

Sub-area Study and Analysis 5T Sub-area



**BDP UNIT
THAI NATIONAL MEKONG COMMITTEE
DEPARTMENT OF WATER RESOURCES
MINISTRY OF NATURAL RESOURCES
AND ENVIRONMENT**

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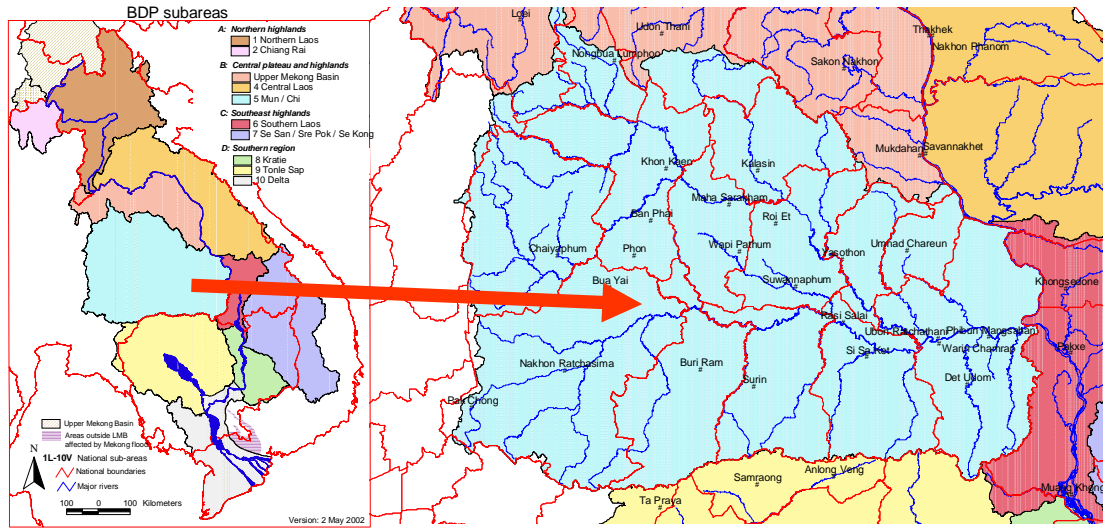
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Acronyms and abbreviations

BDP	-	Basin Development Plan
DWR	-	Department of Water Resources
EGAT	-	Electricity Generating Authority of Thailand
FYP	-	Five Years Plan
GPP	-	Gross Provincial Product
GMS	-	Greater Mekong Sub-region
kv	-	Kilovolt
kW	-	Kilowatt
kWh	-	Kilowatt-hour
MCM	-	Million Cubic Metre
MRC	-	Mekong River Commission
MSL	-	Mean Sea Level
MW	-	Megawatt
PWA	-	Provincial Waterworks Authority
RBC	-	River Basin Sub-committee
RBO	-	River Basin Organization
RWO	-	Regional Waterworks Office
RID	-	Royal Irrigation Department
SA	-	Sub-area
SAWG	-	Sub-area Working Group
TNMC	-	Thai National Mekong Committee
WHO	-	World Health Organization

Map of sub-area 5T



Executive summary

1. SA-5T in Thailand's part is divided into 2 main river basins, namely, Chi and Mun river basins, covering a total area of 119,177 km². They are under the jurisdiction of 15 provinces. High ridges form the western boundary of the area, i.e. Phetchabun range with elevation of 1,400 m MSL. Phu Phan range forms the northeastern boundary with elevation of about 600 m MSL. On the south are Banthat and Dong Rak mountain ranges with elevation of 300-1,350 m MSL. The central part of the SA is a low ridge, dipping southwards to Mun River. The area near the confluence of Mun and Chi rivers is low-lying land.
2. The Ninth National Economic and Social Development Plan stipulates that an efficient use of water resources is supported to ensure sustainable and equitable benefits.

The present government's policies delivered to the National Assembly on 26 February 2001 have embraced natural resources and environment issues as follows:

- To manage the environment, natural resources and biodiversity in an integrated manner;
- To promote and encourage participation;
- To support the notion of taking social costs into consideration;
- To promote technological research and development with a view to increasing Thailand's capacity to manage, conserve and restore the environment;
- To set national environmental standards;
- To set standards for controlling the importation of chemical, toxic and hazardous substances.

Thailand has adopted a new concept of regional administration - a bureaucratic system that can efficiently respond to the Government's strategic management. For effective management, provinces have to be grouped together. Provincial water resources management plans will be in line with these strategies. SA-5T is classified as the Upper and Lower Northeast groups of provinces and strategies are presented as follows:

Group 1: Khon Kaen, Maha Sarakham and Roi Et, with one main strategy “Improving Trade, Investment and Service Capabilities”;

Group 2: Nakhon Ratchasima, Chaiyaphum, Buri Ram, and Surin with five strategies;

1st strategy: Evolution of the export-oriented production of organic agricultural products (Jasmine Rice) to support the Kitchen of the World policy;

2nd strategy: Agro-processing development in support of the Kitchen of the World policy;

3rd strategy: Silk and textile product development in support of Fashion City policy;

4th strategy: Development of automobile industry to support the Detroit of Asia policy;

5th strategy: Development of tourism industry to support the government's tourism policy.

Group 3: Ubon Ratchathani, Si Sa Ket, Yasothon, and Amnat Charoen.

1st strategy: Restructuring and building production partnership with neighbouring countries;

2nd strategy: Building partnership in tourism and service sector with neighbouring countries.

3. The climate in SA-5T¹ is divided into 2 river basins, namely, Chi and Mun, because this SA covers a very large area. The collected data were divided based on the boundaries of river basins in Thailand. Average annual rainfalls in SA-5T vary from 800 to 2,500 mm. About 89% of the yearly rainfalls occur in the wet season (May-October). The mean annual runoff totals 30,744.3 million cu.m. Average runoff during the wet season (May-October) is 26,966.9 million cu.m. (87.71% of the mean annual runoff). During the dry season (November-April), mean runoff is 3,777.4 million cu.m. (12.29% of the mean annual runoff).
4. Population was divided into urban and suburban areas. Data were collected from those of Department of Provincial Administration 2001, population by province during 1994-2001, and administrative areas at province, district, and tambon levels of Department of Provincial Administration. The total population on 2001 is 16,377,000 persons and forecast on 2021 is 18,584,000 persons. In the SA-5T and the Northeast, Khon Kaen has the highest per capita income/year, i.e. 40,582 baht/person/year, while the Nongbua Lamphu province is ranked the lowest, i.e. 16,832 baht/person/year. The difference between the maximum and minimum average income per capita/year is 2.4 times.
5. The results from cross cutting issues are presented by sectors as follows:
 - *Watershed Management:* Forest cover in SA-5T is, at present, relatively very small compared to the total area, i.e. 12%. This has severely affected the retardation of rainwater, thus causing frequent floods, especially on the low-lying lands near the confluence of Chi and Mun rivers. Another impact is the increasing demand for agricultural land and construction of accommodations for ecotourism, thus leading to encroachment on and decrease of the already-diminishing conservation areas.
 - *Irrigated Agriculture:* Agriculture is the main occupation of more than 70% of the population in the sub-area. Impacts of this sector come from the high ratio of water utilization for agriculture and the incremental water requirement in the dry season, thus resulting in water shortage. Furthermore, an anticipated growing number of people in the industrial areas will also push up the water requirement. It is, therefore, vital to improve the efficiency in water use for agriculture and formulate a water use plan.

¹ Master Plan Study for Integrated Water Resources Development and Management and Irrigation Improvement for the 9th Plan, 25 Basins Study Report (Chi River Basin, Mun River Basin), April 2003

- *Water supply for domestic and industrial consumption:* The growing water requirement for consumption in the next 20 years, an increase of 14% of the current demand (2001), and the double of water need for industrial use. A likely approach is to manage the existing water resources to the maximum potential. Efficiency in water utilization should be enhanced for every activity within the basin.
- *Hydropower:* Power demand in SA-5T will be on the increase as industrial development. Construction of a hydropower plant, which is a clean energy source, is highly unlikely because of the impacts on the people on a wide range. One possibility is to improve the efficiency of the existing power plants and extend the grid system from other parts of the country. Additionally, dialogues on power purchase should be held with neighbouring countries.
- *Flood Management:* For the maximum benefit of SA, flood management has to be related to watershed management through a continual increase in forest cover and reservoir operation. A study should be conducted on the feasibility of drainage areas and water diversion route that has little adverse impact in combination with a water use management plan for dry and wet seasons to prevent wastage.
- *Fisheries:* Nowadays, local fishing still provides sufficient protein source of food for the inhabitants. Hydropower sector helps raise fish catches because reservoirs can be sources for local fishing while affecting the natural migration of fish at the same time. Agriculture is another sector that can contribute to the fisheries. Farmers can use the same land for farming and fish culture. In this regard, organic agriculture should be practiced to avoid accumulation of chemical residues.
- *Navigation:* This sector is relatively less relevant to SA-5T compared to other sectors because long-distance water transport no longer exists in this SA. Dredging of water courses is mainly done for drainage purpose, not for navigation.
- *Tourism:* The national tourism statistics show that the ratio of tourists in the Northeast is lower than other regions and with less spending. If a tourism linkage is established with nearby countries in accordance with the strategies of provincial groups, the number of tourists will increase. They will be quality tourists because arts and culture will be promoted as a selling point.

Introduction

The Basin Development Plan (BDP) is one of the four core programmes of the Mekong River Commission (MRC) with the following principal concepts and process.

(1) A development plan with emphasis on stakeholders' participation in the formulation process in accordance with the specified and well-accepted five stages.

- ◆ Sub-area Study and Analysis;
- ◆ Formulation of development scenarios;
- ◆ Preparation of integrated development strategies;
- ◆ Compilation of a long list of projects and programmes;
- ◆ Preparation of a short list of priority projects and programmes.

(2) The Lower Mekong Basin (LMB) is divided into 10 sub-areas (SA) based on the hydrological conditions and country boundary. The Mekong Basin's part in Thailand includes SA-2T (covering Kok and Mekong river basins in the North), SA-3T (Mekong River Basin in the Northeast), SA-5T (Chi and Mun river basins), and SA-9T (Tonle Sap sub-basin) (Figure 1 depicts the BDP sub-areas of the Lower Mekong Basin.)

(3) Three activities were simultaneously undertaken, i.e. (1) formulation of development plan, (2) public consultation and participation, and (3) capacity building of the institutions and stakeholders involved in this plan.

Activities accomplished in April 2004 encompass the preparation of Integrated National Sector Overview which presents an overview at country level of eight sectors related to the Basin Development Plan, namely, watershed management, irrigated agriculture, water supply for domestic and industrial uses, hydropower, flood management, fisheries, navigation, and tourism. This report gives details sub-areas 2T with focus on major sectors.

Context and scope of sub-area analysis

- (1) To analyze the present situation of each sector under the BDP in the sub-areas;
- (2) To serve as a sub-area situation report for other member countries, with some important data to be used in formulating more specific regional development scenarios and strategies;
- (3) To provide preliminary data for transboundary meetings;
- (4) To support the first stage of BDP collaborative learning approach and to be the starting point of the process.

National Overview

Some 25 million people live in the Basin's part of Thailand. More than 80% of the population is farmer, growing particularly rice which constitutes the largest portion of all, i.e., about 35 million rai (or, 5.6 million ha). Irrigation area is 8.84 million rai. However, soil fertility is rather poor and of low fertility, with a wide spread of salinity soils. These form a major problem that made it difficult for development and accordingly, revenue of the people, particularly farm income, is low in general.

When compared it to the national profile, it may be said that the Mekong Basin's part in Thailand is least developed; the basin's inhabitants have low income, causing such social problem as migration of labor to other regions. However, depending on the possible use of Mekong water and its related resources, this part of the Basin still has a high potential for development in such areas as industries, tourism, energy, irrigated agriculture, etc.

I. Watershed Management

1. In the Mekong Basin's part of Thailand, lands classified as classes 1 and 2 that are important watershed of river-basins, are very limited in general. For the Mun basin, area of these two categories is only 3.4% (of total basin's area). For the Chi and the Kok basins, they are 13.3% and 36%, respectively.
2. Management of forest/watershed upstream is a part of "river basin management" which normally covers various activities, including allocation of water (quantitatively and qualitatively) among different economic sectors within a basin. It represents, however, one of the most important work/tasks of the MRC.
3. The national FYPs, since the 3rd one of 1972-1976, and especially the Cabinet resolution of October 2000 on National Water Policy have set forth important directives for managing watershed and water resources of the country.
4. As an effort to solve the problem of water shortage during the dry season which is critical in every part of the Mekong Basin, to undertake a comprehensive study and to plan for utilization of underground water within the basin. In the longer term perspective, measures may include diversion of water from nearby basins, taking fully into consideration physical feasibility and possible impacts thereof.

II. Irrigated Agriculture

1. More than 22,300 irrigation projects have already been developed and constructed in the Mekong Basin's part of Thailand, with the total benefited area of over 8.84 million rai. Nevertheless, the irrigated area is small compared to the existing agricultural lands in total. Moreover, large-scale irrigation projects are located

mainly in sub-areas 3T and 5T, e.g., Ubon Ratana Dam, Sirindhorn Dam and Lam Pao Dam. In sub-areas 2T and 9T, most of the projects are of small- to medium-scale with a limited storage capacity. Others are electrical pumping stations that do not have structures for storing water.

2. Problems relating to irrigation in Thailand include lacking of a “unity” in water management work which normally performed by many government departments and agencies, particularly before the implementation of bureaucratic reform. Others problems are the “free access” to and the lack of “effective allocation measure” for water. These have resulted in uneconomic, ineffective and unjust water utilization, leading eventually to the problems of conflict and competition among water users. Additionally, there are such problems as the lack of demand-side-management measures, limited knowledge on the basin’s ecology, unavailability of appropriate management pattern and no participation of the water users.
3. Relevant policies to help solve the problems include establishment of a unified water management system, enactment of law and improvement of regulations related to water resource, public/people’s participation in water management, decentralization of authority from the Central to regions through the establishment of so-called “river basin sub-committee (RBC)”. Certain roles of the Royal Irrigation Department (RID), for example, would be delegated to local authorities. Other supplementary measures include public relations activities, involvement of private sector in doing operation and maintenance work, collection of fees to cover recurrent cost and/or application of cost-sharing principle for constructing irrigation systems.

III. Water supply for domestic and industrial consumption

1. In quantitative terms, the demand for water for domestic uses comprising home consumption and industrial use, represents the 2nd largest of all. However, it was only recently that MRC has taken this into consideration under the BDP context. Apart from an effort to meet the demand, development of water for domestic uses could contribute to improvement of quality of life of the people living within the basin and enhance sustainable development in the longer term.
2. PWA is considered the main agency. As a policy, it places an emphasis on quality of the water, following the standards established by the World Health Organization (WHO). Its target is to make waterworks available to rural areas at the rate of 400 villages a year. Priority is to be given to projects where the people are most suffered with shortage of water for home consumption. PWA has also a target to increase its service areas of “potable water” for at least 10 places a year. By 2023, it is expected that all the service areas will be able to provide potable water from tab.

IV. Hydropower

1. Under the Context of the Mekong Committee (1957-1995) and the MRC (1995-present), Thailand has been promoting studies of potential hydropower development within the Mekong River Basin. A large number of potential projects has already

been studied and developed. Several others are still have to be studied further, although the chance for such the development become limited, due to the exhaust of appropriate development sites for large-scale dam construction and opposition of NGOs, domestically and internationally, against construction of dams.

2. The key agencies responsible for hydropower development in Thailand include Electricity Generating Authority of Thailand (EGAT), the Department of Alternative Energy Promotion and Energy Conservation, the Provincial Electricity Authority, the Royal Irrigation Department, etc. Up to the present, some 1,022 units of hydropower related projects have already been developed in the Basin's part of Thailand. Of these, 12 projects have been installed with electricity generators, with a combined capacity of 241 MW. This constitutes about 8% of all the hydropower plants' capacity (2,939 MW) but, just 1% of the total power generating capacity of the country (25,638 MW).
3. Taking power demand in sub-areas 3T and 5T as an example, the peak demand is estimated at 2,006 MW or 7.8% of the total country demand (figure of May 2003), while the total energy consumption is 10,387 million units per year, or 8.9% of the country. This means that on the average, per capita power demand of the people in the basin is only 0.091 kW, with an average energy consumption of 472 kWh/head/year. These figures represent only 31% and 25%, respectively of the national averages. Forecasting figures for the power demand and power consumption of the people in the Basin's area of Thailand in the next 10 year are 2,717 MW and 19,886 million units, respectively.

V. Flood Management

1. The Mekong River Basin is subject to frequent flooding. Within the Basin's part of Thailand and particularly in the wet season, the rising water level of the Mekong river often overtops the river banks in Nong Khai, Nakhon Phnom and Mukdahan provinces. Sub-basins where flood occurs frequently are Nam Songkhram and Nam Kam sub-basins, due to their topographical locations which are relatively low and, lack of effective protection schemes and measures. Currently, Flood Mitigation and Management constitutes another key Programme of the MRC, comprising various new components in addition to the "flood forecasting" which has been implemented continuously in the past.
2. Important policy related to flood and following the resolution of the Cabinet of 31 October 2000 stipulated that the plans for mitigating flood and drought problems should be formulated for areas. Flood forecast, flood mitigation methods and restoration of flood damage should be implemented effectively and justly, taking fully into account the land-use and natural resources involved.
3. In addition, there is a set of policies of the Ministry of Natural Resources and Environment that influences either directly or indirectly flood mitigation activities in the country. They include the policy for reserving, developing and conserving natural resources and the one for resource utilization to meet the various demands to the maximum potentials while sustaining the benefits.
4. In view of the fact that flood problems could be caused by both natural-geographical factors and human acts: economic growth coupled with construction of infrastructures, expansion of urban areas, destruction of swamp/flood plains,

forest and watershed areas, etc., flood protection/mitigation measures should therefore comprise of those of engineering and non-engineering structures. They include, for example, improvement of rule/operation curve for managing the existing reservoirs, installation of flood forecast system, construction of natural flood plains, excavation of culverts/diversion routes, expansion of waterways, construction of large-scale projects specifically for flood protection purpose, etc.

VI. Fisheries

1. Fisheries are important to both consumption-life of the people as well as economics of the country. Because fisheries are also important natural resources of the Mekong Basin that are shared and owned commonly by the riparian countries and peoples living within therein, development of fisheries constitutes one of the most important and key activities of MRC.
2. National policies related to the development of fisheries (2002-2006) include those for the development of fishermen and related institutions, a policy for managing fishery resources and environment, a policy for the development of fish culture and a policy for the development of fishery industries and business which emphasize people's participation in the management of fisheries that will eventually lead to a sustainable development in this sector.
3. Apart from the Department of Fisheries, there are several other responsible agencies, e.g., the Royal Forest Department which is responsible for forest areas including the mangrove necessary for spawning and raising young fish/fingerings, the Department of River-borne and Maritime Transportation which is responsible for registering fishing boats, RID and EGAT which play important roles in managing fisheries in both the reservoirs and rivers, DWR which is responsible for overall management and allocation of water, the Pollution Control Department which is responsible for protecting and solving the problems related to water pollution caused by such things as urban growth, industries and untreated polluted water from agriculture.
4. There are many important factors that cause problems and threat to the well-being of fishery resources, e.g., waste from industries which tend to reduce the quantity of solute oxygen, salinity water caused by underground salt, dam construction which obstruct fish migration, out-law fishing or the use of too powerful fishing-gear to destroy fish, cross-breeding of imported/alien fish species, etc.
5. To increase fishery resources enough for meeting the future demand, several measures for solving the above-mentioned problems are necessary. These may include rehabilitation of water resources, the release of more fingerling to public water bodies, setting up of conservation areas for flora and fauna, restricted areas for fisheries, etc.

VII. Navigation

1. Water-borne transportation on the Mekong and in particular, the Mekong tributaries in Thailand has rapidly lost its importance due to the relatively fast development of road and highway networks in the country. Nevertheless, the use of the Mekong by Thailand and her neighboring MRC member countries for

transportation of goods and tourism (river-based tourism) purposes is still significant.

2. National policies related to the river-borne transportation/navigation on the Mekong river include the development of maritime/trading system to support export business of the country by means of, for example, the development of commercial fleets and strengthening of related industries, construction and management of harbors and deep seaports and cooperation in the establishment of communication and transportation networks and safety measures for inland navigation that link to her neighboring countries.
3. Important problems related to water-borne transportation are bank erosion caused by nature or human act (e.g., sand dredging, construction of buildings in the river, etc.) and sedimentation which make river channels shallow.
4. Long-term development in this particular Sector of Thailand concentrates mainly on the improvement of the aforesaid river-ports at Chiang Saen and Chiang Khong, to meet the increasing demand for transporting goods and tourism on the Mekong. Others include small-scale development and construction of bank protection work, particularly in the areas where problems are most acute to the people's and public properties.

VIII. Tourism

1. Tourism has become one of the most important economic sectors of Thailand. Compared to revenue from other export-goods, tourism can generate income and bring in the largest amount of foreign currency to the country, contributing to stabilization of balance of payment and solving many critical problems of the country. However, activities related tourism are least developed in the context of MRC work, which concentrate principally on the river-based and eco-tourism. Role of the MRC in this particular sector is therefore still very limited and, needs to be performed in conjunction with other development sectors, such as, navigation, conservation of river ecology, environmental protection, etc.
2. National policy and plan for 2004-2006 reflect a strategy for the development of tourism sector in the long-term perspectives. These include the expansion of touristic area to cover a wider Region with Thailand as the center of the network, the shifting of emphasis from quantity to quality, the increase in management roles of local institutions, the importance being placed on the development and rehabilitation of natural resources, etc.
3. Recently, six countries in the Greater Mekong Sub-region comprising Cambodia, China, Lao PDR, Myanmar, Thailand and Vietnam have agreed to jointly develop tourism in the Mekong River Basin aiming at a sustainable benefit, reduction of development cost, a full satisfaction of tourists and, an increase in capacity for competition in the market which in the future, is to become a "single tourism market", with the Mekong River as a selling point. Thailand has a clear role of being a gateway to the Region. Other countries have also been constructing various infrastructures that make a network linking to the Mekong.

Sub-area baseline study

Development Objectives, plans and policies

The Ninth National Economic and Social Development Plan stipulates that an efficient use of water resources is supported to ensure sustainable and equitable benefits by:

- (1) To manage the existing water resources and bring them for use to the maximum potential for agriculture, production, and consumption including change of agricultural production system by shifting to less water consuming crops as well as increase in water use efficiency;
- (2) To manage multi-purpose water resources by means of people's participation process from project preparation and allowing the beneficiaries to involve in investment;
- (3) To study ways and means to manage groundwater, quantitatively and qualitatively, in accordance with its potential as well as to investigate and monitor the land subsidence to proclaim areas of underground water control and to solve the decrease of underground water;
- (4) To enable collection of service fees on raw water being used for industries, commerce and water works together with campaigns and building the public awareness of conservation of water quality and efficient water use;
- (5) To develop water forecast system to improve the management efficiency so as to mitigate water shortage, flood, and water supply problems;
- (6) To formulate a master plan for integrated water management at basin level, emphasizing management of water quality and critical basins as well as participation of the people and communities in the implementation

The present government's policies delivered to the National Assembly on 26 February 2001 have embraced natural resources and environment issues as follows:

- (1) To manage the environment, natural resources and biodiversity in an integrated manner by upholding the principles of good governance and popular participation by the people and the local community;
- (2) To promote and encourage participation by the people and the community in waste control and waste disposal, both of which affect the health, welfare and quality of life of the people;
- (3) To support the notion of taking social costs into consideration when conducting project evaluations of repercussions on the environment and natural resources. In managing the environment and natural resources, the Government supports the principle that whoever causes pollution shall also bear the costs as well as the system of joint rights;
- (4) To promote technological research and development with a view to increasing Thailand's capacity to manage, conserve and restore the environ-

ment. Support the beneficial use of natural resources from all sources, including the recycling of waste and other used materials;

- (5) To set national environmental standards that are suitable for and compatible with Thailand's level of development in the scientific, economic and social spheres. At the same time, such standards should be in tandem with international environmental standards dealing with international trade;
- (6) To set standards for controlling the importation of chemical, toxic and hazardous substances in accordance with the international standards set by developed countries with a view to preventing Thailand from becoming a test site or commercial site for hazardous substances and materials that are sub-standard.

Thailand has adopted a new concept of regional administration - a bureaucratic system that can efficiently respond to the Government's strategic management. This can be achieved through an integrated management system, emphasizing the use of shared resources as well as clearly defined implementation strategies and goals. For effective management, provinces have to be grouped together. Provincial water resources management plans will be in line with these strategies.

SA-5T is classified as the Upper and Lower Northeast groups of provinces as follows:

Group 1: Khon Kaen, Maha Sarakham and Roi Et, with one main strategy.

Strategy on Improving Trade, Investment and Service Capabilities with four support strategies.

1st strategy: To collect and distribute commodities in the region;

2nd strategy: To create potential of industrial competitiveness;

3rd strategy: To achieve production and marketing restructuring;

4th strategy: To develop human capital.

Group 2: Nakhon Ratchasima, Chaiyaphum, Buri Ram, and Surin with five strategies.

1st strategy: Evolution of the export-oriented production of organic agricultural products (Jasmine Rice) to support the Kitchen of the World policy;

2nd strategy: Agro-processing development in support of the Kitchen of the World policy.

3rd strategy: Silk and textile product development in support of Fashion City policy.

4th strategy: Development of automobile industry to support the Detroit of Asia policy.

5th strategy: Development of tourism industry to support the government's tourism policy.

Group 3: Ubon Ratchathani, Si Sa Ket, Yasothon, and Amnat Charoen.

1st strategy: Restructuring and building production partnership with neighbouring countries.

2nd strategy: Building partnership in tourism and service sector with neighbouring countries.

Institutional capacity

In Thailand², the BDP Unit established under the Thai National Mekong Committee (TNMC) leads the efforts. The Unit manages day-to-day activities on BDP and as an organ at the national level, coordinates the work with other key stakeholders within the country. Within the Unit, in addition to the Unit Head, there are other key staff, including the BDP Coordinator who is assisted by a full-time BDP National Specialist (a local and external consultant). BDP within the Thai context is steered by a multi-agency BDP National Working Group (NWG) comprising of members from TNMC member ministries/line-agencies.

In the case of Thailand, as an example, the national water policy has been in place since October 2000, in which among others, public participation in water resources planning has been heavily emphasized. Institutional framework for the peoples' network has also been established and expanded for quite some time. On the side of the Government, 25 major river basins have been identified for planning and management purposes. Moreover, 29 RBCs have been established in all these river basins. The terms "sub-area (SA)" defined by BDP are basically similar to the "river basin" defined by the Thai authorities. Some, such as the Kok river basin, are the same and therefore, without adequate and proper explanations to the local stakeholders, establishment of new SAWG(s) over the existing RBC(s) in the same SA/river basin could lead to confusion.

For the BDP Unit, efforts and time were required much more than anticipated, in order to have all the necessary explanations made to the local people and institutional set-up formalized. This, as a matter of fact, was one of the practical problems experienced by the Unit during the early stage of implementation of the BDP process in Thailand.

BDP activities³ in Thailand used the real stakeholders who know their needs and sub-area well. All BDP working groups were selected from RBCs by themselves relate to 8 sectors of BDP (Watershed Management, Irrigated Agriculture, Water Supply, Hydropower, Flood Management, Fisheries, Navigation and Tourism) but not all sectors depend on sub-area characteristic and activities. The members of RBCs comprise with 4 main groups of stakeholder in sub-area as follows:

- 1) Related government official representatives
- 2) Water user representatives
- 3) Academics, local wise persons
- 4) Non government organisation representatives

² Learning note on SA study and analysis, TNMC, October 2004

³ TNMC-BDP Progress Report (April – September 2004)

Socio-economic description and information on resources users

Population

The population and forecast population were obtained from the report of Royal Irrigation Department⁴. Population was divided into urban and suburban areas. Data were collected from those of Department of Provincial Administration 2001, population by province during 1994-2001, and administrative areas at province, district, and tambon levels of Department of Provincial Administration. The present and forecast populations are shown in the following table.

Type of Community	Number of Population (million)				
	2001	2006	2011	2016	2021
Urban	2.350	2.426	2.504	2.585	2.667
Suburban	14.027	14.475	14.940	15.420	15.917
Total SA	16.377	16.901	17.444	18.005	18.584

Income

Per capita Gross Provincial Product (GPP) income/year in the sub-areas is based on one-year data, i.e. the year 2000, from National Economic and Social Development Board. The study of people's income in rural areas, villages, and tambon within the sub-areas reveals that the structure of household income in the rural areas is mainly based on agricultural activities. Income of the people in SA-5T is shown as follows:

Province	Per capita GPP (baht/person/year)
Ubon Ratchathani	22,224
Nakhon Ratchasima	38,647
Chaiyaphum	27,138
Maha Sarakham	21,658
Loei	30,736
Yasothon	21,109
Khon Kaen	40,582
Kalasin	21,954
Roi Et	22,785
Si Sa Ket	19,555
Udon Thani	26,685
Nongbua Lamphu	16,832
Buri Ram	22,151
Surin	20,347

⁴ Master Plan Study for Integrated Water Resources Development and Management and Irrigation Improvement for the 9th Plan, 25 Basins Study Report (Chi River Basin, Mun River Basin), Royal Irrigation Department, April 2003

Province	Per capita GPP (baht/person/year)
Amnat Charoen	17,938

In the SA-5T and the Northeast, Khon Kaen has the highest per capita income/year, i.e. 40,582 baht/person/year, while the Nongbua Lamphu province is ranked the lowest, i.e. 16,832 baht/person/year. The difference between the maximum and minimum average income per capita/year is 2.4 times.

Inventory of physical features and water resources

Geography

Based on the basin hydrology and administrative areas of MRC, SA-5T in Thailand's part is divided into 2 main river basins, namely, Chi and Mun river basins, covering a total area of 119,177 km². They are under the jurisdiction of 15 provinces, namely, Ubon Ratchathani, Nakhon Ratchasima, Chaiyaphum, Maha Sarakham, Loei, Yasothon, Khon Kaen, Kalasin, Roi Et, Si Sa Ket, Udon Thani, Nongbua Lamphu, Buri Ram, Surin, and Amnat Charoen.

High ridges form the western boundary of the area, i.e. Phetchabun range with elevation of 1,400 m MSL. Chi River originates from these mountainous areas. Phu Phan range forms the northeastern boundary with elevation of about 600 m MSL, stretching from Udon Thani to Ubon Ratchathani. This range is the source of Lam Pao and Yang rivers. On the south are Banthat and Dong Rak mountain ranges with elevation of 300-1,350 m MSL, which are the sources of Mun River. The central part of the SA is a low ridge, dipping southwards to Mun River. The area near the confluence of Mun and Chi rivers is low-lying land.

Climate

The climate in SA-5T⁵ is divided into 2 river basins, namely, Chi and Mun, because this SA covers a very large area. The collected data were divided based on the boundaries of river basins in Thailand.

Significant climatological data include temperature, relative humidity, cloudiness, wind speed, pan evaporation, and reference evapotranspiration computed by using the Modified Penman method. Details are presented in the following table.

Climatological Data of Chi and Mun River Basins

Important Climatological Data	Unit	Mean Annual Range		Mean Annual	
		Chi	Mun	Chi	Mun
Temperature	°C	26.6-27.8	26.9-27.3	27.0	27.0
Relative Humidity	%	68.8-72.7	70.0-74.5	71.3	73.0
Wind Speed	Knot	1.3-3.8	1.4-3.8	2.2	2.2
Cloudiness	0-10	5.0-6.5	4.8-6.5	5.5	5.7
Pan Evaporation	mm	1,659.3-1,918.3	1,576.8-1,891.4	1,771.3	1,793.3

⁵ Master Plan Study for Integrated Water Resources Development and Management and Irrigation Improvement for the 9th Plan, 25 Basins Study Report (Chi River Basin, Mun River Basin), April 2003

Reference	mm	1,785.1–1,894.4	1,803.6-1,847.1	1,824.0	1,825.4
Evapotranspiration					

Rainfall

Average annual rainfalls in SA-5T vary from 800 to 2,500 mm. About 89% of the yearly rainfalls occur in the wet season (May-October). A summary of mean monthly rainfall is given here below.

Unit: mm

River Basin	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Wet Season	Dry Season	Yearly Total
Chi	66.4	165.1	171.8	160.0	203.2	244.0	96.9	11.4	4.4	3.4	13.7	33.5	1,041.1	132.9	1,174.0
Mun	70.5	168.7	175.5	178.4	214.9	261.4	125.4	22.8	1.9	3.0	11.2	32.4	1,124.3	141.8	1,266.1

Runoff

The runoff data of SA-5T compiled from the previous study⁶ shows that the mean annual runoff totals 30,744.3 million cu.m. Average runoff during the wet season (May-October) is 26,966.9 million cu.m. (87.71% of the mean annual runoff). During the dry season (November-April), mean runoff is 3,777.4 million cu.m. (12.29% of the mean annual runoff). Average runoff per unit area is equivalent to 8.18 litres/sec/km². The following table shows a summary of mean monthly run

Unit: million cu.m.

Basin	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Wet Season	Dry Season	Total
Chi	106.8	331.6	695.4	1,032.5	1,866.0	3,029.6	2,683.4	949.8	250.5	115.3	86.7	96.6	9,638.4	1,605.7	11,244.0
Mun	108.7	282.2	1,108.4	1,978.7	3,689.8	5,782.1	4,487.3	1,373.1	356.2	155.1	87.8	90.7	17,328.5	2,171.1	19,500.2

Soils and Land Use

Soils

For the study of soil series in Thailand, Land Development Department has classified soils into 62 phases of Great Groups. Classification of soil series in SA-5T focuses on the soil suitability related to crop cultivation. The 62 phases are classified into 4 classes based on soil suitability.

1. Soil suited to paddy (including soil suited to other crops);
2. Soil suited to upland crops, vegetables, fruit trees and perennial tree crops (unsuited to paddy);
3. Soil unsuited to crop cultivation in general, but may be used for growing certain crops after soil improvement;
4. Soil unsuited to crop cultivation.

⁶ Master Plan Study for Integrated Water Resources Development and Management and Irrigation Improvement for the 9th Plan, 25 Basins Study Report (Chi River Basin, Mun River Basin), Royal Irrigation Department, April 2003

A summary is presented on the area coverage of soil series classified according to the soil suitability for crop cultivation in SA-5T⁷ as follows:

Area Coverage of Soil Series According to Soil Suitability for Crop Cultivation (km ²)					Total
Class 1	Class 2	Class 3	Class 4	Wetlands	
39,712	51,577	11,842	13,632	2,414	119,177

Land Use

Agricultural practice predominates in SA-5T, especially paddy fields. Upland crops commonly grown are drought-resistant types and need low labour input, e.g. sugar cane, cassava, maize, sorghum, and beans. Vegetables and fruit trees are grown only in areas where water is plentiful and available all year round such as land along the river banks, and downstream areas of large dams. The land use data from LANDSAT 2000 shows 5 types of land use as follows:

Land Use Type (km ²)					Total
Agriculture	Forest	Water Bodies	Housing	Others	
80,649	28,961	1,908	2,832	4,827	119,177

Agricultural land is the prevailing type of land use in the SA-5T, i.e. 68%, found mostly on flat terrain along the river channel, followed by forest area which accounts for 24%.

Forest Resources

Forests in SA-5T are mostly located in watersheds and mountain ranges on the west, northeast, and south of the area. Details are presented as follows:

- a. Forest Area: Based on the forest areas by province as presented in Table A-2 in Appendix A, forest cover has steadily decreased during 1993-1998. In 1993, forests accounted for 12.43% of the total areas of the provinces in SA-5T, declining to 12.31% and 12.15% in 1995 and 1998, respectively. In 1998, forest areas in SA-5T totaled 17,264.81 km². When considering the forest area of 28,961 km² as mentioned in item 3.2.2, the difference is remarkably significant. The data in item 3.2.2 were derived from aerial photo interpretation, while those in this section were obtained from surveys.
- b. Forest reserves in the SA-5T according to the Cabinet's resolution on 10 and 17 March 1992 cover a total area of 51,033 km² of the provinces within the SA-5T.
A total of 18,749 km² are proclaimed as forest conservation areas and additional conservation areas. Economic forests and forest areas suitable for agriculture are 29,357 km² and 2,926 km², respectively. They are 36.74%, 57.53%, and 5.73% of the national forest reserves in SA-5T, respectively. Presently, many national forest reserves have been encroached for housing and agriculture. A royal decree was promulgated

⁷ Master Plan Study for Integrated Water Resources Development and Management and Irrigation Improvement for the 9th Plan, 25 Basins Study Report (Chi River Basin, Mun River Basin), Royal Irrigation Department, April 2003

to disafforest many forest areas to be land reform areas under Agricultural Land Reform Office. This has led to the decreased national forest reserves. Table A-3 shows the classification of utilization of soil and forest resources in national forest reserves.

- c. There are 4 classes of conservation areas in SA-5T.
 - (a) National parks, totaling 15;
 - (b) Forest parks, totaling 16;
 - (c) Wildlife conservation areas, totaling 7; and
 - (d) Wildlife sanctuaries, totaling 7.

Details are shown in Annex A.

Wetland

Wetland is an ecological system which is diversified, linking lands and water bodies. It is a productive area where people may utilize for various purposes. Many countries do recognize the value and importance of wetlands that are located worldwide and accordingly, did agree on 13 September 1998, an agreement for conservation of wetlands known as Ramsar Convention in which Thailand was also a member country.

Phnom Donrak mountain range form a border in the southern side of wetlands of the SA 5T. Important sources of the wetland include the Korat Plateau which cover the Chi and the Mun basins (some 75% of the N.E. area). Important tributaries are Phrom river, Chern river and Lam Pao which flow into the Chi, Lam Dom Noi, Lam Takhong, Lam Se-bai, Lam Se-bok, Lam Plai-mat and Lam Dom Yai which flow into the Mun.

A study and investigation to prepare the list and database of wetlands in Thailand by OEPP revealed that there are some eight (8) places in the SA-5T that may be ranked and registered as important wetlands of international standard according to Ramsar criteria*, as shown in the Table below.⁸

Wetlands	Type	Location	Area (km ²)	No.of species	
				Bird	Fish
Beung La-han	Natural swamp with water plants	Chaturas District, Chaiyaphum Province	29.09	56	25
Hunting Prohibited Area in the Huai Chorake-mak Reservoir	Semi-natural reservoir, with water in some seasons	Tambons Sa-met, Ban-bua and Nasa-kae Phrong, Muang District, Buriram Province	6.20	11	18
Hunting Prohibited Area in the Huai Talad Reservoir	Semi-natural reservoir, with water all the year round	Tambons Sa-met and Saka-kae Sam, Muang District, Buriram Province	7.09	30	18

⁸ Thailand's Wetlands Document, Vol. 3, Northeastern Wetlands, Office of Environmental Policy and Planning, DANCED, 1999

Hunting Prohibited Area in the Sanambin Reservoir	Semi-natural reservoir, with water all the year round	Prakon-chai District, Buriram	5.71	23	14
Mekong River	International river	The river passes through Chiang Khong and Chiang Saen Districts of Chiang Rai in the upper reach, then through Loei, Nang Khai, Nakhon Phanom, Mukdahan, Amnat Charoen and Ubon Ratchathani in the lower reach	More than 2,400 kms. long and 60,900 km ²	-	289
Lam Plai-mat	Natural stream and shrub, with flood water in some seasons	Lam Plai-mat and Nang-rong Districts, Buriram	19	5	37
Lam Dom Yai and wildlife conservation areas of Yod-dome and Phu-khieo	A river with lowlands that flood water can reach its tributaries	Tambons Dome-pradit and Sri-vichian, Nam-Yeun District, Ubon Ratchthani Province	About 30 kms. Along the river, with about 225.35 km ²	188	36
Werlands in the Phu-Khieo wildlife conservation area	Lowland with flooding in some seasons	Tambon Huai-yang, Khon-sarn District Tambons Ban-yang, Bankha and Kud-loh, Kaset-somboon District Tambons Na-dad, Nong-Waeng and Nong Bua-Daeng, Nong Bua Daeng District, Chaiphum	1,560	223	26

Remarks: * Ramsar criteria implies the criteria being used in the Convention on wetlands that are considered important internationally.

“ - ” means no data.

Economics sectors

Watershed Management

Classification of Watershed

The Cabinet has endorsed on 27 July 1992, classification of watershed in Thailand that was divided into five (5) classes in accordance with their respective hydrology and natural resources and for effective management of the basins, with the following details.

Class 1 area is further divided into two: Classes 1A and 1B. Class 1A is to be preserved as upstream watershed of a river and therefore, all activities that could affect conditions of the forest therein are strictly prohibited.

For watershed Class 1B, if unavoidable, responsible agencies are required to conduct EIA of the project and to report the outcome to the National Environment

Committee (NEC) for consideration prior to the implementation. In the case where road or mining is to be constructed/implemented in the area, the agencies are required to make a proper control over soil erosion that could be caused by such the activity.

Class 2 area is meant to be conserved basically for forestry and mining purposes, with a restricted rule over “land-use” in the area. The use of land for agricultural purpose is to be avoided.

Class 3 area can be used for activities related to forestry, mining, agriculture and other purposes, with some specific rules to be observed for land and water conservation.

Class 4 area can be used for all activities. For agricultural use, however, slope of the area should not exceed 28% and, there is a need for land-use planning in accordance with land and water conservation.

Lastly, for Class 5 area, it can be used for all activities.

In accordance with the watershed classification for this sub-area which was carried out jointly by NEC and Kasetsart University and endorsed by the Cabinet on 12 July 1988, it was found out that of the 5 classes, watershed class 1A (to be preserved) is about 5.02% and class 5 (can be used for all activities) 66%. More details are given in the Table below.

Classification	Chi basin km ²	Mun basin km ²	Total	
			km ²	percentage
1A	4,607	1,353.75	5,960.75	5.02
1B	409	296.45	705.45	0.59
2	1,445	615.80	2,060.80	1.73
3	1,612	1,391.53	3,003.53	2.53
4	12,137	13,531.28	25,668.28	21.61
5	27,103	51,295.10	78,398.10	66.00
Reservoirs	2,754	241.49	2,995.49	2.52
Total	50,067	68,725.40	118,792.40	100.00

Source: Cabinet’s resolution on Watershed classification and A proposal for Landuse in the Chi and the Mun Basins (12 July 1988)

Remarks: Figures on the areas differ due to the different sources.

Irrigated Agriculture

General condition

Major types of soils in SA-5T are either sandy or sandy loam, with poorly drained character and low fertility. Average precipitation is about 1,200 mm/yr. Heavy rains are expected in August and September. In some areas, rain can be scarce. Rice is the major crop in the area. Most households grow rice basically for home consumption, with surplus to be sold for income. However, non-glutinous rice is of higher preference in the area and favorite varieties are Dok Mali 105, RD15 and RD23. Average rice yield in the wet season is about 2.19 t/ha. Glutinous rice is grown only in a limited area, i.e., near the water resources. Its average yield is 2.06 t/ha.

After rice, economic crops include cassava, kenaf, maize, soil beans, groundnut and sugar-cane.

Fruit trees are grown widely in the basin area, as back-yard orchard or in small plots of the farmers' fields. At present, growing of rubber trees is also gaining more popularity.

Favorite vegetables grown in the areas are sweet corn, chilli, water melon, cucumber, string bean, onion, garlic, Chinese lettuce, etc. Most of them, however, are grown for home consumption. Only the surplus will be sold for cash income in local market.

Crop calendar of selected crops in the Mun and the Chi basins are given in Annex A.

Irrigation

Water resources development projects of various sizes have already been constructed in the area. Basic definitions of projects of different scales can be briefly introduced hereunder.

- 1) Large scale projects mean those with reservoir capacity of more than 100 MCM or, with reservoir area of more than 15 sq.kms or, with irrigation area of more than 80,000 rai (12,800 ha).
- 2) Medium scale projects means those with reservoir capacity of less than 100 MCM but more than 2 MCM or, with reservoir area of less than 15 sq.kms or, with irrigation area of less than 80,000 rai (12,800 ha) but greater than 3,000 rai (480 ha).
- 3) Small scale projects means those with reservoir capacity of less than 2 MCM or, with irrigation area of less than 3,000 rai (480 ha). Most of them are projects constructed by RID.
- 4) Pumping irrigation schemes are those projects that do not have reservoirs. They rely on water from natural rivers/streams that would be pumped up and delivered to beneficiary areas.

There are 15 large-scale projects, with the total irrigation area of 238,040 ha and the total combined reservoir capacity of 7,294.32 MCM. These projects include Ubonratana Dam, Lam Pao Dam, Chulaporn Dam, Kumpawapee Weir, Nong-wai Weir, Thung-saeng Badan, Lam Takhong Dam, Lam Sae Dam, Upper Mun Dam, Lam Nang-rong Dam, Lam Phra-phloeng Dam, Phimai, Weir, Pak Mun Dam, Hua Na Weir and Sirinthorn Dam.

For medium-scale one, there are 154 projects with the total irrigation area of 187,363 ha and the combined total reservoir capacity of 1,869.10 MCM.

For small-scale one, there are 4,074 projects with the total irrigation area of 245,847 ha and the combined total reservoir capacity of 532.19 MCM.

For the pumping irrigation schemes, there are 682 projects with the total irrigation area of 249,526 ha.

Demand for irrigation water

Similarly, the demand for irrigation water⁹ in SA-5T represents the largest of all, i.e., with an estimated figure of 5,591 MCM/yr. The demand quantities in the wet and dry seasons are 4,637 MCM and 954 MCM, respectively.

Water supply for domestic and industrial consumption

Similarly and following the same basis, the demand for domestic water uses was estimated for the people in SA-5T, see Table below.

Water demand for domestic uses (MCM/Yr)				
2001	2006	2011	2016	2021
389.62	402.14	415.07	428.44	442.26

It should be added that in making the estimate of water demand for industrial uses, various industries were classified into 10 major groups, including spare-parts and appliances, chemical substance, food and beverages, black smith, general industries, open-space industries (e.g., charcoal making, cotton weaving, silo, etc.), paper pulp and products from paper, weaving and dyeing industries and, handicraft of wood products. Projection of water demand for the industries within the sub-area is as given in the Table below.

Water demand for industrial uses (MCM/Yr)				
2001	2006	2011	2016	2021
234.02	277.72	330.01	392.64	467.72

Hydropower

Development of hydropower projects in SA-5T has a long history. Several multi-purpose hydropower schemes, contributing to hydropower generation, irrigation water, fisheries, etc., have already been implemented (see the list below). At present, however, development of new schemes becomes more difficult due to their vast impact on both human's life and environment. Due to this, EGAT started to launch several improvement programs for the existing schemes, e.g., the plan for improving Ubon Ratana Hydropower Dam (2005 to 2007), for Sirindhorn and Chulaphorn Dams (2006-2008), etc. EGAT has also a plan to install electrical generators at some of the existing irrigation dams with hydropower potential, e.g., at Lam Pao Dam. Additionally, it has projects to expand transmission lines to accommodate the increasing demand for electricity in the Northeast region, see examples below.

⁹Master Plan Study for Increase in Water Resources and Water Use Efficiency by Grid System in the Northeast, Chi and Mun River Basin, Department of Energy Development and Promotion, Ministry of Science, Technology and Environment, June 2001

- Improvement of 230 kv line between Lam Takhong-Nakhon Ratchasima 2 project which will increase the size of the transmission line that will pass through the northeastern region in 2007-2010, prior to the operation of Nam Theun 2 project. The improvement project is to be finished in 2007.
- Construction of 500 kv line to import electricity from the Lao PDR (Nam Theun 2 project). It is a construction of 500 kv transmission line from Roi Et Station 2 to the Thai-Lao border at Mukdahan, with the distance of about 160 kms. The project is due to be completed in 2009.
- Construction of the 500 kv line connecting the North and the Northeast (Tha Tako-Chaiyaphum-Udonthani), with the distance of 422 kms., to supplement security to meet the energy demand in the northeastern region by bringing in electricity from the North and the Central parts of the country. This project is to be completed in 2011.

Hydropower projects that have been constructed in SA-5T

<i>Project</i>	<i>Location</i>	Reservoir area (km ²)	Reser-voir capacity (MCM)	Generating capacity (Kw)	Production (Gwh)	Year of construction
Chulaphorn	Donsarn District, Chaiyaphum	545	188	1 * 20,000	94.84	2001
Huai Kum	Kaset Somboon District, Chaiyaphum	262	22.8	1*1,300	2.91	1982
Ubon Ratana	Ubon Ratana Dist.Khon Kaen	12,000	2,263	1*8,400	54.73	1987
Lam Ta Khong	Si-Kiew District, Nakhon Ratchasima	1,430	310	1*250,000	1	1981
Lam Phra Ploeng	Nakhon Ratchasima			2*175		1998
Lam Dom Noi (Sirinthorn)	Phiboon Mangsahan District Ubon Ratchathani	2,097	1,966	1*12,000	84.927	1971
Pak Mun	Khong Chiam Dist. Ubon Ratchathani	117,000	225	1*34,000	280	1994

Source: EGAT

Flood Management

1) Flood condition

Chi sub-basin may be considered as a part of the Mun Basin. The Chi river flows into the Mun at Ubon Ratchathani. In recent years, at least two big floods¹⁰ occurred in the Basin, i.e., in 1978 and 1980. In 1978, the cyclone has hit the Northeastern, causing heavy floods in the various parts of the region. Water inflow to Ubon Ratana Dam in the Chi sub-basin was at the rate of 7,100 CM/sec. The release of water from this dam to downstream, which was as high as 3,772 CM/sec., has caused big floods on both banks of Nam Phong, Lam Pao including the Chi river. The flood covered large area from the confluence where the Chi flows into the Mun up to Ban Kaeng Kror in Chaiyaphum province. Total flooding area was as large as 4,296 sq.kms. and the duration was about one (1) month. Of the seven (7) provinces

¹⁰ Chi Basin Water Use Study Report (Royal Irrigation Department 1988)

that were flooded, Khon Kaen, Mahasarakham and Roi Et were affected heaviest.

The flood of 1980 covered only a part of the Chi river and Nam Phong, with the total flooded area of 1,274 sq.kms., or about 30% of the flood area in 1978.

The combined total area of the Mun and the Chi basins is 119,177 sq.kms. Of this, the Mun basin area from upstream down to the confluence with the Chi river is 69,700 sq.kms. Slope of the Mun from the Mekong upto Phiboon Mangsahan District (Ubon Ratchathani) is 0.00025. The slopes from that point to Rasi-salai District (covering the total distance of about 150 kms.) and from Rasi-salai to Phut-thai-song Districty in Buriram become 0.00003 and 0.00007, respectively. These gentle slopes together with the meandering nature of the Mun river make its banks vulnerable to frequent floods. Moreover, the river has a lot of hindrance that retard the natural flow to the Mekong river. Due to these, average flood depths in the upper reach of the Mun are about 0.50 m in every two year and, 2 m in every 25 year period. In the lower reach (from the so-called Lam Phlab-Phla confluence), average food depths are 2 m in every two year and, 5 m in every 25 year period, respectively. The Mun basin was also heavily affected by the floods of 1978 and 1980 too but, not as much as the Chi basin.

2) Areas vulnerable to flood

A study undertaken by Kasetsart University (September 1996) has identified “vulnerable areas” to floods and natural disaster in northeast Thailand. Levels of the flood and probabilities of risk to flooding have been determined in terms of their relation to topographic conditions in each area of the Mun and the Chi basins. Furthermore, correlation between excessive rains and normal water level has been analyzed in relation to the different topographic conditions, land-uses, reservoirs in the region and land and water conservation systems. As the outcome, in terms of flood vulnerability, areas of the basins can be classified into four (4) different zones depending on risk-levels as following:

- (1) Zone that is not subject to flood;
- (2) Zone of a low risk to flooding; could cause certain damage to properties of the people;
- (3) Zone of a moderate risk to flooding; could cause more damage to properties but not to the life of people;
- (4) Zone of a high risk to flooding; could cause great damage to both the properties and life of the people.

Result of the analyses indicated that areas of zones (1) to (4) were 72,456 33,746 10,892 and 1,620 sq.kms., representing respectively 61.3 28.43 9.17 and 1.36 % of the basin’s area. Areas of high flood risk include those in the following six (6) provinces:

- i. Part of the Muang district of Chaiyaphum province;
- ii. Rasi-salai and Kantra-rom districts of Si-Sa-Ket;
- iii. Phanom Phrai district of Roi Et;
- iv. Muang, Kheung-nai, Warin-chamrab and Don Mod-daeng districts of Ubon Ratchathani;

- v. Muang, Maha-Chanachai, Kho-wang and Kham-kheun-kaew districts of Yasothon; and
- vi. Ratanaburi and Tha-tum districts of Surin

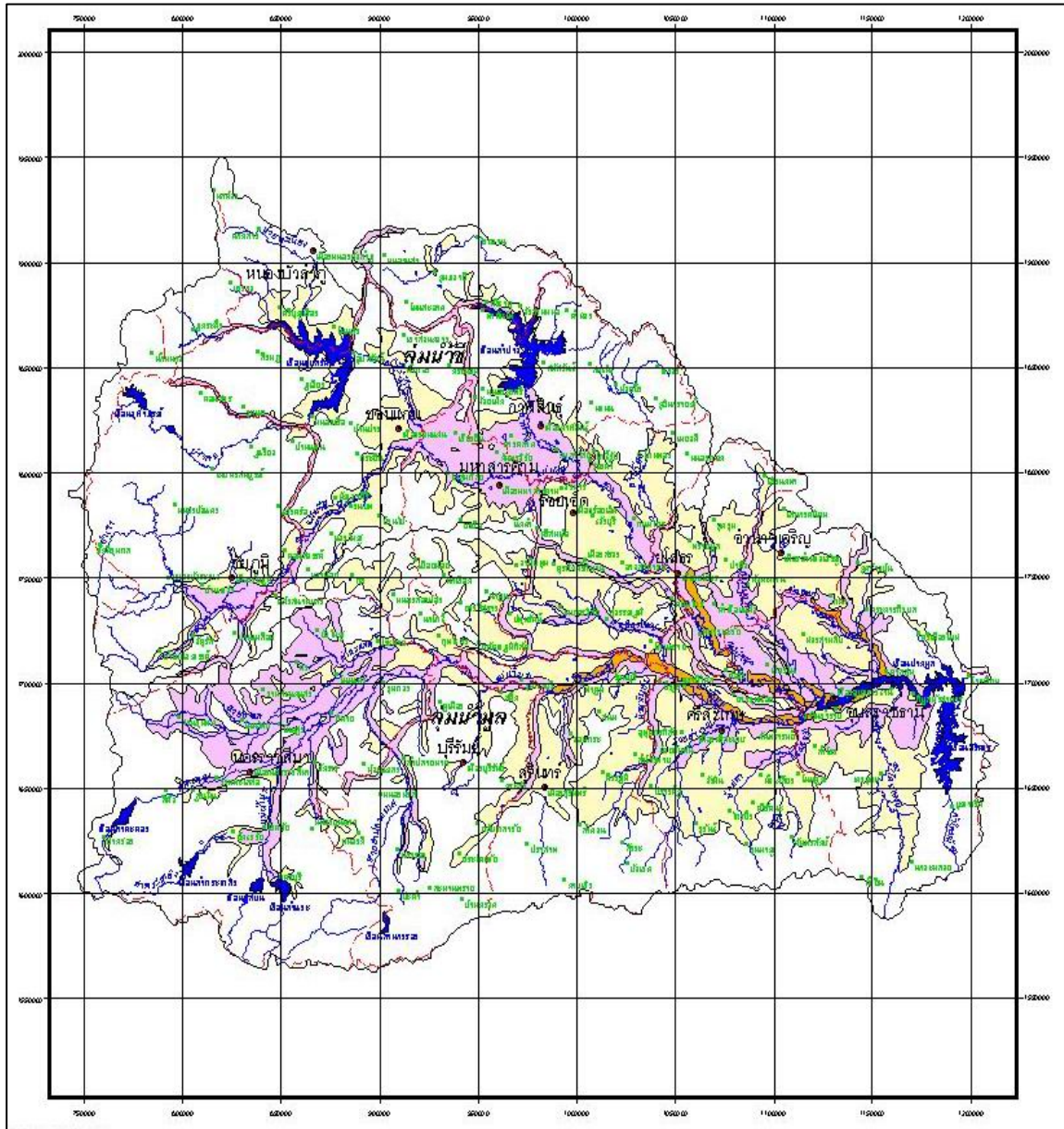


Figure 1 Areas subject to flooding in northeast Thailand

- Dam/reservoirs
- Zone of high risk for flooding
- Zone of moderate risk to flooding
- Zone of low risk to flooding
- Zone not subject to flooding

Fisheries

Types of fisheries

The following types of fisheries are found in the sub-area:

- 1) The first is fish culture in earthen ponds where natural fish from paddy fields will be trapped and fed. Generally, no additional fish feeds are given. However, fish will be caught for both consumption and commercial purposes.
- 2) The second is fish culture in the constructed ponds, with regular feeding.
- 3) The third is fish culture in an integrated farming system. Important fish species include catch-fish, snake-head fish, tilapia and Nile tilapia.

Fish resources

Two important reports on ecological conditions of the sub-area are to be mentioned. One is included in the Interim Report on supplementary study on environmental impact and environmental plan for the Khong-Chi-Mun project (Phase 1) submitted to the Department of Energy and Development Promotion in November 2001. This study has covered results of the surveys at seven (7) fish stations, including Nong-han Kumpawapi (in Udon Thani), Lam Pao Reservoir, Lam-nam Lam-phan and Lap Pao Weir (all located in Kalasin), Mahasarakham Weir (in Mahasarakham province), Yasothorn-Phnom Phrai Weir (in Roi Et) and That-noi Weir (in Ubon Ratchathani).

For the Mun basin, the surveys were carried out from Tha-tum district of Surin province down to Tal-sum district of Ubon Ratchathani. Survey periods were December 1996 (winter season) and during April-May 1997 (summer).

According to the survey, number of fish species found in the Chi basin, varying by seasons, was between 7-36 species. Bio-diversity indexes were 0.43-2.87 or, an average of 2.09 which could be considered "moderate" in the case of natural water resources. In the winter, the number of fish species and corresponding index value could be relatively higher than those in the summer, i.e., 2.19 in the winter against 1.99 in the summer. Fish productivity also varied according to seasons, e.g., averages of 69.94 kgs/ha in the winter and 30.19 kgs/ha in the summer. Year-round average production was 50.06 kgs/ha, which was relatively low. Furthermore, the fishes found were considered low value in fishery terms. They include Pla Paen-Kaew (*Chanda siamensis*), Pla Lod (*Macrogathus siamensis*), Pla Sroi-Kled-Khao (*Cirrhinus jullieni*), Pla Mo-Chang-Yiab (*Pristolepis fasciatus*), Pla Pak-Liam (*Cyclocheilichthys armatus*) and Pla Rak-Kluai (*Acanthopsis choirorhynchus*).

In the Mun basin, however, result of the surveys revealed that number of the fish species was more abundant throughout the river length, i.e., between 14-36 species. Bio-diversity indexes were 1.78-2.81, with the average of 2.44. Fish productivity varied according to locations or stretches, e.g., 49.06 kgs/ha in the upstream area where Tung-lung weir is located, 38.38 kgs/ha at Rasi-salai district, 38.88 kgs/ha at Tal-sum district and 115.00 kgs/ha at Don Mod-daeng sub-districts (Ubon Ratchathani). Most species found were considered low value (in fishery terms), including Pla Khor (*Nemacheilus masyae*), Pla Rak-kluai (*Acanthopsis choirorhynchus*), Pla Taphian-Sai (*Puntius leiacanthus*), etc. Fish species of a higher

value could be found in part of the season but, they were normally small in size which could be the result of a straight and/or shallow stream that made it difficult for the fishes to live and spawn. Moreover, population of carnivorous species was outnumbered compared to the herbivorous ones. These altogether have resulted in the over-all low productivity of fisheries in the basin.

Navigation

Navigation in SA-5T at the present involves only a short-distance long-haul and cross haul traffic. Types of the boat found in the area include ferries, fishing boat, sand-boat, tug-boat and engine boat for sport or pleasure activities.

Environmental issues

Watershed Management

- Lacking of the sense of responsibility in utilizing and conserving land, water and forest resources;
- Lacking of continued maintenance of re-afforested areas.

Irrigated Agriculture

- Lack of proper maintenance for irrigation infrastructures
- Limited distribution system for irrigation water

Water supply for domestic and industrial consumption

- Quality of underground water in some places is not good for waterworks (salty or, with rust).
- Lack of waterworks in many places.

Flood Management

- New constructions have caused flooding problems, e.g., in Kalasin, floods occurred for 5 consecutive years (2000-2004) and with a longer duration;
- Many changes on the land-use.

Fisheries

- Fishermen lack of knowledge on the fishes they are feeding.
- Decreasing fish quantity due to water quality while the demand for it tends to increase due to population.
- The use of prohibited fishing gears.

Analysis

Development opportunities, needs and constraints

I. Development opportunities and needs

Watershed Management

The existing forest in sub-area 5T was deteriorated since the last four decades due to the population growth which need to expand agricultural area, thus, the forest area is low percentage compare to the other sub-areas in Mekong River Basin of Thailand. It was impacted to environmental system especially head of water resources. In this response, Thai government has determined measures of protection/conservation in order to protect forest area such as classification of land use, national reservation area in order to keep natural resources for future, national forest park and wildlife conservation area in order to keep the biodiversity of plant and animal also conserve head of water sources. Some national projects to protect and growing forest in upstream are progressed. For long term plan and success it has opportunity to build-up the sense of responsibility among the people in conserving lands and water by the community with increasing area of community forest.

In national level, construction of weirs to retard water flow and soil erosion in upstream area is needed to be encouraged by government agencies as well as public participation. Therefore, the watershed management is needed to be done in holistic approach which starting from analysis that what are causes and effects be occurred due to it is related to flood problem solving.

Irrigated Agricultures

Many irrigation projects are spread in sub-area 5T, but the maintenance efficiency is low and a limited of water allocation system when it operate for a long time and the purpose of water use is changed as well as the new area faced difficulty to develop a large irrigation then it needs to increase the potential use of water in irrigation area.

Support to irrigation efficiency sub-area 5T required to improve irrigation system (more gates, expanded distribution system, including pipes).

Water Supplies

In the next 20 years, domestic water demand will increase 14 percent and industrial water demand will be double due to the strategic plan of this area, where as the quality of groundwater in some area can not be supplied due to the salinity and ferrous oxide. Thus, using surface water as a supply source is more feasible and low cost. For long-term development of water supplies, surface water quality and quantity is important the upstream watershed area should be taking a good care and have to control over the release of waste and garbage.

In areas where drought is repeatedly occurred, to have community waterworks constructed and should be linked to potential water resources.

Flood Management

Sub-area 5T faced flood problem frequently in the past 5 years, due to many natural area (swamp) are deteriorated and the expansion of urban, the new communities have settle down in the flood plain area they are improved and expanded can be used to absorb excessive water in wet season also improve of natural streams and rivers. This activity can be linked to increase of forest area to absorb water in wet season and release water in dry season.

Lam Pao Dam has potential to reserve more water in flood period by increase the height of crest. For the long term development a necessity to conduct another study on flood mitigation starting from the upstream watershed and to cover as well new watersheds.

Fisheries

The natural fishes in sub-area 5T are decreasing, due to illegal fishing activities still appear then these will be overcome by implanting the sense of responsibility on doing fishing.

Fishermen in sub-area 5T use local knowledge for fish culture which have less technical tools then provision of training course on fishing culture is needed. To protect local fish species and increase fish population in natural, it should be established fish conservation zones where the fish population can grow, e.g., at Wang Thuan and Wang Kwang in Yasothorn province.

Potential social, environmental and economic impacts of development

The provinces in sub-area 5T are separated to four provincial groups which have the common aim to cooperate in economic with neighboring countries comprise with agro-industrial investment, expand production base and tourism. The potential goods and product are to be promoted among sub-areas such as timber conversion, coffee and oil plant.

There are numerous places for tourism in SA-5T, such as, its beautiful nature, historical sites, arts, renowned local and traditional activities including the “fire festival” in Yasothorn, the “candle festival” in Ubon Ratchathani, etc. Additionally, as a new touristic spot, there is a so-called “emerald triangle”, which is a spot that links the border lines of Thailand, Lao PDR and Cambodia. The Thai Government foresees this spot as a potential place that would bring in tourists from around the world in the coming years. It could serve also as a starting point to travel to other countries nearby. In a sense, it helps to link transportation routes from various touristic places. Improvement and/or development activities aiming at a high standard of services in the area are therefore highly important.

In addition, there are two historical routes in the sub-area that link to the old civilization of Khmer.

Route 1: Heading from the West to the East, a large number of touristic spots are on this route, such as, the Prasat (stone-pavillion) Sdock-Kok-Thom in Sakaew

province, Prasat Nong-hong, Prasat Khao Phnom-rung, Prasat Hin Muang-tam (in Buriram), Prasat Dameun and Prasat Sri-khoraphum (in Surin) Prasat Hen-Kamphaeng-yai and Prasat Khao Phra-vihan (in Si Sa Ket). The route passes through Chang-mek in Ubon Ratchthani to Wat Phu, Khone Fall and other natural resources in the Lao PDR, adjacent to the border with Cambodia.

Route 2: It was used by King Jayavoraman VII, running from the Soputh to the North. The route starts from Ankor Wat, Angkor Thom in Seamreap province of Cambodia, passes through Prasat Banteisrei, Kaban- Sapean before entering into the Thai territory at Chong Jom. The routes continues to pass through Prasat Khao Phnom-rung and Prasat Hin Muang-tam in Buriram, Prasat Hin-phimai in Nakhon Ratchasima, Prasat Puey-noi in Khon Kaen and Prang-koo of Muang district, Chaiyaphum province.

Potential transboundary/cross-regional issues and impacts

Watershed Management

Forest cover in SA-5T is, at present, relatively very small compared to the total area, i.e. 12%. This has severely affected the retardation of rainwater, thus causing frequent floods, especially on the low-lying lands near the confluence of Chi and Mun rivers. Besides, roads and bridges obstruct water courses. Evidently, this sector has a direct impact on flood management. Two significant identities of this SA are people's way of life and utilization of swamps. Local inhabitants have mutually benefited from multi-use of these swamps: farming, livestock raising, and natural water retardation areas during high flows.

Nearly all the conservation areas are watersheds and they all are important natural tourism resources of the Northeast. Indirect benefit gained from these areas is job creation for the local people. However, strategies of provincial groups, mentioned in Chapter 3, principally focus on the development that aims at raising production and economic activities in the area, and beneficial linkage with neighbouring countries. The conservation should not be overlooked so as to ensure a balanced use of watershed areas.

Another impact is the increasing demand for agricultural land and construction of accommodations for ecotourism, thus leading to encroachment on and decrease of the already-diminishing conservation areas. As a result, campaigns should be incessantly carried out to build public awareness of conservation, reforestation, and maintenance with people's participation and accessibility.

Irrigated Agriculture

Agriculture is the main occupation of more than 70% of the population in the sub-area. This SA is the major region that produces export-quality Jasmine rice, which is also in line with the strategies of the provincial group. Impacts of this sector come from the high ratio of water utilization for agriculture and the incremental water requirement in the dry season, thus resulting in water shortage. In case demand for rice export expands in the future, there is a trend for more conflicts of water use with

other sectors, namely, hydropower generation, and water supply for industrial use according to the provincial strategies described above. Furthermore, an anticipated growing number of people in the industrial areas will also push up the water requirement. It is, therefore, vital to improve the efficiency in water use for agriculture and formulate a water use plan that is mutually agreed upon among representatives of various regions, with the River Basin Sub-Committee having a greater role.

If sustainable agricultural development is an aim for this SA, organic farming should play a greater role. This agricultural practice does not destroy soil and water resources. On the contrary, it will help improve the environment. This has also been addressed in the strategies of the provincial groups.

Water supply for domestic and industrial consumption

The growing water requirement for consumption in the next 20 years, an increase of 14% of the current demand (2001), and the double of water need for industrial use. The strategies of provincial groups also embrace development of textile and automobile industries. A question is, therefore, raised about where additional water may be found to adequately meet the anticipated demand. It is difficult to build additional water sources because areas with suitable topography become scarcer. A likely approach is to manage the existing water resources to the maximum potential. Efficiency in water utilization should be enhanced for every activity within the basin.

Hydropower

Power demand in SA-5T will be on the increase as industrial development, i.e. textile and automobile, will take place in this SA. Nonetheless, construction of a hydropower plant, which is a clean energy source, is highly unlikely because of the impacts on the people on a wide range. One possibility is to improve the efficiency of the existing power plants and extend the grid system from other parts of the country. Additionally, dialogues on power purchase should be held with neighbouring countries.

Cross-sectoral impacts in this SA will be those on irrigated agriculture during floods. When dam inflows are higher than the normal storage capacity, it is necessary to release the excess water to downstream areas, thus causing damage to croplands. At the same time, hydropower dams contribute to flood management and dry-season farming. Water releases from dams can help meet the water demand in the dry season. If farming areas are greater than planned, there will be conflicts due to the rising water requirement for agriculture.

Flood Management

This sector is of great significance to SA-5T because of the 1978 severe floods. In the past few years, there were also frequent floods. The main causes are the change in land use and blocking of water courses by structural development. As the land is naturally low-lying, it is difficult to solve the problems. The natural conditions have to be taken into account or the low-lying lands should be used as water retention areas

during high flows. The retained water may be used for dry-season farming while also indirectly benefiting the fisheries sector.

For the maximum benefit of SA, flood management has to be related to watershed management through a continual increase in forest cover and reservoir operation. A study should be conducted on the feasibility of drainage areas and water diversion route that has little adverse impact in combination with a water use management plan for dry and wet seasons to prevent wastage.

Fisheries

In former times, fishery and agriculture had notably featured in the traditional way of life in SA-5T. People who had a large catch of fish would exchange them for rice. Nowadays, local fishing still provides sufficient protein source of food for the inhabitants. Hydropower sector helps raise fish catches because reservoirs can be sources for local fishing while affecting the natural migration of fish at the same time. Agriculture is another sector that can contribute to the fisheries. Farmers can use the same land for farming and fish culture. In this regard, organic agriculture should be practiced to avoid accumulation of chemical residues.

Navigation

This sector is relatively less relevant to SA-5T compared to other sectors because long-distance water transport no longer exists in this SA. Dredging of water courses is mainly done for drainage purpose, not for navigation.

Tourism

The national tourism statistics show that the ratio of tourists in the Northeast is lower than other regions and with less spending. If a tourism linkage is established with nearby countries in accordance with the strategies of provincial groups as stated above, the number of tourists will increase. They will be quality tourists because arts and culture will be promoted as a selling point.

However, strengthening of the tourism sector has to be supported by other sectors, namely, management of watersheds, which involve natural tourism resources, and provision of adequate water supply to respond to the demand of future tourists. Reservoirs of several hydropower dams also serve as recreational areas for the local people.

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Annex A