medium sizes with production capacity of 5 and 6 megawatts and electric current of 20.7 and 27.3 million units accordingly which are regarded as efficient projects.

(2) Kok Ing Yom Nan project.

In 2530 (1987), EGAT carried out studies on initial suitability of Kok Ing Yom Nam project in collaboration with European Community and Canadian Government focusing

On pumping water from Ing and Mekong Rivers, where Ing and Yom Rivers meet and flow to central part, all the said projects need to use 450 megawatts of pumping capacity with electric current of 2,500 million units to pump water from the said rivers, however, 1,420 megawatts of production capacity will be obtained from Pong, Kaengsuaten, Sirikit Dams and with electric current production of 9,100 million units approximately. The quantity of water pumped from Mekong and Ing Rivers will be11,000 cubic meters per annum together with water quantity from downstream river of 940 cubic meters per annum. These are multipurpose project which can deliver water to irrigated areas of 4.53 million Rai with project values of 101,490 million Baht (by 2524 (1981), not including tax and interests during the construction period) .

EGAT later on in collaboration with British government carried out studies initial suitability of Kok River pumping project the expanded part of Kok Ing Yom Nam project focusing on pumping water from Kok to Yom Rivers together with pumping water from Ing River. The studies found out that pumping position should be changed from Ing to Kok River mouth as the electric power will be wasted with less water by pumping from one location, the Kok River mouth, then the water will be fast flow by gravity to reservoir of Pong River dam by doing so will get water pumped into downstream of Yom River of the same quantity that is 11,000 cubic meters, in addition, electric benefit, more production capacity will be obtained than Kok Ing Yom Nam project that is 46 megawatts, more production capacity is also obtained from Kok River which will be 1,468 megawatts in total, and to produce electric current of 9,311 million units annually, the cost of the project (the year 1524 not including tax and interests during the construction period) is 103,643 million Baht, it is one of the most efficient projects.

Electric power purchase project from Thailand's neighboring countries.

1) Laos

Electric power purchasing projects before signing Memorandum of Understanding are 2 projects such as Nam Ngum with production capacity of 150 megawatts and electric current of 560 million units per annum, and Seset Project with production capacity of 45 megawatts and electric current of 100 million units per annum for commercial distribution commenced in 2514 (1971) and 2543 (2000) accordingly, other 2 projects that Power Purchase Agreement have been made, they are firm agreements such as Theun-Hinboun and Houay Ho with production capacity of 210 and 150 megawatts and electric current of 1,370 and 570 million units per annum. The sales commenced in March 2541 (1998) and September 2542 (2002) accordingly.

The project being negotiated at present is Nam Theun 2 Project with production capacity of 981 megawatts and electric current of 5,636 million units per annum, and the sales will commence in 2551 (2008).

Other projects have already been planned and listed in order of importance as Lao PDR wants to negotiate such as Hongsa Lignite 720 megawatts, Nam Ngum III 460 megawatts, Nam Ngum II 615 megawatts, Sepian-Senamnoi 390 megawatts and Sekaman 468 megawatts.

2) Cambodia

In the year 2544, the committee of Thailand and Cambodia met in the first time to Consider Cambodia's proposal in asking Thailand to sell electricity to Krisophol, Seammalath, Pratabong in order to solve power shortage problem including future policy in connecting Thailand-Cambodia transmission lines in the year 2545 (2002), the cabinet has approved to sign the Power Purchase Agreement between EGAT and Cambodia, in which EGAT will sell electricity to Cambodia in EGAT's own transmission line starting from 30 megawatts. The PPA is expected to commence in 2547 (2004).

3) China

In 2541 (1998) the 2 countries signed Memorandum of Understanding with cooperation frame work in development of power production in China for sales to Thailand with 3,000 megawatts in 2560 (2017) and joint planning to construct and connect transmission line between the 2 countries, and in the year 2546 (2003) China sent EGAT official letter to consider purchasing power from Jing Hong Project with production capacity of 3,000 megawatts in the year 2555 (2012).

5.5 Navigation and waterways

5.5.1 General

Transportation plays an important role of economy as its role is to shift the goods from the original places to another one in order to respond to production and consumption demands. It makes many utilities such as reducing time-consuming and places. Water Transportation is one of the overall five modes of Thai transportation for instance: highway, railway, waterway, coast and airport.

The transportation by water on the Mekong river basin, especially the waterway in Thai territory has a trend to sharply decline or it almost disapears at present, because of development in road and other mean of transportation. However, the utilization of the Mekong basin with Mekong riparian countries who are the members of the Mekong River Commission for transportation and toursim still has the important role. Therefore, development of waterway in the lower Mekong river basin and capacity building along the bank should be considered.

5.5.2 Waterway transportation policy

The Ministry of Transportation and other concerned government offices such as the department of commerce and water transportation is the one who has a responsibility to develop the waterway under the national socio-ecomonic development plan, principle transportation plan, the plan of the government explaining to the national assembly as well as the policy of the department of commerce and water transportation.

Current government policy of water transportation

The current government policy of transportation by water, especially the policy of water transportation on Mekong River Basin has the following points:

1 Promotion of basic infrastructure development as transportation and communication based on the supportation of production, job creation and generating income.

2 Developing the telecommunication system.

3 Improving and developing mass transportation.

4 Earnestly Promoting development of merchant ship system in order to support the National exportation by developing Thai fleet of ships and concerned industries, constructing and managing the trading ports to match the standardization.

5 Promoting the cooperation in communication network with Mekong riparian countries.

6 Cooperating with Mekong riparian countries in case of safety waterway in both river and sea.

Waterway transportaton strategy

In order to take the above policy into action, the Ministry of Commerce sets the many guidelines for the water transportation policy for rivers as the following points:

- Supporting development of existing ports in appropiate way in order to promote full use of existing ports and avoid the repeated investments in them.
- Dredging the riverbed to maintain the deep of water in order to facilitate the ships pass smoothly all over the year and also supporting private sectors to invest in this sector.
- Promoting the ulitization of modern technology and equipments in the management of waterway traffic system and other safety aspects.

The policy of the Department of Commerce and Water Transportation during development plan, volume 9 (2002-2006) will

- Pay attention to develop the basic facility framework and spread all-round basical services which will raise the living standard of the people as well as the promotion of waterway tourism.
- Consider the promotion and support private sectors to take part in management and conserve the ports on the rivers and canals in the form of commerce.
- Develop the link between waterway transportation and road in order to create more facilitation for the people.
- Restore and develop the canals by dredging and enlarging the canals up to the standard and other necessary facilitation.
- Develop any facilities for goods transportation and passengers using the linkage transportation system in order to reduce the transportation costs.
- Support the public relations by stimulating the people to become aware of the affect of waste water or water pollution caused by fuel and to have a decision - making in solving this problem in their area.

- Set up a plan for the use of water transportation and merchant shipping activities under the principle transportation framework of the Ministry of Transportation (1999 – 2006) and development of transportation plan of multi-model transport in order to strengthen the national transportation system.
- Promote water transportation systems and merchant shipping up to build high adequate qualified human resources both working inland and in ships to have the same qualification as the international standard.
- Consider to set the norm and guideline in port management joining with concerned units by inviting more private sectors to invest.
- Set a safety shipping line, to conserve the environment, to set the safety control measures and to manage efficiently waterway system at the port areas.
- Find appropriate international standard technology to support the patrol, and the management of water traffic in order to make it save as well as to conserve the water environment.
- Accelerate to improve and up to date the computer system including information technology so as to facilitate, conform and assist in effeciently development of water transportation.
- Improve the regulation and management concerning the waterway transportation to match the international standard which could compete effeciently in economic, safety and environment.
- Developi highly qualified human resources who could effeciently perform the jobs in various aspects.

5.5.3 Waterway legislation

There are 3 following main parts:

- Thai navigating act 1913
- Merchant ship promotion act
- The agreement of shipping along Lanxang River- Mekong River, April 2000

5.5.4 Present situation

Average annual waterway transportation

The water transportation is one of five domestic transportation modes of the country. National statistic (1999) stipulated that the highest volume of land transportation was 392.24 million ton (88.85 % of all five modes of transportation) while the water transportation had only 17.91 million ton or 4.06 %. In 17.91 million ton there were five most transporting goods namely grit, soil, sandy soil (covered 39.3 %), rice (13.3 %), petroleum (11.6 %) cassava (9.0 %) and the rest was construction materials.

Main ports within the Mekong Basin

(1) Sub-area 2T

Chiangsaen and Chiangkong port (Chian Rai Province) had been re-constructed by the department of commerce and water transportation for supporting the trade and tourism among Thailand, Laos, Mynmar and south China. These ports could facilitate the ships (carrying capacity about 150 Ton), cruisers and other ships on the Mekong River to anchor alongside the dock. In addition, these also support the project development of the north-south economic corridor which have been officially signed about merchant ship on Lanxang River-Mekong River dated 20 April 2002, These ports had been completely constructed at the end of 2004. This agreement makes a tremendous capacity for shipping, reducing the time consuming and it also conforms to the development plan (volume 8), the government policy as well as the policy of the Ministry of Transportation.

(2) Sub-area 3T

Leuy Province has one port for ferryboat at Chiangkanh District and another 2 at Chiangkanh and Kokphai District (Paksom Province)

Nongkhai Province has a port at Viseth District, Beungkan town (under the management of Indo-China cooperation co, Ltd) and 2 pontoons at Naimeung District (Meung District) and Viseth District, Beungkan Town.

Nakhon phanom Province has a constructing project of port supported by the department of commerce and water transportation. This project is respond to the development plan (volume 7) or followed the provincial development strategy and also spread the link of transportation at the northeast and it would facilitate the communication among province to province and Mekong riparian countries, especially Laos and Vietnam. Because Nakhon phanom is the commercial town who used to trade with Laos at Khammoun Province, this will boost more the number of tourists and businessmen come to the province. This province has 3 ports of ferryboat such as the port of municipal of Nakhon phanom Province, the port of V.S.K international Company and the ferryboat port of Mr Boua Boupravet, Thaouthane town.

Mukdahan Province has 1 ferryboat port of municipal of Mukdahan Province and 1 pontoon at municipal.

5.5.5 Problems and development trends

The volume of water transportation has been decreasing because of the development of road and other mean make the role of water transportation decline. However, there are 2 mains problem of shipping:

Bank erosion

Generally, the river bank erosion could happen at the bend of a river as a result of river bank curve, other sub-factor erosion is from the human being (Digging out the sandy soil, building construction along the river bank etc..), the sharply decreasing of river level, and through the construction of dam to prevent the erosion, but this solution is the sharp remedy which could damage the property of state and private sectors.

The sedimentation level

The sedimentation in the river causes the river shallow and obstable the shipping.

However, there is no merchant ship, espcially in the branch rivers in Thai territory, therefore, the dredging along the rivers are not necessary. Eventhough the dredging would give comfort to rivers, but the area which will be dredged must be considered by engineering, economic, social aspects and also the willingness from local residents

5.5.6 Development trends

Because of the lower role of water transportation, the development line in the longterm would limit only to the improvement of 2 ports in Chiang Rai province, Besides this it would be a plan of small dam construction to prevent the erosion which will use the annual budget to construct at Donghadnak Village, Chiang Mai Province; Khoneyang District, Maha sarakham Province; at Unit 4, Sisongkham Town, Nakhon phanom Province; Beungpra village, Tharatyout District, Sokxai Town, Nakhon Ratchasima Provinceand Songkham River, Nongkhai province.

5.6 Tourism

5.6.1 Introduction

In the last decade, tourism development of Thailand has been changed significantly. The changes are highly effected the country's social economy and politics. Tourism is one of fundamental pillars of the country's development process because it is one of the dominant activities in the economy. This is because foreign earnings from tourism business will lead to find out solution for the country's crisis, and the earnings is one part of raising stability of the country's balance of payment.

Furthermore, tourism also influences the country using resources in highly sufficiency and making them sustainable. Tourism's role and significance to the country's currently social economy and politics is able to conclude as the following:

- It had been main source of foreign earnings in the country since 1982. The earnings become the first revenue when it had been compared with other products.
- The income is distributed to population and jobs are created widely.
- Tourism industry influences production and use of the country's resources in the highest sufficiency, which raises multiplier effect of the production in high rate comparing with other industries.
- Tourism is limitless industry when it compares with other industry in term of number of international tourists which is unlimited increasing in production including both natural and human made.
- Tourism industry helps to conserve each region's inheritable culture and promote to the public.
- Tourism is a countermeasure that increases security at the developed areas.

Tourism is in charge of establishing peace and good understanding among world population including among the national population's harmony. Tourism is a least developed industry comparing with Mekong Regional Committee's (MRC) other development activities. MRC is mainly promoting ecotourism along the river, the role of MRC in this activity is rather limited, and it requires a high support from various developments such as Cruise travel, River and Natural conservations.

In Thailand, Promotion of Tourism is a main activity of The Tourism Authority of Thailand (TAT). The activity involves many related sectors' cooperation including population, private and public and with other countries in Mekong Region cooperating together promotion of tourism activity. Besides, there is also cooperation with Regional Institutes and Organizations such as Asian Development Bank - Greater Mekong Sub-region (ADB-GMS) Committee. However, the cooperation in tourist area is still limited depending on cases or projects that are almost indirect support.

There are various opportunities to promote tourist destination through using of Mekong River and Resource especially through the region's interrelation and cooperation among group of MRC and the cooperation among the population in Mekong Sub-region.

5.6.2 Policies, strategies and related measurements

Development strategies

In general, there are significant tourist strategies from Government's plan and policy in 2004-2006 in the following:

- Long Plan of Tourist Strategic Development.
- Setting up plan to develop old and new tourist sites.
- Focusing on development of infrastructure, sanitary, and security in every tourism points instead of developing only main points as old plan.
- The Tourism Authority of Thailand (TAT) will be coordinating with other sectors in order to make a national plan in long-term tourist development and assign monitoring committee from related organization to evaluate the plan; then informing to the government to approve it.
- Every sectors haave to give cooperation in tourism development because the earnings from tourism is main national income. The TAT coordinates and consider appropriate budget for the development.
- Setting up Product and Service development plan.
- Improving Tourism Industry through extending tourism area and emphasizing tourism development of all regional area where Thailand becomes a Center of Network.
- Changing focus point of tourism industry from quantity to quality.
- Arranging new strategies and management by increasing management role of community organization and giving priority development through preservative resources.
- Having tourism Act that there will be setting up National Tourism Committee and National Tourism Development Organization which will be as a headquarter to co-

invest with community in setting up private company to run their own management of tourism destination.

The TAT has established significant strategies for the Greater mekong Sub-region, as listed below:

- Increasing carrying capacity of tourism place
- Promoting Community's Cooperation in Tourism Development
- Supporting neighborhood's tourism carrying capacity
- Opening Indochina tourism
- Establishing department stores and conference halls in North East (Isan region) of the country, and
- Surveying and promoting adventure travel in the North East destination.

5.6.3 Present situation

Tourism situation of Mekong Sub-region

The North East covers the widest part of Mekong River in Thailand containing high tourism carrying capacity. There is at least 568 tourism destinations including 248 natural places, 253 historic places, and the left 67 places are combined with culture, activity and others. These places have various festivals, activities and other water traditional festivals such as water festival, festival of floating vessel on the rivers (Rowkatong), boat racing festival, festival of floating fired boat (Raireufai), and agricultural travel.

Tourism business in this destination is generally developing. For example, number of tourists in 2002 was 15.15 million increasing 11.63% from 2001 or equal to 9.49 million people. There was 5.66 million travelers, 14.47 million in Thais and 0.68 million in Foreigners. Table 5.10 shows the number of visitors in this part in the last 5 years.

Table 5.10: Number of visitors in the North East (1998 - 2002) (persons)

Year	1998	1999	2000	2001	2002
Visitors	9,393,581	9,918,164	12,281,269	13,570,581	15,148,488
Change (%)		5.58	23.83	10.50	11.63
Tourists	5,784,868	6,170,019	7,676,977	8,585,032	9,493,177
Change (%)		6.66	24.42	11.83	10.58
Travelers	3,608,713	3,748,145	4,604,292	4,985,549	5,655,311
Change (%)		3.86	22.84	8.28	13.43

Source: The Tourism Authority of Thailand (TAT)

Even if total earnings from tourism industry was increasing every year because of number of visitors increasing in above, in the same period, both Thai and Foreign visitors' spending in the North East part was potentially decreasing, as shown in the following tables.

Table 5.11: Visitor's spending in the North East (baht/person/day)

Year	1998	1999	2000	2001	2002
Visitors	676.40	671.65	636.93	626.37	619.68
Change (%)	-	- 0.70	- 5.17	- 1.66	- 1.06
Tourists	740.61	718.50	684.06	669.93	668.61
Change (%)	- 33.80	- 2.99	- 4.79	- 2.07	- 0.19
Travelers	573.48	594.54	558.34	551.35	537.54
Change (%)	-28.35	3.67	- 6.09	- 1.25	- 2.50

Table 5.12: Revenue from tourism business in the North East (million baht)

Year	1998	1999	2000	2001	2002
Total revenue	15,572.03	15,443.28	18,274.72	19,678.44	22,800.86
Tourists	13,502.48	13,214.72	15,744.21	16,976.63	19,760.89
Travelers	2,069.55	2,228.56	2,530.51	2,701.81	3,039.97

Source: Tourism Authority of Thailand (TAT)

Thailand's role in regional tourism

According to data from 1998, total number of international tourists visited Thailand, the Lao PDR and Cambodia was 8.92 million. Thailand was the most significant tourism market among three countries, because per cent of tourists visited Thailand reaching 87.94% of total while Laos and Cambodia had only 5.61% and 6.45% respectively (see Table 5.13).

Table 5.13: International tourists in Thailand, Lao PDR and Cambodia in 1998

Country	Number of tourists (persons)	Percent
Thailand	7,842,769	87.94
Lao PDR	500,200	5.61
Cambodia	575,393	6.45
Total	8,918,353	100.00

Besides, six countries in Mekong Sub-region: Thailand, Laos, Cambodia, Vietnam, Myanmar, and China had an agreement to develop tourism destination in the Mekong Sub-region in order to gain the highest sustainable benefits, reduce investment of development, make tourists satisfy, and increase competitive carrying capacity. In the future, there will be development of destination as single tourism market, which has Mekong River as a sale point. Development process has 3 steps in the following:

- First step (in 1999-2004): Emphasizing a role as a Regional Gateway by preparing own development center. Thailand has a clear role to be as a door through the region. Tourists are able to travel to the city of Thailand and pass to other city of other regional countries.
- Second step (in 2002-2006): Style of development is Hubs and Sub-hubs. Network of Tourism Transportation will be more perfect: road, boat, train, and airport. There is systematic development of tourism center in the region. Tourists are able to travel

from the major and minor center to all around and between regional tourism destinations.

– Third step (in 2007-2013): Style of development is GMS Tourism Network and Circuit. There is network of tourism transportation, which will provide circuitously travel to both around and among group of regional tourism destination.

The above agreement is a deal that every countries have to develop their countries' infrastructure and tourist destination in order to ready develop regional tourism as a single tourism market.

Infrastructure networks in the Mekong Region

In order to bolster the Single Tourism Market in Mekong Sub-region, the Countries have developed infrastructure network such as road, train, air and water transporting networks including important projects below:

- Improving cruise traveling project along Mekong River from UNAN till Luang Prabang, total long distance at 930 Km.
- Improving cruise traveling project in Dang River in Vietnam.
- Improving cruise traveling project at South of Laos and Cambodia.

There is one important project related Mekong River: Network of transportation from East to West which make West and East connect together especially connecting Mukdahan-Savannaket-Dongha provinces and establishing 2nd bridge across the Mekong River.

5.6.4 Planned development

Carrying capacity

Based on the country's recovering economic situation, Thailand's Development and Research Institute showed analysis and evaluated record that in 2002-2006 the North East of Thailand will have number of tourists increasing 4.8% per year. Therefore, number of tourists in this part was expected to reach 12.31 million in 2002, 12 million (97.4%) in Thai and the left in Foreign with average of stays 3 days per person, and gaining total revenue about 28,270 million baht (see Table 5.14).

Table 5.14: Forecast of number of tourists in the North East part in 2002-2006

Year	2002	2003	2004	2005	2006
Visitors (million people)	9.49	10.71	11.24	11.77	12.31
Domestic	9.26	10.45	10.96	11.47	11.99
Foreign	0.23	0.26	0.28	0.30	0.32
Average of stays (day)	3.17	2.84	2.84	2.84	2.83
Domestic	3.18	2.84	2.84	2.84	2.83
Foreign	2.84	2.82	2.84	2.84	2.86
Total revenue (million baht)	22,800	21,910.51	23,861.81	25,967.98	28,269.80
Domestic	21,615	21,098	22,987	25,041	27,283
Foreign	1,185	812	874	926	986

Source: The Tourism Authority of Thailand (TAT)

Furthermore, Research Science and Technology Institute of Thailand had reported result of the research on Mekong River's carrying capacity to TAT. The research was pointed out major traveling road in the future being as trans-boundary in Mekong Sub-region. Thailand has a capacity to develop trans-boundary tourism along 6 sectors of the Mekong River:

- From Chiangsaen to Chinghong
- From Chiangkong to Luangprabang
- From Chiangcan to Sangkom
- From Friendship bridge to Beungkan
- From Nakhon Phanom to Mukdahan
- From Kongchiem to Kongfonh and to Satreungtreng

5.6.5 Problems and development trends

Data from above showed that the Mekong Sub-region still has higher carrying capacity and should be continuously developed. Rate of spend per tourist trends to decrease. This is because there is lack of promotion of new tourism destinations and development of other infrastructure to attract more tourists and make them stay longer. Therefore, various solutions should be developed and implemented at the same time. For example the strategies of TAT comprised:

- Raising level of North East (Isan) Tourism Sub-Committee to be as Regional Organization having duty to monitor, evaluate, and advise policy or development of North East Tourism plan under North East Development Committee.
- Raising tourism implemented role and increasing budget to Tourism association and assembly.
- Increasing quality and quantity of tourism activities by giving more contracts with private company to run in projects.
- Establishing Tourism Development Fund by having committee from various sectors to supervise and the TAT has position as a Secretariat office on Tourism Development Fund.
- Supporting to develop public and other fundamental facilities
- Establishing various centers such as Art and Cultural center, Handicraft center and Community Museum.
- Raising role of private organization.
- Encouraging community authority to produce more tourism publication.
- Encouraging Tourism assembly or association: hotel, restaurant and various interest group coordinating together to produce public relation in order to encourage more travel in province.
- Supporting activities that encouragement of travel in city such as shopping street
- Setting up Tourism Development Plan in each area by considering connection between area and with nearly tourism area
- Supporting to develop fundamental public facilities and the facilities for tourism area considered not being harmful to balances of dwelling and nature.

- Pressing to establish appropriately foster forest project in order to continuously conserve forest garden.
- Supporting Safari travel in order to attract Asia tourists and tourists from neighboring countries.

Moreover, the TAT has set up strategy to protect depreciable and depreciatory tourism area by improving carrying capacity and giving active role to community managing authority that is the closest tourism area to be as a keeper of the places.

For Tourism Development Plan for the Group in Mekong Sub-region, beside of infrastructure network, there are general concepts to connect focus area in below:

- Tourism style should be appropriated with each area's tourism resources, which can be various styles: ecotourism, boat travel, boundary tourism, and Cambodian Cultural Road trip.
- Setting up Travel Road being able to be various styles: Spot travel by using tourism center to be starting point for round trip such as Hanoi – Bangkok and Bangkok – Hanoi; Loop travel combining various tourism places of various countries based on market's demand to be as one trip such as Vientiane-Danang and Network which is organized as mixture travels through various countries' tourism places: 5 Chieng Tourist sites, and
- Together development of tourism places, especially for tourism places having area connecting together or having purpose to do co-management such as Angkor Wat, Bolawen plateau, and area of fresh-water dolphins.

The tourism development along the Mekong River in the six sectors mentioned above: From Chaingsaen to Chinghong, from Chiangkong to Luangprabang, from Chiangkan to Sangkom, from Friendship bridge to Beungkan, from Nakhon Phanom to Mukdahan, and from Kongchien to Kongfonh and to Satreungtreng, should be carefully considered by all involved sectors and should be classified as an important task.

5.7 Domestic and industrial water supplies

5.7.1 General

The need of people and society on the water for consumption and industrial purposes is the second and third important necessary; therefore the development of water source in the future is needed to be considered and given more priority to the component of demand in this aspect in order to make the better lives of people and develop the regional economy in the long term to be sustainable.

The water source development and procurement for consumption and industry partly are under the responsibilities of many organizations such as the Regional Water Supply, the Prefecture Water Supply, Sub-district authority, Provincial authority and the village water supply by ministry of health which is the main working unit that serve people in Thailand, there are 226 offices in 73 provinces covering 654 prefectures and all can serve approximately 10 million people, 90% of the raw water source using in this service comes from on the ground water sources and other 10% is pumped from underground.

The good quality water and well quality maintaining are very important for the better lives and sustainable development, as mentioned in the header 4.1 that the quality of water in

Mekong River and the Mekong Basins in Thailand is generally in the good level regarding to the science measurements, it can be used for living and other purposes through the normal cleaning process, however the dangerous from the waste water from the industries and the household is the matter that needs to be paid more attention and correctly recycled before letting it down to the river or other natural water sources.

5.7.2 Related policies and measurements

Policies on community water supplies

(A) National level

In order to develop the state owned-enterprises, the government assigned the Capital and the Regional Water Supplies to be the main organizations to recover the economy and regenerate the national income by combining the potential and ready state owned-enterprises together, to be under the efficient management of the professional organization that is free from the political intervention and to open for the people to invest in the business of the enterprises and to support some enterprises that have been ready for registering into the assets market in the appropriate time.

The master plan for reforming the state owned enterprises recommended the 3 options relating to the water supplying as follows:

1 Regional Water Supply Companies (in commercial and public purposes) to serve people in Central, Northern, Northeastern and southeastern parts

2 Regional Water Supply Companies by separating company for public purpose and for the local authority or government e.g. 5 Regional Water Supply Companies (in commercial purpose) and Local/Government Water Supply Companies (for public purpose)

3 To decentralize the decision making power to 224 implementing agencies

4 Policies of the water supply sector are following:

- It should be a main authority to be responsible for defining the general policies for the whole water supply sector.
- The social based- service policies should define clearly the target consumer groups who should get the assistance to provide them support money for the specific group
- There should be an independent authority in the water supply sector to supervise the relating economic issues such as defining of the water fee.
- The fee for waste water recycling service should be collected and it should be announced to the public on the important of recycling the waste water.

(B) Regional level

Currently, the Regional Water Supply has no policy to increase the number of the Water Supply unit, but they have plan to increase the efficiency of the existing units in order to serve people more and they also pay the attention to make the quality of the supply water be in the standard of WHO.

The Regional Water Supply targets to expand the water supply area to the villages located around the supply units by implementing the service for 400 villages per year, which will be 40 villages per unit. The attention is also paid for the projects in the area that people most urgently need water.

In terms of water quality control for supplying water to the people, The Regional Water Supply has controlled the water volume and pressure at the level that is sufficient for water consuming and they also improve the water quality to be standard according to the WHO defined, that is to increase the people's confidence in the cleaning, safety and ready for consuming water, the department has set the area for drinkable water at least 10 places per year, at the moment there are already 42 places within 33 provinces and in 2566 (2023) people will be able to drink the water from every tap that supplied by the water supply unit.

Policies on supervision of industries

Industry is a potential sector in using water in the part; it is under the responsibility of the Industrial Factory Department that has vision in supervising and pushing the industrial business to be implemented and sustainable developed by emphasizing in the field of environment and the safety and recognized by the international community. The mandate of Industrial Factory Department is to supervise, promote and support the industrial business in order to increase the capacity in production and competition in the sustainable development way and to be recognized by the international community, in addition it also mandated to control the dangerous materials and chemicals in order to maintain the quality and safety of the environment.

Target of the department is to make the industrial business developed in the sustainable way, increase the capacity in competition by focusing on using the existing natural resource efficiently, to protect and limit the industrial pollution and to maintain the safety for creating the balance between the development and maintaining the quality of the society by encouraging the participation from people, community and local authority seriously and continuously.

Management measures

The planning of water supply for consumption and industry in the Sub-Mekong Basin area which comprises many sub-areas that are different in terms of the size of area, geographic characteristics, natural resources and the social and economic situation of the people in each basin, the details for the specific management will be diverse, however the basic principles are quite similar as presented below:

Central organizations

Thailand used to face the problems due to there were many organizations mutually need to get benefits from the water sources, in combination with the unclear policies, working repetition, un-systematic development, lacks of the fairness in benefiting form the water source in the society and there are some confliction problems, therefore it should be the centralized organization to prioritize appropriately the water using in different aspects or purposes, to be a unit to compile the all related data and be a center for exchanging information, data and be a coordinator for the related matter.

Public relations

Due to there are many organizations who have many projects or activities those need to use the water from the sources, each activity will effect to all organizations and people who are living in the areas, therefore it is necessary to publicize to the related parties on what implementation has been done, what are the effects of those and what are the related information.

Technology transfer

An important measure that can be an instrument for solving the problems is the transfer of technology that is appropriate for the related body especially in terms of using water in the industrial factories in the efficient ways such as the water source selection, the selection of system for improving the water quality, the selection of the water utilizing approaches in the production process in the factories including the waste water cleaning, those should be implemented in the efficient ways in order to develop the competitive capacity in the world market and be sustainable.

5.7.3 Present water utilization

Public water supply

The information on the water utilization of the Regional Water Supply (in the year 2546) (2003) in the Mekong Basin in Thailand is as follows:

Sub-Area 2T

This area comprises 3 provinces e.g. ChiangRai, ChiangMai and PhaYao, there are 30 production and water distribution units, those can serve the water in average 177,600 m^3 per day for 282,000 households among the total population of 595,000 households (424 km^2) or the service proportion is equal to 47.4%, the average water used per day per household is 630 liters.

Sub-Area 3T

This area comprises 8 provinces of. Leuy, Oudonethany, nongBuaLumPhou, NongKhai, SkonNaKhorn, MoukDaHanh and AmNathChaleun, there are 92 production and water distribution units, those can serve the water in average of 263,600 m^3 per day for 618,000 households among the total population of 1,346,000 households (1,018 km^2) or the service proportion is equal to 45.9%, the average water used per day per household is 428 liters.

Sub-Area 5T-1

This area comprises 5 provinces of. Xayaphoum, KhornKaen, KaLaSinh, RoiEt and YaSoThorn, there are 73 production and water distribution units, those can serve the water in average 263,600 m^3 per day for 648,000 households among the total population of 1,092,000 households (559 km^2) or the service proportion is equal to 59.4%, the average water used per day per household is 407 liters.

Sub-Area 5T-2

This area comprises 5 provinces of NaKhornPhaNom, BouRiRum, SouRin, SiSaKet and OuBonRachaThaNy, there are 65 production and water distribution units, those can serve the water in average 163,200 m^3 per day for 433,000 households among the total population of 625,000 households (363 km^2) or the service proportion is equal to 69.3%, the average water used per day per household is 377 liters.

In sum (excluding data of Sub-Area 9T) there is about 868,000 m^3 per day (317 million m^3 per year) in the Mekong Basin Area in Thailand has already been managed for consumption, the management can serve approximately 1,980,000 households among the total population of 3,660,000 households, the total area for distributing water is 2,364 km^2, the average water used per day per household is 438 liters.

Industries

The data on water utilization of the factories which located in the Mekong Basin area that we can compile indicates that about 645 factories need to use the water into their production process in total volume about 50 million m^3 per year, the distribution picture in each sub-area can be briefly summarized as following:

Sub-Area 2T

There are 198 factories that need to use the water into their production in the total volume of 2 million m^3 per year.

Sub-Area 3T

There are 118 factories that need to use the water into their production in the total volume of 5 million m^3 per year.

Sub-Area 5T-1

There are 128 factories that need to use the water into their production in the total volume of 23 million m^3 per year.

Sub-Area 5T-2

There are 201 factories that need to use the water into their production in the total volume of 20 million m^3 per year.

Even the data presented above excluded the data on sub-area 9T, but due to the current policies and development plans which are pushing this area to be the new industry area that integrate the business and trading cooperation with the neighboring countries into Indochina and it is understood that the demand for water supplying the industry, tourism and so on will be significantly increased.

5.7.4 Future demand

Based on the information on the water demand for implementing the activities in Thailand until 2553 (2010) indicated that it will be increased from 52,601 m3 per year to 74,704

million per year or it will increase about 42%, what needs to be observed is the increased demand on the water for consumption and industry in the same period are 137.7% and 79.4% respectively (please see Table 5.15).

Table 5.15: General future water demand in Thailand (Mm3 per year)

Water utilization	Present	2553 (2010)	Increase (%)
Consumption	3,118	7,411	138
Industry and tourism	1,312	2,353	79
Irrigation and agriculture	48,172	64,941	35
Total	52,602	74,704	42

Considering the demand of water for each sector in the future, we see that the part with the highest increased demand for consumption is the eastern part (101.5%) second is the basins in the northeastern and northern parts (76.7% and 19.2%), the part where have highest increased demand on water for industry is the northern part (449.8%) second is the eastern part (138.3%) and the northeastern part (66.9%) respectively (please see Table 5.16).

Table 5.16: Estimated increase in water demand (%)

Region	Consumption	Industry/tourism
Northern	19	450
Northeastern	77	67
Eastern	102	138

In terms of quantity the estimated demand on water for consumption and industry in the Mekong Basin area in Thailand in 2553 (2010) will be as follows:

- Demand for consumption will increase from 159 million m3 to 378 million m3
- Demand for industry will increase from 51 million m3 to 93 million m3

5.7.5 Problems and solutions

It is seen that there is very high demand on water for consumption and industry and it tends to be increased rapidly and based on the nature of water for those purpose the water should be cleaned and safety, the problems and/or guideline for solving these should be considered more in many aspects in terms of geographic and management as follows:

1) Surface water

The quality of surface water in the main water sources in the basin has problems on the high mixture of bacteria in the group of Phycol coliform, there is this kind of problem in average

32% of total sources, and this characteristic may lead to be risk in distribution of diseases such as diarrhea, Asiatic cholera, constipation and thaifoid diseases, the second is the problem that low oxygen dissolution which is now 26% of total, the aquatic animal may could not live in this environment, the third one is the turbid problem in the river especially in the rainy season which is now 11% is facing this problem and it can be also dangerous for the aquatic animals.

The water quality in each season has different characteristics such as in the high water flowing season many water sources face the turbid problem which is increased more than 100 NTU due to the geographic conditions are mountains, sloping land and high land that the water can bring the sediment down to the river, and in the low water flowing season especially in the northeastern part there is the spreading of the salt from briny soil to many water sources that sometimes the water in those sources could not be used, in addition the surface water is mostly not sufficient for the production in the dry season.

2) Groundwater

The most occurred problem comprises the problems on quantity and quality of water, in terms of quantity the problem emerges due to the over use the underground water that makes the water volume in the source decrease and do not sufficient for using, the generating problem is decreasing of the groundwater level. The quality of groundwater is the main factor for water for consumption; this problem may naturally happen or due to the mixture of the waste or any human activities such as:

- There is the iron in the water over the standard
- The salty water problem due to the salt stone level underground especially in the northeastern part and it creates the chemicals such as Soul fad, Magnesium and sodium.
- The problems on the mixture of the wastes that is on the ground and underground, it mostly comes from the human activities such as the waste water or other wastes from the community, in the northeastern part there is the underground water that has the volume of nitrate over the standard.

3) Rainwater

Sanitation in cooperation with the Provincial Health Office conduct research on the quality of rainy water in terms of potential, chemical and bacteria and compare with the qualified consumption water, the result is that mostly is in the preferable quality. In terms of quantity, the rainy water volume is not sufficient in the dry season furthermore they found that the reservoirs to fill rainy water is not enough.

In conclusion, apart from the insufficient water volume especially in the dry season there are also many factors that make the water low quality and could not be immediately utilized due to there are some pollutions or poison mixed in the water which is now gradually harder. To those problems, it is necessary to do campaign on conservation of the natural water sources and to use the water correctly and carefully.

4) Management of the water source

30 organizations from 8 ministries in the past recommended that there are some problems on the management of the water source as following:

- Lack of unity in formulating policy and vision
- The working repetition from many organizations, lack of the coordination and there is no any center organization.
- The existing laws and regulation are only for particular aspect for each organization, some laws and regulations are not updated to be accordance with the current situation.
- Lack of the unity among the government organizations that makes the water development is not systematic and lead to the water shortage.
- The water allocation without prioritizing the important and the basic principles of the fairness and the benefits of the society lead to the conflictions in utilizing water.
- The problems on protecting and alleviating the damage form natural disaster especially the flood the affects to many area for many years.

5) Water production and supply

Quality of the raw water

– The turbidness will be increased in the rainy season; the rainy water will erode the soil and other mixed things down to the nearby water sources, then the water will naturally and immediately sediment that affects to the expenditure for improving the water quality.

– The water weed is a problem from the water keeping in reservoir or in the river that the water is slowly flow or do not move, in addition there are enough nitrogen and phosphorous when the water get the sun the weed will be grown up, this an important problem for the water supply production because the surface of the sand will be faster clogged and there will be also the bad smell from the weed.

– The mixture in the water sources tend to be increased due to the water sources are located in near the industrial factories, agriculture area and community that produce the wasted down to the public water sources and it lead to be problem for the raw water source for the water supplying.

Low water quantity

In comparing with the increased demand on water using in many activities such as for agriculture activities (some type of agriculture), industry, and tourism and so on, the increasing of population makes the demand for the water supply increase, another problem is the quantity of the raw water in the dry season due to the quantity of water from the nature is increased and it is not enough.

Water supply and distribution

The system for distributing water supply has 2 main problems e.g. the water losing and quality of water in the pipe is not equal due to the water pipe may be expired especially for the cement pipe that is many about 40,000 km. It is usually broken and loss the water about 28-30%, there is estimation that there are about 30,000 km of water pipe is expired. The generating problems is the increasing production expenditure, decreasing of water for distribution those make the responsible organization as Regional Water Supply Department

has less income. Therefore, the survey and maintenance of the pipe system should be done continuously.

6) Industrial supplies

- The raw water source is very rare, in some area it is needed to pump the water from very far- away area, and it is necessary to have the reservoir to keep the water for enough using throughout the year.
- The water quality is needed to improve especially the quality of the raw water before using, each production process in a factory need to use water in different quality; therefore, there should be the system for adjusting the water quality in each factory.
- There is the need for knowledge on technology for improving the quality of water to be suitable with each production process including the need for technology on the water economical an recycling, if the technology is appropriate and correctly the getting water will be qualified and it will save the expenditure for improving the water quality and also decrease the non-qualified products.
- There is the need for knowledge on technology in cleaning/recycling waste water suitable with the waste level, the investment level of the factory, factory size and the location, this aims to decrease the cost of the factory and decrease the quantity of dirty waste flow outside the factory.

The most of industrial business create the waste water, there is the laws for regulating all factories should have their own waste water recycling system based on the setting standard before let it down to outside, however the dirty letting off has possibility to affect to the water sources especially on the ground water source, in the future when the industry has been expanded in this region, the waste water irrigating system will be also increased, therefore the measurements regarding to this matter should be implemented more strictly and carefully.

5.8 Flood management

5.8.1 General

The flood usually happened in the Mekong River Basin due to the effects from the monsoon that blow from TangKia gulf and make more rain fall especially in the Mekong basin area in Thailand, in the rainy season the water level in Mekong increases over the bank and flood the bank area in NongKhai, Nakhornphanom and Mukdahanh provinces, the sub-basins that are usually flooded are the basin in SongKhram River and The basin of Kamh River due to it is low area and lack of efficient protection measurements.

Because of the same reason, the flood is a problem that the MRC country members are facing, as a result the flood damage the agriculture, assets and it usually kill people and animals. In order to alleviate and solve the problems MRC organized a programme so called "Flood Management and Mitigation" that includes many aspects in addition to the flooding forecasting that used to implement so far.

However, this report will explain mainly in the part of the implementation in Thailand.

5.8.2 Policies and measures

National water policies

(according to the Ministerial Agreement dated 31 October 2543) (2000)

The parts relating to the flood are following:

- To develop the plan for alleviating and solving the flood and drought, including the fairly and efficient warning system after disaster by paying attention to the using of land and related natural resources.
- To develop the decree on water resource to be the main law for the country's water resource management, to review and improve the existing decrees and to implement it according to the setting steps, that aims to have the effective enforcement and it is also needed to consider to improve the existing laws and regulations to be consistent each other.
- To continuously support sufficient budget for implementing the action plan according to policy including the research, publication, data compilation and technology transferring regarding to the water matter to the public.

Policies of Ministry of Natural Resources and Environment

In addition to above policies, there are some policies related to the management of natural resource and management that will effect directly and indirectly to the flood management activities, the policies should be known are following:

Natural Resources

To conserve, develop, renew and maintain the abundant of the natural resources and manage its utilization for meeting the people demand based on the potential in the sustainable way and it is necessary also to promote and implement the projects according to the royal guidance.

Environment

- To make the community in the rural and urban area have better environment and living quality by cooperating with the city planning and community regulating to be consistent with local potential.
- To prevent, maintain and renew the environment to be better and in the standard level that does not dangerous for the people's health and it also need to use the appropriate technology in managing the environment.

Management

- To improve, solve and propose new draft of the law that can be used as a instrument for operating and to enforce the related regulations in order to work successfully and to be consistent with the situation.
- To monitor, check and evaluate the operation by defining the clear benchmark.

5.8.3 Present situation

1) Sub-Area 2T

The study using GIS found that 42% of NamKok area has a risk to be flooded in the middle level and 13% of NamInk area has risk to be flooded in the critical level especially in the lower NamInk area and NamChanh.

2) Sub-Area 3T and 5T

In the middle and lower of the sub-area which size 4/5 of the total area, where is the flat land in the basin which is mainly for agriculture and it is usually flooded, significantly in the year 2521 (1978) the great flood occurred in 2 sides of the river e.g. NamPhong, LamPao and NamChi due to the cyclone storm especially for NamChi the water flooded the areas in both side of the river all line of the river from the meeting point between NamMoun and NamChi up to the north in the area of KangKhor village in XayaPhoum Province, the flood also occurred in Namphong from the meeting point between NamPhong and NamChi to the area of Oubonrath dam, in NamPao area it is flooded from the meeting point between NamPao and NamChi up to the north upper of NamLeuy in KaLasinh province till the end of LamPao dam, along the river the water flooded from the meeting point between NamYang and NamChi up to the area of Phonthong sub-district in RoiEt province.

The highest water flow is going down this year to Oubonrath dam for about 7,100 m3 per second and the highest water volume that relinquishes from the dam is 3,772 m3 per second, the water flooded for 1 month in NamSi bsin area for 4,296 km2. the flooded area is the area of Mahasalakham, RoiEt, Kalasinh, Yasothone, Sisakhet and Ounbonrathany provinces, the first three provinces are the most damaged areas, the main damaged area is paddy field, the total loss value is about 1,795 million Baht.

Two sides of Nammoun area which the river has small slope in the distance of 150 km from Phiboulmansahanh sub-district to Lasisalai sub-district, this area is flooded quite often than others, in addition this NamMoun area is very winding and have many islets, so the water transfer to the end of river in very slow speed, the water flooded two side of the northern NamMoun, in the meeting point between LamPhubPla the water level is 0.5 meter over the 2 years flooded trace and 2 meters over the 25 years flooded trace.

3) Measures for preventing and reducing the existing floods

Even there is Oubonrath and LamPao dams within NamChi who can decrease the hardness of the flood in the certain level but the water absorbing area of both dams is covering only 25% and 13% of the basin respectively. Those dams can not control all flood water volume in NamChi, the current flood preventions used for agriculture area is to build the soil dike for preventing flood in NamChi basin, the soil dike for protecting the planting area is under NamVai-NamPhong project, LamPao project, ThoungSengBadanh project and BanToum-BanTiew project which has 300 km length. However, the dike can prevent the flood for only 10 years flooded trace.

In NamMoun, there are many water reservoirs such as Lumtakong dam, Lamprapheung dam, upper Mun dam, LamNanLong dam, Sirinthone dam and PakMoun dam, but those mostly are water reservoirs for agriculture which are not mainly for flood preventing. Therefore, it is not possible to protect all area from the flood, just only some part in the end of the reservoirs that can be protected.

5.8.4 Problems and solutions

Problems

As partly mentioned in the beginning that the problems and flood in the Mekong Basin in Thailand are generated from many factors, we can summarize those problems by main types as following:

Geographic conditions

The geographic condition is low area or the area that has been affected by the water; it is also risk to get long flood, in the mountainous slope the forest there has bee trespassed that leads to be the landslide.

Land use

The changes in using land such as changing from the agriculture land to be a community land that makes the ecology in that area where changes the way to transfer the natural water; it will could not be operated easily as usual, then the flood will be very hard and longer then before. In addition, to use the land without the overall district plan controlled by the provincial level makes area have no any appropriate and systematic flood protection and alleviating planning, trespassing into the water source is also the problems for the water transferring system.

Construction of infrastructure

Basic infrastructure such as construction of road and train way that designed bridge and pipe inappropriately, this will be the barrier for the flow of natural water that leads to be the flood.

Inefficient regulation enforcement

The laws and regulations relating to the water matter such as Law on Public Water Trespass and Law on District Plan those can not be efficiently enforced, in addition it is lacking of the organization responsible for the flood protection and alleviating planning.

Lack of good management

The lack of the good management includes lacks of the budget and warning system make the flood can not be prevented, oppositely it destroys the people's lives and assets increasingly every year.

Future solutions

Flood is a disaster that happens due to the nature and the geographic condition; the economic growth will develop the infrastructure and expand the urban community that trespasses into the natural water sources and damage the area in two sides of the dam that absorb the natural water and to cut the forest in the water source forest, those increase the problems on the flood, therefore it should define the non-structural and structural measures together, the main concepts are presented following:

(1) Non-structural measures

comprise the following approaches:

- To improve the rules in managing the water in the existing and new reservoir.
- To define the measures on appropriate designing to be unified or similar by studying the effects of flooding due to the infrastructure in all basin area, then to review the regulations on the designing in each working unit for seeking the way to revise, regarding to the previous flooding we need to review the efficiency of the infrastructure that already implemented.
- The management of flooded areas
    - To give the guideline for using land/define the risk area to be flooded/control the underground water pumping.
    - To develop the forecasting and warning system, flood facing system and after flood improving system and to install the equipment and tools for forecasting and warning for the flooding.
    - To define the appropriate measures to estimate the water volume from the previous year traces.
    - The management of water source in order to slow the water flow and reserve the water such as to plant the forest for protecting the soil from the erosion.
- The awareness rising in conservation of forest, water source forest, river, channel and water transferring ways need to be started from the nursery school level in order to build the new generation to love natural resources and environment.
- The using of district plan for controlling the district development and land use zoning in order to avoid the emerging of the barriers for water transferring and to systematically plan for prevent the flood in the town.
- To propose to establish the water fund in order to solve the water problem that includes the flood insurance.
- To increase the strict and enforcement of the existing laws, revise and add some article that used to be weak in management of flood resolution by pushing to have the decree on national water resource.
- To develop the management system for the whole basin in order to have the decision making system in alleviate the flood problems.

(2) Structural measures

- To develop the protection system in the urban community by considering in the changing of the water level that may be affect to the area nearby.
- To develop the project for two sides of the dam by allocating the water reservoir in the time that water hardly floods in order to reduce the damage from the flood.
- To dig the water shortcut/diversified channel and wide up the river in order to facilitate the water flow and improve the road and bridge, pipe under the road, water door to be suitable with the local conditions.

- To study and install the water pumping station and the water transferring system to facilitate the water flows.

- To develop the river branches to keep the water and slow the flow, and to improve the river conditions and the dike along the river banks.

- To develop the big water source project to alleviate the flood.

3) Present and future measures

The water resource department is the new working unit that organized the Water Crisis Center in order to compile the data, research, analyze and recommend the solution for preventing the flood, firstly the planning for preventing the flood in the future can be divided into 3 following periods:

(1) Period 1: 4 years

The preparation of all data relating to the flood that should be correct, fast, update and to develop the warning system for analyze the flood situation throughout the country in order to manage the solution appropriately and efficiently by defining following projects:

– Project for establishing the Center for Preventing and Alleviating the Water Crisis.

– The feasibility study project for installing the measuring system and Regional Data Center to manage the water crisis in the basin in Thailand.

(2) Period 2: 5 years

This period is for preparing the direction for preventing the flood that comprises following projects:

– Project for developing the master plan for preventing the flood in the sustainable way.

– The study Project on the appropriateness and designing the construction plan, flood preventing project based on the critical level of the risk area or the flooded community.

– The study Project on improving and developing the system, defining the regulations of water management in the basin throughout the country.

(3) Period 3: 10 years

To construct and develop the water source in order to alleviate the flood that comprises the following main project:

– The Flood Preventing System Construction Project.

The Irrigation Department also pays important role in managing the flood by defining the may related and important development projects such as:

Upper NamSi Basin composes:

- Si River Dam Project.

- YangNaDi Dam Project
- PlongKhounPhet Dam Project

Upper NamPhong Basin composes:

- NamSeun Dam Project
- HouiPraTao Dam Project that belongs to the Energy Development and Promotion Department (former) which is already constructed, it will increase the capacity of flood preventing in the upper Si River area.

In addition, Mun River is an area that usually face the flood problems comparing with others, the flood preventing concept by improving its water transferring system by adjusting the river in the straight direction in order to reduce the winding of the river such as to improve Mun River starting from the meeting point between Mun River and Chi River to the meeting point in HouiTapTan, to increase the depth and the wide of the river, to construct the river bank dikes for preventing the flood and to dig the dikes for preventing the natural water out in order to use the flat land around the river banks and facilitate the water flow at the same time.

5.9 Watershed management

5.9.1 General

Management of Water Source Forest is a part of Watershed management that manages the "Defined Area" to get water in appropriate quantity and quality and in timely, the size of a watershed is depended on the basin area and the environment will be varied or similar, the principles of watershed management focuses on the using water and all existing resources within the basin in the most efficiency way.

In the past, the management of natural resources gives priority to the provincial level which is "administrative zone" this is the first level that makes the management of natural resources and environment not be done by the overall way in all basin's area, and the development planning was not consistent and combination that lead to the argument in seeking for the benefits from the natural resources environment and so on.

In order to develop the natural resources to get the optimum benefits for the nation and the citizens; the government has given the priority to the planning by area that is the new system especially for the management of natural resources in the big basin and it is also the most appropriate in the current situation. The independent management units have been established for manage the basin so-called the National Water Resource Committee Office, which is under the Prime Minister Secretary Office, by the National Water Resource Committee Office divided the basin in Thailand into 25 main basins and also organized the committee responsible for each group of basin and manage it in consistent and appropriate with the condition of each basin.

Apart from that, the Water Resources Department has the sole role in relating to this matter, the department has defined the vision of the organization e.g. "To be the main organization that aims to be the top of integrated water resources management of the country, the management should be efficient and sustainable, based on the righteousness for the well being of the people"

The concept "The integrated water resources management in efficient and sustainable way" mentioned in the vision of the committee means that any operation relating to the water matter starting from the planning, developing, conserving, managing water resources and so on should be implemented under the cooperation between the private and public sectors, using people as a working center, being within a good resource allocation system, fair, using participatory approach, organizing the training for disseminating the knowledge, transferring technology, monitoring and evaluation especially in terms of efficiency and sustainability those will promote and build up the awareness in utilizing for the optimum benefits, be worthy everywhere, sufficient, productive, according to the setting objectives, fast, safe time, economized and continuously.

Above are the necessities that require the good management system which is equal, fair and balance with the ecology system, have regularly monitoring and maintenance system, including setting up the standard and disseminating the knowledge and understanding on how to utilize the water resources to the people and other water resources users in order to use the water appropriately in terms of quantity and quality, and to avoid the water shortage. However, the basin management is an important part in MRC's objectives that focuses on Management of Water Source Forest.

5.9.2 National Development Plan and the basin management

National development plans

Thailand has had policies regarding to the procurement and management of water resources since starting the 1st Socio-Economic Development Plan (2504-2509) (1961-66), which focused on the water source procurement and irrigation expansion in the beginning in order to be consistent with the policies that emphasized the country's economic growth, the 3rd Socio-Economic Development Plan (2515-2519) (1972-76) was a plan that realized on the Integrated Planning and had a concept for planning in the basin level instead of operating by projects e.g. it concentrated in the direction for developing the master plan in every basin with the aim to rank the priority to be clearer. Currently, Thailand has the 9th Socio-Economic Development Plan, apart from the policy on management of water resources and the integrated development based mainly on the river basin and to focus on building the capacity for the organizations who use and conserve the water resources at the same time, for the water resources conservation is still in the beginning step.

The main directions for the water resources utilization based on the 9th Socio-Economic Development Plan are the following:

1 The utilization of existing water sources should be done fully for the purposes of agriculture, production and consumption, and to change the agricultural production system to grow the plant which needs less water, while to increase the efficiency in using water.

2 To procure the water source which can have used for any purposes through the people's participation process since the beginning of the project formulation, and to encourage people jointly bearing the investment.

3 To study and define the guideline for managing the quality of underground water and its utilization to be according to its potential including the survey and monitoring the soil subsidence in order to announce the Underground water controlling area and solve the underground water diminishing problems.

4 To have a system to collect the fee for using raw water starting from the water using in the industry, commercial activity and water supply system beside with the

awareness raising and building up the motivation of people to concern about the quality of water source and use it worthy.

5 To develop the forecasting system for the water resources in order to increase the efficiency of the management and to facilitate the water shortage problems resolution, to prevent the flood and to procure the water.

6 To develop the main integrated water resources management in the basin level by giving the priority to the management of water's quality and the management of critical basin area with focusing on people and community's participation.

Related ministerial agreements

The Ministerial committee regarding to the development and/or the utilization of water in the Mekong Basin in the part of Thailand issued many agreement and in many occasions (as indicated in the heading 2.4.3), however the agreement relating to national water policy especially in 31st October, 2543 (2000) include the following core matters:

- To quicken the water resources decree to be the main law for managing the country's water resource by reviewing and improving the existing decrees and pushing up the implementation of the process that leads to the enforcement, considering, improving and revising other related laws and regulations to be consistent each other.
- To organize the water management organization in the national level for the basin and the local level which has backing-up laws by allowing the national organization to define the policy, supervise and cooperate in order to bring the policy into the practice and assign the organization in the basin and local levels define the water management plan for the basin by involvement from all stakeholders.
- To focus on procuring the water appropriately and fairly for using water in many purposes, that is also to meet the basic needs in agriculture and consumption by ordering the important of each type of water using in each area in order to use the water efficiently and sustainable, those should be under the clear water using rules and the users should be shared the responsibility in receiving the services, and it depends on the capacity of the participation of the service receivers and the level of services.
- To define the clear direction in procuring and developing the water sources, in order to procure the costly water which is according to the potential and needs for appropriate quality water in each activity, it is also need to give the awareness in conserving other related natural resources and environment.
- To procure and develop the water sources for agriculture everywhere and fairly in order to meet the basic needs in implementing agriculture and consumption as well as the basic government services in every aspects.
- To develop and include the water related knowledge into all education levels in order to raise the awareness for the people to realize the important of water's value and understand of using water in the efficient way and the needs to conserve the environment of the water natural sources and other built water sources.
- To support and promote the participation and to define the type of participation including clear roles and responsibility of people, private and public organizations in management of water resources in using water, maintaining and conserving the water source, checking and monitoring the water quality for managing the water resource in the efficient way.

- To push up the setting up of the flood and drought relieving and solving plans including the warning system, defining the direction, relieving the disaster and renewing the situation before the disaster in efficient and fair way with the awareness on using land and related natural resources.
- To support the budget for the action plans according to the policy including budget for research, promotion, compiling of data and information and transferring the technology regarding to the water matter to the public sufficiently and continuously.

5.9.3 Management of the Mekong Basin in Thailand

The management of the Lower Mekong basin includes 4 main basins e.g. NamKok, NamChi, NamMoun and NamTonlesap basins where are different in terms of size, physical characteristics, natural resources, and the socio-economic situation of people in each basin, the measurements and principles in managing the sub-region appropriately and specifically may need time in studying and planning. However, the primary components which are important and need to consider are presented in the following:

Watershed management

The forest plantation or reforestation especially in the water source forest to be abundant enough to meet the primary basic needs, the selection of planting area and the trees' varieties should be appropriate. In the past, due to the soil within the Mekong basin was low abundant and most of the area is plenty of sand, the awareness raising for forest planting was not much successful, and recently the promotion for forest planting is increased especially in the water source area and there is also the organizing of community forest that can reduce the forest trespassing that can increase the forest in some area, even it is not much increasing in overall.

Water management

This may includes the construction of new building such as irrigation, water reservoir and so on in order to serve the water from the rainy season to use in the dry season and to improve the water allocation system, water transferring, maintaining of water system and so on in the more efficient ways.

Groundwater development

The groundwater in the Mekong basin area in Thailand especially in the northeast that was not seriously developed and utilized. Due to the salty level of the water, the water pumping for using without any concerning with the salty water level that is underground and the pumped water will be brackish water. The maintaining the balancing between the fresh and salty water in this region especially for basins in Mekong, NamMoun and Nam Chi are now needed to be careful, however, to do not pump any water from the ground for using may change the balancing situation in the inappropriate way e.g. the salty water will be increased into upper level which would be dangerous for the environment in the future. Therefore, to install the motor for pumping the water from the ground in some areas may be necessary for water using and conserving the balancing between the fresh and salty water in the certain level.

Water conservation

Apart from the management of the water existing in the basin, the water conservation is also an important standard and should be implemented along with the water management because we have limited water and the current utilization of the water quantity per a production unit especially in the agricultural production in generally is quite higher than necessary, so there should be the motivation and bringing people to participate in the water conservation scheme, and the modern technology should be brought into the production and the changing of plant's variety and the planting system.

To motivate the people to conserve the water should include the promotion for raising awareness of the shared owning and using water in economical way; it also includes the law and regulation enforcement, the installment of water using measurements which should be financial standard, to ask for the water fees depending on the using volume. When people have awareness in conserving the water, the basin management will be easier implemented and we can use the water that we can save to use for other purposes which can increase the income for the society and the country as a whole.

Water diversion

A standard that could be considered as a direction for the basin management is Water Diversion from the Nearby Basin to use, which could be the Intra-basin Diversion such as the diversion from Mekong to use in the basin in northeast part (in case of project for Mekong-NamChi-NamMoun) and the Inter-basin Diversion such as in case of project for NamKok-NamInk-NamNanh, both cases need to consider the possibility in terms of physical area and the appropriateness in other aspects as sufficient before the actual operation, the inappropriateness in terms of physical will make the water diversion across the basin burn bigger budget than the necessary and it will lead to the environment effects.

5.9.4 Current situation, problems, and directions for the future

Current situation

Forest resources

The existing forest resources in the Mekong basin area in Thailand is very tiny, comparatively there is quite abundant in only NamKok basin area (see Table 5.17). However the data on the classification of land and forest using zone of the northeast part in general indicates that about 352 conservation forests which cover 12.1 million Rai, 20.4 million Rai of economic forest and 1.9 million Rai for agriculture, apart from that 3.5 million Rai is national parks and 1.85 million Rai is area for conserving the wild lives.

Table 5.17: Forest area in the Thai parts of the Mekong Basin

Basin	Total forest area (km2)
1. NamKok Basin	6,862
2. NamChi Basin	1,363
3. NamMoun Basin	1,188
4. Other Basins	1,325
Total	10,738

Data from the aerial photographing in 2545 (2002)

The important forests in the northeast part including:

- The groves: the forest in the river's bank or the area that temporary flooding which composes small and medium forest with some trees' groves.
- Dry Dipterocarp: the forest that is never flooded such as shorea, Mai Hieng, Mai Krad, generally people can access easily to the forest which make this forest has been much damaged.
- Mixed Deciduous Forest: the unspecified forest which composes red wood, dipterocapus costatus and macrocapus that can use for many purposes depended on the size of wood.
- Dry Evergreen Forest: the dry forest which composes many types of big trees such as dipterocapus costatus, ormosia, gold hopea, the forest in general is damaged due to the tree can be processed for selling and some kind of wood has very high demand in the market.

Basin's quality level

In 27 July, 2545 (2002) the ministerial committee agreed to define the quality level of the basins in Thailand into 5 levels in order to divide the basin zone and the potential in terms of hydrography and natural resource that aims to benefits for the basin management in the efficient way, the quality level 1 and 2 are water source forest areas which is very important part and need to conserve that people could not do any development activity in. As per the Mekong basin in Thailand, the basin's quality level has been detailed in Table 5.18. We can see that the proportion of quality level 1 and 2 which are water source area is very low especially for NamMoun and Nam Chi basins, both basins are linked and it is an area that need to increase more forest when compare with NamKok basin that has highest forest area in the quality level 1 and 2, this makes NamKok basin has sufficient water in comparing with others.

Table 5.18: Distribution of basin quality level in the Thai parts of the Mekong Basin

Basin	Distribution of basin quality level (%)				
	1A	2B	2	3-5	Total
NamKok Basin	36	4	16	44	100
NamChi Basin	10	1	3	86	100
NamMoun Basin	2	1	1	96	100
Other Basins	13	4	9	74	100

Source: Adjusted from Tangtham (1992), Water Resources Department

Problems and development directions

An important problem for management of basin is the increasing of population within the part that rise up the demand for using more land and natural resources and it could not control the balancing then lead people to trespass the forest for doing the agricultural activity which is the main reason for water shortage and flood at the end.

Figures 5.3 and 5.4 show the basin's quality levels in the North and Northeast respectively.

Figure 5.3: The basin's quality levels in the North

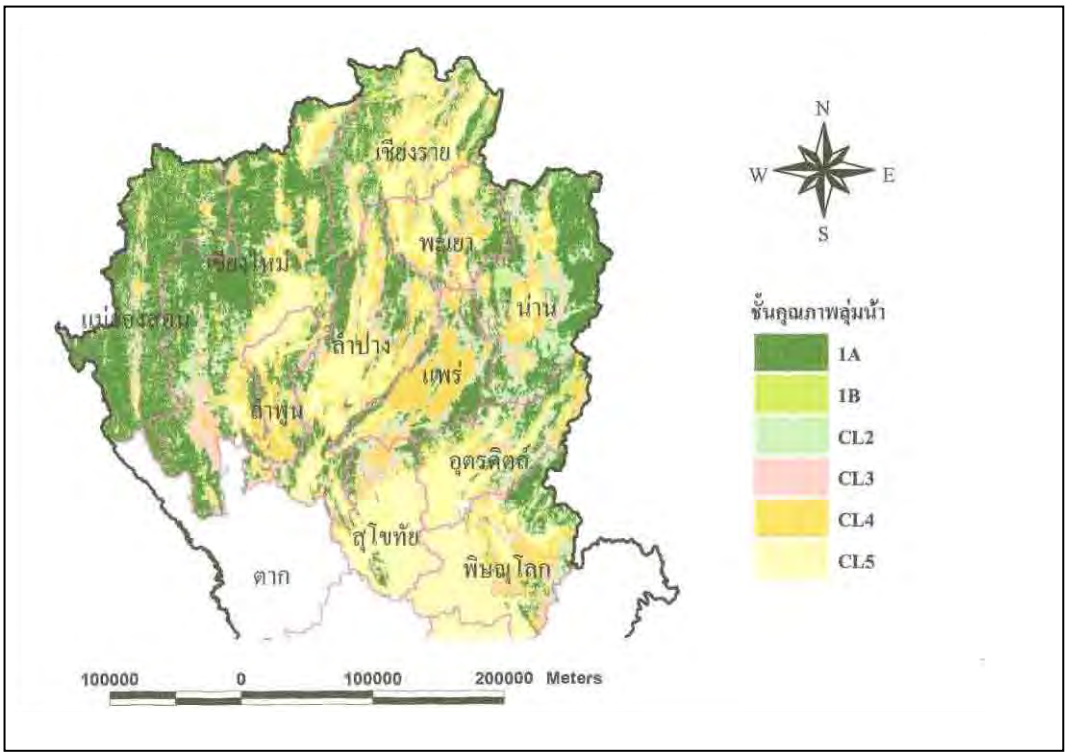
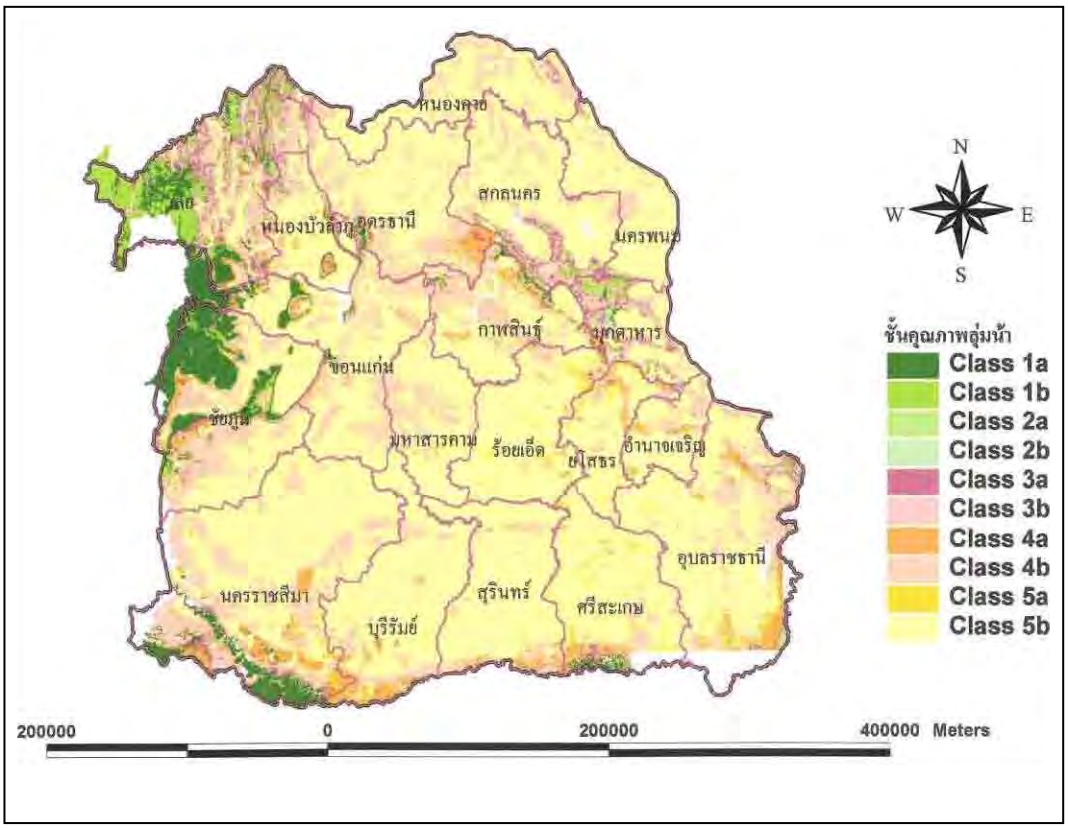


Figure 5.4: The basin's quality levels in the Northeast



Forest encroachment

In addition to NamKok basin, which still keeps the forest in the preferable situation, oppositely the forests in the Basin of Mekong, NamChi and NamMoun were damaged a lot, based on the data from forestry department during 2516-2532 (1973-89) the forest in this areas were trespassed about 17.9 million Rai (1.12 million Rai per year in average) and the trespassed rate was intolerable during that period.

The study to compare between the conservation forest area and the total basin area found that Mekong basin in Thailand, especially for NamMoun and NamChi Basins, have lowest proportion of conservation forest to the total basin area, in comparing with all basin area within the country it indicates that the forest in the river basin in the northeast part is the most used, therefore, it is necessary to increase the forest area to have more conservation forest in order to supply more cost-water for the dry season.

In addition the affords in planting more the forest in the basin in each level, the big constructions in the future such as the water reservoir that will lead to damaging of the forest in the wide scope, it should be avoid by bring people to participate in taking care the area, because the construction of big reservoir will not only damage the forest but it also limits the geology e.g. the northeast area has salty stone level in the top level about 100-300 meters or it may be more shallow than that in some area, so the construction must make the surface ground salty.

Drought

The drought in the dry season occurs in every sub-basin, but the heaviness of the problem is diverse, apart from NamKok basin that does not face much problem, but NamMoun and NamChi basins usually face the heavy drought and take long time, the surface ground land is not enough for doing agricultural activity and consumption. In many area, even there are some Dams or water reservoirs but the water distribution or the irrigation system does not cover all area, however as mentioned before that some underground water in this part is salty and the planning for using the water from this source should be clearly studied and planed in order to do not pump the water over the appropriate level of balancing between fresh and salty water.

Floods

The flood is a problem regularly occurring in the rainy season due to the forest cutting in the water source forest which makes the area could not keep the water in the ground and/or could not reduce the speed of water flow in the rainy season, so the water heavily and fasten flows. Furthermore, the rivers in some areas have the sedimentation in the bottom and the river could collect less water. In addition to the forest plantation, the channel digging or expanding the reservoir area for being new space for collecting the surface ground water, this will be a new solution.

Soil quality

Most of the problematic soils are in the northeast part in NamChi and NamMoun, it is low quality soil. Some areas, the soil is salty, people could not well utilize it for planting. Apart from solving this problem with the general water management, it also needs to do more study or research especially for how to improve the soil quality in the natural way such as rotating planting system and so on that does not use high cost.

Water quality

The water quality in Mekong in general is still in the good standard, the water quality indicator measured in every spot in NongKhai, Nakhonphanom and Khongchiem is in the standard level 2 and it can be used for consumption through the regular disease cleaning system, it can be also used in conserving the aquatic lives, fishery, swimming and other water sports.

In general the water quality in the northeast part is ranked from the usable to good levels, the water quality problem is in the area that the water flows through the community or industrial factories, most of the problems are not so complicated, but it needs to do more consideration on the problems resolution specifically for the construction or the introduction of the waste water cleaning system in the community and the agricultural places.

6 Viet Nam

6.1 General

The Mekong River with its profuse water potential has long been the decisive factor for the riparian development. The Mekong water resource is really a natural and precious resource for many economic sectors and livelihoods for the people living in the basin. It also brings tremendous benefits on economics to these countries.

Due to the geographical characteristics and crucial significance of water resources towards the identification and formulation of development framework of each territory, the basin development planning with its objective on identifying optimal ways to utilize its territorial resources has not long been new to many countries in the world. However, the inter-country basin development planning is still new in both terms of theories and practices. With the aim at clearly identifying tendencies on social - economic development for Viet Nam territory belonged to the Mekong River basin, as premises for sub-basin analyses, the following analysis is based on studies and syntheses on social economic development for entire Lower Mekong Basin in the Viet Nam territory. These analyses and argued statements are proceeded on two main areas: The Central Highlands and the Mekong Delta. The panorama on status of social economic development and its strategic tendencies on the development in the 10 coming years is viewed in relation to the Mekong water resource exploitation, environmental impacts, and transboundary issues imposed by economic sectoral developments.

6.1.1 Development potential of the Lower Mekong Basin

The Lower Mekong River basin covers with the total area of over 72,000 km2 in which the Central Highlands and the Mekong Delta are respectively 40,9% and 53,8% of total area of all river basins belonged to Mekong River system passing through the Viet Nam territory (Table 6.1).

Sub-area 10V consists of 12 provinces belonged to the Mekong Delta with the natural area of 51,400 km2 (15.3% of the whole country). This large and fertile delta, with the 700 km seashore length and approximately 360,000 km2 sea - water territories of privileged economic zone, has great advantages on economical geography. The sub-are 10V has the most potential and strong points on the development for fisheries and agriculture in the country. Territorial area (not includes islands) is nearly 3.96 Mil. ha, in which 2.6 mil. ha is used for agriculture and aquaculture. The tidal flat area is appropriately 480,000 ha, in which nearly 300,000 ha has potentials for aquaculture in salty and brackish water. Besides that, other resources such as gas and petroleum (potentially gas volume could be exploited in South West sea reached to 123 -125 bil. tons), limestones (430 mil. tons), granite rock (450 Mil. m3), tile clay (40 mil. m3), sandy gravel (10 mil. m3), peat (370 mil. tons) and mineral water. Plain geography with interlacing river systems and 25 small and medium bays creates favorable conditions for navigation development.

Table 6.1: The Mekong Basin in Viet Nam

BDP sub-area	River	Province	Basin area		Population	
			Area (km2)	*%*	*Population (no of people)*	*% of total area*
1V	Nam Rom	Dien Bien-Lai Chau	1,390.0	1.9	97,760	0.1
4V	Sebanghieng	Huonghoa-Quang tri	2,473.0	3.4	70,310	0.1
4V	Sekong	Thua Thien Hue				
7V	Sesan	Gia Lai, Kon Tum	29,650.0	40.9	4,330,000	5.5
7V	Srepok	Dak Lak, Lam Dong				
10V	Mekong	Mekong Delta	30,000.0	53.8	16,500,000	21.0
8V	Prekchlong	Tay Ninh				
Lower Basin			72,513*		20,998,070*	26.7*

* Not including sub-area 8V

* Mekong Delta area (Mekong Delta)

The Central Highlands has its natural area of 5,556 mil. ha accounted for 16.5 % whole country. Lying on the west of the southern middle part of Viet Nam where its riverheads of 4 large river systems, in connection to road systems namely 14, 14B, 19, 20, 24, 25, 26, 27 and 40, this area has direct relationships with the southern part of Lao PDR and the North East part of Cambodia and partly with Thailand and Myanmar. The Central Highlands belongs to the tropically humid monsoon area, rather equable heating regime, relatively plentiful solar radiation, being less affected by negative phenomenon such as typhoons, heat-dry wind, hoarfrost favorable conditions for creating and developing diversified collectivities of crop plants, tropical and subtropical animals, as well as eco-tourism and recreation.

Water resources in the Central Highlands bring significantly hydro-power potential with its theoretical capacity of 57 bil. KW/h (21% of whole country) and economic capacity is 17 bil. KW/h (30% of whole country). With the amount of 4.43 mil. ha of forestry land, 1.02 mil. ha of agriculture land in which 1.36 mil. ha taking 66% of whole country bazan land, all these fertile and fat lands are most valuable potentials for developing high-valued industrial crops at larger scales such as coffee, rubber, green-tea and paper material trees.

Apart from that, the Central Highlands has also raw bauxite ore minerals with the deposit of 3.05 bil. tons that contributes significance to the whole country and some locations filled with gold, tin, iron, lime, clays, constructive stone, and china, laterit, bentonit, diatomit, precious stone, peat and coal... all create the development for many important industries.

The total population in the Lower Mekong basin by the year 2001 is approximately 21 mil. that accounts 26.7% of whole country, with 16.5 mil. in the Delta and 4.33 mil. in the Central Highlands, including 30 % of 37 ethnic minority people. The urbanization rates are 18.1% for the Delta and 27.2% for the Central Highlands.

Table 6.2: Demographic status and living standard

Indicator	Unit	Whole country	Central Highlands	Mekong Delta
Population in 2001	Mil.	78.686	4.33	16.5
Average population density	per/km2	239	146	550
Average income	1000 VND/per	5,700	3,000	6,300
Poverty household	% of total	17.2	24.9	14.4
Development investment capital 1996-2000	VND bil. thousand	555	26.9	82.2

Due to favorable natural and economic conditions, population density rate in Mekong Delta is high up to 550 pers/km2, meanwhile in Central Highlands is with 146 pers/km2. The basic nature of population for both these areas is a diversity of peoples with very high migrant rate from other places. Despite of very high economic development potential and favorable conditions, the living standards in these areas are still quite low in comparison with other areas as well as the high poverty rates (Table 6.2).

6.1.2 Status for socio-economic development

Investment and development policies

In 5 year duration 1996 - 2000 total investment for the society in the Mekong delta is estimate 96 thousand bil. VND, in which national budge is 18.7 thousand bil. VND and foreign capital is 16 thousand bil. VND. Thanks to strong investment on large scale water resources infrastructure construction that creates fresh water lines protecting salinity intrusion and washing alum away; constructing flood control dyke system for flood in August, that capital develops well and effectively contribute to the productive food output that assures the national food security and partly for rice exportation. The investment for water resources is in collaboration with the transportation development and resettlement (planning and establishing communities out of flooded areas) that contributes to the improvement of the people living standards. The annual average growth rate is at 7.5%. GDP per person in 2000 is 412 USD (current rate is approximately at national average rate(413 USD) just the second position but the East South Mekong delta. Looking at the investment capital structure on economic sectors, there is strong declines of investment capital from national business and the incensement of the non-state business from 44% in 1985 to 70% in 1995.

In the same period, the total investment capital for whole Central Highlands is 25.00 bil. VND, increased 49.5% compared to its first estimation and it multiplies 4 times compared to total capital in period 1991-1995, in which the investment capital for agro-forestry - fishery development takes 39% of the total capital. This important factor creates momentum for economic development that its speed is much higher than the national average (11.5% in 5 year duration 1996-2000). It reaches and get over-fulfill norms. Due to the national budget and credits strongly invested in the Central Highlands especially on energy industry, national electricity network, transportation, water resources and construction (taking 35% total investment. Those investment results have partly contributed to complete and develop the infrastructure on technical and social ones, upgrading and newly constructing some big infrastructures such as: Ialy Hydropower plant (capacity 720 MW), Ham Thuan – Da Mi hydropower plant (475 MW), some important strategic roads from the Central Highlands to Eaten part of South West Mekong delta, Coastal South Middle part and Lao PDR,

Cambodia, upgrading airports namely Lien Khuong, Buon Ma Thot, Pley Ku, Cam Ly, and water resources head works: Ayun Ha, EaLau Dam (Gia Lai province), Dak Cam Lake (Kon Tum province), first phase Ea Soup Lake (Dac Lac), and 10 water supply projects and rehabilitation of electricity systems in towns and townships with the cost at over 600 bil. VND have been carried out.

It is obvious that in recent years, investment for agriculture has been paid much attention, especially the mobilized capital from local people is very high. It is mainly spent on long time industrial crops (5,754.5 bil. VND). However, the investment is still limited to expend the production scope as well as investment for hatchery centers, water resources fields... It therefore could not fully exploit the potentials of the Central Highlands. Industrial investment has good results mainly on energy sectors invested by the state. Local industry sectors do not have opportunities to upgrade their very old equipment. Investment for transportation and communication system managed by the government is still dispersed. Urban infrastructure is generally good, but the rural infrastructure is still poor.

Transition in economic structure

In the Mekong Delta, in the 10 past years, economic structure has been moving in positive moods. However, in the comparison to the whole national structure transpiring, its moving in the Mekong delta is considerably slow (Table 3). Proportion of agriculture, forestry, fishery declines from 61.2% in 1991 to 54.7% in 2000, equivalent proportion of industry and construction increase from 11.8% to 17.4% and its service sectors from 27.1% to 27.9% in the same time.

In the Central Highlands, the tendency of the structure transition is especially slow. In 10 years, industrial GDP density increases and GDP in agriculture decreases only 1.5%. Density of service sectors is nearly constant (Table 6.3).

Table 6.3: Economic structural transition

	1991	1995	2000	Changes over 10 years
Whole country	100.0	100.0	100.0	
Agri- forest- fishery	40.49	27.18	24.53	-16 %
Industry - construction	23.79	28.76	36.73	+13 %
Services	35.72	44.06	38.74	+3 %
Mekong Delta	100.0	100.0	100.0	
Agri- forest- fishery	61.2	61.8	54.7	-7 %
Industry - construction	11.8	13.8	17.4	+6 %
Services	27.1	24.4	27.9	+3 %
Central highlands	100.0	100.0	100.0	
Agri- forest- fishery	66.7	46.8	65.2	-2 %
Industry - construction	11.7	13.5	13.2	+2 %
Services	21.6	39.7	21.7	-

Main constraints in development

Social economic development in the Mekong Delta is hindered with major obstacles on hydrology regime and quality of land resources. The unfavorable area for cultivation is very high, containing 1.6 mil. ha of alkaline soil at high acid rate, aluminum toxious concentration and lack of phosphorus; 0.75 mil. ha of sulphat soil which is impossible to provide freshwater in dry season. Nearly half areas are annually flooded for 3 - 4 months that causes serious difficulties for production and livelihoods.

In the Central Highlands there is limitation on social economic development related mainly to the scarcity of water resources in some times per year due to the unequal distribution of the humid regimes causing one severe dry season from 3 - 4 month duration to 5 - 6 month duration (depending on the area). Because of curved geography, hydraulic works requires more investments than that in other areas. Groundwater is more exploited with huge volume in order to supplement to the needs of production and living that causes impacts to the ecological balance in the area.

Although the Government has paid much attention and given direction by their legal documents on the social economic development for the Mekong Delta and the Central Highlands, in 10 past years, its economy grows slowly, unstably and stands out of market demands. Those are presented as follows:

- Economic structures slowly transfer especially agriculture, forestry and industry sub-sectors. Dynamic movement of GDP structure is smaller than that of whole country. Industry and construction density of GDP in 2000 takes only 17.4%, in spite of its diversity and initially progressive outcomes, the service sector is still at its preliminary start up at the amount of 29% of GDP (while the national figure is 50%).
- Traditional agriculture production modes are gradually improved, however, the scientific and technological inputs in their products are small that leads to the unstable production, poor product qualities, les competitive advantages. The production scales are not adequate enough, thus it does not meet the processing industrial demands.
- Investment mechanism is not appropriate, investment for application of science and technology in the production is not fully paid attention in the Mekong delta. There is insufficient investment on nurse ling seeds, plant grow technique, preservation, processing domains… that reduces the efficiencies of big investment on production infrastructure such as hydraulic works. On the contrary, in the Central Highlands, the long time dry season is irresistible, investment for irrigation schemes, especially for industrial crops, is not appropriate to its production scales; in addition, investment for processing industry and processing technology infrastructure is still limited.
- Foreign investment in the two areas is too tiny at its scale, thus it could not promote the effectiveness on improved technology capacities and production management by enterprises and local labors.
- Labor employed mechanism needs to be improved (meanwhile redundant workers, high unemployment rate are available, as one of solutions to increase the employments and incomes, industries required more labor force such as textile and electronics are not developed).
- Rural industrialization is not fully rational, small scale industrialization in the rural is mainly spontaneous with low technology. In general, the people living standards are improved, the gaps between classes and regional zones are still big: gaps between

average of highest incomes of 20% households and lowest incomes of 20% households are 13 times, meanwhile the national rate is 8.9 times and the North West part is 7.1 times.

Assessment of the constraints

- Investment for science-technology application in the production is still low and inefficient. Goods production does not rely on competitive advantages of agri-products. In order to make full use of advantages on its natural resources, the application of science technology in agricultural and fisheries production is not focused and less in quantity. The scientific calculation based on water and land usage is not synchronous for the assurance of stable and high productive effectiveness.
- Social economic infrastructure systems are poor that does not meet the development requirement. Due to the limitation of its capital, the infrastructure development can not be done in synchronous manner, on the other hand, frequent occurrence of natural calamities damages the its quality. The national highway No.1A even upgraded is overloaded that creates more transported fees. In the Mekong delta, the inland waterways transportation is advantageous in the region however the exploitation is still limited due to the lack of sea ports and river-ports whose capacities could load and transport the goods. In comparison to other regions, the rural transportation is still less developed.
- Investment for hydraulic sector has gained positive outcomes, however, it does not fully meet the demands for high quality goods production, especially aquaculture development (in the Mekong delta) and long term industrial crops (in Central Highlands).
- Less developed urban systems that limit the opportunities for trading activities and service provision since the urbanization rate is 3,5%/year (the national rate at 4.52%/year). Attention paid to the urban infrastructure issues make it more developed. In the rural, technical and economic infrastructures are still poor.
- Low qualified human resources, numbers of people who are trained with technical expert ice takes only 7-8% of total labors (the national one is 15.5%), in which their knowledge from college to upper levels takes only 1.3% (the national one is 3.4%). Average rate of people who are at schooling ages is just at 57%. Current schooling culture is only at the class 5. Numbers of teachers are insufficient, schools and their facilities are not adequate and not good (18% of class-rooms are temporary (highest rate in the country). Unemployment in urban areas and lack of work in the rural are still high (6.15% in 2000).
- Social conditions for people living standards and their livelihoods are so poor. Schooling education and vocational training are inadequate, illiterate and school-drop rates are still high.

6.1.3 Social and economic development by 2010

General

In general, the Mekong Delta and the Central Highlands are both identified as development prioritized areas in the coming years.

In order to take our country escaping from the less developed situations, the national social economic development strategy has points out following targets:

- GDP in 2010 will be 2 times of that in 2000. Fully meet the demands on goods consumption and production, promoting exportation. National domestic economy accumulation gains over 30% GDP. GDP density on agriculture takes 16-17% of total GDP, industrial one: 40-41% and services: 42-43%. Agricultural labor rate is about 50%.

- Annual population decrease is at 1.1%, poverty alleviation, rapidly reducing poor households, providing more employment opportunities and people working rate up to 40%. Social and natural environment is protected and improved in safe and sound manners.

- National competences on science and technology are capable of being applied by modern technology and world knowledge approaches, and self-development on some core domains.

- Infrastructure composition could meet the requirement for social economic development, national security and defend and future demands. Transportation systems, especially the rural transportation, important dyke system and concrete and developed irrigation systems.

- National economic vital roles are strengthened. More various economic sectors involve in the development in the diversified manner. Investment sources are mobilized for long term and strong development.

For the Mekong Delta, continuously bring into play the most important roles of granary, agricultural production and fisheries exportation of the country. Improving the production and its qualities of goods on foods, vegetables, husbandry and fisheries; Developing processing and engineering industries for agricultural purposes, home craft industries and services. Making full use of advantages of goods on agricultural and fisheries products, taking initiative of friendship extension to the South East Asian countries on import-export domains and tourism. Strongly transferring the economic structures, increasing labor density in services industries, making master plans for infrastructure development, residential areas and sectoral productions to be in line with conditions for annually flood control and salinity intrusion prevention.

For the Central Highlands: By the crucial strategic significance on economic, political and social aspects, development orientation for the Central Highlands has been paid in consideration of regional collaboration, especially Lao PDR, Cambodia and Thailands. The effectiveness of the area development is taken account of overall benefits on the principle of improving the living standards, culture, intention of the people in order to assure the unity of the peoples in the Central Highlands and strengthening the friendships with the neighboring countries.

6.1.4 Objectives of social and economic development

Economic growth

The Mekong Delta, striving for GDP annual average growth rate at 1.3-1.5 times compared to the national growth rate, establishing modern production zones on agriculture and

fisheries with high value and quality products, high competitive power, assuring the national food security and maintaining the rice exporting capacities of over 3 mil. tons per year, producing specific agri-products with high comparative advantage, national highest exporting agri-product yield, striving the industrial growth at 14-16%/year, industrial density in GDP 33-34%, developing large scale hi-tech processing industry, establishing 2 large scale gas-electric industrial zones.

– Perfecting infrastructure systems to meet the development requirement; providing safety areas for people affected by floods.

– Giving suitable solutions on cultural and social problems (such as people do not have lands for their production, unemployment, illiterates...); gradually making the people having the modern and civilized lives.

The Central Highlands, striving for GDP growth rate at 9-10%/year, in which industry and service density is highly increased. GDP annual average per person in 2010 will be 2.2 times compared to that in 2000 (Table 6.4). In agricultural sector, areas of coffee and rubber will not be expended. Maize, cotton and fruit-trees will be more developed.

Table 6.4: Growth index by year 2010

Period	1996 - 2000	2001 - 2005	2006 - 2010
Whole country	6.9	7.5	7.5
Agri-foresty	4.3	4.0	3.8
Industry, construction	10.6	11.0	10.0
Services	5.8	6.1	6.4
Central Highlands	8.7	10.2	9.8
Agri-forestry	11.0	8.1	7.4
Industry, construction	7.8	17.7	16.6
Services	6.0	12.6	10.7
Mekong Delta	5.3	9.1	9.5
Agri-forestry	3.4	5.1	5.0
Industry. construction	9.2	15.3	15.0
Services	5.7	11.5	10.5

Source: processed by provincial statistics

Exploiting promising potential of hydropower (in the Dong Nai and Se San River systems); developing technical human resources for industrial and services sectors; implementing projects on exploitation of boxid, aluminum and alumni; giving priorities to processing industries for agricultural and forestry products; promoting forestry with settled agriculture and fixed residence, establishing; establishing material zones for paper industry and plank woods.

Population growth controlling with the stable target of 5.5-6 mil. people in 2010; in 2005 alleviation of poverty households, there is no extremely poor villages, 100% of villages all have enough 7 essential infrastructure projects, poverty rate will be decreased to 13% (annual average decrease of approximately 18,000 households).

Giving better solutions on social problems, ensuring the essential infrastructure, enhancing the intellectual knowledge and improving much people's sprits, especially the cultures of ethnic peoples.

Transition in economic structure

For the Mekong Delta, identified target of economic structure transfer in 2010 is the density on agricultural increased value in the total economic increased value will reduce to 41%, respectively increased density on industry to 25% and of service sector at 34% (Table 6.5).

For the Central Highlands The intention on the economic structure transfers forward to the specialization of the goods production, it focuses on the long time industrial crops, hydropower development and processing industries, mine exploitation industries, so that by 2010 density on increase industrial value is at 22 % and services of 21.5 %.

Table 6.5: Orientation on economic structure transfer (%)

	2000	2005	2010
Mekong Delta	100.0	100	100.0
Agriculture	53.0	43.5	41.3
Industry	17.9	24.0	24.5
Services	29.1	32.6	34.2
Central Highlands	100.0	100.0	100.0
Agriculture	67.4	60.8	56.2
Industry	12.6	17.3	22.3
Services	20.0	21.9	21.5

Source: Processed from provincial statistics.

6.1.5 Recommendations on water utilization

National level

Water supply and its hygiene for the citizens:

- Assuring the adequate amount of water supply and its hygiene for the citizens and forecast this water demands for next 10 - 20 years.
- Water provision for citizens and hygienic purposes is crucially essential because of its assurance to people's health and their life qualities. Thus it should be most prioritized in all water demands. In case of water insufficiency in dry season, water demands for agriculture, fisheries, industries… should be reduced in order to assure the sufficient water supply for citizens and hygienic purposes.
- Sewage needs to be fully treated to prevent the pollution of water to the residential and lower parts. In the case, it could not be fully controlled, extents of its impacts should be assessed on the influence to surface and ground water resources

- Decentralize the management of water supply to citizens basing on locations, living standards, residential features for proper measures. For example:

  Central Highlands: The urban water supply could be possibly assured in terms of its resources and supply systems (surface and ground water), however, out of those who takes water from water surface, in rural areas, by their wells, people take superficial ground water for their domestic and hygienic usages, due to the limited amount of ground water, especially in dry season, serious water insufficiency occurs, the overexploitation deteriorates the ground water and makes it polluted. Therefore, the more construction of small and medium scaled reservoirs and big reservoirs on the mainstreams not only harmonizes the water flow to assure the sufficiency of water for sectoral water demands, but also provides sufficiently water quantity to maintain minimum water flow in lower parts and increased ground water volumes for rural and urban domestic usages.

  The Mekong Delta: People in almost flooded areas use the surface water, the coastal ones take the surface and superficial ground water by their wells. In general, water qualities of both surface and ground water need more attention due to the polluted causes derived from the upper parts and its residential water usages. Moreover, overexploitation of superficial groundwater which is infected by salinity in the Mekong Delta and pollution (in both areas) that causes serious water insufficiency in some areas.

- Efficiency of water supply and its usage should be set as targets so strategy on water resource protection and water demand management could be in place. It could be said that water demand for citizens does not cause pressures on the state water resources, but its water demands decrease, the water sewage and its process also decrease. Regional cooperation on water sewage standards as well as making full use of rain fall water should be paid attention, that facilitates the water supply and rural hygienic purposes could be in good manners.

Assuring water volumes for production sectoral demands :

- For agricultural sector: study and review the effectiveness and efficiency and constraints in water supply domains to each area, each kind of plants in order to identify the planning for reservoirs and scheduling the water supply regimes to each location. There should have a strict assessment on the groundwater deposits, supplementary threshold water capacity for long term industrial crops in surface water insufficient periods.

- For industrial sectors, there should have supplementary studies and completed indicators of water usage and water demands, industrial pollution treatments in order to calculate exactly the water demands for each category of business activities. Water fee for industrial usages should be closely calculated to the extent of sewage treatments. For the newly established or operated industrial zones, the water supply and drainage systems should be planned with updated information in order to have synchronous and timely solutions. Large scaled projects in industrial zones must have water environment impact assessment and its solving treatments. Water supply and drainage systems for production purposes should be completed in the way that does not affect to the water domestic usages. The industrial sewage and water for aquaculture should be paid special attention in the case that these water releases which could be recycled in the lower parts; The amount of water for treatment and dilution to secure the water quality and its environment is at many times of that for industries, especially agri-products and food processing industry, sea product processing ….

– Planning on water supply and drainage systems for domestic usages should be in close collaboration with other plannings as the premise for the overall infrastructure development with modern and long term manners.

Transboundary issues

Central Highlands: The most important significance in transboundary water issues is the construction of hydropower plants and hydraulic works, reservoirs in Vietnamese territories. During the surveys and studies, Viet Nam has paid much attention to and carried out some essential studies on the hydropower environmental impacts. The hydraulic works, especially the reservoirs, in its studies and construction periods, have been put in right principles on integrated requirements that are not only for agricultural sector but also for other sectoral purposes, including water for domestic and hegemonic usages. Existing reservoirs have been exploited for agricultural and power generating purposes in combination to water demands for domestic usage. Therefore, the more construction investment in reservoirs on the mainstreams and tributaries of Sª San and Srepork rivers is in line with the demands on water flow harmonization, decreased flood volumes, increased dry season water for Central Highlands as well as for the downstream areas in Cambodia and Lao PDR, and the Mekong mainstream that brings the protection on ecological environment, supplementary water volumes for dilution since the water sewage increases. Up to now and in the coming time, it is definitely said that water usage for domestic and hygienic purposes in the Central Highlands does not cause negative impacts to the lower parts in terms of its volumes and water quality. In the future, since population and its production highly increase, the more construction of reservoirs and better treatments to water releases before it becomes water sources that must be carried out on the common view of minimal water flow maintenance and agreed principles in the exploitation and operation of water flood released artificial reservoirs in the upper parts.

The Mekong Delta, as the lowest area of the Mekong River basin, its impacts to the upper parts are minimal, perhaps only the navigation and flood release capacity. The Mekong Delta is not affected by Trans-boundary impacts from domestic and hygienic water usage but also being impacted by all water uses for various purposes of economic sectors such as agriculture, industry, husbandry, hydropower, transportation, flood control, tourism services. The watershed deforestation will make faster floods, higher flooding areas, longer and deeper flooding and in the dry season if the water resources coming to Viet Nam are not sufficient for water demands and maintaining water flows, it will cause widen salinity intrusion, droughts, high leveled pollution that causes damages to all other sectors. Water releases from upper parts, especially that in the Cambodian part of the Delta, are not well treated, it will directly impact to water quality, livelihoods of people living in the Mekong Delta. It is not accounting for the impacts of water quality from the upper parts for maintaining the bio-diversity including migration of fish, specific habitants of the coastal wetlands...

The increased water demands on its usage and drainages in upper parts of the Basin are indispensable. However, if that demands could not be limited as well as the water quality is not controlled, tranboudary impacts will be most serious occurred to the Mekong Delta in comparison to all other lower Mekong basin areas, in both dry and wet seasons. These could only be considered and analyzed in the most integrated and scientific manners under the framework of the Basin Development Plan. In order to do so, at initial steps of scenarios formulation, they should be put in, because if only taking account of water demand indicators, that would not be comprehensive and inadequate. In addition, indicators on sewage amount, water regime and quality should also be added.

6.2 Agriculture and irrigation

6.2.1 Development status

With nearly 21 mil. population (taking 27% total national population) and natural land area of nearly 31% in the whole national one, the Central Highlands and the Mekong Delta (within the Lower Mekong Basin) are specified by their high density on agriculture in the economic structure that are respectively equivalent to 65.2% and 53% (year 2002). Especially diversified products made in Mekong Delta take 40% of total value of agri-forest-fishery national products, in which rice (16.7 mil. tons in 2000) takes 50% of rice yield and 90% of national rice exported value; fisheries takes 55% of its output and 51% its national exported value.

The tendency of the transferred structure on agriculture is decreased density, meanwhile increased density on husbandry and agricultural services is changeable but still limited. In the comparison of the whole country panorama, productivity of crops and agricultural production value per area has tentatively increased in recent years. Productivity of agricultural labor is respectively increased (from 6.95 to 10.83 mil. VND/person/year). Established agri-productive areas specialized on rice, coffee, rubber, sugar cane, tea, mulberry, cotton that creates important premise for development of agricultural production linked to processing industry and increased people living standards.

Table 6.6: Agricultural production (status and planned)

	2002		2010	
	Central Highlands	*Mekong Delta*	*Central Highlands*	*Mekong Delta*
Cultivation, 1000 ha				
Rice	186.1	3,814	219.6	3,800
Corn	145.2	25.8	124.3	46.5
Coffee	451.0	-	350.0	-
Rubber	89.3	-	157.0	-
Cotton	20.7	0.4	40.0	24.0
Tea	26.2	-	26.5	-
Pepper	10.8	-	9.0	-
Cashew	27.9	-	59.8	-
Sugar cane	31.6	-	36.0	-
Fruit tree	-	223.2	-	280.5
Husbandry,1000 heads				
Cattle	493.7	269.4	1,305.0	374.0
Pig	1,191.3	1,369.0	1,400.0	4,000.0
Poultry				64,000.0

However, many advantageous points on agriculture in these areas are not exploited and promoted in adequate manner. The area rate of high quality rice to meet the export demand in the Mekong delta is still low, the post harvest technology needs to be perfected. The strength on large cattle husbandry development of the Central Highlands is not fully put into effective practice, its products are few. In the Mekong delta, pig and poultry growth is on

average of 4.5 – 4.8%/year, cattle is decreasing on average of 11%/year. In addition, being gone abreast the slow improvement on social economic and socially cultural matters for people living there, many ecological environmental issues in some parts are serious such as the degradation of forestry land, lack of water in dry season, flash flood in wet season in the Central Highlands and forestry resource exhaustion, especially the coastal area, polluted water, salinity, aluminum… in the Mekong Delta.

6.2.2 Development orientation

Making full use of comparative advantages on agriculture, basing on particular conditions from each area, the tendency on agriculture development for the lower Mekong basin will be the development of a comprehensive agriculture with diversified products. Major agricultural goods are considered as rice, maize, long term industrial crops, fruit-trees, vegetables and husbandry products (Table 6.7).

Table 6.7: Status and forecasting of some agricultural product yields

	2002		2010	
	Central Highlands	*Mekong Delta*	*Central Highlands*	*Mekong Delta*
Yield, 1000 tons				
Rice	610.0	17,467.2	973.1	19,000.0
Maize	425.4	98.6	573.2	220.0
Coffee	611.9	-	750.0	-
Rubber	41.7	-	89.0	-
Cotton	25.3	-	75.0	-
Tea	133.3	-	162.0	-
Pepper	12.3	-	14.0	-
Cashew	10.5	-	48.5	-
Sugar cane	1,354.4	-	2,830.0	8,000.0
Fruit tree	-	1,503.3	-	3,400.0
Meat, 1000 ton				
Cattle	83.2	399.0	97.7	679.2
Pig	15.5	316.7	18.2	439.7
Poultry	67.7	82.3	79.5	240.5

– *Rice:* assuring the stable areas of 3.8 mil. ha in the Mekong Delta with the rice yield of 19.7 mil. tons, that could meet the demand for domestic usage, national markets and exportation. Areas where one time crops are unstable should be transferred to other purposes. For the Central Highlands, investment for upgrading and completing small and medium hydraulic works is for the increase of rice areas from 186 thousand ha to 220 thousand ha, intensive cultivated areas for two time crops are especially paid attention so that it could basically meet the local people demands on rice.

– *Maize:* Current maize areas in the Central Highlands can be reduce approximately to 21 thousand ha to be replaced by other high value industrial crops such as rubber, cotton, cashew. As to the Mekong Delta, for the target of increased production

yields of pigs and poultries, by 2010 there will have been about 560 thousand tons of meats, and the maize areas need to be extended with more 20 thousand ha in the combination of having new high yield seeds provided.

– *Long-term industrial crops:* with high values such as rubber, cotton, cashew whose potentials could be extended in terms of areas and productive yields in the Central Highlands; bring into play roles on collecting more long term industrial crops during 5-7 coming years. The scale extension of long term industrial crops such as pepper, coffee, sugar canes… needs to be gradually taken up. Especially, the project on extension for sugar cane areas after 2005 that could be 2 times of present areas in order to have 36 thousand ha of sugar canes with its yield of over 48 thousand ton/year should be carefully considered.

Promoting the extension of cultivated areas of high valued tropical fruit-trees in the Mekong Delta such as mango, mangos teen, rambutan… taking 3.4-3.5 mil. tons of various fruits; more developing on specialized vegetables in the Central Highlands such as green peas, asparagus, cauliflower, temperate zone flowers in order to serve for increasing domestic market demands.

One of solutions for agricultural structure transferring toward the industrialization for better effectiveness in agricultural investment is to improve the structures of cultivation and husbandry, increasing the density of husbandry product values in the total agricultural productive values; making full use of cattle husbandry advantages of the Central Highlands for striving increased numbers from 494 thousand units to 1,305 thousand units by the year 2010. As regards to the Mekong Delta, it has great potential of provender for cattle, preferring the big herds, increasing the numbers from 1,370 thousand units to 4 mil. units by the year 2010. By the year 2010, the total fresh meat amount in various kinds by the year 2010 will be 700 thousand tons. In Mekong Delta, some areas that have favorable conditions for cattle growth reached to amount of 64 mil. units that could adequately provide demands on meat, milk, eggs for people living in the Lower Mekong Basin.

6.2.3 Water demands for agriculture

Water demands for agricultural production are synthetically calculated from norms on water usage requirements and tendencies on development planning for main plants and animals by the year 2010. Preliminary calculated results show that water demands for agriculture in the Mekong Basin provinces are approximately 2.84 - 3.24 and 17.15 - 19.18 bil. m3 of water.

If the most important factor that should be considered in water supplying for Central Highlands is the potential of surface water resource, surface water timely regulated capacity and its demands as well as supplementary groundwater exploiting capacity, then for the Mekong Delta, the most important attention for agriculture water supply is the hydrology regimes by times and standards of other various factors affected to water resource quality.

Table 6.8: Water demands for agriculture in Central Highlands

	Unit	Units (2010)	Unit demand	Water demand
Cultivation			(m3/ha)	(1000 m3)
1. Rice	ha	219,600	4,000 – 4,500	878,400 – 988,200
2. Corn	ha	124,300	2,000 – 2,500	248,600 - 310,750
3. Vegetables	ha	58,000	2,000 – 2,200	116,000 - 127,600
4. Mulberry	ha	9,100	2,000	18,200
5. Sugar cane	ha	36,000	2,500 – 3,000	90,000 - 108,000
6. Cotton	ha	40,000	2,000 – 2,200	80,000
7. Coffee	ha	350,000	3,500 – 4,000	1,225,000 - 1,400,000
8. Tea	ha	26,500	1,500 – 2,000	39,750 - 53,000
9. Pepper	ha	9,000	2,000 – 2,500	18,000 - 22,500
10. Fruit tree	ha	32,200	2,000	64,400
11. Decorative flower	ha	400	2,000 – 2,500	800 - 1,000
Total, cultivation				2,779,150 - 3,181,650
Livestock			(liter/day)	(m3)
1. Buffalo	head	742,500	90 - 106	24,390 - 28,730
2. Milcho cow	head	15,000	120	110
3. Pig	head	1,400,000	50	25,550
4. Poultry	head	835,000	20	6,100
Total, livestock				56,710 - 61,010
Total, agriculture				2,835,860 - 3,242,660

Table 6.9: Water demand for agriculture in the Mekong Delta

	Unit	Units (2010)	Unit demand	Water demand
Cultivation			(m3/ha)	(1000 m3)
1. Rice	ha	3,800,000	4,000 – 4,500	15,200,000 - 17,100,000
2. Corn	ha	46,500	2,000 – 2,500	93,000 - 116,300
3. Vegetables	ha	230,100	2,000 – 2,200	460,200 - 506,200
4. Sugar cane	ha	100,200	2,500 – 3,000	250,500 - 300,600
5. Cotton	ha	24,000	2,000 – 2,200	48,000 - 52,800
6. Fruit tree	ha	280,500	2,000	561,000
Total, cultivation				16,612,700 - 18,636,900
Livestock			(liter/day)	(m3)
1. Buffalo	head	88,300	90 - 106	2,900 - 3,400
2. Macho cow	head	12,000	120	90
3. Pig	head	4,022,000	50	25,550
4. Poultry	head	63,359,000	20	6,100
Total, livestock				56,150 - 60,490
Total, agriculture				17,152,050 - 19,176,740

6.2.4 Water demand for aquaculture

Table 6.10: Capacity and demand of water supply for aquaculture development

	2005		2010	
	mil. m3	*% of potential*	*mil. m3*	*% of potential*
Central Highlands	578	2.5	1,122	4.8
Mekong Delta	11,984	2.7	13,339	3.0

Data on fresh water demands for aquaculture is relatively accurate, because of low proportion on aquaculture water demand compared to water resource potential in both areas, meanwhile there are still many large inundated areas, especially in the Mekong Delta it can be used for aquaculture purposes in certain months. On the other hand, required water volume for maintaining and protecting inundated ecologies is much more than that for aquaculture. One not less important factor is the quality of the water resource that is affected much by agricultural modes cultivated in surface water areas which greatly determine the effectiveness of the aquaculture business, but is not only the water volume to be used. In the calculation of water demand for aquaculture, attention should be therefore paid much to water demands and their water use procedures of other related economic sectors located in the same areas such as forestry, agriculture and waterways transportation...

6.3 Fisheries

6.3.1 Development status

Sea product exploitation: In 2002, the exploitation of sea products of eight provinces belonged to the 10V is 614,480 tons that accounts for 42.8 % of total country capacity. Inland fisheries exploitation in the Mekong Delta is 50,000 tons/year, in which estuary is 30,000 tons/year.

Aquaculture: Potential areas for aquaculture in the Central Highlands and the Mekong Delta are respectively 10,000 ha and 543,000 ha, taking 67% of the whole country total area. In difference of fisheries natural capture method in large lake and fish pool, fish cage for right away purposes in the Central Highlands, the great potential of water surface area for aquaculture of the Mekong delta (543,120 ha) has been rather well exploited during recent years. Fisheries productivity in Mekong Delta in 2002 is 530,000 tons that increases 2.2 times, export turn-over in 2001 is 7.1 mil. USD that takes beyond 60% of total country exportation on fisheries.

Especially in the year 2000 and 2001, there is a great conversion of large rice cultivated area (over 200,000 ha) to shrimp cultivated purpose. In addition, in some provinces such as An Giang, Dong Thap the fresh water fish cage development is strongly promoted with total cages of 5,470 in 2001 and its yield of 15-20 tons/ cage/year. The main product is the catfish with high economic value and for exportation.

Table 6.11: Status for fisheries productivity within the Lower Mekong basin

	Whole country	Central Highlands		Mekong Delta	
	1000 t	*1000 t*	*% of country*	*1000 t*	*% of country*
Total production 2002	2,435	10.4	0.40	1.273.7	52.3
Sea exploitation	1,725	2.3	0.10	829.3	48.1
Aquaculture	710	8.0	1.10	444.4	62.6
in which shrimp	155	5.2	0.03	118.4	76.5
Aquaculture area (ha)	755,178	5.6	0.07	547.1	72.4

By large scale fisheries productivity and good infrastructure for fisheries processing in the Mekong Delta, total fisheries exporting value in this area has contributed nearly 51.4% to total national one. However, the investment status for self-developed fisheries cultivation in the Mekong Delta and uncontrolled capture methods in the 7V are the main reasons affected to the fisheries environment: natural resource deterioration, polluted aquaculture environment, habitant degradation.

6.3.2 Development orientation

Fisheries development is one of tendencies for effective implementation of the general strategy on transferring agricultural and rural structures in the national industrialization and modernization period. Target of national fisheries development in 2005 will be 2.67 mil. tons and in 2010 of 3.51 mil. tons. In which, the density of aquaculture yield increases from 47.6 % to 60.1% of the total fishery yields. The highest increased density is the brackish fishery. The capture yield in the Mekong Delta is stable at the amount of 700 thousand tons/year. Aquaculture areas in the Central Highlands and the Mekong Delta are tentatively extended to 310.6 thousand ha of inland fisheries and 545 thousand ha of coastal fisheries in 2010 (Table 6.12).

Table 6.12: Aquaculture planning and fresh water demand for aquaculture

Target	Central Highlands		Mekong Delta	
	2005	*2010*	*2005*	*2010*
Aquaculture area (ha)				
Shrimp	-	-	410,000	545,000
Fish	17,000	33,000	297,000	310,600
Cage fish	2,000	2,000	4,400	4,400
Fresh water demand (mil. m3)	578	1,122	11,984	13,339

To archive planned target, apart from the mobilization of wild water surface areas posed aquaculture potentials (10,079 ha), there should have consideration on the transferring intentions of some one rice crop areas into 1 rice crop plus 1 shrimp areas (116,049ha), from 2 rice crops areas into 1 rice crop plus 1 shrimp areas (43,306 ha) and from 3 rice crop areas into 2 rice crops plus 1 shrimp areas (18,906ha). Estimated fresh water for the Central Highlands is 578 and 1,122 mil. m3 for year 2005 and year 2010, so as to the Mekong Delta with 11,984 and 13,339 mil. m3, respectively. Water demand for fisheries however is not

simply the quantity of water, it also takes into consideration of other water related conditions such as the water depth, inundated time (length and duration), water quality, nutrient concentration, density of sewage in the pool…especially in the fish cages and shrimp ponds. On the other hand, due to the ecological significance, especially of wetland areas, they also bring benefits on tourism, culture values…that requires the careful calculation of its utilization with other purposes on tourism, aquaculture, bio-diversified development...

Specific sectoral studies have shown that premise and favorable conditions for fisheries development in Viet Nam as well as the lower Mekong basin are available in terms of land resources with water surface areas in both quality and quantity. Human resources related to fisheries in rural areas are abundant, traditional experience and self-motivation of the fishermen that initially proves the promising opportunities of fisheries development and to the world and region integration. In addition, the legal framework for fisheries development is gradually finalized with the target of promoting business production capacities, more opened environment for product consumption in domestic use as well as for exportation, being established and implemented the sustainable development of fisheries in Viet Nam.

However, the Vietnamese fisheries sector in general and fisheries sector in the Vietnamese parts of the Mekong Basin in particular have coped with many difficulties related to the resource deterioration born by its overexploitation even with resource extirpated modes; negative changes of the coastal environment derived from production activities and people living there, that makes the decrease of sea bio diversities composed of aquatic life and polluted aquaculture environment. One of crucial direct impacts to the effectiveness of fisheries activities is the way of resource utilization, especially the water resources. Firstly, it should notice on the industrial water sewage, the exploitation of coastal, riverine wet lands, the utilization of agricultural chemistry affected to the water environment for agricultural and fisheries, the limitation of water resources in the Central Highlands. Moreover, the Tran-boundary fisheries benefits in which the most important issue is to assure the adequate ecological conditions in Viet Nam for fish migration, that requires one proper and effective management mechanism.

6.4 Hydropower

6.4.1 Development Status

The total capacity of Vietnamese power plants is 8,750 MW, in which hydropower of 48.8%, thermo-electricity of 20.4% and gas turbine and diesel of 30.8%. In 10 years, power production average rate in Viet Nam is at 12% and production scale increases 3.5 times and reaches the amount of 26.594.106 kwh. Power consumption average rate per person increases from 113 to 341 kwh/year. Resource structure for electricity production changes greatly with the big incensement of the power production by gas turbine (from 5.4% to 23%) and the decrease of the hydropower and thermo-electricity (respectively from 61.9% to 54.7% and from 32.7% to 22.3%).

According to the scientists, the theoretical potential of the two river systems Sesan and Srepork take approximately 35 bil. kwh (Table 6.13), in which planning for hydropower cascaded system in Se San River composes of 6 schemes with annual power generation at 8.23 bil. kwh,at the moment Yaly 720 Mw hydropower plant, Drayhlinh 12 MW hydropower plant have been in operation.

Table 6.13: Characteristics and potentials of the Se San and Srepok Rivers

River	Length	Area	N	Eo	
	km	*km2*	*MW*	*10^9 kwh*	*10^3 kwh/km2*
Se San	224	11,450	2,480	21.72	1910.3
Srepok	508	18,200	1,539	13.58	746.0
Total		29,650	4,019	35.30	1190.0

In the Srepok River, Dray Hlinh 12 MW scheme is newly operated. Two schemes namely Chu Bongkrong Buon Kroup (280 MW) and Srepok 3 (180MW) could be only used in 2006 - 2010. Gas thermo electric potentials in the Mekong Delta is estimated at 2,070 MW by three schemes namely O mon I (600 MW), Ca Mau (720 MW) to be operated after 2005 and O mon II scheme (750 MW) after 2010.

6.4.2 Development orientation

After the year 2005, the two schemes namely Sesan 3 (260MW) and Pleikrong 110 MW (on the Sesan River) will be under operation and so as by 2010 schemes namely Sesan 4 (330 MW), Sesan 3A (100 MW), upper KonTum (220 MW) will be exploited on the Sesan River. On the Srepok River, there is a newly operated hydropower plant – DrayHlinh with capacity of 12 MW. The schemes Bongkrong BuonKroup (280 MW) and Srepok 3 (180MW) will have been operated by 2006 - 2010 (Table 6.14).

Table 6.14: Orientation of investment for electricity production in the Lower Mekong Basin

	2001 - 2005			2006 - 2010		
	Scheme	*MW*	*Time*	*Scheme*	*MW*	*Time*
Hydropower capacity, MW	-	-	-	-	7,976	-
Central Highlands	-	843	-	-	1,163	-
Sesan cascades	Yaly	720	2002	Sesan 3	2,73	2006
	Pleikrong	110	2003	Sesan 3A	100	2006
	DilinhI	5,4	2002	Sesan 4	330	2010
	Dilinh II	7,1		Upper Kontum	220	2010
Srepok land height	Drayhlinh	12	2002	Chu bong Krong-BuonKroup	280	2010
				Srepok 3	180	2010
Thermo electric capacity					8,000	-
Mekong Delta					2,070	-
				O mon I	600	2006
				Ca Mau	720	2006
				O mon II	750	2010

Hydropower resource of the Central Highlands belonged to the Mekong River plays an crucial important role on meeting the electricity demand of Viet Nam as well as extending the trade-off on electricity with Lao PDR. It also helps to regulate the water for the production and people domestic use. However, the construction of big volume reservoirs such as Pleikrong (1020 mil. m3), Yaly (779 mil. m3), Sesan 4 (471 mil. m3), Buon Tou sranh

(430 mil. m3) will cause significant impacts to the natural and social environment such as migration, resettlement, forestry area decrease, vegetation cover change, fisheries, land quality, hydrology regime, especially the environmental issues in the lower Sesan River basin in the Cambodian territory.

Transboundary environmental issues impacted by the upper stream water utilization are one of priorities to be taken in the Mekong cooperation framework that at present Viet Nam tries to study and develop hydraulic modeling on flow regime unto the confluence of Sª San River and Srepok River in order to assess the environmental impacts and propose their solutions on impact mitigation.

6.5 Navigation and waterways

6.5.1 Development status

Viet Nam is a country that has great potentials on waterways transportation. River and canal networks in the Northern part and Southern part cover mostly economic, political, cultural, scientific centers and population in the whole country, that creates a favorable waterway systems served for the social economic development.

Table 6.15: Main waterways of the Mekong Delta

Itinerary	Length (km)
National itinerary (300 DWT ship, 1000DWT barge)	
Ho Chi Minh – Ca Mau	356
Ho Chi Minh – Kien Luong	319
Ho Chi Minh – Plain of Reed – Long Xuyen Quadrangle	288
Mekong and Bassac itinerary for 3000-5000 DWT ship	
Mekong River from Tieu gate to VN - CPC border	227
Bassac River from Dinh An gate to VN- CPC border	228
Subsidiary lines connecting ports	
Line connecting Kien Giang – Ca mau	
Line connecting Dai Ngai - Bac lieu – Ca mau	
Line Quan lo – Phung hiep	

The waterways network in Mekong Delta is the most copious and diversified in the whole country. There are nearly 13,000Km that could be exploited for transportation (in which 5,000Km could be used for 30–50 Ton-ships). The government now manages only 2,312 km concluding Mekong River, Bac Sac River, main lines from Ho Chi Minh City to Ca Mau - Kien Luong, taking less 20% total lengths of rivers and canals in the Mekong Delta.

Waterways transportation has more strengths and comparative advantages to other models of transportation due to the following reasons:

- Popularity, huge transported capacity, decreased price, low investment and rehabilitation.

- Waterways lines connecting to big seaports where international navigation points, in the remote mountainous area where rail and road transportation are also hard, the waterways transportation is the most effective model.
- Capable of transportation for huge quantity of goods that reduces road accidents and heavy traffics, energy savings…
- Less environmental pollution
- Less cost for investment in exploitation of waterways transportation, high socialization, rather high safety, therefore low cost for waterway transportation insurance.
- For many tropical countries, inland waterways transportation is the advantageous strength for tourism service

On the other hand, while road transportation system is not developed, rail transportation system is not fully existed, the continuity of exploitation on waterways transportation and investment for transportation development has recently taken great proportion of transportation in the region (Table 6.16).

Table 6.16: Waterways transport versus total transport volume in the Mekong Delta

	1994		1995		1996		1997	
	1000 t	Mil. t-km	1000 t	Mil. t-km	1000 t	Mil. t-km	1000 t	Mil. t-km
Transported goods	11,997	1,274	13,406	1,472	14,831	1,636	16,299	1,769
Goods transported by waterways	7,433	955	8,247	1,096	9,150	1,193	10,102	1,318
Proportion (%)	62	75	62	74.4	62	73	62	75

In conformity with waterways network, ports and harbor systems are diversified, however, its technical facilities are poor. Group of ports in the Mekong and Bassac rivers in which Can Tho is the central port is the most important. A part from that, there are also some river ports such as My Thoi on the Bassac River right bank (1.2 mil. tons/year accessible for 2000 DWT ships); Vinh Thai on the Co Chien River left bank (0.3 mil. tons/year, for 1000-2000 DWT ships); My Tho port on the Mekong River left bank (0.7-1.0 mil. tons/year, for 1000-3000 DWT ships); Cao L nh port on the Mekong River left bank (0.3 mil. tons/year, 1000 DWT ships) and local ports such as Ca Mau, Dai Ngai (Soc Trang province), Nam Can port, Ong Doc port, Hon Chong port (Kien Giang province), and others.

However, water resources usage for waterways transportation is burdened with many constraints. These are:

– Although the waterways transportation is very plentiful, mostly under natural exploitation, that depends much on the waterways topology, water levels (very variable according to seasons), and silt regime …
– Main transported lines are not fully controlled and obstacles are not solved such as engulfed facilities, brige buttresses, close gates, ground cliff and damaged brake water, even riverine encroached projects (mainly houses, fish cage nets) that all hinder navigation and inland transportation as well as creating environmental polution.

- Port facilities and infrastructure are poor. Vessel capacities and speed are slowly upgraded. Investment rates are not appropriate to the potentials and its strengths (only 2% of the total investment for transportation).
- Huge untrained human resources, inland waterway transportation activators are poor river dependents whose interlectual knowleges are low that limites their legal and scientific competencies.
- Landing systems are quite available but unpromoted without united planning, its low accessible capacity, mainly rudimental loading service, therefore, its management and collaborated operation are difficult. On the other hand, its unadequate investment makes the landing systems backward with unsufficient loading facilities.
- Inland transportation facilities are at poor qualities (wooden made ones take 40-45%, mental ones are nearly 50%), low capacity engines, less safe and limited speed ones.

Inland transportation activities cause environmental pollutions in practice with the forms of dusts, scattered chemicals, oil spreads, waste gas, harbor sewage, toxic or oil releases, dredged heavy mental disorder, non-exist fisheries habitants. In recent years, environmental pollution studies, impact assessment and application on reducing polluted activities derived from waterways transportation have been paid attention by the Ministry of Transportation and the Inland Waterways Administration in Viet Nam. However, in order to solve that environmental issues for inland waterways transportation in a comprehensive manner, there should have proper policies, environmental monitoring activities with adequate assistance on required resources.

6.5.2 Development orientation

Effective investment for navigation sector requires activities directly related to the improvement for waterways, passages, riverbeds... in the project form to be invested as follows:

- Bassac River Mouth Rehabilitation Project with the aims of river clearance for 3,000 – 5,000 TDW ships accessed in Can Tho port and to Cambodia.
- Mekong Updated Survey Project with the aims at improving the transportation capacity in this waterways.
- Inland waterway Standardization Project: formulation of criteria on (waterways, fleets, harbors, transportation...) to improve the management, safety and international economic integration.
- Information System Management Project.
- GIS Development Project (GIS) on river technique management.
- Inland Waterways Environment Protection Project.
- Multi-transportation Development Project.
- Waterways Safety Control Center Project.

International cooperation and navigation development in the Mekong River basin has great potentials, especially waterways transportation between Viet Nam and Cambodia. Basing on the view on exploitation for specific transportation strength of the Mekong Delta, general sector development strategy is to develop the River transportation sector in Viet Nam at the synchronic and modern manners on waterways, ports, means of transportation and loading,

in order to meet the increasing needs on goods and passenger transportation with its higher quality, reasonable cost, quickness and safety; Strengthening its specific management capacity; Ensuring the sustainable development and international economic integration. By the year 2010, it would transport 100 mil. tons of goods that takes 67% total national volume of waterways transportation as well as 438 mil. passengers (Table 6.17).

Table 6.17: Forecast waterways transport volume in the Mekong Delta

	2005	2010	2020
Transported goods volume (mil. tons)	35	50	100
% of the whole country	64	68	67
Passengers (mil. passengers)	186	253	438

Markets for inland waterways transportation will be strengthened and extended to following categories:

- Transportation for traditional goods (coals, construction materials, stationeries, agricultural products...).
- Transit transportation in Mekong River- Bassac River to Cambodia.
- Multi-modeled transportation: transporting containers from sea-going ships to inland ports and vice versa, study on increase of transportation markets for containers (40 feet module) by inland waterways
- Transportation for international and domestic tourists by inland waterways and Tour to Phnom Penh, Xiem Riep in Cambodia.

In order to achieve those targets, intentions to waterways transportation would be:

- Upgrading two main waterways from Ho Chi Minh to Kien Luong and Ca Mau into fully complete lines (H=3m, B=21:30m for 200Cv tug-boat, 250T barge), upgrading waterways, signal systems, stations, controlling equipments...
- Complete the waterways from Ho Chi Minh to Kien Luong through the plain of reeds and Long Xuyen quadrangle at lever 3 criteria (B=20 m, H=3m 300CV tug-boat and 300T barge)
- Construction investment for completing some focal ports such as My Tho, Cao Lanh, Dong Thap, Ca Mau as the III level ports undertaking goods loading in this area. Making Plans for port systems, investment for construction of one shipbuilding in Can Tho would also be made.

6.5.3 Water demand for inland waterways transportation

On technical aspect, the minimum water depth in dry season (LAD,m) is used as the indicator of water demand planning for inland waterways transportation. The water demands for each itinerary is presented in Table 6.18.

Table 6.18: Water demand for waterways transportation in the Mekong Delta

Name	Itinerary	Distance	Size	LAD
		(km)	*(DWT)*	*(m)*
Hochiminh – Kien Luong	passing Vinh te. Ben Luc market, Vam Co Dong, Rach Gia – Ha Tien	297.8	300	3.0
Hochiminh – Kien Luong - Ba Hon	Passing Ong Lon canal , ditch Cay Kho, Rach soi, Rach Gia ditch - HaµTien – Ba hon ditch	320.8	300	3.0
HCM - Ca Mau – Nam Can	Passing Te ditch, Ong Lon ditch, Can Giuoc River, Ganh Hao River, Bay H¹p ditch, Tac ditch, Nam Can	393.3	300	3.0
Moc Hoa – Ha Tien	Up to Vm Co River , passing Cai Bac River, Hong Ngu ditch....Ha tien swamp	183.5	200	2.5
Confluence Hieu Liem - Soai Rap River	Confluence Hieu Liem - Dong Nai River – Sai Gon River – Nha Be River – Soai Rap River	144.0	300	3.0
Tan Chau – Hong ngu – Cua Tieu	Border of VN- CPC - through Tan Chau – Dong Thap ,Vinh Long , Ben Tre,Tieu gate	260.4	3,000	6.0
Rach gia – Ca Mau – Ong Doc River gate	Rach gia town – to Ca mau – Ong Doc River	182.6	1,000	4.0
Mekong River	Border of VN - CPC through the sea	260.4	5,000	7.0
Hau River	Border of VN - CPC through the sea	228.0	5,000	7.0
Ham Luong River	Confluence Tien River - Ham Luong to Ham Luong gate	86.0	1,000	4.0
Quan Lo – Phung Hiep	Confluence Phung hiep - Hau giang –Quan Lo ditch – Phung Hiep to Ca mau	104.5	300	3.0
Go Dau – Vam Co Dong River – Soai Rap gate	Ben Soi – Vam Co Dong River - Go Dau – Duc Hue – Ben Luc - Soai Rap	189.0	3,000	6.0
Moc hoa – Soai rap gate	Moc Hoa – Vam Co Tay River passing Tan An - Soai Rap gate	163.5	1,000	4.0

6.6 Tourism

6.6.1 Development status

The territories belonging to the Lower Mekong basin in Viet Nam is one of cultural cradles of Vietnamese peoples in which many historical heritages supplementary bring forwards profound tourism resources. Main tourism models in the region can be cultural, historical and eco-tourisms such as mangrove-forest ecosystem (Ca Mau), tropical and sub-tropical forest eco-systems (Central Highlands), ocean eco-system, coral eco-systems (Phu Quoc) and swamp eco-system (Mekong delta), famous landscapes as water-falls and reservoirs in the Central Highlands, cultural materialism and immaterialism (architecture, music, custom. costume...), rural tourism, mountain hamlets and villages (culture of minority peoples), vocational trade villages, museums, and traditional feasts.

Up to now, the infrastructure for provinces in the Mekong basin covers airlines to 5 airports namely Pleiku, Buonmethuot, Ca Mau, Rach Gia, Phu Quoc); road systems No 9, 12, 21, 22; maritime system with Phu Quoc sea-port, 11 river ports connecting western towns to Cambodia that all brings favorable conditions for tourism development and enrichment in the Central Highlands as well as in the Mekong Delta.

Nevertheless, tourism infrastructure especially hotels, restaurants, tourism services still remain limited. There are nearly 500 hotels with 13,750 rooms, taking 18 % of the whole country hotel capacity in 18 provinces in the lower Mekong basin; Restaurant systems newly developed in recent years are not capable of fully serving tourists at high levels. Tourism services have not been copious, their activities involved the public participation are still poor, monotonous, and not very attractive. In the meanwhile, human resources for such tourism are not trained at their specific expertise in line with the market mechanism and integration and there is no training enter on tourism in these areas.

In order to exploit the rich and diversified tourism potentials in the lower Mekong basin, the tourism sector has been carrying out many specific and integrated studies for identifying possibilities on investment for non-smoke industry in coming time. Having a look on tendencies and opportunities for tourism development, it is clear that international tourism needs are more increased. The tourism oriented to the east destination is more and more desirable and that creates more favorable international cooperation relationships. On the other hand, governments and international organizations give favor on technical and financial supports for tourism in Viet Nam, it therefore becomes a real economic sector that plays important roles on contributing to incomes and creating more employments. In recent years, numbers of road tourists have been rapidly increased, especially at the road frontier passes with Lao PDR, Cambodia and Thailand... Numbers of domestic tourists are also increased. By the extension activities to remote areas where potentials on tourism are abundantly rich, it contributes to the improvement of living standards and creating relations and enhancing intellectuals of people there.

Table 6.19: Tourist locations in the Central Highlands and the Mekong Delta

Location	Province	Location	Province
1. National Park		3. Famous Beach	
Yok Don	Dac Lac	Phu Quoc	Kien giang
Bach Ma	Hue	Hon chong- Mui nai	Kien giang
Tram Chim	Dong Thap	4.Cultural Tourism Point	
2. Natural Resource Zone		Sam Mountain	An Giang
Chu Yangsinh	Dac Lac	5.Prioritised Tourism Point	
Chu Moray	KonTum	Gold stream	Lam Dong
KonKa Kinh	Gia Lai	Lac lake	Dac Lac
Kong Cha Rang	Gia Lai	Pleicu great lake	Gia Lai
Ngäc Linh	Kon Tum	Sam Mountain Tourism Zone	An Giang
Phu Quoc	Kien Giang	Bird Preservation Zone RNM	Ca Mau
Uminh Thuong	Kien Giang	Phu Quoc Natural Resource Preservation Zone	Kien Giang
Vo Doi	Minh Hai		
Lac lake	Dac Lac		
Tam Nong	Dong Thap		

However, due to the higher and higher competition, business environment on tourism is more severe. Tourists seem to stay in shorter time and rarely return to their old visited place. Moreover, the tourism infrastructure and service qualities are still limited, therefore benefits from tourism activities in the lower Mekong basin are much lower to that in other tourism development area. Many challenges on its management, information services, and coordination between other economic sectors...therefore need urgently solving in order to ensure the long-term effectiveness of tourism business. Investment for tourism must therefore be synchronous in line with other planning for development of other economic sectors and social domains, including the constructions of cultural schemes, protected and preserved zones, environment protection. It is necessary to identify the scopes on tourism investment for these areas between the government and private sectors with its institutional framework. One of the best solutions for investment mobilization on tourism development is to promote the positive public participation in management and planning activities; giving priorities to private investment on tourism services; assisting local citizens in implementing tourism activities in the form of small and medium scale enterprises taking tourism services such as food production, restaurant business, accommodation, information and culture.

6.6.2 Development orientation

Under the lower Mekong basin framework, there are 3 investment projects for tourism developments:

- "A three country destination" with the aims at extending cross-border tourism development in the cooperation scope between the Indochina countries namely Viet Nam, Lao PDR, Cambodia. In the common basic of shared borders, tourism resources and products, mutual benefits, cooperation on tourism can be made in the more sustainable and efficient manners. The project is proposed to last to 2010 with the total budget of 500 mil. USD from 3 country contribution and international donor assistance. Project emphases on investments for tourism infrastructure, promoting advertisement for one shared destination and creating tourism products connecting these three countries as well as improving border gate open programme and human resource capacities.
- Specific Tourism Zone Investment project: located in the Middle-North part zone of Viet Nam where sub-project in Quang Tri province and Middle- South part zone of Viet Nam where sub-projects in Kien Giang, Ca Mau provinces.
- Mekong Tourism Development Project: (national budget of 12.2 mil. USD, ADB loan of 8,5 mil. USD) with the following aims:
  - Investment for rehabilitation of tourism infrastructure for An Giang and Tien Giang provinces to promote tourism in the Mekong delta which connects to Cambodia and Lao PDR in the Mekong River basin;
  - Community based tourism development;
  - Sustainable cooperation and development for the Mekong sub-region on tourism.

6.7 Domestic and industrial water supplies

6.7.1 Development status

In the Central Highlands and the Mekong Delta, there are 7 provincial cities, 15 provincial towns, 137 districts, 164 wards, 155 towns and 1,738 communes with the population of 20.85 mil. persons in 2001 of which 20% in urban areas and 80% in rural parts.

Table 6.20: Urban water supply status in the Lower Mekong basin in 1998

No	Province & town	Population	Water supply plant & its operation year	Designed & present capacity (m3/day)		Source, no of wells		Water pipe length > 100m (m)
I.	Central Highlands	455,100	5(plant)	47,000	22,000			135,880(m
1.	Kon Tum							
	Kon Tum Town	36,600	Kon Tum (1984)	3,000	1,000	Dac Bla River		9,640 (ϕ100-150)
2.	Gia Lai							
	Pleyku Town	125,000	Pleycu (1979)	20,000	12,000	Great Lake		30,000
3.	Dac Lac							
	Buonmathuot Town	280,000	Buonmathuot (1+2)1949	23,000	8,000	S. Barao		93,120
	Krongpak Town	13,500	Krong pak (1992)	1,000	1,000	-		3,120
II.	Mekong Delta	2,593,007	53 plants	241,960	196,360			468,041
1.	Long An	108,000	10 plants	18,200	13,100	canal	10 (gk)	
2.	Dong Thap	586,675	7 (plants)	14,500	7,280	canal	5 (GK)	
3.	An Giang	349,500	5 (plants)	19,900	24,000	canal		33,330 (ϕ100-400)
4.	Tien Giang	189,933	9 (plants)	51,500	45,600	canal	14	40,800 (ϕ100-500)
5.	Ben Tre							
	Ben Tre Town	110,000	Son Dong	7,200	3,000	canal		27,000
6.	Vinh Long	148,500	3 (plants)	16,100	4,950	canal		36,620
	Vinh Long Town	137,000						
	Tra On Town	11,500						
7.	Tra Vinh	163,400	3 (plants)	8,560	4,550		6	33,118
8.	Can Tho	392,000	6 (plants)	54,400	48,480	canal	4	195,813
9.	Soc Trang	126,932	4 (plants)	12,200	10,600		8	37,300
10.	Kien Giang	161,000	3 (plants)	19,000	16,500	canal	4	33,060
11.	Minh Hai	257,067	2 (plants)	20,400	12,300		20	31,000

In recent years, the State has prioritized the development investment for urban water supply systems by its national budget, capital from international financial organizations. However, due to the characteristics of water supply and its loss, phenomenon on lack of water in the urban areas in the dry season (Central Highlands) is still remained. In all cities and provincial towns, there are water supply systems served by 5 water supply plants in Central Highlands and 53 water supply plants in the Delta with the respective capacities of 47,000 m3/day and 242,000 m3/day. On the average in both these areas, water supply amount is accumulated up to 70 liters /person/day at 15% rate.

The water drainage and environmental hygienic issues in towns of Mekong Delta have been significantly solved. However, inundation and environmental pollution caused by unprocessed sewage water release is widely spread. Especially, there are nearly 40% of provincial cities where septic tanks, a tow compartment latrines, public toilets, unprocessed water release are still used and occurred.

People living in the rural areas belonged to Mekong Delta take surface water from canals for their domestic usage; In the Central Highlands, surface water and ground water from wells are mainly domestic uses that takes from some areas where its hygienic standards are not appropriate.

6.7.2 Development orientation

With the aims at continuously improving the living standards, filling the gaps on social economic development in the region, the government pays much attention to the water supply and hygiene, especially in the rural and poor area. This is also one of prioritized domains in the strategy for sustainable growth and poverty alleviation in which solutions for clean water supply and hygiene issues imply the contribution for poverty alleviation, disease prevention, labor force increase, creating more opportunities on re-production of social labor forces such as recreation, tourism.

For the Mekong Basin parts of Viet Nam, water supply criteria by the year 2010 would be 120-150 liter/person/day for all 100% urban population and 60 litre/person/day for 85% rural population. For water drainage, a part from the target of water inundated drainage, by the year 2020, urban cities must have appropriate sewage water processing structures, and in the rural areas, all 100% households have hygienic latrines.

In the past, if the water demands for industries in the Mekong Basin parts of Viet Nam are rather low in comparison to that for agricultural production, and now in the tendency for economic development derived from industrialization, water supply for industrial sectors hinders burden difficulties to water managers. Up to now, in the Central Highlands, there are nearly 14 thousand industrial bases, the most noticeable ones are hydropower industry, agro-product processing, forestry, engineering industry, construction material and small scale and unconcentrated mine exploitation industry. In the Mekong Delta, industrial structure is more plentiful in which some key industries have been formed such as agricultural and marine product processing, food grains and foodstuffs (rice husking, suger production, marine processing...), textile, chemistry, construction materials (cement). In the Mekong Delta, there are especially 84 thousand industrial production bases, established 6 industrial zones with the size of 650 thousand ha located in Can Tho, Long An, Tien Giang, Vinh Long, Dong Thap provinces where high water demands and water related environmental issues need to be considered in the coming years.

At the moment, water supply and drainage in the urban areas are depending on the existing water supply and drain systems for local citizens that causes pressure on water supply infrastructure systems. Low effective collaboration on both local infrastructure and water

management between various sectors is the main reason that affects to the low effectiveness of the water supply and drainage management, difficult control, monitoring and solution. In addition, lack of water domestic usage and unprocessed water drainage often occur. However, in comparison to other water demands, hygienic and adequate water supply for local citizens must be first prioritized in all kinds of water demands. In the difficult cases on water resources, there should be careful considerations on the allocation for agriculture, fisheries, industry purposes at the minimal manner.

Water resources, both ground water and surface water, are limited, meanwhile water demands are increased. Effectiveness in water usages is therefore much paid attention. The water supply activities must be close managed in the lowest manner of water loss, especially urban water supply systems, sewage water should be accounted in cities and water fee will be also estimated gradually.

6.7.2 Water demands for domestic and industrial usages

Basing on the forecasts on population increase and water supplied norms, the water demands for domestic usage are 1,162 mil. m3 of water in 2010 and 1,890 mil. m3 of water in 2020 (Table 6.21).

Table 6.21: Forecast domestic water demand for the Lower Mekong Basin

Area	2000	2010	2020
Central Highlands			
Domestic water use	96 Mm3	175 Mm3	325 Mm3
Mekong Delta			
Domestic water use	496 Mm3	987 Mm3	1,565 Mm3

By the year 2010, the industrial growth rate in the Central Highlands will be continuously at about 11-12 % focusing on development of hydropower, mine exploitation, agri-forestry processing industry.

In the Mekong Delta, hydropower plants namely Omon I and Omon II (600MW), gas turbine mix electric plant (720 MW) will be constructed in the connection of gas-electric complex industrial zone (800 thousand tons /year) in Ca Mau, Kien Giang cement plant (3.05 mil. tons/year); 2 complex on textile- sewing- dueing in Can Tho and Long An; small and medium scale fisheries processing centers located in Ca Mau, Soc Trang, Can Tho, Tra Vinh (over 250 thousand ton/year). A part from that, development proposals include more 6 industrial zones.

There will be some small and medium industrial zones (30-40ha) in Can Tho, Bac Lieu, An Giang, Ben Tre provinces, extending industrial complex in towns in which processing industries and preliminary treatment for post harvested agri- products, assistance for trade villages...

Table 6.22: Planning for development of industrial zones in Central Highlands and its water demand for industries (1000 m3/day)

Province	Industrial zone	Main industry	Water demand (m3/day)
KonTum	Hoa Binh; §ac To; Ngoc Hoi	Agri-forest processing, civil material, textile, shoe, chemistry, mechanical	70,000
Gia Lai	Tra §a, ChuPak, An Khe vµ Aynpa	Agri-forest processing (food, vegetable oil, fruit) domestic goods, mechanical, civil material	170,000
Dac Lac	Tam Thang, Gia Nghia, Buon Ho Eaknong	Agri-forest processing, civil material, mechanical, fertilizer, consummated goods, foder	100,000
Others	Small industrial units	Processing industries, domestic goods production, TAGS, textile, wooden production...	250,000

According to the preliminary calculation on water demands for industrial purposes in the Mekong Delta to the year 2010 and 2020 are respectively about 700 mil. m3 and 1,350 mil. m3.

6.8 Flood management ín the Mekong Delta

6.8.1 Development status

8 out of 11 provinces in the Mekong Delta are affected by Mekong riverine floods. Water flow regimes in the flooded areas are significantly impacted by Mekong water flow, tides in the East Sea, West Sea and inland water regimes. The flooding season is nearly coincided with the raining season (from July to December). Floods in the Mekong delta flowed by two directions derived from inundated areas in the Cambodian territories (10- 15%) and from Bassac River and Mekong River (85 - 90%). The main flood drainage releases to East Sea, its partial flow to West Sea and Vam Co River.

Floods in the Plain of Reeds are mainly flowed by surplus water from Cambodia (88%), and from Mekong River through Hong Ngu, Muong Lon and An Binh canals (12%) with the biggest volume in 1996 at 32 - 33 bil. cubic meters.

Floods in Long Xuyen quadrangle are mainly derived from Mekong River floods gone through inundated areas in Cambodia and from the Bassac River along Rach Gia - Ha Tien canals. Total flooding volume into Long Xuyen quadrangle in the 1996 flood is 4,430 m3/s in which its discharge through borders takes 56%.

Flood trends from Cambodia to Long Xuyen quadrangle and the Plain of Reeds are huger and huger in volume, however, its characteristics are small scales in mainstreams and big scales in inland areas. Especially due to flows from Cambodia that dominate fertile flows in Mekong River and Bassac River, it restrains the fertile rate in these areas.

Floods in the Mekong delta bring various benefits such as alluvia deposit and sea extended land area, increased fertility, creating fisheries resources, environmental improvement, enrich fields, aquaculture development. On the other hand, floods cause obstacles on land potential exploitation and rural urbanization towards modern civilization. Therefore, the master flood planning for the Mekong delta is closely interlinked to the strategy for exploitation of Mekong water resources and its delta. Planning for the water resource utilization and

protection is therefore developed in close combination of the planning for sector developments on transportation, construction, fisheries and agriculture for the sake of modern rural civilization development. The core point in the planning is to identify the proper solutions on transferring upper Mekong River floods into the Mekong delta and to the sea in an appropriate manner; minimizing negative impacts on its production, livelihoods and ecological environment.

Taking over the results in studies carried out by the Southern Sub-Institute of Water Resources Planning, the whole year time flood control project for all cities, public communities and infrastructures is formulated in order to deal with timely flood controls on agricultural production, deep inundated areas and whole year flood controls in narrow inundated areas.

Planning for flood inundated areas is divided into 3 areas with various levels of flood controls:

- Non-controlled flood areas located in the north of N1 National High Way with the area of 117.7 thousand ha, the solution is to stand apart from floods with dyke systems to protect winter-spring rice crops and summer – autumn rice crops.
- Flood control areas in certain time bound by the southern part prevented from the floods and the northern part of Nguyen Van Tiep, Cai San canals and the eastern part of Bo Bo – Rach Tram – My Binh canals with total 859 thousand ha; these areas are for two time rice crops and decrease of 20 - 40 cm water depth in Long Xuyen quadrangle and 10 - 40 cm water depth in the Plain of Reeds.
- Flood control areas in whole year time is the remain location in the flooded area (938,490 ha) that serves for its rural infrastructure planning and development, modern agriculture production.

6.8.3 Development orientation

Long Xuyen quadrangle: Combine structural measures for flood control coming from borders into Long Xuyen Quadrangle and drainage to the West Sea, construct salinity prevented schemes, fresh water preserve from West Sea, control floods from Bassac River to the Long Xuyen Quadrangle. The project comprises 4 structural complexes:

- West coastal system: dredging and digging 20 newly canals for flood release from Rach Gia – Ha Tien canals towards the West Sea; construction of West Sea coastal dyke system; 20 sluices for salinity intrusion prevention and widening bridges in the street No 80.
- Border overflowed flood control by construction of dyke system for overflowed flood prevention on the Vinh Te canal at its south bank, dredging and widening the Vinh Te canal for flood release at 1961 flood rate.
- Inland flood drainage canal system towards the West Sea composes of 18 network canals and level I canals (721km).
- Flood control system from Bassac River to Long Xuyen Quadrangle composes of 8 head gates of its ditches.

Western Bassac River Area (Can Tho – Kien Giang) proactively control floods in whole year time in order to enrich the Bassac River siltation into inland areas, water environment improvement by preventing floods from Long Xuyen Quadrangle, drainage into C¸i Lín

River. Flood control schemes are constructed along the street No 80 and area bound on two sides of street No 91 at appropriate scales.

The Plain of Reeds: inundated by overflowed floods from Cambodia through the borders at the rate of 8400 m3/s, total flood volume from 27-28 bil. m3 and from the Mekong River along 3 canals namely Hong Ngu, Dong Tien and An Binh with its maximum rate of 1.100 m3/s and its volume of 4,2 bil. m3, its drainage to Mekong River through entrances along the street No 30, No 1 and rivers of Vam Co Tay, Vam Co Dong. The objective of flood control in the Plain of Reeds is to ensure one summer-autumn crop and Winter-Spring crop production in timely manner by 5 scheme complex as gates along the Mekong River whose operation could reduce flooding rate in August with decreased depth of 0.2-1.0 m in the Hong Ngu canal, in Nguyen Van Tiep canal with its decreased depth of 0.2-0.25 m that assures for water drainage and inland salinity intrusion prevention.

Area between Mekong River and Bassac River: whole year time flood control for areas limited by the southern part of Vinh An canal, the northern part of Vinh An canal, taking measures for people community preventions in unflooded areas as well as flood monitoring and avoiding by two time stable crop arrangement.

Long time deep inundated areas along Vinh An canal is controlled by embankments of level II canal system that creates closed cells that control the early seasonal floods and it establishes resettlements along main roads, house –proofing over the 1961 flood rate.

For inundated areas in southern part of Vinh An canal, dyke head gates at various scales are used in order to minimize floods and inland water drainage, toxic clearance, enrich siltation and fisheries into fields.

There would be managing flood controls to increase agricultural production, land potential exploitation especially fallow areas, crop diversification, hydrology regime improvement, minimizing negative impacts caused by floods. Although the flood control reduces partially natural fish capture productivity, it facilitates favor conditions for aquatic development.

Environment impacts of flood control measures

Due to the whole year time flood control for large areas up to 910,000 ha in which agricultural land is 693,000 ha, that creates favorable conditions for agriculture and fisheries development, living standard improvement and people livelihoods, infrastructure development, civilized rural development, minimizing flooded time and its severeness, ensuring complete summer-autumn harvests.

Construction of scheme systems that protect citizens, life-lines for transportation and minimizing damages caused by floods.

Reducing less silt flooding flow from borders into the Plain of Reeds and eastern part of Long Xuyen Quadrangle, transferring floods with more siltation from Mekong and Bassac rivers into inland areas, making use of flooding flow to push acid away and have fields cleaned.

Owing to the floods into delta that increases siltation and acid clean out, alum clearance, reclamation on land and this regional water environment.

Making use of west coastal salinity protection system, water fresh is done in coastal areas in Rach Gia – Ha Tien, that creates crop time increase and supply water for domestic usage in this area.

Level I canal systems are supplemented that creates more inland waterways transportation lines, making use of digging land and canal dredging to develop road systems and house proofing.

However, construction of flood control schemes would generate significant impacts to water regime in the Mekong Delta and other production activities and livelihoods as follows:

- Decrease urban water circulation to the outside, increasing demands for urban sewage and domestic water processing.
- Reduce water flows in sea river mouth gates, siltation increase.
- Limit the exploitation capacity of natural fisheries resources due to the interruption of their immigration, habitants, breeding and lively environment limitation.
- Increase monitoring demands on siltation, alum, soil erosion, sour water transmission.
- Loss on construction site areas, compensation for resettlement, housing and crops.

6.9 Forest management

6.9.1 Development status

Forests in Central Highlands has crucially significant importance to the Central Highlands due to its values on forestry resources, economic development, security-defend stability and ecological protection. The forestry land area is over 2.99 mil. ha, the forest cover rate in the Central Highlands (53.2%) is much higher than the national targeted rate (43%, in year 2000). Contracted forestry area is 1.547 mil. ha, reforestation of 26,300 ha and newly planted area of 10,000 ha. The transferring purpose of partial forestry area into long term industrial crops and freely immigrants exploited new land areas that decrease annually on average of 10,000 ha of natural forest. Annual timber productivity is 380 thousand m3. Although the big timber volume is exploited, it is not processed with the forestry principles that makes forestry quality deteriorated, high economic value and rich forest is very low. Timber utilities rate is low (2 - 2.5 m3 original wood on m3 product).

The Mekong Delta is the granary of Viet Nam, it is frequently affected by floods and salinity intrusion. In this area, the forestry is a very small scale sector in comparison to other economic sectors and its density is more and more decreased. The forest area land is more narrow, its decrease from 348,700 ha in 1990 to 273 thousand ha in 1998 with the forestry cover rate at 6.8%. Due to forestry fire in early 2002, natural resource of forest is only 81,500 ha. Asynchronous development policies such as reclamation policy, food tree extension promotion, aquaculture cultivation...are the main reasons of forestry deterioration on land.

Main challenges to the forestry sector development :

- The national land use planning is not stable due to the increasing development demand and land extension used for other economic purposes, therefore developing, protecting and land enriching activities are hindered with many difficulties.
- The procedure of contracted assignment on forest land that the land is run by its owners has been applied into large scales, however, there is no policy on promoting the forest contracted owners in development investment and forestry production in order to assure the sustain abilities on ecology.

- There is lack of a master plan on material zones related to processing industry and forestry markets in both national and international, therefore, its productivity is low, the forestry product exploitation is still prodigal with high cost, low capacities on competitive quality towards foreign products.
- Forestry science develops slowly in comparison of new production methods and increased competitive capacity of its products, insufficient competent scientists, inadequate state management, especially overlapping management functions between production and its business, development and protection, agricultural and forestry sectors.

6.9.2 Development orientation

Strategy on forest protection and development has been identified to 3 main categories of forests: protective forests, specialized forests and productive forests as following:

- Due to the special significance of the protective forests in land erosion prevention, water flow and climate harmonization… for the protective forests the important protection and crucially important protection, they are not only protected and remained in areas, but also should be more developed in the Se San and Srepok River basins, the coastal protective forests and mangro forest ecosystem in the Mekong Delta is also specially prioritized for regeneration and reforestation with the agri-forest combined modes.
- Fully complete specialized forests in Central Highlands and pay adequate attention to the wetland belonged to the Mekong Delta, where there are unique ornamental living creatures, remaining the protected sites with indigenous plants in certain zones, improving the management activities, prohibiting all forest harmful intervention.
- For the productive forests: more investments on developing new forests exploited for paper materials, artificial plank materials, exported carpenter products, industrial woods, woods for mines, specialties such as resin pine, cinnamon, anise ...

With the overall targets, orientation for forestry development is as follows :

Central Highlands

- Forest protection and development in close connection to the stable political and national security remain, social economic development of the whole southern part of Viet Nam, striving for forest cover rate in 2010 at 61.4%.
- Delineate and take care of watershed protective forests in order to protect fertile lands and water resource harmonization, including ground water, for rivers, hydropower plants, reducing droughts and floods to the lower parts.
- Develop and protect national park Yokdon, further planning and protecting natural preserved zones in order to keep scarce genes of indigenous plants and animals and eco-tourism development, preserving rare animals such as elephants, grey bulls, gayals, peacock.
- Regulate natural forests and invest more on intensified forests for paper materials, artificial planks, preserving precious trees: barian kingwood, Cam Lien, santal perfumed tree, rosewood and other oil trees… providing materials for traditional trade villages on handicraft and advanced carpenter products, and non-timber

products such as turpentine, Chai côc, Ngoc Linh ginseng, Boi Loi, bamboo sprout, honey bees, etc.

- Develop forestry product processing zone with modern equipment and high technique operating systems for each kind of products at two preliminary and fine levels located in Buonmathuot and Kon Tum areas, constructing the material provided zones for artificial plank plants (MDF), paper factories in Gia Lai, Kon Tum and Dac Lac provinces.

Mekong Delta

- Implementing the integrated business operation for forestry and fisheries sectors in appropriate modes for the sake of environmental protection and people living standards improvement, promoting the cultivation and development of high value exported reptiles.
- Tense to rehabilitate the ecosystems of the mangrove protective forests along the coastal lines, rehabilitate ecosystems of cajuput forest located in sulphate soils in order to stabilize and maintain the sustainability of the coastal wetland ecosystem, strengthening the guard of National wetland park Tram Chim (Dong Thap province), natural resources preserved zones, bird grounds, historical relics, environmental landscape, etc.
- Forestation to provide basic construction materials (Cajuput tree) and continuous plantation in dispersed plants near canals and street lanes.

Transboundary issues in the Mekong Region

- Forest fire problems and its demands on monitoring and observation.
- Protection of the bio-diversity for 3 border areas of the Indochina (focuses on natural preserved zones) and for the whole of lower Mekong basin.
- Development of public forest network in order to archive the target on poverty alleviation and sustainable development.
- Development of sustainable integrated cultivation modes in the Mekong delta.
- Develop modes on watershed integrated management for all countries in the Mekong region for the sake of sustainable development.

Solutions to archive the targets on forest protection and development

- Strengthen the state management competence, administration innovation and its institutional pattern in forestry sector, change the forest control into forest police for monitoring the implementation of Forest Protection Ordinance.
- Consolidate and reorganize state forestry enterprises to manage, protect and exploit the forests in an integrated manner; paying more attention to the development of processing industries and service industries; implementing the privatization of forestry enterprises and having open cooperation, international investment, establishing some corporations that could manage and harmonize the forest development processes and its production.

- Synchronous planning for focused material providing zones closed to industrial zones, forestry product processing plants, identifying the scale of processing bases in line with capacities on providing materials for each sector, each goods items... in order to bring into play advantages of each economic zones.
- Policies for forestry investment:
  - Increase the government budget, credit capital for the protection and development of the protective forests and specialized forests, investment for infrastructure and human resource development.
  - Having proper policies and its mechanism to attract donor assistance and international funds and other governments (ODA, FDI capital) in order to enhance the development of protective and specialized forests including rural buffer zones and carrying out afforest ration projects at small household scales, having joint venture in forest product processing on the basic of strictly followed the Law on Investment of Viet Nam
- Giving priorities on planning and developing national forestry zones, materials provided areas; gradually allot forestry lands to local people and forestry communed development. In the forestry allotation, there should have cultivated lands for agri-forest production in order to contribute to the forest benefits and poverty alleviation, especially the remote mountainous areas.
- More concentrated implementation of the programmes for newly forestry sapling systems, improving the foreign modern technology import, especially seeds, machines, equipment and modern processing technologies; tax-reducing and exemption for productive bases where new equipment and technique is applied.
- Promptly formulate policies and market strategies for forestry products; giving favorable conditions for forestry products' circulation in order to promote all economic components to participate in markets, creating sound competitiveness and guarantee the benefits of producers and consumers.
- The Government adequately invest more on government staffs who are assigned to deal with forestry issues, assisting the implementation of programmes related to the forestry environment and its local citizens. This should be frequently carried out, mainly in short-term training courses, on-job training, do by learning.
- Promote other economic partners to participate in protecting and doing business on forests, facilitating local people to approach and apply the modern agri-forest methods which are for forestry goods development and food security, income increases and stable lives.
- Identify concretely and clearly sites for material provided areas so all partners participate in productions of forestry goods in longer times, flexibly putting into practice of promoted methods such as decreased interest rate on afforest ration for materials; tax-exemption in two first periods to forests for materials; forestation insurance, inherit appropriate percentage from annual forestry living organism growth, seed provision...

7 Issues and priorities

Between them, the national sector overviews have identified a number of development issues and priorities that are shared by two, three, or all four member countries. Some examples are listed below.

New efficiency criteria

The present development towards lower trade barriers, as promoted by bodies such as ASEAN, AFTA and WTO, will provide new opportunities as well as new challenges.

In relation to water-related development in general, and water utilization in particular, an important challenge is the need of high efficiencies within the production systems. *'Business as usual'* is no option in this connection. The water efficiency (produced output per m3 of water) must be competitive by international standards, as well as the economic efficiency of water utilization (the value generated per m3 of water).

Apart from appropriate, integrated water resources management, this may in many cases require optimization of traditional technology, or gradual introduction of new technology, with due attention paid to unexpected side effects.

The long-term economic transition will inevitably, in the course of time, reduce the significance of primary production systems in favour of agro-industries and various services, including tourism. Therefore it is important to pay due attention to irreversible impacts of development efforts with a shorter time horizon. Examples of issues with a longer time horizon are groundwater preservation, wetland habitat preservation, and biodiversity preservation.

Balance between sectors and between stakeholder interests

The prospect for successful implementation of policies and development schemes are supported when the balance is observed between different stakeholders competing for water (or land or other finite resources). The interests can represent upstream/downstream uses, short-term/long-term value generated, urban/rural priorities, and a variety of in-stream and off-stream water uses.

Sometimes, economic development may seem inconsistent with an aim of environmental preservation, but often, a closer examination can reveal synergies that can support both aims.

Win-win solutions are not always available, but when they exist, they provide a clearly attractive course of action as compared with significant trade-offs where one goal is pursued at the cost of other, incompatible goals. Successful integrated development policies and schemes from within the Lower Mekong Basin can set an important example for similar applications elsewhere.

Among the sectors considered in the present report, there is some competition for the water, but there are also many synergies.

Poverty alleviation and rural livelihoods

Most sector development initiatives are in some way related to poverty alleviation. Direct and short-term effects are in particular found within irrigated agriculture, fisheries, and tourism. Apart from poverty alleviation as such, expansion and consolidation of rural livelihoods serve important social and economic purposes in their own right.

Related development efforts have a lot to do with water resources management, providing access to water, as well as protection against droughts and floods, but important synergies exist with parallel development of new technology (and extension services), development of transport infrastructure and financial infrastructure, access to fairly open markets, and supportive management of land tenure. This is a clear example where integrated management has a value that exceeds the sum of otherwise prudent sector-wise management.

Public participation

It has been said[1] that *'integration and public participation are the keys to real IWRM. Without them, it is not IWRM'.*

Today, there is a clear tendency towards direct public participation in the decision-making process, as well as in the daily water management. Water user groups exist in all four MRC member countries, and stakeholder involvement in various decisions is gradually being introduced in some of the member countries, but is still a new modality, in need of consolidation, including generation of some sound traditions as a supplement to the formalities.

It is expected that public participation will be facilitated by the river basin committees / river basin organizations that are planned or being established in many places within the Lower Mekong Basin. Also, the ongoing decentralization/deconcentration efforts will assist in the involvement of the general public in decisions that affect their welfare and livelihoods.

Land use planning and conflict resolution

A variety of issues exist in connection with the interfaces between water resources management and land use management, as well as within related conflict resolution.

This will also improve the prospects for sustainable forestry, which is a somewhat overlooked development option with a particularly strong potential for generation of revenue as well as livelihoods.

Also, appropriate land management and clear land tenure rights can support the national economic development by making it possible for land owners to take loans (a somewhat controversial measure in the short term, but attractive in the long term), and as a basis for land taxation.

In some places, community-based land use management has been successfully introduced, with a particular ability of conflict prevention and conflict resolution.

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[1] by Prof. A. Apichart (Oct 2004): *Network of Asian River Basin Organizations (NARBO) - working to make IWRM a reality.* ADB's Water Champions website, http://www.adb.org/

8 Solutions

No solutions are offered in the present document.

Recommendations on appropriate responses to the various sector issues and priorities will be addressed by the *'Strategic Directions for IWRM in the Lower Mekong Basin'* (in preparation, mid 2005).

Recommendations on viable development initiatives are compiled in parallel in connection with stages 4 and 5 of the BDP planning process.

9 Findings and recommendations/ lessons learnt

An economic structural transition is in progress within the Lower Mekong Basin, in the direction of reducing the significance of agriculture, the traditional main livelihood, in terms of GDP contribution and in terms of employment. This transition is most visible in Thailand and Viet Nam. In all four MRC member countries, however, agriculture represents a higher share of occupation than of GDP contribution. In the short term, industries (including agro-processing industries) are important engines of growth, while in the long term, it is possible that the service sector (notably including tourism and recreation) represents a strong potential in all four member countries. Paddy cultivation should remain an important livelihood, but the national economic development should not make itself dependent on it.

The upcoming opportunities represented by lowered trade barriers are from case to case subject to some competitive advantage, which in turn requires high efficiencies within the production systems.

In consequence, there is a continued need for technological development within all water-dependent production systems, based on scientific research, in an international dialogue, and disseminated by regional or national bridging institutions and local extension services. In this connection, due to geographical and institutional similarities, there is a clear scope for regional collaboration.

In parallel, there is a need of increased investment, public as well as private, and foreign as well as domestic, as appropriate from case to case.

Income and living standards in the Lower Mekong Basin are lower than in the parts of Thailand and Viet Nam that are outside of the Basin. A scope remains for accelerated economic development.

10 Relevance

10.1 Relevance for NMCs and/or line agencies

The NMCs and the national line agencies have a general interest in knowledge-sharing with their sister organizations in the region. As one example, the development and the significance of the tourism & recreation sector in Lao PDR can serve as inspiration for other countries, and the same is the case for the achievements within agricultural diversification and agro-industrial development in Thailand and Viet Nam. Without copying, the basis for policy-making and strategy formulation becomes broader and better with inspiration and lessons learned within the region.

A compilation of discrete information about national sector development issues and policies can contribute to a gradual harmonization and convergence at the national level, as well as the regional level for which the work is intended.

Ideas emerging from the national level will be carried forward into the BDP process wherever appropriate. Ideas that do not fit into the scope of the BDP will not be discarded, however, but will be directed towards existing local, provincial or national planning channels. Thus, the involvement of national planning institutions or agencies has been important from the earliest stages to allow this filtering to progressively take place and to ensure general conformity with the national planning procedures in the riparian countries.

10.2 Relevance for MRCS and/or BDP Phase 2

The BDP will coordinate with, and add value to the national and sub-basin or provincial planning processes, with smooth interfaces and without any intended inconsistencies. It focuses on aspects with trans-boundary or basin-wide implications, and on developments where a multi-country approach has clear advantages.

BDP aims to provide a process for identification and promotion of ideas and plans from the context of national plans, and then in a regional context, to determine their significance to identify areas where joint initiatives could provide a regional benefit. By reviewing the national plans and policies, common and trans-boundary issues can be identified and regional strategies and initiatives formulated. Hence the importance of the present document and its underlying working papers.

10.3 Recommendations

The national sector reviews should be maintained and updated with new information at suitable intervals, for example every 5 years.

In this connection, the reviews could be further coordinated between the countries, aiming at an improved consistency (subject to availability of data and information).

The work could be coordinated and synchronized with the continued state-of-the-basin reporting by MRC.

11 Concluding general outlook

The national sector overviews were prepared after the closely related national sector overviews and in parallel with the BDP sub-area studies. The produced information has been applied in connection with various subsequent activities (scenario analysis and strategy formulation), and the sector overviews have been re-visited during preparation of the BDP Planning Atlas.

During BDP Phase 2, the sector overviews should be carried up to date, in a more condensed form, as introduced in the BDP Planning Atlas, and possibly in connection with preparation of a new State of the Basin report.

The work should be carried out by the NMCs and the involved line agencies that have the particular expertise within each sector.

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