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RIVER BASIN WATER MANAGEMENT PROPOSAL PRELIMINARY STUDY DESIGN

(Thailand)

October 1990

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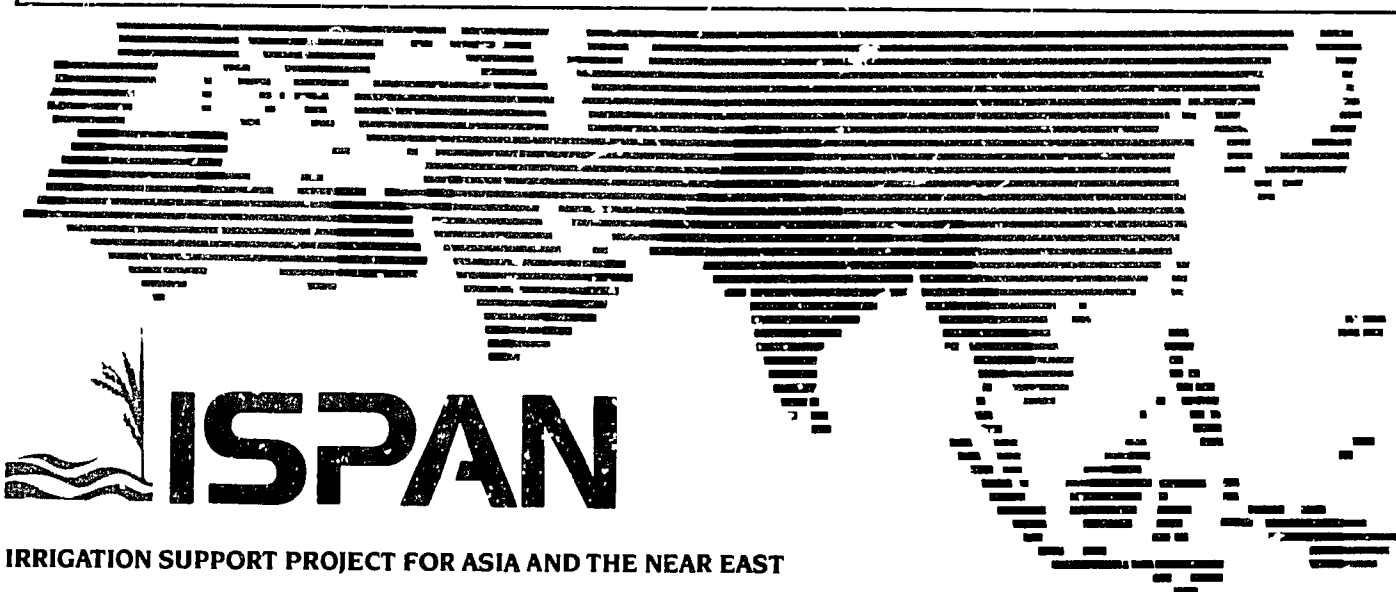

IRRIGATION SUPPORT PROJECT FOR ASIA AND THE NEAR EAST

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RIVER BASIN WATER MANAGEMENT PROPOSAL
PRELIMINARY STUDY DESIGN
(Thailand)

Prepared for the USAID Mission to Thailand
under ISPAN Activity No. 667B

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ACRONYMS

EGAT	Energy Generating Authority of Thailand
GDP	Gross Domestic Product
ISPAN	Irrigation Support Project for Asia and the Near East
M&I	Municipal and Industrial (water use)
MCM	Million cubic meters
MSL	Mean sea level
NESSI	Northeast Small Scale Irrigation Project
PWWA	Provincial Water Works Authority
RID	Royal Irrigation Department
RTG	Royal Thai Government
TDRI	Thailand Development Research Institute
USAID	U.S. Agency for International Development (Mission to Thailand)

EXECUTIVE SUMMARY

This document provides the broad outline for an applied study focusing on basinwide water allocation and management problems in Thailand. North and Northeast Thailand were selected for the study due to their population (20 and 33 percent of Thailand's population, respectively), size (67 percent of the country's land area), and strategic economic importance. These two regions also illustrate that water allocation conflicts are not just isolated problems related to tourist resorts and urbanized areas. Data for this proposal were collected in two northern basins (Mae Klang and Mae Taeng) and two northeastern basins (Lam Ta Khong and Huai Aeng) during March and April 1990. Support for developing the proposal was provided by the Thailand Mission of the U.S. Agency for International Development (USAID) through the Irrigation Support Project for Asia and the Near East (ISPAN).

Starting in the 1960s, Thailand's economic growth rapidly outstripped that of other countries in the region. Between 1960 and 1985, Thailand's GDP expanded more than 18-fold, with a 7.5 percent annual growth rate for the period. This rate of development can be linked directly to the country's abundant resource base, its private sector-oriented economic policies, and its relative stability. However, it is becoming apparent that the resource base is being stressed; Thailand's land, water, fish, forests, and mineral resources cannot continue to support such rapid economic growth.

Conflicts over available water supplies dramatically illustrate the degree of over-exploitation that is starting to restrict the country's further economic growth. These problems are not limited to the more developed Central Plains; similar problems are starting to manifest themselves in both North and Northeast regions of the country.

North Thailand

The Mae Taeng area is both directly and indirectly affected by rapid economic growth in Chiang Mai Province. Direct impacts include rapid industrial investment in the subbasin itself, with more than 100 industrial plants in Mae Taeng District and an additional 40 plants in Chiang Dao District. In addition, a number of small tourist hotels, bungalows, and condominiums have been built in the subbasin to attract individuals who wish to get away from the hustle of Chiang Mai.

Rapid expansion in the valley has led to increased competition for available water. Unfortunately, water in the Mae Taeng canal has been seen simply as another water source and, as a result, nonagricultural users have installed pumping systems to extract water from the canal. The main offender has been the Chiang Mai Provincial Water Works Authority (PWWA). At present, the PWWA pumps about 600,000 m^3 of water from the Mae Taeng canal each month[1]. In addition, it estimated that there are over 1,000 pumps extracting water from the canal. The majority of these pump around 100 m^3 per month, but another set of larger users extracts more than 1,000 m^3 per month per unit. Conservative estimates are that another 200,000 to 300,000 m^3 per month are being pumped from the canal by private users. As expected, this much pumping from an irrigation canal has ramifications for water users downstream. The situation is now so serious that the Royal Irrigation Department (RID) is considering developing another irrigation weir on the Mae Khan[2] to serve Hang Dong and San Patong.

[1] PWWA also pumps another 600,000 m^3 each month from the Ping River and, with assistance from the Japanese government, will soon double its capacity there.

[2] The Mae Khan already has a number of water users on that river and its tributaries, and it is not certain that enough additional unused water is available to meet the needs of the more than 10,000 ha of land now receiving water from the Mae Taeng canal.

Mae Klang subbasin, a major tributary of the Ping River, was selected for this study since it represents a clear case of water conflict between upland and lowland water users. In the hill region above the valley, increased settlements and expanded populations have exacerbated conflicts over basin water supplies. In Chiang Mai Province alone, 1,062 hill settlements are presently located in areas of Class I watershed, wildlife sanctuaries, national parks, and public forest. Over the past five years, Chom Thong watershed has undergone serious changes, with 75 hill tribe settlements (10 located in the ecologically sensitive area) now permanently settled in Chom Thong. As a result of these new villages and the introduction of new crop practices such as cabbage production, Chom Thong has almost 900 ha in cabbage, which produce over 16,000 tons annually. Cabbage production systems compete directly with lowland farmers for dry season water. In addition to competing for scarce water supplies, the system of cultivating cabbage on steep slopes leads to erosion and sedimentation problems. An even more dangerous practice is indiscriminate use of agricultural chemicals.

The largest and most important river basin in Thailand is the Chao Phaya Basin, which serves primarily the Central Region. However, the headwaters for the Chao Phaya Basin originate in the mountain regions of the North. Flow in the Ping, Wang, Yom, and Nan Rivers in Northern Thailand to a large extent determine the quantity of water resources available to the Central Plains and Bangkok. Nowhere is this more apparent than in the flows from the Ping River (in the North) into Bhumiphol Dam. Data indicate that inflow into Bhumiphol has declined since 1975, primarily as a result of the Ping River's reduced flow. Declining inflow into the dam clearly reflects rapid economic development and growth of the upper North, particularly Chiang Mai Province, where the two subbasins studied are located. In addition to rapid expansion of municipal and industrial (M&I) water use in the Ping Basin and its tributary basins, irrigated area in the Ping Basin has more than doubled since 1975 and now exceeds 300,000 ha out of a total potential irrigated area of 625,000 ha. This indicates that flow in the Ping River will continue to decline and, if nothing is done, water shortages at Bhumiphol Dam are likely to be even more acute in the future.

Northeast Thailand

Northeast Thailand also covers 170,000 km^2, encompassing one-third of the country's land area. With a population exceeding 18 million people, this region contains one-third of the country's population as well. In contrast to the rest of the country, Northeast Thailand is classified semiarid tropics because of its longer dry season. The long dry season and wide rainfall variation from year to year make irrigation a necessity for much of the region. However, because of its rather limited water supplies, it is estimated that no more than 20 percent of Northeast agricultural land is even potentially irrigable.

The two subbasins selected for study in the Northeast are Lam Ta Khong subbasin in Nakhon Ratchasima Province and Huai Aeng subbasin in Mahasarakham and Roi Et provinces. Cassava production in the watershed area above Huai Aeng reservoir is a major cause of reservoir sedimentation. Sediment inflow into the reservoir continues to reduce the available storage: in the past 18 years, the reservoir has lost 20 percent of its storage capacity. This is a very common problem in Northeast Thailand and one that must be addressed if government is to obtain a positive return on its investment in medium- and small-scale irrigation systems.

However, Huai Aeng has an even bigger problem with respect to available water supply, as the nearby Thai Army camp pumps its water supply directly from the Huai Aeng reservoir. This large camp was pumping 4,000 m^3 per day in 1989, and with the recent expansion of the camp may pump as much as 20 percent of the reservoir's annual capacity in the future. Ironically, while pressure is being placed on farmers to pay for irrigation water supplies, water users at the military camp pay nothing for the water they pump.

Lam Ta Khong is a relatively wide and long subbasin that contains the second-largest city in Thailand, Nakhon Ratchasima. Here, many users compete for the available water. The Lam Ta Khong reservoir has a storage capacity of 310 MCM and was designed and built as an irrigation reservoir to serve a wet season area of 20,406 ha and a dry season area of 8,000 ha. Average annual inflow from

1969 to 1989 was approximately 259 MCM. At present, in addition to the irrigated area along the canal, official and unofficial M&I users and the Thai Army Division II camp are increasingly using a larger percentage of the available supplies.

The city of Nakhon Ratchasima pumps its water supply from the Lam Ta Khong as the river passes the city. Due to rapid industrial growth up the Lam Ta Khong subbasin and the population explosion in the city and surrounding district, Nakhon Ratchasima has seen available dry season water dwindle over the past few years. In order to address this problem, a direct pipeline from Lam Ta Khong reservoir to Nakhon Ratchasima's treatment plant is in the final stages of construction under World Bank funding. When the 60 km pipeline is completed, Nakhon Ratchasima's M&I water capacity will increase from 24,000 m^3 to 93,000 m^3 per day. More importantly, instead of having less opportunity to take water from the Lam Ta Khong, Nakhon Ratchasima will be able to pump directly from the reservoir, thus having first opportunity to take as much water as it requires. All other users, public and private, will have access to the remaining water after Nakhon Ratchasima.

Not only will access to the direct pipeline ensure Nakhon Ratchasima of sufficient dry season water, it will also help reduce its water-treatment costs, as many upstream users treat the Lam Ta Khong River as a drain to dispose of wastewater. By the time the river has passed the city of Pak Chong and over 100 industrial plants on its 100 km trip down the basin, water quality is very marginal. The direct pipeline for Nakhon Ratchasima will significantly reduce its water treatment costs, while imposing an additional cost on the other users as their treatment requirements will increase dramatically.

Although a number of factors have led to Thailand's present water crises, the major factor and the one that must be faced before the problem will be finally resolved is the lack of a single planning and guiding authority, at either basin or national level. In Thailand, water resource development is implemented by 34 agencies and 17 committees under 8 ministries. Yet Thailand has no national water plan nor national agency overseeing and coordinating water-resources development in the country. This situation is compounded by the lack of legislation that clearly defines the rights and duties of riparian users. None of the five laws that relate to surface water management specify the rights and duties of water users, nor do the present laws actually establish water rights that would preclude over-allocation of the available supply. Thirty-four agencies, all attempting to fulfill their own narrow mandates, severely restrict effective development of multipurpose projects. On the other hand, the private sector, survival of which depends on water resource development, has little say in its future direction.

River Basin Water Management Proposal

As indicated, Thailand's present administrative structure does not encourage resource management and development on a basinwide basis. In order to examine larger basinwide issues, this study proposes to establish, on a trial basis, River Basin Water Management Committees for the Ping River in North Thailand and the Mun River in Northeast Thailand. In order to ensure that all concerned provinces are directly involved in the deliberations of the committees, they will be chaired on a rotating basis by the respective provincial governors (four in the Ping Basin and five in the Mun Basin). The water management committees will work very closely with the respective Provincial Committees for Natural Resource Management.

To help the committees understand the issues, five subbasins will be selected in each of the two regions. Local data-collection staff from Khon Kaen and Chiang Mai Universities will be stationed for two years at these locations to help involved agencies collect data needed for planning and operational purposes. Where there is conflict over water allocations, the study teams will collect information required to resolve the problem.

The study is designed to operate for three years, recognizing that the types of institutional change envisioned cannot be accomplished very rapidly. The first year and a half will see more emphasis on data collection, mapping, and documentation of supply-demand relationships. The latter part of the second year and early part of the third year will involve more concentration on improving the working of the water basin committees and helping them make some of the critical decisions. The latter half of the

final year will see a concentration on policy changes and policy makers at the Bangkok level, with some of the focus placed on identifying and defining legal issues that must be addressed in order to have effective basinwide water allocation. At this stage, the research project will work jointly with the Thailand Development Research Institute (TDRI) to ensure that the results are incorporated into policy recommendations developed by the institute.

Insights gained from committee actions (and lack of actions) will help define institutional and legal constraints to optimal management of Thailand's water resources. At the rate Thailand's economy is growing, these insights will soon be required to design the new institutional, legal, and administrative system that Thailand must have to ensure enough water to maintain steady economic growth over the coming decades.

Eventually, Thailand will require some form of river basin authority or administrative entity. The experience from this pilot study then can be used directly when it becomes necessary to establish some form of basin administrative organization. Similarly, in the Northeast there will be a need for an administrative entity to monitor and allocate water resources in the Mun and Chi basins and also in the smaller subbasins as economic growth stretches the supplies in the smaller basins.

1

PRESENT SITUATION

The Irrigation Support Project for Asia and the Near East (ISPAN) has already provided technical assistance to the Bangkok Mission of the U.S. Agency for International Development (USAID) in the form of conceptualization, design, and conduct of a four-month applied study of the Northeast Small Scale Irrigation Project (NESSI). The study assessed the NESSI experience and looked ahead to the requirements of medium-scale irrigation in Northeast Thailand within the context of rapidly expanding private-sector involvement in water management, extension, and marketing. ISPAN employed an innovative and cost-effective method, using limited expatriate involvement and emphasizing the use of local experts, particularly staff from Khon Kaen and Kasetsart Universities.

The present basin water-management study results from problems identified during the NESSI study. Development of the study proposal was funded through an ongoing relationship between USAID/Bangkok and ISPAN, with ISPAN providing technical assistance in irrigation and natural resource management. (Appendix A contains the scope of work for the study preparation.)

Since the 1960s, Thailand's economic growth has rapidly outstripped that of other countries in the region. In fact, Thailand has had one of the most dynamic economies in the world during the past quarter century: between 1960 and 1985 (based on current prices), Thailand's GDP expanded more than 18-fold with a 7.5 percent annual growth rate. This rate of development can be linked directly to the country's abundant resource base, its private sector-oriented economic policies, and its relative stability. For 1990, the Royal Thai Government (RTG) is predicting an annual GDP growth rate in excess of 13 percent. However, it is becoming apparent that the resource base is being stressed: air and water pollution, erosion and sedimentation, forest destruction, declining fish populations, toxic wastes, and water scarcity are all signs of over-exploitation of Thailand's resource base. Thailand's land, water, fish, forests, and mineral resources cannot continue to support such rapid economic growth.

Water conflicts dramatically illustrate the degree of over-exploitation that is starting to restrict the country's further economic growth. Phuket, with its world-famous beaches and lovely islands, now faces water shortages and pollution problems because hotels are not required to provide water and sewerage treatment facilities. Pattaya, a popular beach resort south of Bangkok, has been a major source of foreign exchange over the past two decades; it is now being forced to truck in domestic water. And while farmers cultivating over 200,000 ha of dry season crops in the Central Plains are crying for water, the Energy Generating Authority of Thailand (EGAT) refuses to release any more, as the water is required for energy generation and for the rapidly expanding municipal and industrial (M&I) needs of Bangkok and its surrounding area. However, these problems are not limited to the Central Plains; similar problems are starting to manifest themselves in both North and Northeast regions of the country (Figure 1). These water conflicts provide an excellent example of the future if Thailand does not address its water allocation problems. To have long-term sustainability of its economy, Thailand needs to change the way development is planned and managed.

Although a number of factors have led to Thailand's present water crises, the major factor, and the one that must be faced before the problem will finally be resolved, is the lack of a single planning and guiding authority at either basin or national level. In Thailand, water-resource-development activities are implemented by 34 agencies and 17 committees under 8 ministries (see Table 1). Yet, Thailand has no national water plan nor agency overseeing and coordinating water-resources development in the country. This situation is compounded by the lack of legislation clearly defining the rights and duties of riparian users. None of the five laws relating to surface water management specify water user rights

and duties, nor do the present laws actually establish water rights that would preclude over-allocation of the available supply. Thirty-four agencies, all attempting to fulfill their own narrow mandates, severely restrict effective development of multipurpose projects. On the other hand, the private sector, survival of which depends on water resource development, has little say in its future direction.

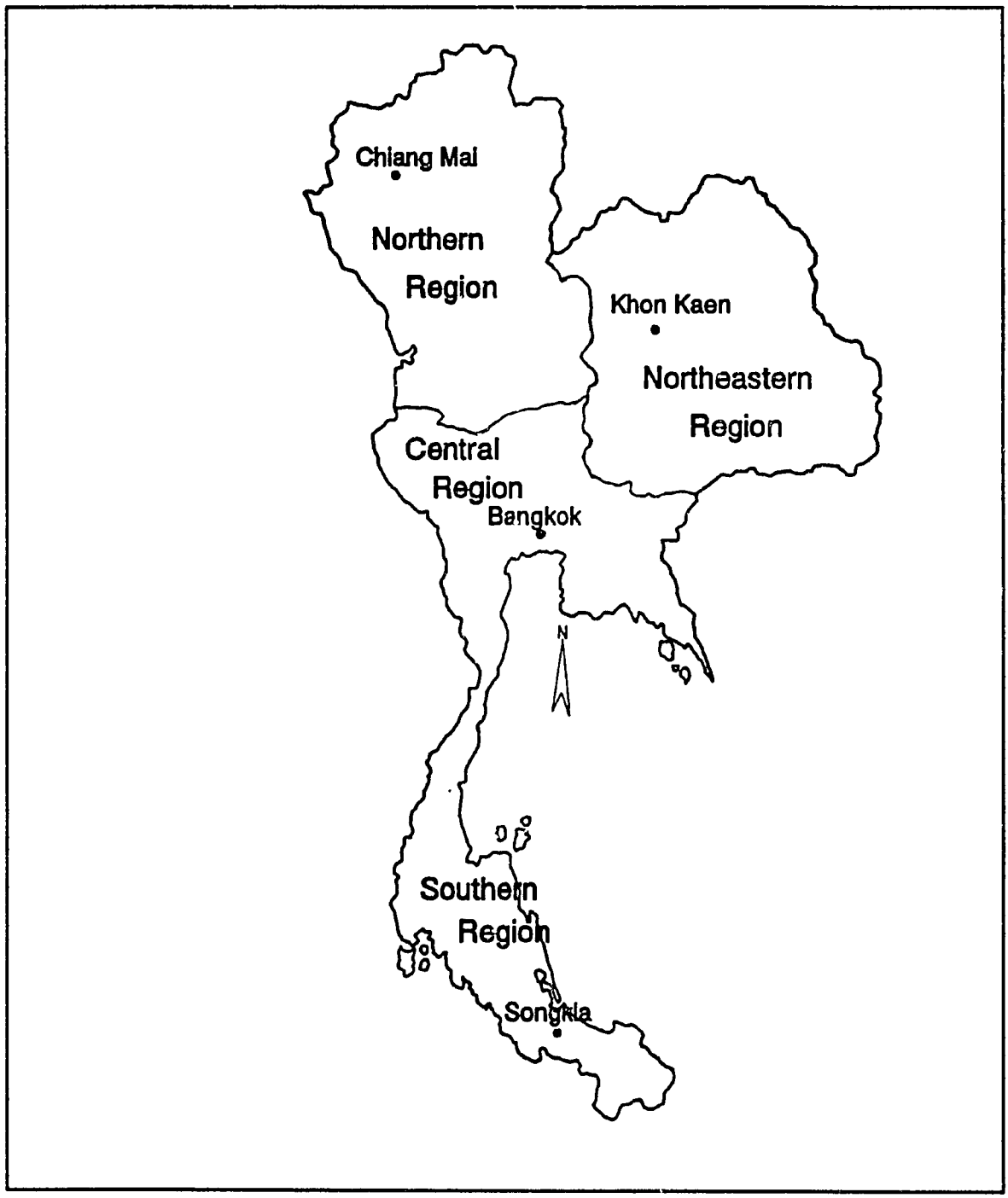

Figure 1. Regional Map of Thailand

Table 1

Agencies Involved in Water Resource Development

Ministry of Agriculture and Coops

Office of the Permanent Secretary
Royal Irrigation Department
Dept. of Agricultural Extension
Dept. of Agriculture
Royal Forestry Department
Land Development Department
Coops Promotion Department
Department of Fisheries
Dept. Of Livestock Development
Agricultural Land Reform Office
Royal Rain Making Research and Development Institute

Ministry of Interior

Local Administration Department
Dept. of Public Works
Dept. of Public Welfare
Office of Accelerated Rural Development
Dept. of Community Development
Department of Lands
Metropolitan Water Works Authority
Provincial Water Works Authority

Ministry of Public Health

Department of Health

Ministry of University Affairs

Khon Kaen University
Kasetsart University

Office of Prime Minister

Electricity Generating Authority
Rural Employment Generating Committee

Ministry of Industry

Department of Mineral Resources
Department of Industrial Wastes

Ministry of Communications

Department of Harbors
Meteorological Department

Ministry of Defence

Naval Hydrographic Department
National Security Command Headquarters
Royal Thai Army

Ministry of Science, Technology & Energy

National Energy Administration
National Environment Board
National Research Council

Source: Thailand Development Research Institute. Thailand Natural Resources Profile. Bangkok, May 1987.

2

NORTHERN THAILAND

Northern Thailand covers an area of 170,000 km^2, approximately one-third of Thailand's total land area. Geographically, the North Region can be divided into two subregions, the Upper and the Lower North. The Upper North contains the main watersheds of the country; the Lower North includes the alluvial plains and terraces that comprise the upper delta of the Chao Phaya River. Both Upper and Lower North contain a number of river basins in which extensive irrigation projects have already been developed. River basins in the North can be divided into international basins that provide part of the flow of such rivers as the Salaween (Burma), the Mae Kok (Laos and Burma), and the Mae Khong (Laos and Burma) and national basins that eventually provide most of the flow in the Chao Phaya River. The first table in Appendix B provides a partial list of basins and subbasins in Northern Thailand.

In the North, water problems are becoming more apparent. Competition for water for agriculture, energy, M&I requirements, tourism, industry, and fresh-water fish production can be found in a number of the region's basins and subbasins. Particularly problematic are situations where upland agricultural development, such as poppy-replacement programs, are leading to direct competition with already-established communal and public irrigation systems. Similarly, efforts to promote international tourism and economic development in the more isolated parts of the North are stretching available water supplies and causing conflict with local ethnic groups as well as farmers. The problem is further compounded by deforestation, which results in microclimatic changes and declining rainfall and runoff levels.

In the upper Ping Basin, it is estimated that irrigation by community weirs has taken place for over 700 years. The use of groundwater for supplemental irrigation is equally old, although it has not been widespread due to higher per-unit costs in the past. Along with the more recent development of medium- to large-scale surface water projects, Chiang Mai Province has the highest percentage of irrigated land in Northern Thailand. The subbasins selected for this exercise, Mae Taeng and Mae Klang (see Figure 2), are both in Chiang Mai Province and are tributary to the Ping River. Table 2 details some of the subbasins in Chiang Mai and Lamphun provinces. Within the two selected subbasins, there exists extensive public and private irrigation development. The largest public scheme in the two basins is the Mae Taeng Irrigation Project. There are no large-scale public irrigation systems in Mae Klang, but the Royal Irrigation Department (RID) does operate four reservoirs and two medium-scale irrigation schemes in the district.

Table 2

Partial List of Subbasins in Chiang Mai and Lamphun Provinces

Name	Length (km)	Area (km^2)
Mae Kok[1]	180	12,0001
Mae Fang	70	1,920
Mae Ngon	22	N.A.
Mae Thalop	21	N.A.
Mae Soon	20	N.A.
Huai Mae Jo	12	N.A.
Mae Taeng	135	2,340
Mae Ngad	100	1,368
Mae Kuang	95	1,842
Mae Pang	20	N.A.
Mae Long Kad	20	N.A.
Huai Mae Soon	24	N.A.
Mae On	37	N.A.
Mae Tha	90	1,082
Mae Khan	85	1,865
Mae Sapok	30	N.A.
Mae Wang	40	680
Mae Klang	32	595
Mae Ya	20	N.A.
Huai Mae Tia	5	N.A.
Mae Cham	170	3,941
Mae Tuen	150	3,160

[1] Includes some land in Burma
N.A. Not available

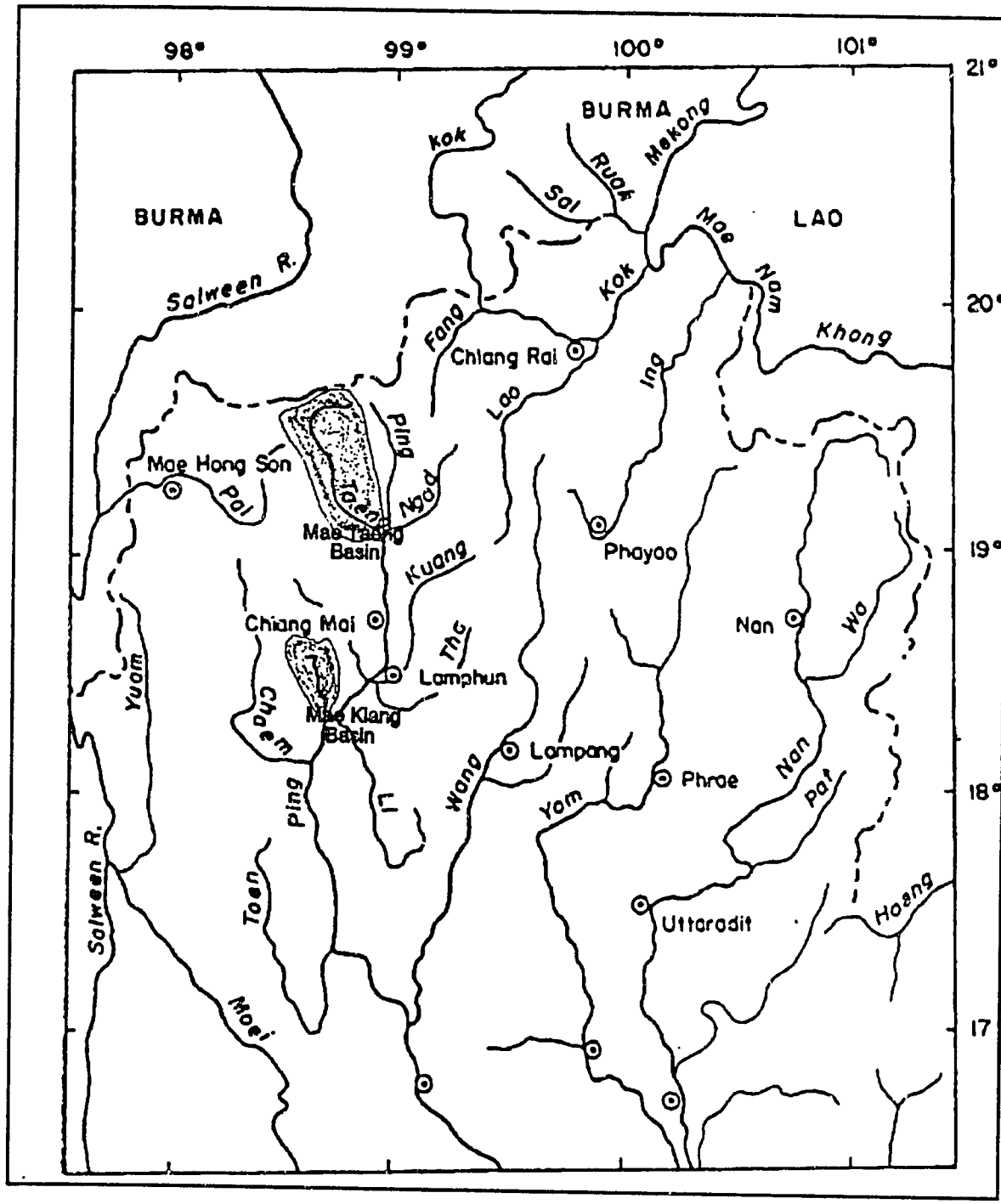

Figure 2. Location of Subbasins in North Thailand

Mae Taeng

The Mae Taeng subbasin is approximately 135 km long and is drained by the Mae Taeng River. The river originates in the mountains about 1,500 m above MSL and flows through the subbasin. The Mae Taeng irrigation weir diverts water into the Mae Taeng canal at 375 m above MSL, and then the Mae Taeng flows on for another 8 kms before it flows into the Ping River at 330 m above MSL. Water was first delivered in the Mae Taeng irrigation project in 1967, but the entire project was not completed until 1973. The Mae Taeng canal runs more than 70 kms along the west side of the Chiang Mai Valley and is designed to serve 28,000 ha of land in five districts: Mae Taeng, Mae Rim, Muang, San Patong, and Hang Dong.

Mae Taeng area is both directly and indirectly affected by rapid economic growth in Chiang Mai Province. Direct impacts include rapid industrial investment in the subbasin itself, with more than 100 industrial plants in Mae Taeng District and an additional 40 plants in Chiang Dao District. In addition, a number of small tourist hotels, bungalows, and condominiums have been built in the subbasin to attract those wishing to get away from the hustle of Chiang Mai. Indirect impacts result primarily from the fact that the Mae Taeng canal serves land in five districts including Hang Dong and San Patong, which are south of Chiang Mai City. With extensive public and private water development in the subbasin, Mae Taeng project staff have worked hard to maintain flows in the irrigation channel. As can be seen in Figure 3, maintaining canal flows over the past 14 years has reduced the water passing over the weirs. This reduction, combined with a similar situation in Mae Faek irrigation scheme and increased pumping by the provincial water works authority (PWWA), has resulted in a serious decline in the Ping River flow as it passes Chiang Mai.

Rapid expansion in the valley has led to increased competition for the available water. Unfortunately, water in the Mae Taeng canal has been seen as simply another water source and, as a result, nonagricultural users have installed pumping systems to extract water from the canal. The main offender has been the Chiang Mai PWWA, which at present pumps about 600,000 m^3 of water from the Mae Taeng canal each month[3]. In addition, it estimated that there are more than 1,000 pumps extracting water from the canal; the majority of these pump around 100 m^3 per month, but another set of larger users such as the Chiang Mai Phucome Hotel, Chiang Mai University, and numerous condominiums extract over 1,000 m^3 per month per unit. Conservative estimates are that another 200,000 to 300,000 m^3 per month are being pumped by private users.

As expected, this much pumping from an irrigation canal has ramifications for water users downstream. In the case of the Mae Taeng, water users in Hang Dong and San Patong districts are finding it more and more difficult to get enough water to grow a dry season crop. Figure 4 graphically illustrates the shortfall in water supplies for the dry season. In some cases, partial relief has been provided as previously irrigated land has been sold and converted to housing, thus proportionally reducing the magnitude of irrigation water demanded. The question then arises, How many farmers have been forced to sell their land because the irrigation system could not provide enough water? Certainly, many farmers have been forced to buy expensive wells to replace irrigation water siphoned off as the canal runs through the valley. The situation is now so serious that RID is considering developing another irrigation weir on the Mae Khan[4] to serve Hang Dong and San Patong.

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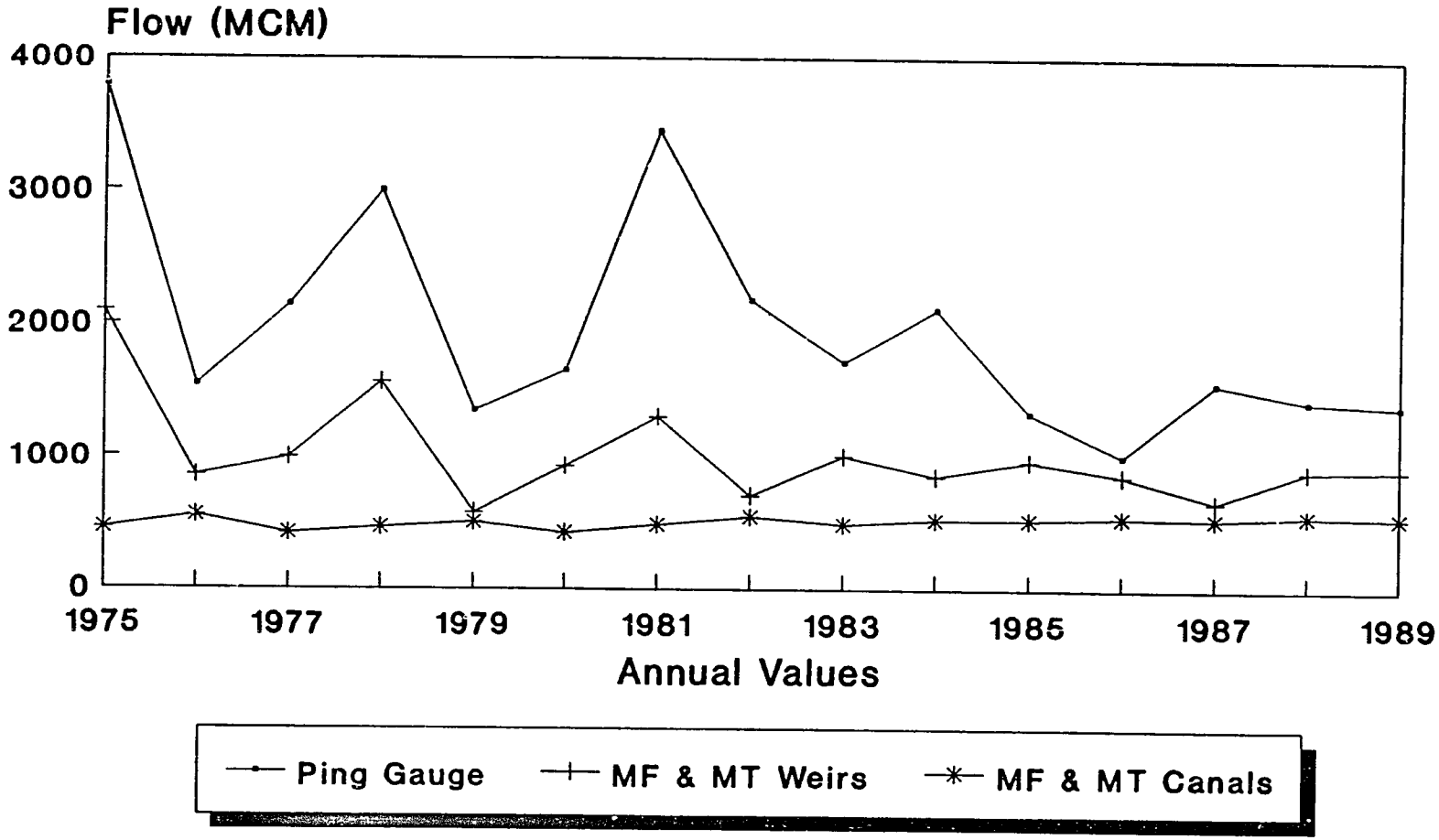
[3] The PWWA is also pumping another 600,000 m^3 of water each month from the Ping River and, with assistance from the Japanese government, will soon double its pumping capacity there.

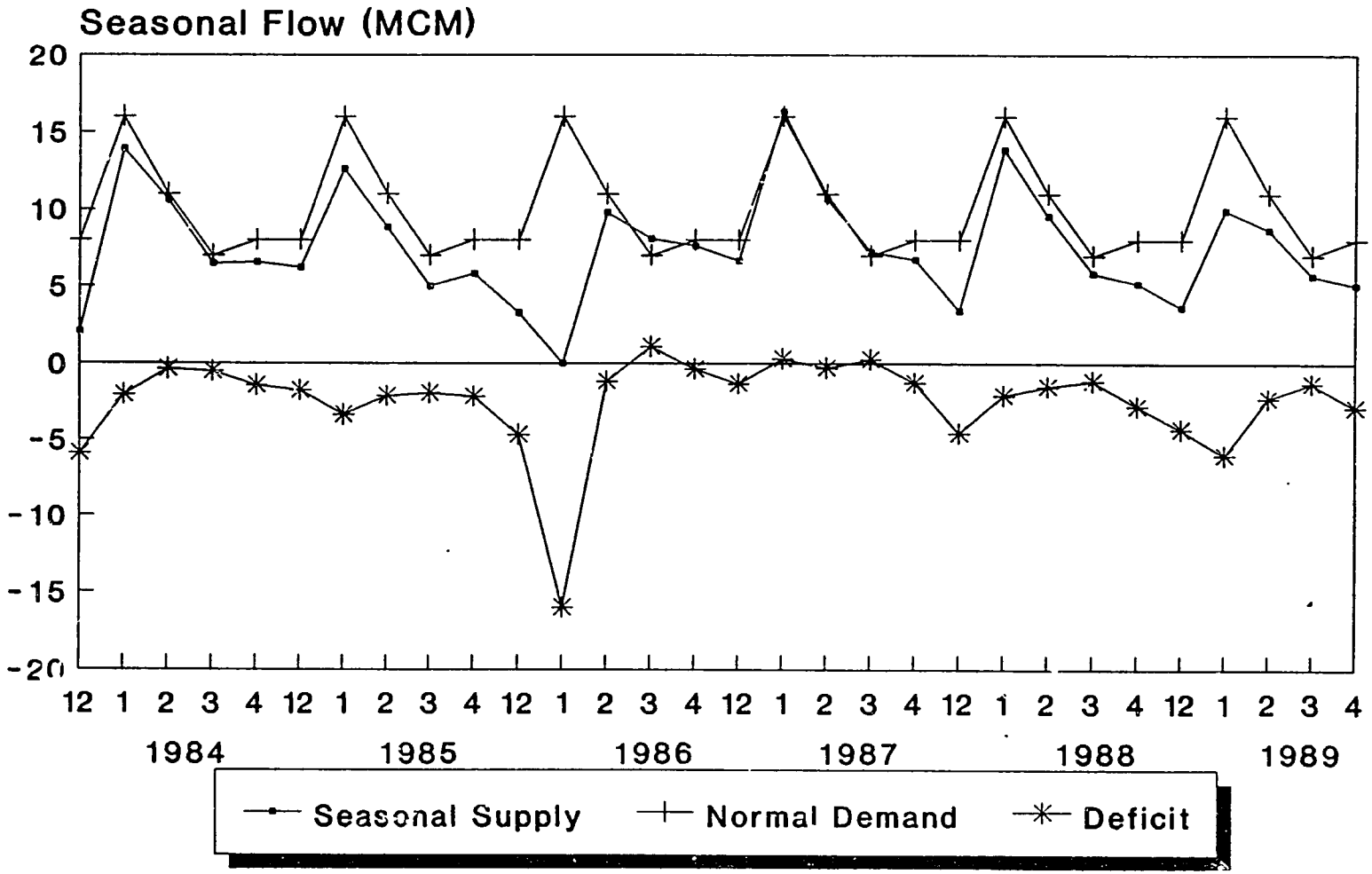
[4] The Mae Khan already has a number of users of water from that river and its tributaries and it is not obvious there is enough additional, unused water available to meet the needs of the more than 10,000 ha of land now receiving water from the Mae Taeng canal.

Figure 3. Comparison of Flow on Mae Ping at Mae Taeng and Mae Faek



Data From RID Region 1 Office-Chiang Mai
Ping Measured at Naowarat Bridge
Quantity at weirs is flow to Ping River

Figure 4. Mae Taeng Water Supply and Demand
San Patong and Hang Dong Areas



Water *quality* problems are also becoming much more apparent, as individual households, condominiums, and organizations are allowing untreated wastewater to flow back into the canal. Combined with the increased use of potentially dangerous agricultural chemicals in the Mae Taeng subbasin and in the irrigated areas along the canal, untreated wastewater is rendering the canal water almost undrinkable by the time the water flows south of the city. Again, families and villages that have used this water for domestic purposes are being forced to look for other, more expensive sources.

Even with expanded pumping from the Mae Taeng irrigation canal and the Ping River, Chiang Mai's population growth combined with rapidly expanding tourism and industrial development has created a situation where water consumption from the PWWA has been increasing by 10 percent per year. Supply and demand statistics for recent years (Figure 5) show that even after the latest expansion in system capacity, PWWA still operates at or above full capacity[5].

Only about 65 percent of the households are being served by the city water supply system. The other 35 percent depend upon other water sources, such as groundwater and direct pumping from the Mae Taeng irrigation canal. Although estimates suggest that there are over 6,000 groundwater wells in the city and suburbs, no regulation requires that wells be registered, so this number could significantly underestimate the actual total. Around 80 percent of these wells are used for domestic consumption. Because pumping removes about 15,000 to 18,000 m^3/day (with an average recharge rate of 10,000 to 13,000 m^3/day), the piezometric surface has been declining at a rate of 0.5 to 1.5 m/year depending upon the location. As a result, some shallow wells have been abandoned and the users (when possible) have shifted to the city water supply or to pumping from the irrigation canal.

The other 20 percent of the groundwater wells are large, deep wells serving industry, tourist hotels, and condominiums. Although these wells are having no problems with water supply, long-term monitoring indicates a slowdown in the rate the water table returns to its normal level. As the city continues to grow and the rate of pumping increases, some groundwater users will be forced to shift to the city supply. This will place additional pressure on the city's capacity to meet its water requirements.

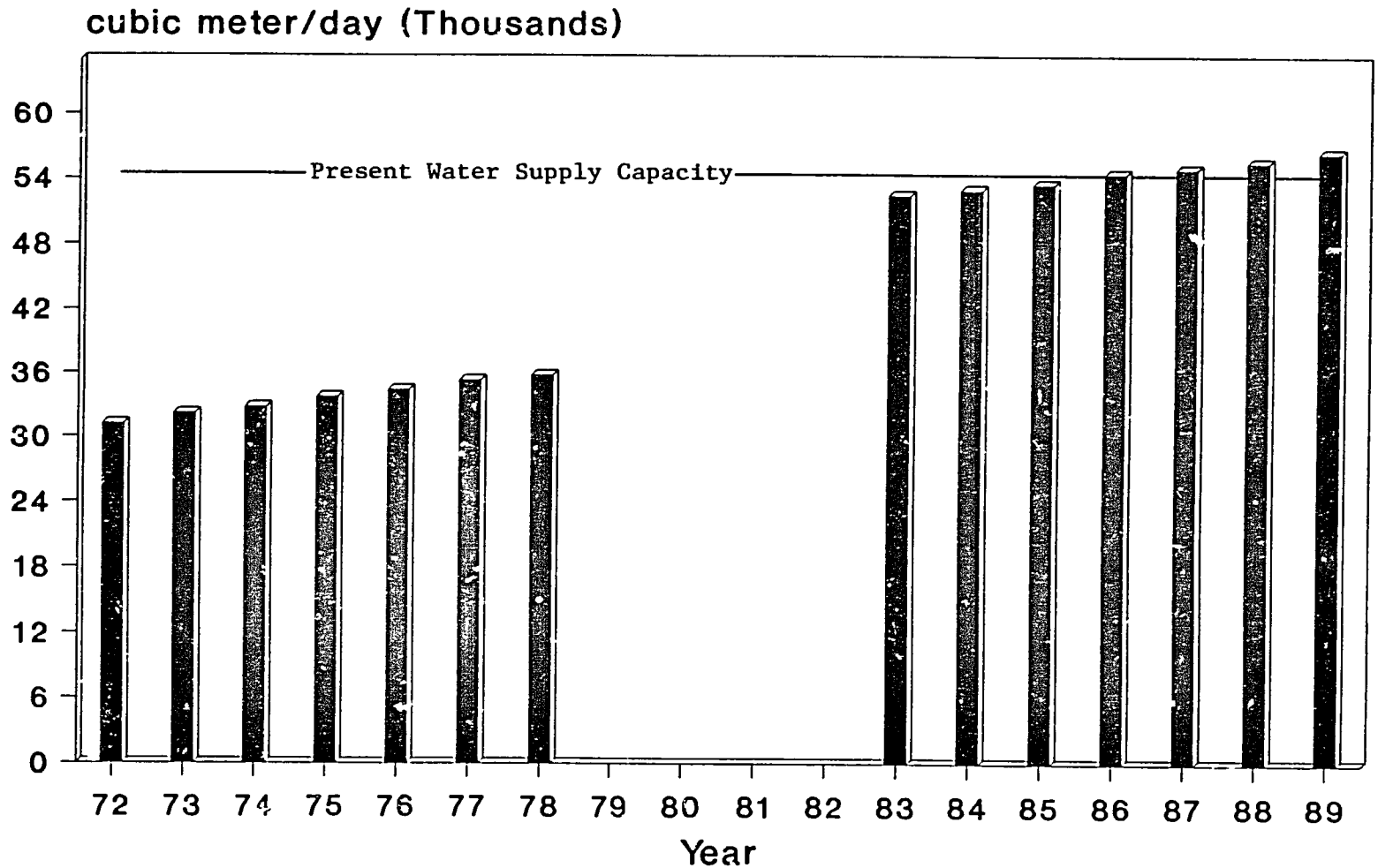
Mae Klang

Mae Klang subbasin, a major tributary of the Ping River, was selected for this study because it represents a clear case of water conflict between upland and lowland water users. Originating from the western range or Inthanon, which stretches north-south along the Thailand-Burma border, the river of Mae Klang feeds a valley agriculture of about 7,000 ha. The highest peak of Inthanon is about 2,500 m, and the rugged mountains stretching southward from Chiang Mai City are rich sources of tropical and subtropical rain forest, wildlife, and water. Mae Klang River is 23 k long, with two-thirds of its length running through steep hills before dropping downward to serve the small valley prior to entering the Ping River. Historically, the subbasin's largest city (Chom Thong) is believed to be an autonomous settlement dating back over five centuries, and the hill region has been home to Lua and Karen tribal groups for several hundred years.

Generally, rainfall ranges between 900 and 1,200 mm and has a similar pattern to Chiang Mai-Lamphun Valley. Conditions are favorable for rice, cash crops. and fruits and can sustain multiple-cropping agriculture when irrigation water is available. Rice production depends mainly on small, private/communal irrigation systems. Newly developed agricultural land in the upland areas is cultivated under rainfed conditions. There are over

[5] As indicated, the Japanese government is helping the PWWA expand its pumping capacity, and by 1991, the authority will be able to pump an additional 600,000 m^3 per month (or approximately 20,000 m^3 per day) from the Ping River.

Figure 5. Supply and Demand Statistics PWWA Chaing Mai City



After Teerawash Intrasta

20 communal irrigation systems diverting water from four subbasins, including Mae Klang. In lowland areas of Mae Klang Basin, increased land in intensive agriculture and expansion of cultivated land have strained available water resources and resulted in a greater chance of conflict between upstream and downstream farmers during the dry months (January to April). The short-term solution to this problem has been to use a pumping system to serve Mae Klang's tail section.

In the hill region above the valley, increased settlements and expanding populations (2.5 to 4.5 percent) have exacerbated conflicts over basin water supplies. With an estimated population of 4,000 families (average family size of 5 to 6 people), hill people now use 18,000 ha to support themselves. This expansion has become a major threat to basin water resources, as reliability of supply has been dropping all over the North Region as a result of watershed damage and deforestation. In Chiang Mai, a total of 1,062 hill settlements are presently settled in areas of Class I watershed, wildlife sanctuaries, national parks, and public forest. Over the past five years, Chom Thong watershed has undergone serious changes, with 75 hill tribe settlements (10 located in the ecologically sensitive area) now permanently settled in Chom Thong. (See Table 3.)

These new villages and the introduction of new crop practices—such as cabbage production to reduce the area in poppies—have brought lowland and upland farmers of Chom Thong into direct competition. Out of about 5,000 ha planted in cabbages in North Thailand, it is estimated that Chom Thong has almost 900, producing more than 16,000 tons of cabbage annually. Cabbage production systems compete directly with lowland farmers for dry season water supplies. In addition, the system of cultivating cabbage on steep slopes leads to erosion and sedimentation problems downstream, which increase the maintenance cost of the communal irrigation systems. An even more dangerous practice is indiscriminate use of agricultural chemicals, which creates a health hazard to Chom Thong's drinking water.

As can be seen from the letter sent by the Chom Thong Watershed Conservation Club to the Prime Minister (Appendix C), the local organization at Chom Thong is well organized and powerful. This organization has reported four major problems in the Mae Klang Basin: irrigation water shortage, sedimentation, toxic chemical runoff, and poisoned drinking water. The present problems result from conflicting policies on watershed conservation and on highland agricultural development. Moreover, Mae Klang's current situation reveals that previous development schemes have pushed two communities into a confrontation when triple cropping is encouraged in the lowland and year-round cabbage cultivation in the highland. Without a careful basin water-resource design, conflict in such cases is almost inevitable. Even now, intensive development in the upper and lower basin is starting to reduce average annual flow in the Mae Klang (Figure 6).

The largest and most important river basin in Thailand is the Chao Phaya Basin, which primarily serves the Central Region. However, the headwaters for the Chao Phaya Basin originate in the mountain regions of the North. Flow in the Ping, Wang, Yom, and Nan Rivers in Northern Thailand determine, to a large extent, the quantity of water available to the Central Plains and Bangkok. Therefore, even though this study selected subbasins in the North and Northeast regions, it must be recognized that the Northern and Central regions are hydrologically linked. Nowhere is this link more apparent than in the flows from the Ping River (in the North) into Bhumiphol Dam, one of the two major large-scale dams supplying the Central Plains and Bangkok. From Figure 7, it is clear that inflow into Bhumiphol has experienced a decline since 1975.

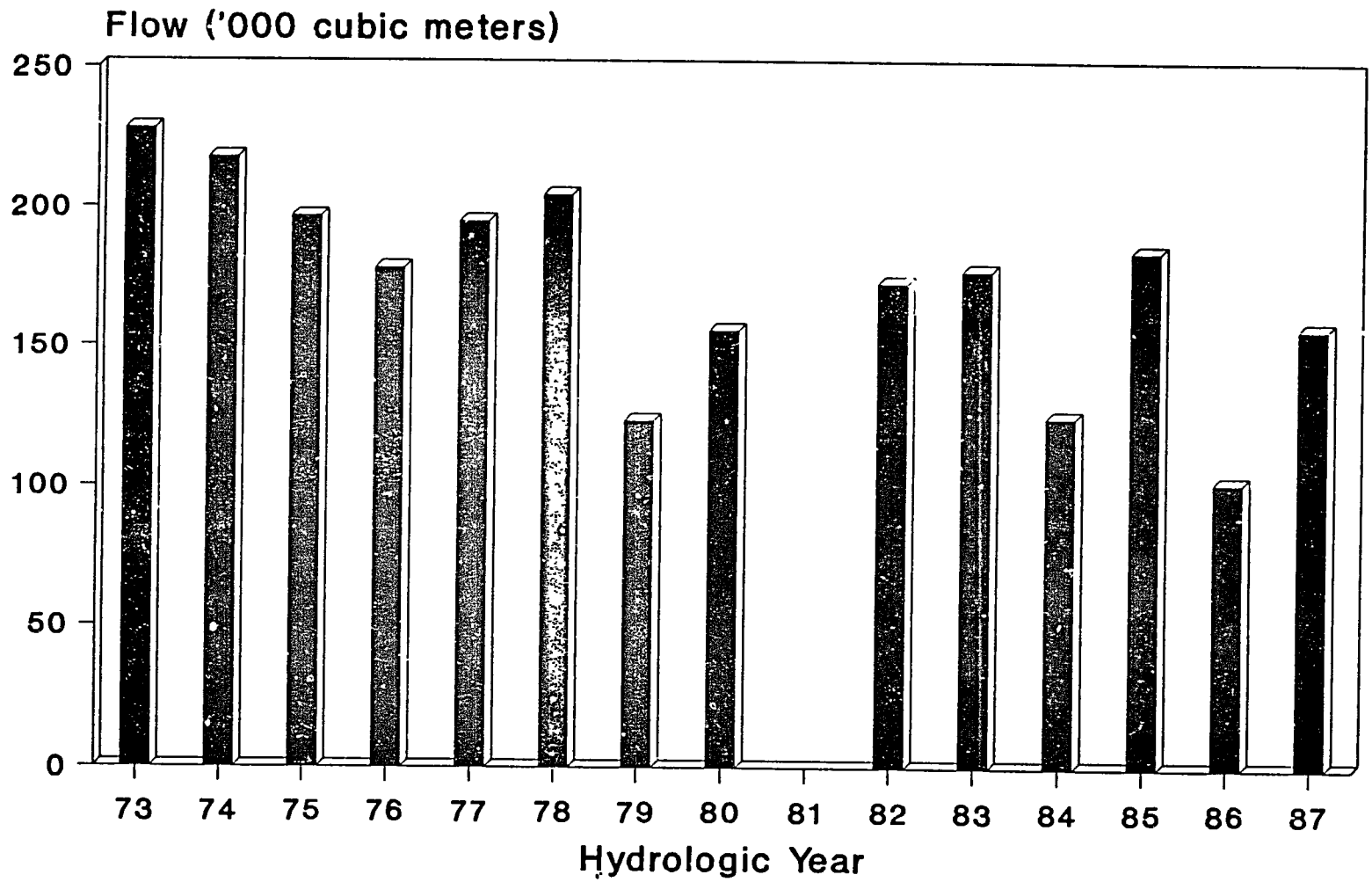
Declining inflow into Bhumiphol Dam clearly reflects rapid economic development and growth of the upper North, particularly in the province of Chiang Mai, where the two subbasins studied are located. In addition to rapid expansion of M&I water use in the Ping Basin and its tributary basins, there has been a doubling of irrigated area. Since 1975, irrigated area in the Ping Basin has more than doubled and now exceeds 300,000 ha out of a total potential irrigated area of 625,000 ha. In addition, industrial development has spread out of Chiang Mai City and its suburbs and can now be found expanding rapidly in the subbasins of the tributary rivers, such as the Mae Taeng and Mae Klang. This indicates that flow in the Ping River will continue to decline and that water shortages at Bhumiphol Dam are likely to be even more acute in the future.

Table 3

Hill Population and Forest Settlement in Chiang Mai (1986)

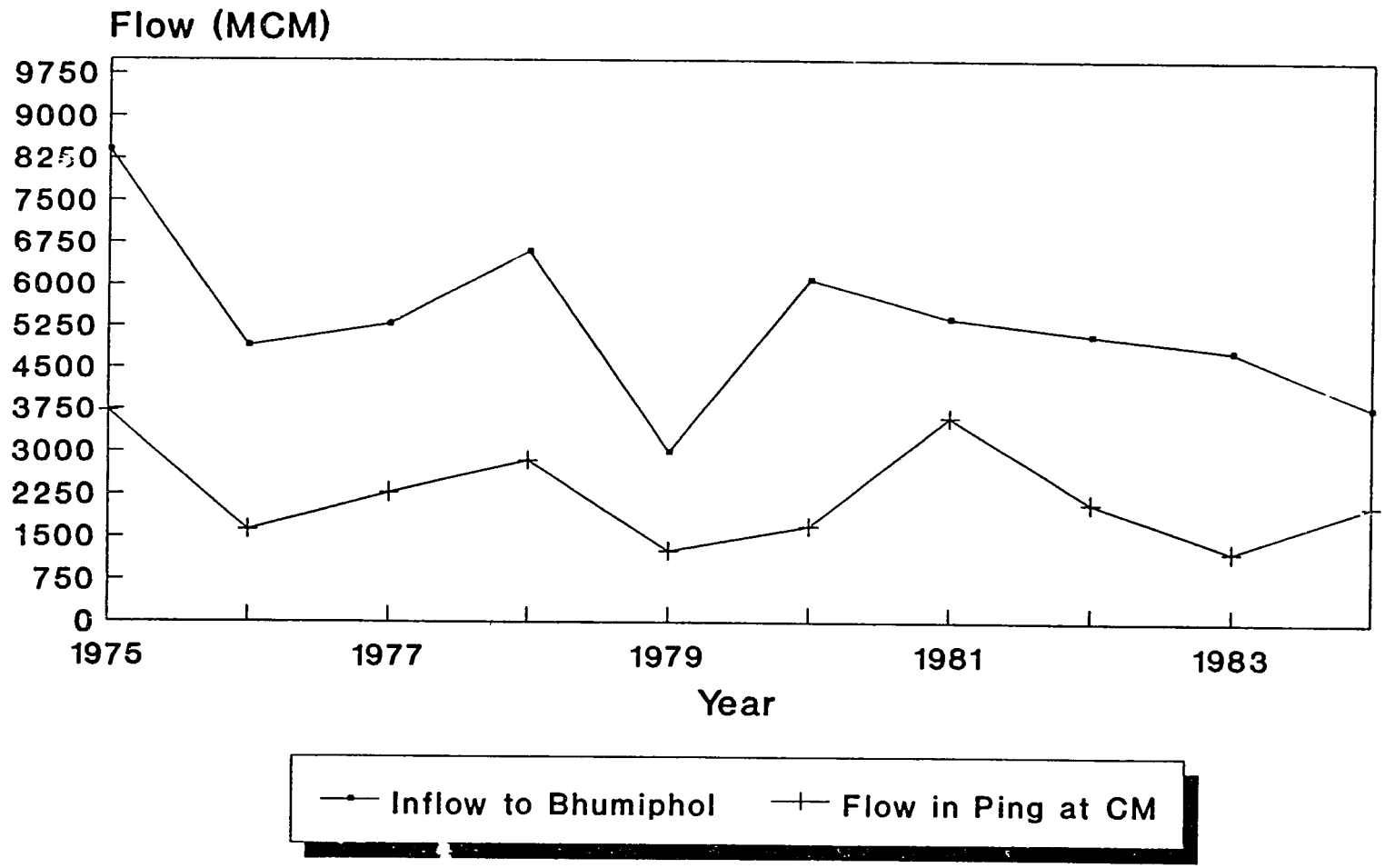
No.	District	Total Number of Settlements	Watershed Class I		Wildlife Sanctuary		National Park		Major National Park		Public Forest	
			Settlements	%	Settlements	%	Settlements	%	Settlements	%	Settlements	%
1	Mae Ai	78	27	34.62	-	-	-	-	-	-	51	65.38
2	Fang	54	10	18.52	-	-	-	-	-	-	44	81.48
3	Chiang Dao	85	10	11.75	15	17.65	4	4.71	-	-	56	65.88
4	Phrao	43	14	32.56	-	-	-	-	-	-	29	67.44
5	Mae Taeng	64	7	7.14	-	-	-	-	-	-	57	89.06
6	Mae Rim	14	1	20.75	-	-	2	14.29	4	28.57	7	50.00
7	Samoeng	53	11	-	-	-	-	-	-	-	42	79.25
8	Muang	1	-	-	-	-	-	-	1	100.00	-	-
9	Sankampaeng	7	-	-	-	-	-	-	-	-	7	100.00
10	Doi Saket	2	-	-	-	-	-	-	-	-	2	100.00
11	Hang Dong	7	-	-	-	-	-	-	6	85.71	1	14.29
12	San Patong	40	4	10.00	-	-	11	27.50	3	7.50	22	55.00
13	Chom Thong	75	10	13.33	-	-	14	18.67	17	22.67	34	45.33
14	Hod	69	7	10.14	-	-	-	-	-	-	62	89.86
15	Doi Tao	13	-	-	-	-	-	-	-	-	13	100.00
16	Mae Chaem	217	6	2.76	-	-	5	2.30	8	3.69	198	91.24
17	Om Koi	228	9	3.95	53	23.25	-	-	-	-	166	72.80
18	King Wiang	12	4	33.33	8	66.67	-	-	-	-	-	-
	Total	1,062	120	1.13	76	7.16	36	3.39	39	3.67	791	74.48

Figure 6. Annual Flow in Mae Klang at Ban Muang Klang



Data from Thailand Hydrologic Yearbook

Figure 7. Bhumiphol Dam and Ping Flow Annual Flow Values



Data taken from RID, Thailand
Hydrologic Yearbook various years

3

NORTHEAST THAILAND

Like Northern Thailand, Northeast Thailand also covers 170,000 km^2 and encompasses one-third of the country's land area (Figure 1). With more than 18 million people, it contains one-third of the population of the country as well. In contrast to the North region, Northeast Thailand drains not into the Chao Phaya River but into the Mae Khong near the city of Ubol, due to the natural barrier created by the Korat Plateau. Northeast Thailand has three major basins: one international basin along the Mae Khong and two internal basins along the Mun and Chi Rivers that eventually join the Mae Khong. Table B-2 in Appendix B provides a partial list of the region's basins and subbasins.

Northeast Thailand is no stranger to water problems, as its semiarid climate features more frequent droughts than the North experiences. Competition for water for agriculture, energy, M&I requirements, tourism, and fresh-water fish production can be found in every basin and subbasin in the region. Particularly problematic are situations where agricultural development for cassava replacement and reforestation programs are leading to direct competition with already established irrigation systems. Efforts to promote tourism and economic development are also seriously stretching the region's limited water supplies, especially those in the medium-scale irrigation reservoirs. These problems are particularly acute in the Northeast, where deforestation has been the most severe (see Figure 8).

Erratic rainfall and generally poor soils contribute to low agricultural production and slow economic growth in Northeast Thailand. With low production levels and high population, the region's per capita income is the lowest in the country. With its longer dry season, Northeast Thailand is classified semi-arid tropics, in contrast to the rest of the country. The longer dry season and wide rainfall variation from year to year make irrigation a necessity for much of the region. At present, of the 9.37 million ha cultivated, about .93 million have some form of public or private irrigation. Unfortunately, because of its rather limited water supplies, no more than 20 percent of the Northeast's agricultural land is estimated to be even potentially irrigable.

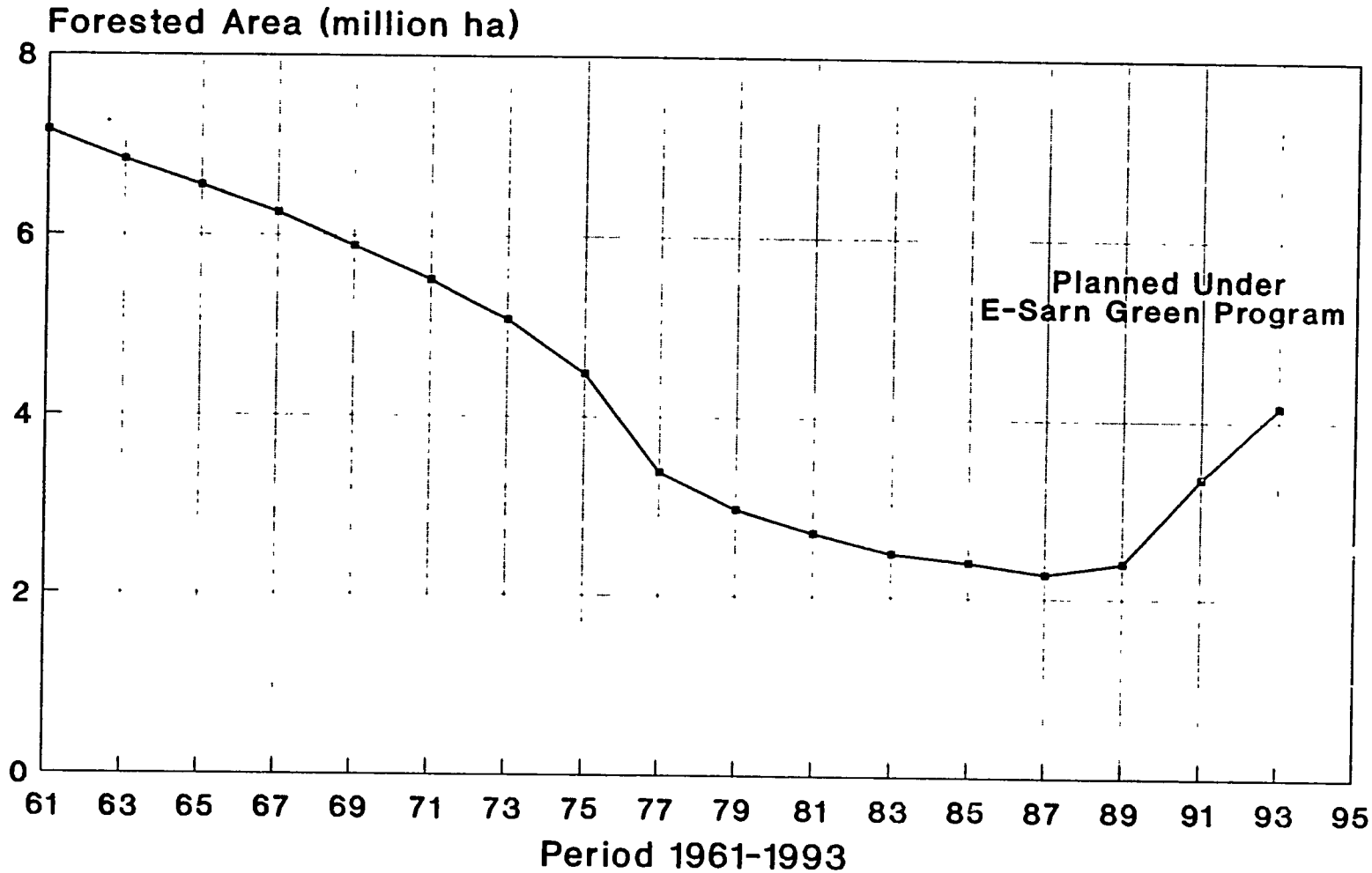
The two subbasins (Figure 9) selected for study in the Northeast represent widely divergent sets of issues: Lam Ta Khong subbasin in Nakhon Ratchasima province is relatively long (220 km), and has an area of approximately 4,070 km^2; in contrast, Huai Aeng subbasin in Mahasarakham and Roi Et provinces is quite short and has a total area of less than 200 km^2. However, both are representative of other subbasins in the Northeast and therefore provide a good example of water conflicts that are starting to manifest themselves.

Huai Aeng

Huai Aeng subbasin drains into the Huai Aeng and is captured and stored in a medium-scale reservoir about 22 km from the city of Roi Et. The reservoir was started in 1962 and completed in 1965. From 1982-86, the irrigation scheme and dam were rehabilitated under NESSI, with funding provided by USAID. Design capacity of Huai Aeng is 21.89 MCM, but at present the storage capacity is estimated at 17.8 due to sedimentation in the reservoir. Service area for the irrigation system is 3,370 ha, but given the nature of the area's rainfall (about 1,100 mm on the average), it is estimated that normally less than 20 percent of this area can be served during the dry season. Since project completion, dry season cropping area was 763 ha in 1986-87, 504 ha in 1987-88, 390 ha in 1988-89, and 290 ha in 1989-90.

Cassava production in the watershed area above the reservoir is a major cause of reservoir sedimentation which continues to reduce the available storage. This is one factor that explains the low dry season cropping intensities. Over the past 18 years, the reservoir has lost 20 percent of its storage capacity. This is a very common problem in Northeast Thailand and one that must be addressed if government investment in medium- and small-scale irrigation in the Northeast is to have a positive economic return.

Figure 8. Forested Area in NE Thailand



Area for 1989-93 reflects planned reforestation under E-Sarn Green Program

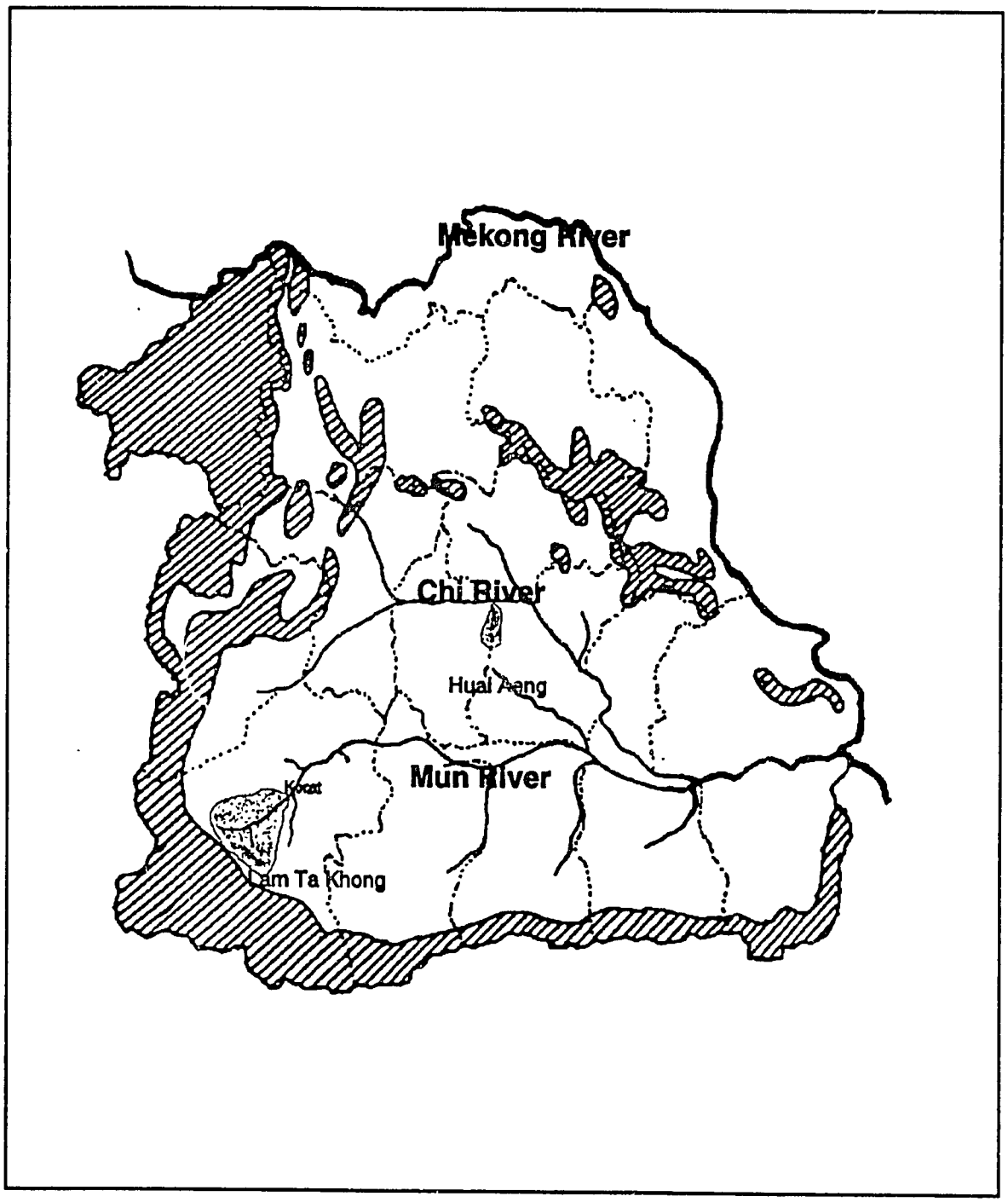


Figure 9. Locations of Subbasins in Northeast Thailand

However, Huai Aeng has an even bigger problem with respect to available water supply, as the Thai Army camp at Pra Phutta Yod Fah is pumping its water supply directly from the Huai Aeng reservoir. This large camp was pumping 4,000 m^3 per day in 1989 and with its recent expansion, the camp will likely pump as much as 20 percent of the annual capacity in the future. A similar situation can be found at Huai Chorakhe Mak, where the city of Buri Ram is pumping M&I water to meet its rapidly expanding needs. At present, Buri Ram is pumping 18 percent of the available storage and, based on estimated growth, will be using over 33 percent of the reservoir's annual capacity by the end of the decade. Given the rapid expansion of the Northeast's medium-size towns and the limited number of water sources, this type of competition is expected to escalate as various users scramble to obtain enough water. Ironically, as pressure is being placed on farmers to pay for irrigation-water supplies, water users such as the military camp at Pra Phutta Yod Fah and the city of Buri Ram pay nothing for the water they are withdrawing from the medium-scale irrigation reservoirs. Figure 10 illustrates the present and expected future pressure on Huai Aeng water supply if the Army continues to expand its use of reservoir water.

Lam Ta Khong

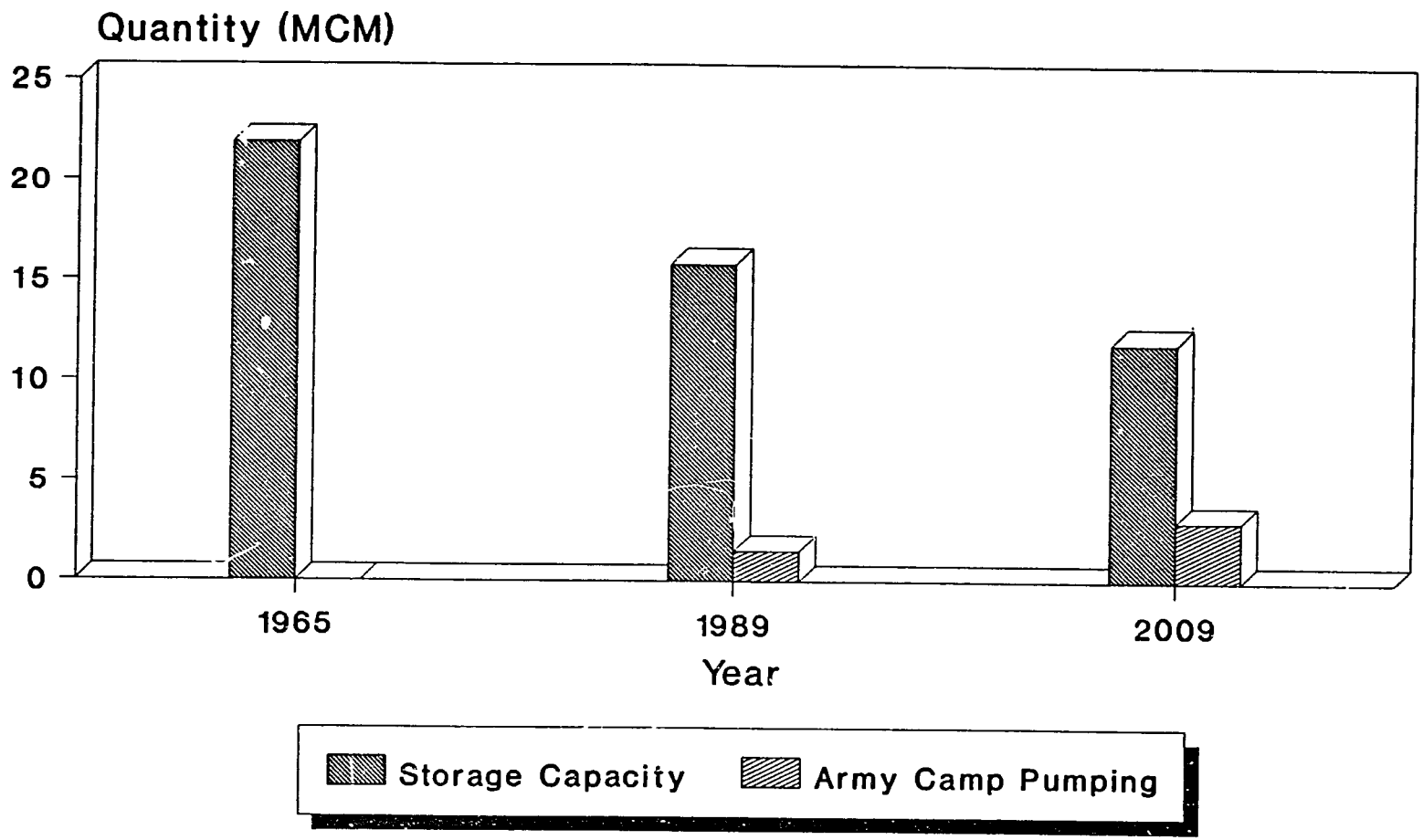
Lam Ta Khong is a relatively wide and long subbasin that contains the second largest city in Thailand (Nakhon Ratchasima); thus, a large number of users compete for the available water. The Lam Ta Khong reservoir has a storage capacity of 310 MCM and was designed and built as an irrigation reservoir to serve a wet season area of 20,406 ha and a dry season area of 8,000 ha. Average annual inflow from 1969-89 was approximately 259 MCM. At present, in addition to the irrigated area along the canal, official and unofficial M&I users as well as the Thai Army Division II camp are increasingly using a larger percentage of the available supplies.

The city of Nakhon Ratchasima pumps its water supply from the Lam Ta Khong as the river passes the city. Due to rapid industrial development up the Lam Ta Khong subbasin and the population explosion in the city and surrounding district, Nakhon Ratchasima has seen available dry season water supply dwindle over the past few years. Since cities such as Pak Chong, large industrial producers such as C. P. Poly[6], the Lam Ta Khong irrigation scheme, and the Thai Army Area II military camp outside of Nakhon Ratchasima all have had first opportunity to take water from the Lam Ta Khong, Nakhon Ratchasima's water situation during the dry season has become critical. In order to address this problem, a direct pipeline from Lam Ta Khong reservoir to Nakhon Ratchasima's treatment plant is in the final construction stages (under World Bank funding). When the 60 km pipeline is completed, Nakhon Ratchasima's M&I water capacity will increase from 24,000 to 93,000 m^3 per day. More importantly, Nakhon Ratchasima will be able to pump directly from the reservoir and thus have first opportunity to take as much water as it requires. All other users, public and private, will have access after Nakhon Ratchasima to the remaining water supply. As indicated in Figure 11, once the pipeline is complete, agricultural and non-urban industrial users will struggle to operate with an increasingly limited water supply.

Not only will access to the direct pipeline assure Nakhon Ratchasima of sufficient dry season water, it will also help reduce water treatment costs because in many locations, upstream users use the Lam Ta Khong River as a drain to dispose of wastewater. Thus, by the time the river has passed the city of Pak Chong and over 100 industrial plants on its 100 km trip down the basin, water quality is very marginal. As a result, during times of low flow, water treatment costs increase rapidly. The direct pipeline for Nakhon Ratchasima will significantly reduce its water-treatment costs, yet at the same time impose an additional cost on the other users, as their treatment requirements will increase dramatically.

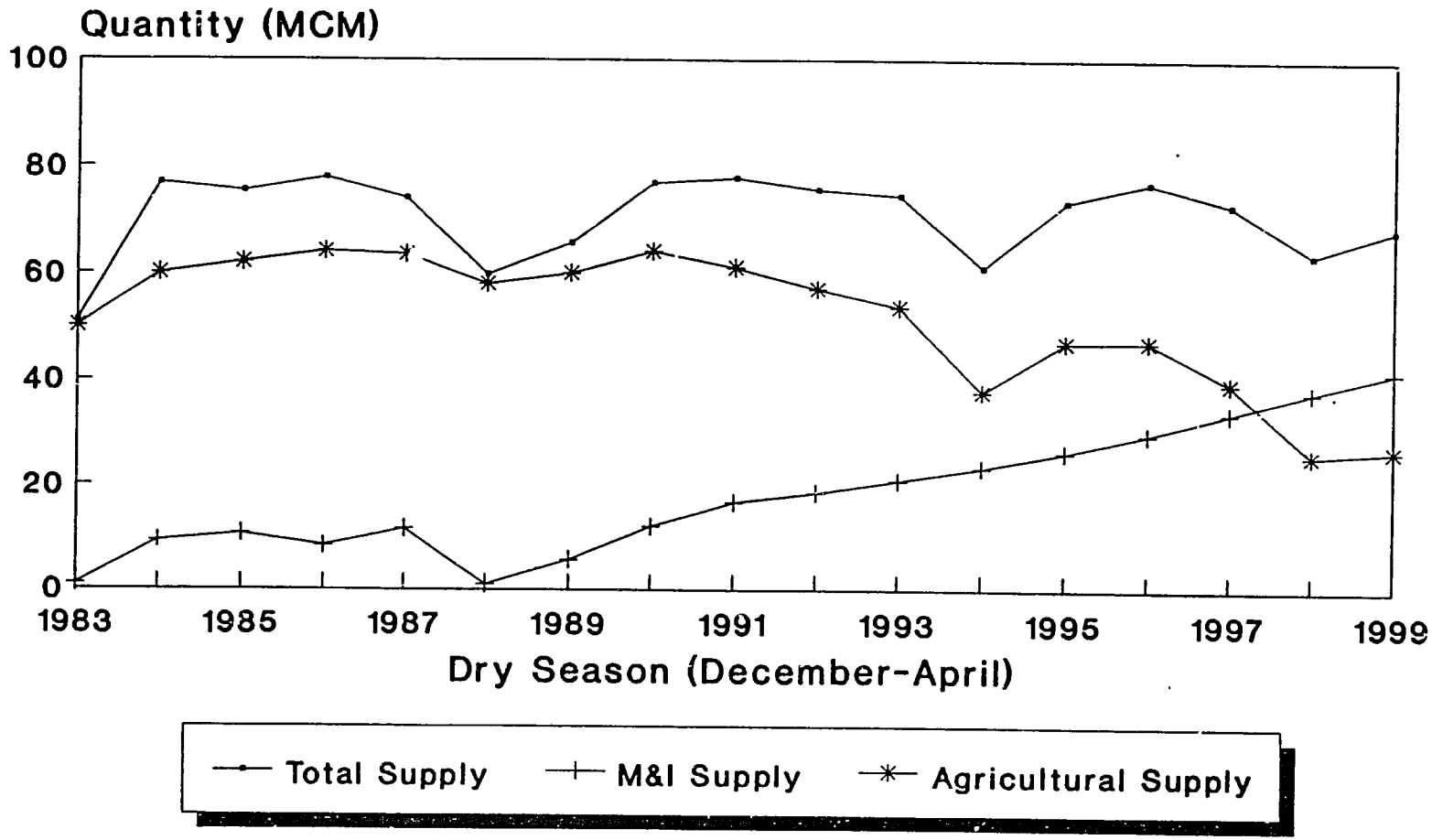
[6] At present, 25 organizations, industrial plants, and other assorted water users are paying a monthly water fee to the Lam Ta Khong project office for the right to pump water from the Lam Ta Khong channel. The fee varies from 225 to 8,205 baht per month for an estimated water supply of 1,500 to 42,500 m^3 per month, respectively.

Figure 10. Storage Capacity and Army Pumping
Huai Aeng Reservoir, Roi Et



Based on NESSI Study data
Army Camp pumping data from Team
Engineering reservoir model

Figure 11. Lam Ta Khong Water Supply Dry Season Allocation



Agriculture also includes non-urban industrial water users
M&I is for Korat City

4

RIVER BASIN WATER MANAGEMENT STUDY PROPOSAL

Background

Of the more than 60 river basins and subbasins in the Northeast, it is estimated that 10 percent are already at a level where no more water development is possible and that another 15 percent are rapidly approaching this point. In the North, of the 85 river basins and subbasins, it is estimated that 10 percent are already at full development and another 10 percent are also rapidly approaching this point. Development of water resources in Thailand is not coordinated or well regulated and, therefore, additional water users can tap a water source even after it has been fully developed.

Water Conflicts

In Northern and Northeast Thailand, water conflicts are expected to continue. M&I water demands in major cities such as Chiang Mai and Nakhon Ratchasima are increasing at rates of over 10 percent per year. Given Thailand's economic growth rate, it seems certain that M&I water use will continue to expand quite rapidly as long as the water is available. In addition, with the government's success in persuading hill tribe families to diversify crop production, it appears that increased upland areas will be planted in high-value crops. Finally, as Thailand's economy matures and the rate of industrialization accelerates, demand for non-urban industrial water can be expected to increase even more rapidly.

As previously indicated, one of Thailand's major problems with water resource management is the lack of a single planning and guiding authority and a proliferation of agencies involved in water resource development. Another factor, perhaps equally critical, is the historical unwillingness to allow decision-making at the local level. Thus, while in theory government line agency staff work under each provincial governor, in fact, these individuals in the past have been directly linked with their central government office regarding resource development questions. This system is starting to change, however, as the RTG has taken the positive step of formally creating Provincial Committees for Natural Resource Management in each province[7]. The functions of these committees include the following:

1. Analyze and identify policies and strategies for natural resources.
2. Approve district-level plans and projects.
3. Regulate and provide guidance to concerned agencies to create efficient coordination.
4. Monitor and evaluate project performance.
5. Carry out other assignments of the National Committee for Rural Development.

Table 4 illustrates the membership of the committee. Upon examining its make-up it is clear that not all of the concerned parties are represented on the committee. In particular, the provincial and metropolitan waterworks authorities as well as EGAT are not represented. Even more critically, private-sector users such as industry, agriculturalists, and tourist-oriented organizations (hotels, restaurants, and entertainment facilities) are not given a voice in decisions that are critical to the success of their businesses.

[7] As one would suspect, the degree of active participation by these committees varies widely from province to province. In general, the committee's importance is determined by the provincial governor's view of how important natural resources are to the economy of the province.

Table 4

Membership of Provincial Committee for Natural Resources Management

	Individual	Committee Position
1.	Deputy Governor	Chairman
2.	Provincial Permanent Secretary	Committee Member
3.	Provincial Officer of Forestry Dept.	Committee Member
4.	Provincial Officer of Forestry Dept.	Committee Member
5.	Provincial Officer of Agricultural Extension Dept.	Committee Member
6.	Provincial Officer of Land Dept.	Committee Member
7.	Provincial Officer of Land Reform Office	Committee Member
8.	Provincial Officer of Fishery Department	Committee Member
9.	Provincial Officer of Royal Irrigation Dept.	Committee Member
10.	Provincial Administration Office	Committee Member
11.	Appointed Members	Committee Members
12.	Chief of Provincial Office	Committee Member and Secretary

In the larger context, a provincial-level committee makes it difficult to address water conflicts that occur at a basin level, particularly when the basin cuts across numerous provinces. This situation in Thailand is clearly becoming a constraint to rational development and management of national water resources. Water conflicts that are starting to emerge in many cases reflect the fact that water development is based on very narrow agency and provincial interests and does not take into account the downstream impacts.

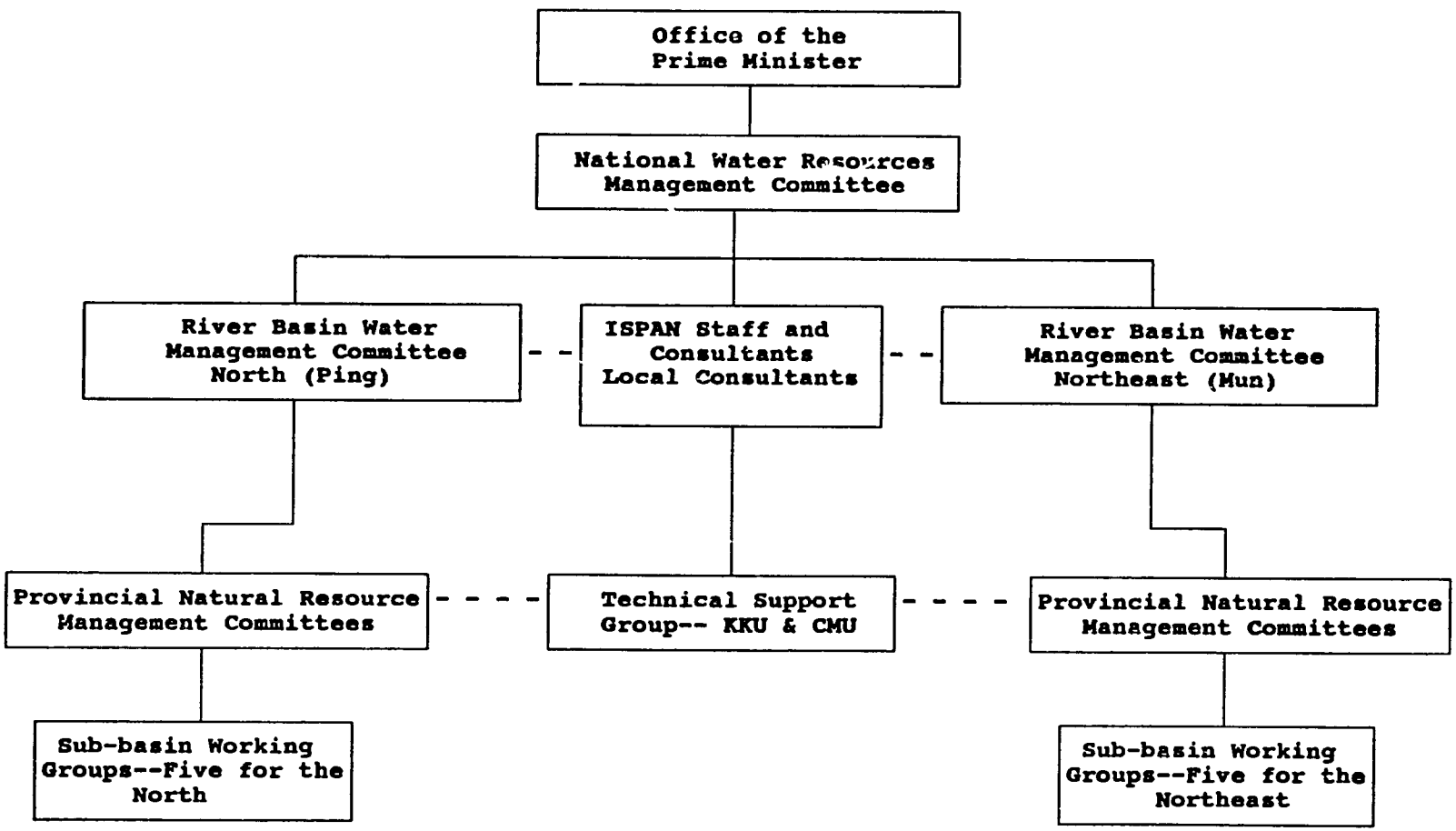
Water Management at the River Basin Level

As indicated, Thailand's present administrative structure does not encourage basinwide resource management and development. In order to examine the larger set of issues, this study proposes to establish, on a trial basis, River Basin Water Management Committees for the Ping River in Northern Thailand and the Mun River in Northeast Thailand. As can be seen in Figure 12, in order to link these committees with central decision-making, it is proposed that they be organized under the Office of the Prime Minister, reporting back through the National Water Resources Committee. The two project offices will also coordinate their research closely with ongoing activities of the Thailand Development Research Institute (TDRI). In order to ensure that all concerned provinces are directly involved in the deliberations of the water management committees, the two committees will be chaired on a rotating basis by the respective provincial governors (four in the Ping Basin and five in the Mun Basin). As illustrated in Figure 12, the River Basin Water Management Committees will work very closely with the respective Provincial Committees for Natural Resource Management.

In most cases, particularly in situations that require research and data collection and management, provincial committees lack the expertise needed to collect and analyze the data. In order to overcome this chronic problem, selected faculty from Khon Kaen and Chiang Mai Universities and expatriate experts recruited through ISPAN would serve as a technical working arm for the committees.

To bring the realities of the tradeoffs and water allocation decisions that need to be made directly to the committees, five subbasins would be selected in each of the two regions. Local data-collection staff

Figure 12. Proposed Organization Chart for Project



from Khon Kaen and Chiang Mai Universities will be stationed for two years at these locations (see Figure 13). Their responsibility will be to monitor and document water supply and demand in the subbasins and to work closely with involved agencies to help them collect data needed for planning and operational purposes. Where there is conflict over water allocations, the study teams will collect information needed to resolve the problem. From time to time, the teams will report to their respective water management committees and help the technical experts and consultants obtain the information they need to provide technical assistance to the committees.

ISPAN will identify and recruit experts to provide technical skills not available at the Thai universities. Besides senior water resource engineers and economists, ISPAN will also help provide institutional specialists, particularly in the area of water law and water contractual agreements. In addition, local consultants in a number of disciplines will be recruited. Normally, these consultants will be involved on a continuing basis to ensure their familiarity with the study objectives.

The study is designed to operate for three years, recognizing that the types of institutional change envisioned cannot be accomplished very rapidly. The first year and a half will see more emphasis on data collection, mapping, and documentation of supply-demand relationships. The latter part of the second year and the early part of the third year will involve more concentration on improving the working of the water basin management committees and helping them make some critical decisions. The latter half of the final year will see a concentration on policy changes and policy makers at the Bangkok level, with some of the focus on identifying and defining legal issues that must be addressed for effective basinwide water allocation. At this stage, the research project will work jointly with TDRI to ensure that the results are incorporated in policy recommendations developed by the institute.

The tentative budget for the three-year study is $2,100,000. Following the model for the NESSI study, more than 75 percent of this budget is for local expenses and for Thai participation in the study, with the bulk of the funding going to Khon Kaen and Chiang Mai Universities. Table 5 provides budget details.

Expected Outcome

The study is designed to be implemented in two of the most important subbasins of Northern and Northeast Thailand, respectively. Insights gained from the committees' actions (and lack of actions) will help define institutional and legal constraints to optimal management of Thailand's water resources. At the rate Thailand's economy is growing, these insights will soon be required to design the new institutional, legal, and administrative system that Thailand must have to ensure sufficient water to maintain steady economic growth in the coming decades.

In the long run, it appears that there may have to be an overall water-sharing agreement between North and Central Thailand. Without such an agreement, given the present rate of development in the North, there will soon come a day when no water flows from Northern Thailand to the Central Region. Since the Central Plains and Bangkok are almost totally dependent upon this flow, such a stoppage is clearly unacceptable. Yet, even if an overall agreement is in place, it will still be necessary for the individual provinces to coordinate water usage in order to ensure that each province receives its share and also passes the remainder downstream to users in the adjoining provinces.

This coordination will eventually require some form of river basin authority or administrative entity. This pilot study will be very valuable, as the experience can be used directly when it becomes necessary to establish some form of basin administrative organization. Similarly, in the Northeast, there will be a need for an administrative entity to monitor and allocate water resources in the basins of the Mun and the Chi and also in the smaller subbasins as economic growth stretches the supplies in the smaller basins.

Figure 13. River Basin Water Management Project Project Staffing in North and Northeast

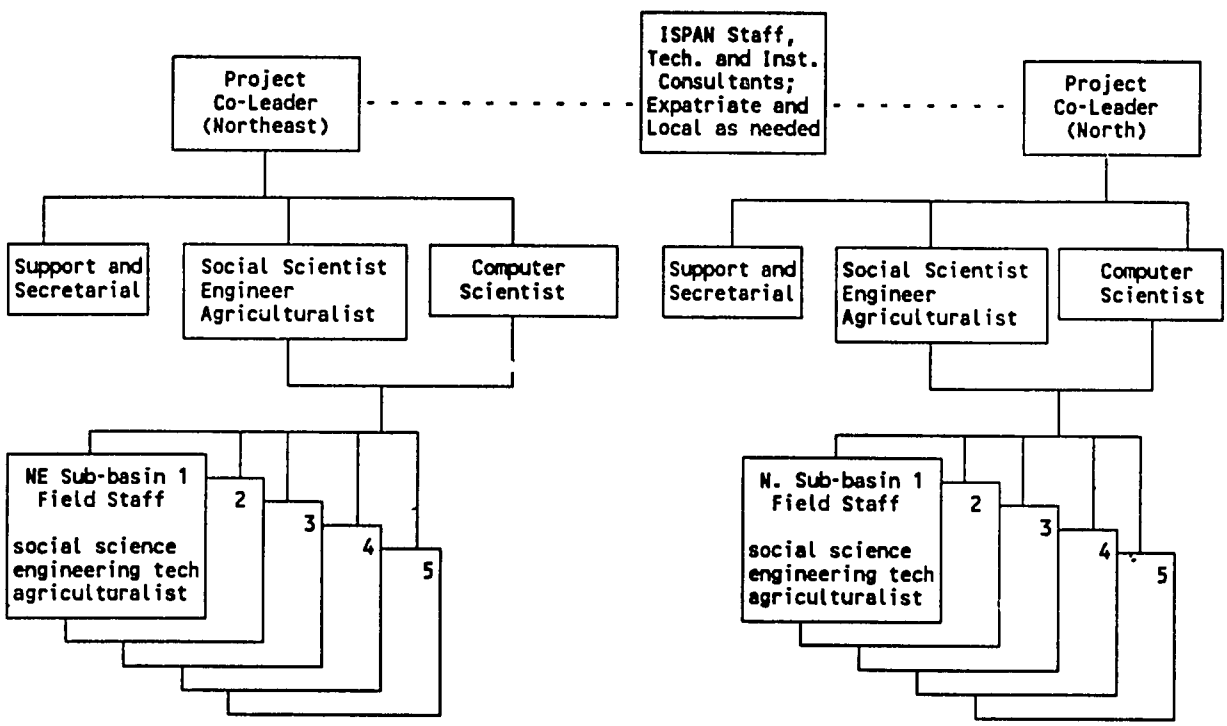


Table 5 Tentative Budget for Three Year River Basin Study

ISPAN River Basin Water Management Study					
	YEAR 1	YEAR 2	YEAR 3		TOTAL
Salary Costs					U.S. Dollars
ISPAN Acctg & Sectry	10307	10307	10307		30,920
ISPAN Prof. Staff	29167	33334	41875		104,376
Intl Consultant	48000	64000	64000		176,000
Deputy Leader KKU	13440	13440	13440		40,320
Deputy Leader CMU	10560	10560	10560		31,680
Sr. Soc. Scientist KKU	9600	9600	9600		28,800
Sr. Soc. Scientist CMU	12480	12672	12672		37,824
Sr. Engineer KKU	12000	12000	12000		36,000
Sr. Engineer CMU	12000	12000	12000		36,000
Sr. Agricul KKU	9600	9600	9600		28,800
Sr. Agricul CMU	9600	9600	9600		28,800
Computer Staff KKU	5760	5760	5760		17,280
Computer Staff CMU	5760	5760	5760		17,280
Field Staff					
Eng KKU (5 people)	18000	24000	18000		60,000
Agr. KKU (5 people)	13500	18000	13500		45,000
Soc. Sc KKU (5 people)	13500	18000	13500		45,000
Eng CMU (5 people)	18000	24000	18000		60,000
Agr. CMU (5 people)	13500	18000	13500		45,000
Soc. Sc CMU (5 people)	13500	18000	13500		45,000
Local Consultants	28800	43200	33840		105,840
Secretary KKU 2 people	3600	3600	3600		10,800
Secretary CMU 2 people	3600	3600	3600		10,800
Driver KKU 2 people	4800	4800	4800		14,400

ISPAN River Basin Water Management Study					
	YEAR 1	YEAR 2	YEAR 3		TOTAL
Driver CMU 2 people	4800	4800	4800		14,400
Typist KKU 2 years 2&3	2400	4800	4800		12,000
Typist KKU 2 years 2&3	2400	4800	4800		12,000
	Subtotal*				1,094,320
Travel Intl					
--Intl Air Ticket	24000	35000	35000		94,000
--Per Diem	13600	17000	17000		47,600
Travel Local					
--Per Diem	64440	75240	74400		214,080
--Local Air Tickets	3500	5000	6000		14,500
Equipment					
--MC 12@$2000	24000				24,000
--Vehicles 4@$24,000	96000				96,000
--Computer field	22000				22,000
--Computer field	9000				9,000
Operating Expenses					
--Fuel & Maintnce	35000	35000	35000		105,000
--Supplies	8000	10000	10000		28,000
--Telp, Fax, Tlx, etc.	15000	15000	15000		45,000
	Subtotal				699,180
Workshops and Publications					
--Publications	21000	30000	36000		87,000
--Seminar	11000	11000	11000		33,000
--Workshops	15000	15000	12000		42,000
--Conference			12000		12,000
	Subtotal				174,000
Contingency	42500	42500	47500		132,500
		*****TOTAL*****			2,100,000

Appendix A

Scope of Work for ISPAN Applied Study

A. Purpose

This study will review the current status of water resource development and water resource use in Northeast and North Thailand. The study will assess current water demands for irrigation, domestic, industrial and other uses and make projections for future demands in the regions. The study will identify and explore policy issues related to water resource planning and allocation.

B. Background

USAID has provided assistance to Thailand's irrigation subsector for more than 30 years. During this time, a number of large, medium, and small scale irrigation projects have been developed. Much of the irrigation emphasis has been in the impoverished Northeast, which has the lowest rate of per capital income in the country, but considerable work is still required in the North. USAID and other donors more recently have become involved in watershed development and management. The Mission's most recent irrigation project, NESSI, reveals that restricting attention to the reservoir and the irrigation command area is inadequate. The NESSI Applied Study noted that a vast amount of uncoordinated water resources development has occurred over the past decades and called for a total basin management study which would be carried out prior to deciding to develop new reservoirs in the Northeast sub-watershed basins. The study identified a number of trends which merit further attention. For example, the growth of urban centers in the Northeast has rapidly increased the demand for domestic water supplies, and this water is being pumped from reservoir systems originally designed for agriculture. As a result, farmers who are contributing operation and maintenance fees and labor are receiving inadequate supplies. Water works authorities, which receive the water without cost, charge domestic users, but the payments do not revert back to the RID and are not used to maintain the system.

Furthermore, numerous government agencies, including the Royal Forestry Department (RFD) have supported the development of small scale irrigation systems up and down stream from the RID systems without apparent planning and coordination. At the same time, there has been considerable private sector investment in contracting farming of high value crops and in agro-processing. Given the planned expansion of agro-industry and tourism in the Northeast and the North and the agricultural requirements for water, it is time to review the irrigation subsector in the context of the larger basin characteristics and requirements and attempt to identify the policy implications of continued unplanned, uncoordinated development of water resources in both regions.

C. Study Approach

The study will focus specifically on medium sized basins, where little research has been done to date. The study will be conducted in two phases: Phase I will consist of a three week in-country review and preparation of a detailed scope of work for the basin water management study, while Phase II, which will be funded separately, will be based on the Phase I findings and design. Phase I will include:

- Visits to relevant offices in Bangkok, the Northeast, and the North;
- Site visits to selected medium sized basins in the Northeast and North, which experience conflicting water demands and development efforts;
- Identification of collaborating Thai institutions and/or researchers; and
- Submission of a scope of work for the applied study.

The study design team will determine the feasibility of selecting two to three medium sized basins for long-term study in the Northeast and the North. The team ought also to recommend basins for the study.

Point to consider for the scope of work include:

- Present and projected uses of water resources;
- Planned development of water resources, particularly medium scale;
- Allocation of water for agricultural and non-agricultural uses;
- Installation of small weirs and other diversions and implications for water supply;
- Land use upstream and downstream; and
- The institutional setting: cooperation and coordination among RFD, RID, and other agencies and implications for basin development.

D. Consulting Services Required

The Phase I team will be multidisciplinary and include an American water resources planner, geographer, or related discipline, who will complement two Thai experts from the Northeast and the North. Their suggested specializations are water resources engineering and social science. RID and RFD are also encouraged to participate actively.

Phase II will likely require a larger team, with more varied expertise, but the exact composition will be determine during the design phase. The scope of work will set forth staffing requirements and a schedule, in addition to study objectives, methodologies, and deliverables.

E. Schedule

The design phase is expected to last three weeks, with the team spending roughly a total of one week in Bangkok to meet RTG and USAID staff at the beginning and prepare and submit the written scope of work for review by USAID and RTG at the end. The interim period of roughly two weeks will be divided between the Northeast and North. The team is expected to visit Khon Kaen and Chiang Mai Universities to determine faculty interest in participating in Phase II.

Phase II is expected to last from 12 to 24 months, depending upon the design.

Appendix B

Basins and Subbasins in North and Northeast Thailand

Table B-1

Partial List of Basins and Subbasins in North Thailand

Subbasin	Area (km^2)	Remarks
Mae Ngat	1,368	
Mae Taeng	2,340	
Mae Kuang	1,842	
Mae Khan	1,865	
Mae Tha	1,082	
Mae Chaem	3,941	
Mae Li	2,090	
Mae Tuen	3,160	
Mae Klang	595	
Mae Wang	680	
Mae Fang	1,290	
Mae Kok	12,000	Includes some area in Burma
Mae Rim	515*	
Khlong Suan Mak	520*	
Huai Mae Raka	500*	
Mae Chan	375*	
Mae Krai	80*	
Mae Sao	145*	
Mae Mao	135*	
Mae Chai	70*	
Mae Na Wang	110*	
Mae Suai	500*	
Mae Pun Luang	300*	
Mae Lao	3,200	
Mae Chedi	200*	
Mae Ing	5,700	
Mae Pum	165	
Mae Pua	300*	
Mae Haeng	980*	
Mae Ka Nai	34	
Mae Tian	200*	
Mae Suk	100*	
Mae Hat	100*	
Mae Pai	5,600	
Mae Cha	350*	
Mae Samat	700*	
Mae Khong	200*	

* Rough Estimate

Table B-1 Partial List of Basins and Subbasins in Northern Thailand (continued)

Subbasin	Area (km^2)	Remarks
Mae Sanga	460*	
Mae Hong Son	44	
Mae La Luang	400*	
Mae Sa Riang	400*	
Nam Yuan	4,890	Includes La Luang and Sa Riang
Mae Moei	8,400*	
Mae La Mao	2,000*	
Nam Khek	993	
Nam Kwae Noi	4,500*	
Pa Sak River at Kaeng Sida	836	
Huai Nam Phung	400*	
Lam Kong	600*	
Huai Wong Chom Pha	60*	
Huai Na	90*	
Huai Nam Chun	150*	
Mae Tip	65*	
Mae Sapuat	80*	
Mae Khanat	200*	
Mae Tui	700*	
Mae Chang	1,150	
Mae Soi	650*	
Mae Ngao	490*	
Mae Pi	660*	
Mae Suat	240*	
Mae Mok	1,050*	
Huai Pong	110*	
Khlong Tron	1,150*	
Nam Pat	4,000*	
Nam Wa	2,350*	
Nam Hao	90*	
Nam Khun	100*	
Nam Yao	400*	
Nam Pua	460*	
Huai Mae Yao	980*	
Nam Yang	150*	
Khlong Butsabong	680*	

* Rough Estimate

Table B-2

Partial List of Basins and Subbasins in Northeast Thailand

Basin	Subbasin	Area (km^2)	
Mae Nam Khong Basin		44,900	
	Huai Bong	1,503	
	Huai Bang sai	1,608	
	Huai Cham	441	
	Huai Luang	4,137	
	Huai Muk	539	
	Huai Nam Kan	3,721	Includes Nam Phung
	Huai Lam Mong	2,672	
	Loei	4,041	
	Huai Suay	1,331	
	Nam San	745	
	Nam Heung	4,090	Includes area in Laos
	Nam Thop	750	
Song Kram Basin		13,400	Drains into Mae Khong
	Upper Song Kram	3,535	
	Nam Yam	1,500	
	Huai Khlong	750*	
	Huai Nam Mao	490*	
	Huai Hi	780*	
	Lam Nam Un	4,080*	
Chi Basin		40,000	Includes Nam Pong
	Huai Rai	1,600*	
	Lam Khan Chu	1,780	
	Lam Prong Khun Phet	457	
	Huai Pa Thao	498	
	Huai Tat Ton	369	
	Lam Kra Chuan	296	
	Lam Pao	7,985	Includes Lam Phan
	Lam Nam Yang	4,138	
	Lam Chi Long	410	
Nam Pong Subbasin			Drains into the Chi Basin
	Lam Nam Phrom	5,430	
	Huai Bong	540*	
	Nam Mo	560*	
	Nam Phuai	1,480	
	Lam Phaniang	3,040*	
	Huai Som	370*	

*Rough estimate

Table B-2 Partial List of Basins and Subbasins in Northeast Thailand (continued)

Mun Basin		85,310	
	Lam Phang Chu	1,340*	
	Lam Thap Than	3,480	
	Lam Thung Luang	890	
	Huai Khayung	2,700	
	Lam Dome Noi	2,240	
	Lam Chakkarat	1,470	
	Lam Phra Ploeng	2,330	
	Lam Ta Khong	4,070	
	Lam Tha Moen Chai	510	
	Lam Plai Mat	6,380	Includes Lam Nong Rong
	Lam Se Bai	4,150	
	Lam So Bok	3,120	
	Lam Chiang Krai	3,110	
	Lam Sioe Yai	4,760	Includes Lam Sioe Noi
	Lam Takhona	1,585	
	Lam Sam Ran	3,495	
	Lam Chae	595*	
	Lam Chi Noi	2,927	
	Lam Plub Plu	1,900*	
	Huai Kwang	500*	
	Huai Seo	520*	
	Huai Tha	1,470*	
	Huai Tako	90*	
	Huai Saneng	240*	
	Huai Sen	375*	

*Rough estimate

Appendix C

Translation of Chom Thong Watershed Conservation Club Letter to the Prime Minister of Thailand

Watershed Conservation Club
112 Rim Nam Road, Mu 4
T. Ban Luang, A. Chom Thong

June 25, 1989

To the Prime Minister:

Referring to our letter of May 20, 1989 sent to the Prime Minister, the Club has now received the letter of 23rd May, 1989 from the Office of Secretariat.

WCC has not yet seen any action taken to solve the problem. People of Chom Thong feel very frustrated and worried due to the continuing problems created by minority groups in this district. WCC again wants to send a request to the Prime Minister to decide and order to all concerned agencies to take action on the following matters:

1) Stop forest clearing by hill peoples in the watershed headlands.
2) Ban use of chemicals, insecticides which create toxic water in the drinking water supply of the city of Chom Thong.
3) Move out hill people from Khun Klang, Khun Ya of Tambon Ban Luang and Pha Kluay of Tambon Mae Soi due to their threat to watershed without concern of the needs of the lowland farmers. Especially, WCC is requesting to move hill people from Pha Kluay first.
4) WCC humbly requests to have urgent action taken within this year 1989. If any delay occurs, there will be no watershed left, and this will create a serious problem for agriculture in Chom Thong district.

With our sincere, our wills, and not to create any social unrest which threatens national peace, WCC wants to solve this problem. As our traditional practice for several generations, the watershed headlands have to be strictly protected due to its value to sustain our livelihood. If the government is not able to solve this problem, WCC will volunteer to be responsible to solve this problem to preserve this natural area, which means our lives.

With our respectful regards.

(Nai Suwit Namathep)
President
Watershed Conservation Club
Chom Thong