No. 52

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF AGRICULTURE AND COOPERATIVES
THE KINGDOM OF THAILAND

THE STUDY
ON
THE AGRICULTURAL LAND REHABILITATION AND CONSERVATION PROJECT
IN
SURAT THANI AND NAKHON SI THAMMARAT PROVINCES

FINAL REPORT

OCTOBER, 1995

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FINAL REPORT
OCTOBER, 1995
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PREFACE

In response to a request from the Government of Thailand, the Government of Japan decided to conduct a study on the Agricultural Land Rehabilitation and Conservation Project in Surat Thani and Nakhon Si Thammarat Provinces and entrusted the study to Japan International Cooperation Agency (JICA).

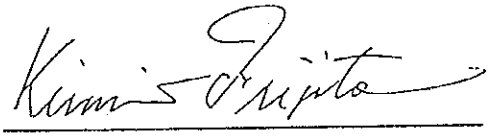
JICA sent to Thailand a study team headed by Mr. Takanori Takatsuka, Sanyu Consultants Inc., four times between March 1994 and August 1995.

The team held discussions with the officials concerned of the Government of Thailand, and conducted the field survey at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I with to express my sincere appreciation to the officials concerned of the Government of Thailand for their close cooperation extended to the team.

October, 1995



Kimio Fujita
President
Japan International Cooperation Agency

October, 1995

Mr. Kimio Fujita
President,
Japan International Cooperation Agency,
Tokyo, Japan

Letter of Transmittal

Dear Mr. Fujita,

We are pleased to submit to you the Final Report of the Study on the Agricultural Land Rehabilitation and Conservation Project in Surat Thani and Nakhon Si Thammarat Provinces. The report contains the advice and suggestions of the authorities concerned of the Government of Japan and your Agency, as well as the formulation of the above mentioned project. The comments made by the officials concerned of the Government of Thailand during the discussions on the draft report held in Bangkok City and Tokyo are also included in this report.

The Study aimed to formulate the agricultural land rehabilitation and conservation plan for the farmlands affected by the 1988 flood. As the results of the study, we proposed construction projects such as drainage improvement, irrigation development, farm land conservation, soil and soil layer improvement, and farm road improvement, and agricultural supporting service activities project for improvement of farming practices. The concepts of the proposed projects meet the aims of natural resources conservation and proper land use policy of the agricultural development plan in Thailand.

The projects are feasible and will produce many economic and social benefits, and environmental conservation effects. Furthermore, the implemention of the projects will contribute greatly to the stabilization of living of the farmers in the flood-affected area. We recommend that the Government of Thailand implements these projects as a top priority.

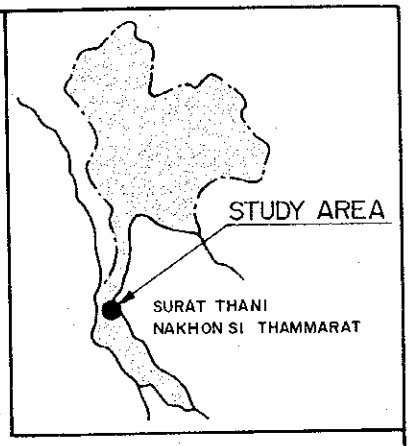
We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs, the Ministry of Agriculture, Forestry and Fisheries and the Embassy of Japan in Thailand. We also wish to express our deep gratitude to officials concerned of the Government of Thailand for the close cooperation and assistance extended to us during our study.

Very truly yours,

T. Takatsuka

Takanori TAKATSUKA
Team Leader
The Study on the Agricultural Land Rehabilitation and Conservation Project in Surat Thani and Nakhon Si Thammarat Provinces
Sanyu Consultants Inc.

LOCATION MAP



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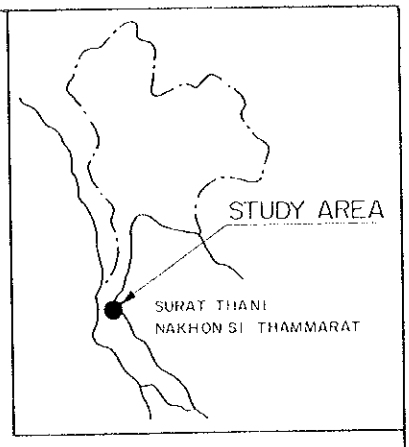
LEGEND	
	GENERAL STUDY AREA
	MASTER PLAN STUDY AREA
	FEASIBILITY STUDY AREA

A. CHAIYA
AO BAN DON
A. DON SAK
A. THACHANG
A. KHANOM
401
A. PHUNPHIN
4010
41
401
4009
GULF OF THAILAND
A. KHIAN
A. THA SALA
4104
LEAM TALUMPHUK
41
NAKHON SI THAMMARAT
A. PA PHANANG
401
A. THUNG YAI
4013
A. CHIAN YAI
A. HUA SAI

SCALE 1 : 1,000,000

LOCATION MAP



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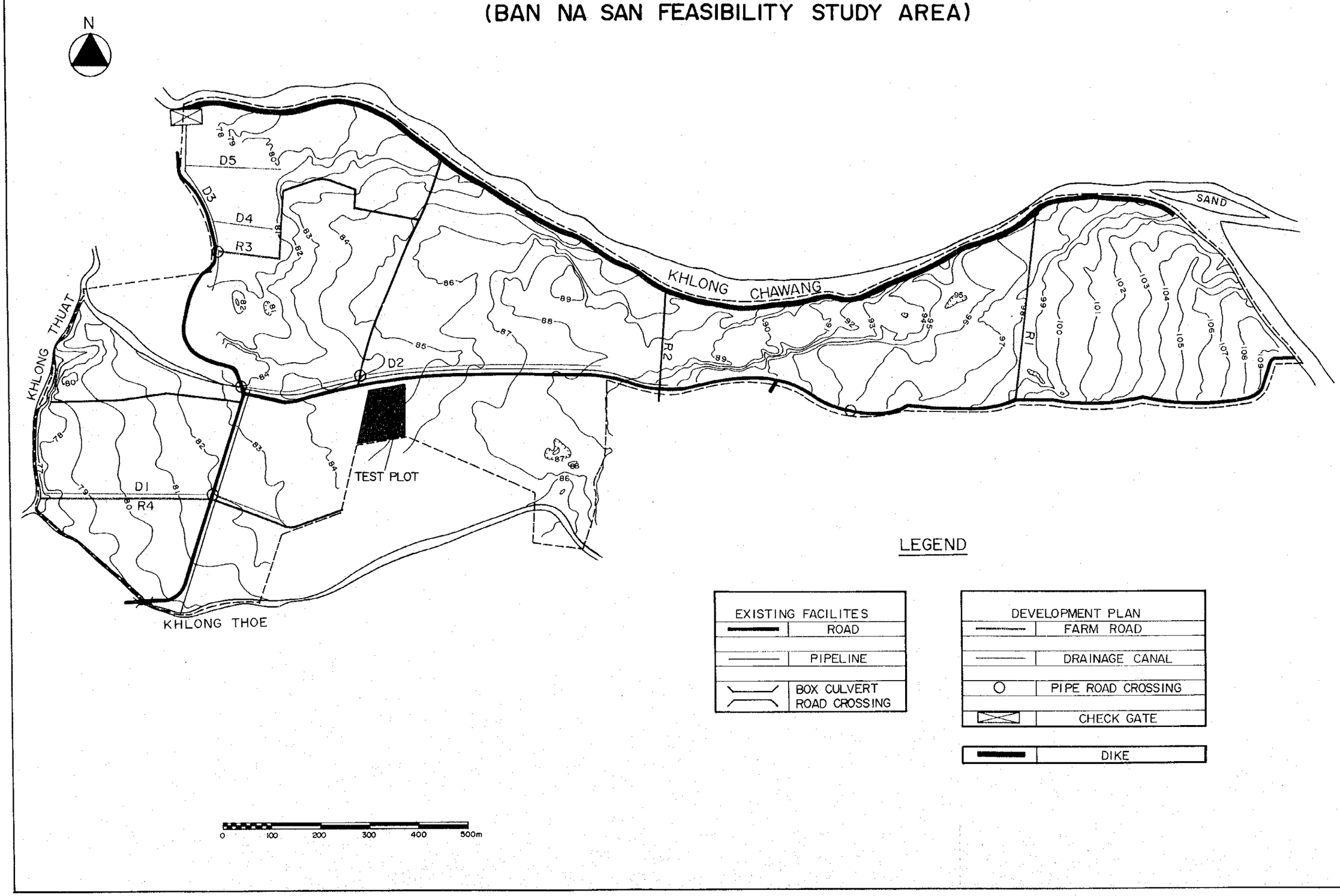
LEGEND	
	GENERAL STUDY AREA
	MASTER PLAN STUDY AREA
	FEASIBILITY STUDY AREA

A. CHAIYA
AO BAN DON
A. DON SAK
A. THACHANG
A. KHANOM
401
A. PHUNPHIN
SURAT THANI
4010
B. NIKHOM
41
C. SURAT THANI
401
GULF OF THAILAND
4009
K. TAPI
A. BAN NA SAN
A. KHIAN SA
BAN NA SAN
B. WANG HIN
K. CHAWANG
HUAI TUN
B. NA RENG
A. THA SALA
4104
B. HUAI KO
A. WING SA
C. NAKHON SI THAMMARAT
LEAM TALUMPHUK
A. PHRASAENG
A. PHIPUN
B. NAIKHICO
B. NA KHLIANG
A. PHROMMAKHIRI
41
B. KIRIWONG
K. TADI
NAKHON SI THAMMARAT
A. CHAWANG
A. LAN SAKA
A. PA PHANANG
401
A. THUNG YAI
4013
A. RON PHIBUN
A. THUNG SONG
A. CHIAN YAI
A. HUA SAI

SCALE 1 : 1,000,000

GENERAL PLAN
(BAN NA SAN FEASIBILITY STUDY AREA)

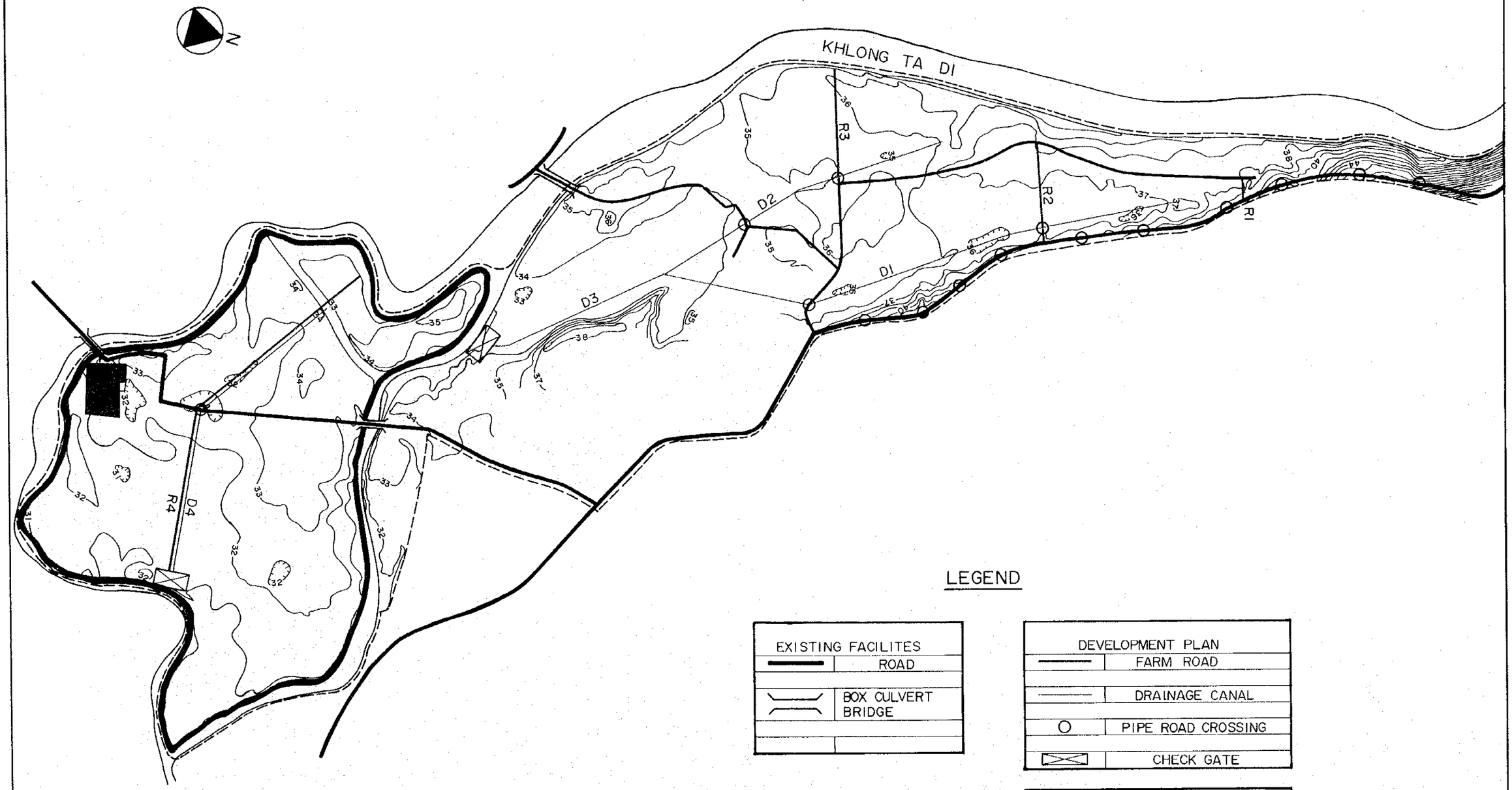


LEGEND

EXISTING FACILITES	
	ROAD
	PIPELINE
	BOX CULVERT ROAD CROSSING

DEVELOPMENT PLAN	
	FARM ROAD
	DRAINAGE CANAL
	PIPE ROAD CROSSING
	CHECK GATE
	DIKE

GENERAL PLAN
(LAN SAKA FEASIBILITY STUDY AREA)



LEGEND

EXISTING FACILITES	
	ROAD
	BOX CULVERT BRIDGE

DEVELOPMENT PLAN	
	FARM ROAD
	DRAINAGE CANAL
O	PIPE ROAD CROSSING
	CHECK GATE
	DIKE

SUMMARY

A MASTER PLAN STUDY

A.1 INTRODUCTION

A.1.1 Background

(1) This report is prepared based on the Scope of Works (S/W) conducted between the Department of Land Development (DLD), Ministry of Agriculture and Cooperatives, the Kingdom of Thailand and the Japan International Cooperation Agency (JICA) for the Study on the Agricultural Land Rehabilitation and Conservation Project for Ban Na San and Lan Saka districts in Surat Thani and Nakhon Si Thammarat Provinces in April, 1993.

A.1.2 Socio-Economic Background

(1) The overall national economy of Thailand marks a substantial growth. Although the Gross Domestic Product share of the agricultural sector in the national economy gradually declines, the sector is still important to the economy as the agricultural employment share remains high, 62% of total employment.

(2) In the past, the increase in agricultural production was achieved by extension of farmland through developing the natural forest. The reclaimable forest, however, is becoming less and less. Subsequently, natural and land resources have been deteriorating. Under such circumstances, the Seventh National Economics and Social Development Plan has emphasized the necessity of extending public services and subsidization to the deteriorated lands for management of natural resources.

A.2 THE FLOOD AFFECTED AREA

A.2.1 Physical Conditions and Causing Factors

(1) The monsoon attacked the fourteen (14) provinces of Southern Thailand in November, 1988. Surat Thani and Nakhon Si Thammarat were the two most severely affected provinces.

(2) Tremendous heavy rainfall brought by the Northeast Monsoon caused landslides on the weathered granitic slopes near the ridge line of the Kao Luang. The landslides flowed down to the valley and turned into debris flow. Subsequently, these flows deposited thick layers of sediment on the farmland and caused damage to agriculture.

(3) As the other factor causing landslides, it is considered that rapid change of land use in the mountainous slopes, from natural forest to rubber plantation, bring deterioration in land potentiality of disaster prevention.

A.2.2 Surat Thani and Nakhon Si Thammarat Provinces

(1) The major economic status of the Surat Thani is agriculture, occupying 35% of the gross provincial product (GPP) in 1991 and 69% of the economically active population. Most of the agricultural production is rubber, which is one-fifth of the national production. The GPP (nominal) of the province accounts for 25 million Baht in 1991. The GPP per capita is estimated to be 31,442 Baht, which is considerably low compared with 44,055 of the nation. However, it is high compared with 27,084 of the southern region.

(2) The GPP (nominal) of Nakhon Si Thammarat province accounts for 32 million Baht in 1991. The status of agricultural sector in the province holds the first position, occupying 24% of the GPP. Agricultural production is characterized by rubber. The GPP per capita is estimated to be 20,926 Baht, which is low compared with those in the southern region and Surat Thani province, due to high population density, 149 person/km^2.

A.2.3 Environment

(1) In Thailand, there are treaties and regulations on environment related to agricultural development. The regulation on watershed management for conservation of water resources and appropriate land use is pertinent to agricultural and forest development. According to the regulation, development and economic activities are prohibited in the watershed of the Kao Luang which has been delimitated as the conservation and preservation area for natural forest and wildlife. Non of the sediment deposited agricultural land is located inside the conservation and preservation areas.

(2) Excessive deforestation for commercial use and diversion to cultivated land have caused reduction of natural forest, and have directly or indirectly brought flood and landslide damage. Moreover, habitat environment of wild animals and plants are changing with deforestation.

A.3 GENERAL CONDITIONS OF THE BAN NA SAN AREA

A.3.1 Physical Features

(1) Ban Na San area is located in Amphoe Ban Na San in the southern part of Surat Thani province. The Chawang river runs from east to west in the central part of the area. The area has a typical rainfall pattern affected by the Southwest Monsoon. Average annual rainfall is 1,660 mm and monthly rainfall is about 200 mm from May to November. Rain is scarce from January to March. Flood discharge is estimated to be 682 m^3/s (10-year return period) for the catchment area of 210 km^2 at the downstream point of the area.

(2) Chawang river basin has suffered from debris flow. Sediment deposited soil reached to a thickness of 50 - 150 cm along the river. The deposited area is 9,825 rai.

A.3.2 Socio - Economy

(1) In Amphoe Ban Na San, the land for fruit trees and tree crops characterized by para rubber and rambutan occupies 83% of agricultural farm land.

(2) The net cash income of an average farm household in the Amphoe as of 1991 is 92,756 Baht, out of which 39,466 Baht is net farm income. The main source of farm income comes from rubber. Income from fruit tree should be increased to mitigate inclination toward rubber income which is unfavorable due to low rubber price.

(3) Besides agricultural cooperatives, some farmer's organizations which aim at supporting supply of agricultural materials and credit exist in Amphoe Ban Na San. At present, Bank of Agriculture and Agricultural Cooperatives (BAAC) is the major agricultural credit financier.

A.3.3 Agricultural and Rural Infrastructures

(1) In the area, low-head sprinklers have been used to irrigate fruit tree crops. Generally, irrigation is conducted on a farm household basis by utilizing small pumps to lift water from sources such as the Chawang river, its tributaries and small farm ponds.

(2) Except for the natural river system, no major drainage facility is observed in the area. Drainage capacity of these natural streams has been largely reduced due to sediment deposit and rise in bed elevation. After the 1988 disaster, river improvement such as redredging, embankment, reshaping and slope protection has been carried out by Royal Irrigation Department (RID) in the downstream of the Chawang river.

A.3.4 Environment

(1) After the disaster, the related agencies have provided rural infrastructure facilities such as electricity and water supply and housing in a resettlement area for the suffering people. Therefore, the living conditions were restored up to the level of the unaffected area.

(2) The forest rehabilitation by replanting trees is executed by the Chulaporn Research Institute (CRI). No valuable ecosystem that needs preservation exists in the study area.

A.4 GENERAL CONDITIONS OF THE LAN SAKA AREA

A.4.1 Physical Features

(1) Lan Saka area is located in Amphoe Lan Saka in Nakhon Si Thammarat province, 15 km west to Nakhon Si Thammarat city. The area has a typical rainfall pattern affected by the Northeast Monsoon. Average annual rainfall is 2,370 mm and is about 40 % greater than Ban Na San. Tha Di river runs from northwest to southeast through the central part of the area. The catchment area up to the downstream point in the area is 105 km^2. Flood discharge is estimated to be 872 m^3/s for a 10-year return period.

(2) The agricultural land was covered with sandy sediment brought by debris flow. The deposited area amounts to 2,765 rai. The deposited depth is more than 150 cm in most of the area. After the disaster, the land became unsuitable for fruit tree growing. At present, upland crops such as corn and banana are planted in limited area.

A.4.2 Socio - Economy

(1) Most of the farmland is used for rubber and fruit tree growing, same as in Amphoe Ban Na San. The dominant perennial crop is para rubber. However, this is likely to decrease in the future, due to the trend of diversifying into fruit trees. Farmers usually practice mix-cropping of fruit trees on their lands. Out of them, mangosteen is the most popular crop.

(2) Agricultural land in Amphoe Lan Saka is 117,300 rai. The average size of farm household is smaller than that of Amphoe Ban Na San or the Province. The net farm income of an average size farm household is 13,010 Baht. Compared with that of Amphoe Ban Na San, it is less than half. Most of the income comes from rubber and fruit trees. Fruit income holds a higher share than that in Amphoe Ban Na San.

(3) Most of the villages are communities of strong solidarity. Farmers organized themselves into some rather strong and active groups aiming at thrift and credit and marketing service

for agricultural products. Agricultural cooperatives and BAAC also provide supporting service to the farmers, like in Amphoe Ban Na San.

A.4.3 Agricultural and Rural Infrastructures

(1) Irrigation is not a common practice, due to mix-cropping. Except for the natural river system, no prominent drainage facility exists. Flooding occurs during every rainy season, due to insufficient flow capacity caused by risen river bed.

(2) RID has executed river improvement project such as redredging, embankment and riprap in the upper stream of the Tha Di river. However, no improvement plans is formulated for further downstream channel.

A.4.4 Environment

(1) Rural infrastructural facilities have been provided for the flood affected people, like in Ban Na San. There is no valuable ecosystem which requires protection.

A.5 BASIC DEVELOPMENT PLAN FOR THE BAN NA SAN AREA

A.5.1 Development Approach

(1) In order to rehabilitate the flood-affected area and to conduct sustainable agriculture with soil and water conservation, the following project components are proposed in the master plan study.

- Improve the low fertile soil in the sediment deposited area for introduction of suitable crops.
- Alleviate the inundation damage by preventing flood intrusion from Chawang river.
- Improve the infrastructural facilities at farm level for soil and water conservation and effective farming.
- Strengthen the present farmer's organizations and supporting services for propagation of farming technique including soil improvement.

(2) For the development plan, the study area is divided into upper, middle and down stream areas based on soil features and present rehabilitation plans/projects. In the downstream area, the depth of deposited soil is relatively shallow. At present, rubber and fruit tree growing is practiced as before since damage to the agricultural land was less compared

with the other two areas. Land rehabilitation is not necessary. Therefore, the basic development plan is formulated for the upper and middle areas. In the plan formulation, fruit tree growing is mainly introduced after land rehabilitation, from viewpoints of agricultural development policy in the province, natural and social characteristics of the area.

(3) Based on the anticipated project components, two alternative plans ; ① Agricultural land rehabilitated with full scale river improvement of Chawang river (case-1), and ② Embankment constructed only at the necessary locations along the Chawang to alleviate and prevent flood intrusion without redredging (case-2), are considered.

A.5.2 Land Use

(1) In case-1, it is possible to introduce fruit trees to the rehabilitated area, since flood damage will be alleviated by river improvement.

(2) In case-2, fruit trees are planned in higher elevation. Upland crops may be planted in the remaining area,taking account of inundation condition. Low lying area near the Chawang river will be used as grassland, since it is not suitable for fruit trees and upland crops due to possible prolonged inundation.

A.5.3 Agricultural and Rural Infrastructure Improvement

(1) For fruit tree growing, low head sprinkler irrigation system is planned, like the existing situation. Water is extracted from the Chawang river, its tributary and small farm pond. The farmers pump water by using their own pumps and feed it to their sprinklers.

(2) Embankment construction plans were studied by hydraulic analysis, based on the boundary conditions of the improved river section in the downstream, design discharge of 550 to 1,041 m^3/s and present cross sections, and for a length of 16,500 m.

(3) Only rehabilitation of the present road is planned, since electricity and drinking water supply have been restored. In the rehabilitation, some of the road surface will be paved with asphalt or sediment.

A.5.4 Soil/Soil Layer Improvement and Farm Land Conservation

(1) Deposited soil is classified as low fertile soil consisting of coarse sand and gravel. To grow crops in the deposited area, alternative soil/soil layer improvement methods are planned, based on the depth and distribution of the deposited soil. Soil improvement is conducted by means of using organic residue and growing leguminosal crops. On the other hand,

removal of gravel, replacing deposited soil with new good soil, exchange with lower original soil and soil dressing on the ground surface are planned as soil layer improvement methods.

(2) In order to practice soil and water conservation on the rehabilitated land, some conservation measures have to be taken at on-farm level. This requires construction works such as ditch and collecting canals, appurtenant structures such as check, weir and farm roads for effective farming.

A.5.5 Farming

(1) Fruit trees and upland crops are introduced into the area which will be alleviated from flood damage by construction of embankment and soil/soil layer improvement. Fruits such as rambutan, durian, mangosteen, longkong, saraka and so on will help to increase and stabilize incomes for farmers. For the fruit trees, groundwater level should be deeper than one (1) meter below surface.

(2) Upland crops and vegetables such as sweet corn, baby corn, peanut and mungbean, etc. can be introduced to the low-lying area along the river, except for rainy season. Pasture grass can be grown in the area under prolonged inundation, shallower groundwater and deep sediment including gravel and rock. It is mix-seeded with gramineous and leguminous crops. Soil in the grasslands will be improved gradually.

A.5.6 Strengthening Program for Farmer's Organization and Agricultural Supporting Services.

(1) The farmer's organization is important in providing a linkage between the farmers and the government agencies. In order to achieve the goals of the proposed project, the existing farmers' organization should be strengthened through various training programs. Agricultural supporting services cover quite broad scopes of activity among which recommendations on use of certified seeds, fertilizers and chemical products are the most essential works which can affect the cost of crop production and farmer's profit to a great extent.

(2) For an effective implementation and strengthening farmers' organization, project operation should have technical assistance in the form of a technical advisory group to provide technical services for farmers and agencies concerned. A technical advisory group should be staffed with specialists of different fields such as horticulture, livestocks, agricultural extension, soil improvement and conservation, farmer's organization, marketing and agricultural credit. Technical service activities advised by these specialists should be planned as an agricultural supporting project.

A.5.7 Proposed Projects

(1) The following projects are proposed based on the above development plans.

Projects	Quantity	Case-1	Case-2
Drainage improvement			
- River improvement	m	16,500	-
- Construction of embankment	m	-	13,900
Irrigation system development	rai	2,106	1,213
Farm land conservation	rai	2,305	1,723
Soil/soil layer improvement	rai	2,106	1,723
Social infrastructural improvement			
- Road improvement	km	10.7	10.7
Agricultural supporting activities	set	1	1

The above projects are implemented under the Ministry of Agriculture and Cooperatives (MOAC). Especially, drainage improvement will come under RID. The others shall be implemented by DLD, Department of Agricultural Extension (DOAE) and the other agencies concerned. For smooth implementation, a committee have to be organized under the MOAC, and the DLD is assigned as the coordinating agency.

A.5.8 Project Justification

(1) The total project cost is estimated to be 260 million and 150 million Baht, for the development alternatives of case-1 and case-2, respectively.

(2) The economic viability of the developmental plans is low. However, the proposed plans are in line with the national agricultural development policy which is one of the pillars of the 7th National Economic and Social Development Plan, and are expected to produce many indirect social benefits.

(3) Comparing the economic analysis of the two alternative development plans, economic viability of case-2 is higher than that of case-1. Case-2 can also be launched earlier, therefore, case-2 is recommended as the basic development plan.

A.6 BASIC DEVELOPMENT PLAN FOR THE LAN SAKA AREA

A.6.1 Development Approach

(1) For land rehabilitation and conservation in Lan Saka, the same project components as in Ban Na San are proposed. First priority is given to drainage improvement and prevention of flood intrusion from Tha Di river.

(2) The sediment deposited area is divided into three areas, upper, middle and down stream areas by topographic condition and the on-going rehabilitation projects/plans. The upper stream area was the most affected area. After the disaster, however, restoration projects such as reconstruction of houses and river improvement had been implemented by the agencies concerned. Almost all of the projects have been completed. Consequently, the necessity of land rehabilitation is low compared with the middle and down stream areas.

(3) For plan formulation, two development alternative plans are considered, same as in Ban Na San. Case-1 is the full scale improvement of the Tha Di river including redredging and construction of embankment to alleviate flood damage. In case-2, embankment is constructed only at the necessary locations along the river.

A.6.2 Land Use

(1) Development plan of land use and farming practice is formulated putting stress on fruit tree growing, same as in Ban Na San. For land use planning, present land is classified into three parts, high, medium and low elevation areas, by assuming inundation depth. Fruit trees may be introduced into the high and medium areas. In the middle stream area, raising bed is constructed for planting fruit trees, which is effective to mitigate inundation damage on root system. The height of ridge is about 0.5 m.

(2) In the low elevation area which is easily affected by inundation, cultivation of upland crops and vegetables are introduced from January to September, except for the rainy season from October to December.

A.6.3 Agricultural and Rural Infrastructure Improvement

(1) Like in Ban Na San, low head sprinkler system is proposed for irrigating fruit trees. Irrigation water is supplied from Tha Di river, excavated small farm ponds and/or shallow wells.

(2) Construction of embankment and river improvement were planned based on the hydraulic analysis for design discharge of 1,184 - 1,364 m^3/s and river length of 15,000 m, etc..

(3) Improvement of road surface of the existing roads is planned as rehabilitation of the infrastructural facilities.

A.6.4 Soil/Soil Layer Improvement and Farm Land Conservation

(1) Deposited soil is consisted of fine sand and silt. Measures similar to those in Ban Na San are applied for soil/soil layer improvement. The soil can be improved by means of upside down-plowing or mixd-plowing because the subsoils below the sediment are consisted of silt loam and silt clay loam. Removal of gravel is not necessary. Improvement area is estimated by the development alternatives, based on the land use plan.

(2) For soil and water conservation in the rehabilitated fields, ditch and collecting canals, appurtenant structures and farm roads are planned, same as in Ban Na San.

A.6.5 Farming

(1) Similar kinds of fruit trees and upland crops as in Ban Na San are introduced into the area. In order to attain a certain level of crop yield, fertilizing with chemical fertilizers as well as soil/soil layer improvement are required.

(2) For cropping, organic matters should also be provided due to lack of basic constituents of the deposited soil.

A.6.6 Strengthening Program for Farmer's Organization and Agricultural Supporting Service

(1) The major activities of the present agricultural organizations are short-term credit and supply of farm inputs. For project implementation, the organizations have to be strengthened through training programs. To strengthen supporting services in the area, emphasis should be given to technical know-how suited to the change from traditional cultivation methods to modern ones after soil improvement/conservation. The problems of supporting services are weak technical know-how, poor soil condition, agricultural credit, etc..

(2) For an effective implementation of strengthening program for farmers' organization and agricultural supporting service, project operation should have a technical advisory group to provide technical services for a project unit task force and local farmer's groups, same as in Ban Na San.

A.6.7 Proposed Projects

(1) The following projects are proposed based on the above development plans.

Projects	Quantity	Case-1	Case-2
Drainage improvement			
- River improvement	m	15,000	-
- Construction of embankment	m	-	28,800
- Construction of drainage canal	m	8,500	8,500
Irrigation system development	rai	1,289	1,027
Farm land conservation	rai	1,407	1,407
Soil/soil layer improvement	rai	1,407	1,407
Social infrastructural improvement			
- Road improvement	km	5.4	5.4
Agricultural supporting activities	set	1.0	1.0

The above projects are implemented under the same concepts, committee and organization as in Ban Na San.

(2) No negative impacts on social and living conditions of villager and natural environment will result from project implementation. Agriculture preservation and forest conservation in accordance with the concepts of watershed management should be introduced and extended into the mountainous slopes of the Tha Di river basin to prevent recurrence of flood disaster such as landslide and landslip. On the slopes, monitoring activities will be required regularly to prevent encroachment and to improve land use conditions.

A.6.8 Project Justification

(1) Based on the above proposed plans, the total project cost is estimated to be 514 million Baht and 240 million Baht for case-1 and -2, respectively.

(2) Like in Ban Na San, the economic viability of the two development alternatives is low, compared with those of general agricultural development projects. However, non-quantitative social benefits will be generated through implementation of this project.

(3) Case-2 is recommended as the basic development plan, since the economic feasibility is higher.

A.7 SELECTION OF PRIORITY PROJECT AREAS

A.7.1 Basic Approach for Selection and the Criteria

(1) It is more effective and practical to select priority areas for rehabilitation works as an initiator. In the study, therefore, priority areas are selected for feasibility study.

(2) For selection criteria, soil and social conditions, environmental effect and anticipated project scale were considered.

A.7.2 Subdivision of the Study Areas and Selection

(1) The master plan study area is divided into five parts in Ban Na San and three parts in Lan Saka, based on the present land use, the distribution of deposited soil and the river conditions.

(2) The subdivided areas were examined based on the selection criteria. As a result, the following two areas were selected as the priority areas.

- Ban Na San ; upper stream area, A = 1,329 rai
- Lan Saka ; middle stream area, A = 850 rai

B FEASIBILITY STUDY

B.1 PRESENT CONDITIONS OF THE BAN NA SAN F/S AREA

B.1.1 Physical Features

(1) The priority area (the F/S area) is located in Muban 4 of Tambon Perm Poon Sab, on the river terrace which is distributed on the south-east end of the Ban Na San area and extends in the left bank of the Chawang river. The area covered by sediment deposited soil is 730 rai.

(2) The elevation of the F/S area changes from 109 to 78 m M.S.L. The widely distributed river terrace and fluvial plain can be classified into five topographic types, river terrace, buried river terrace, fluvial plain, swampy place and present river channel. Out of them, fluvial plain is mainly overlain by the deposited soil. Groundwater level usually exists at about 3.0 to 4.0 m below the ground surface.

(3) In the F/S area, Chawang river flows from east to west. Mui and Thuat rivers are the tributaries of Chawang. Thoe river flows along the southern fringe of the area and joins Thuat river. The catchment area and the length of Chawang river at the downstream point of the F/S area are 133 km^2 and 16.5 km respectively, and the average slope of the river bed is very steep, approximately 1/100.

(4) According to the depth distribution of the deposited soil, the class of more than 150 cm has the widest distribution, 45% of the total. Deposited soil is consisted of gravel or coarse sand including many quartz and micas, which has very high hydraulic conductivity and small water holding capacity. Soil fertility is also very low.

(5) Sediment deposited area is classified into orchard land, waste land and public land such as road and canal. Rambutan, durian, and cashew nut planted in the orchard land are of two growing stages ; bearing trees planted before the 1988 flood and pre-bearing trees planted after the disaster. Waste land is consisted of sandy land along the Chawang river and grass land between the pre-bearing orchards and marsh land, which have been abandoned after the disaster.

B.1.2 Socio-Economic Conditions

(1) The population of the village is 899 as of 1994. Almost all the people are engaged in agriculture. The total farm land of the village is 5,830 rai, and is 100% owned-land. The average farm size per farm household in the tambon is estimated to be 43.3 rai.

(2) The farmer's economic survey was conducted by interviewing 20 farm households whose lands are in the sediment deposited area. According to the results, rubber occupies most of the farm income. Compared with the average farm household cash net income (92,756 Baht) of Amphoe Ban Na San, that of the large farmers having land over 50 rai is 123,668 Baht, the medium farmers from 30 to 50 rai, 127,195 Baht and the small farmers under 30 rai, 63,339 Baht.

B.1.3 Agriculture

(1) The growth of trees planted in the area is classified into four groups ; poor, fair, normal and good. Poor and fair groups occupy 68 % of the total planted area and require some improvements on farming practice and soil/soil layer. Especially, for pre-bearing rambutan, 80% of the planted area needs improvement. Some parts of the waste land could be improved for cultivation by soil/soil layer improvement.

(2) As the active organizations in the area, there are Lam Poon orchard farmer's group aiming at joint collecting and shipping of rambutan fruit, and thrift and credit group established for credit services and thrift for the members. Aside from these groups, BAAC is the major source of agricultural credit in the village, 59% of the total household are members of BAAC. Supply of fertilizer, seedling and seed are carried out mostly by private sectors in Amphoe Ban Na San.

B.1.4 Agricultural and Rural Infrastructures

(1) After the disaster, DLD constructed a small scale fixed weir to extract water from Mui river. The diverted water is conveyed by an existing open channel in the upper area and by a free flow pipeline in the middle and downstream areas. Small ponds have been traditionally used by farmers, especially in the lower end of the area.

(2) Pre-bearing orchard land in the middle area is less prone to flooding now. But, the strip of sand deposited land along Chawang river is subject to frequent flooding every year.

(3) The lateral road branching from the main road and leading to the F/S area is a sediment pavement road with 3 m width. It is used as the village and farm road and is well maintained. Roads in the F/S area are unpaved with width of about 2 m. Road density is small.

B.2 PRESENT CONDITIONS OF THE LAN SAKA F/S STUDY AREA

B.2.1 Physical Feature

(1) The priority area (the F/S area) is located in Wat Chan and Yan Yao villages of Tambon Kam Loan in south-east part of the Lan Saka area, and extends in the left bank of Tha Di river. Flood affected area is 723 rai.

(2) The widely distributed fluvial plain can be classified into three topographic types; present natural levee, older natural levee, and swampy land. The older natural levee which had been distributed along the Tha Di river before the disaster was eroded by the flooding and is overlain with the deposited soil. This topographic unit is defined as the present natural levee. The swampy land is widely distributed between the older natural levee and the river terrace. The groundwater level occurs about 2.0 m below the ground surface on the older natural levee.

(3) Tha Di river flows from north to south and diverges into two directions inside the F/S area. The two divergences join again at the downstream point of the area. The river width is narrow and the depth is shallow, and the route and guts are not stable and change by flood. The catchment area and the length at the downstream point of the area are 82.8 km^2, 16.8 km respectively, and the average slope of the river bed is approximately 1/400 in the area, which is relatively steep.

(4) Deposited soil is derived from weathered granite and is consisted of fine sand. Silt and clay contents are very low. The level of soil fertility and nutrient holding capacity are relatively higher than those in Ban Na San. The depth more than 150 cm has the widest distribution, 39% of the whole sediment deposited area. Following this, the class from 50 to 100 cm occupies 18%.

(5) At present, only very limited area of the sediment deposited area is used for mix-cropping of orchard. Besides this land, there are waste lands such as swamp, grass land and depression.

B.2.2 Socio-Economic Conditions

(1) Total population of the villages is 1,455. The average farm size per farm household estimated on the tambon basis is 11.8 rai.

(2) The farmer's economic survey was carried out on the selected 20 farm households, same as in Ban Na San. According to the results, rubber occupies 34% of the average farm net income. The mixed fruit orchards composed mainly of the mangosteen occupy a large share

of the income. Compared with 42,660 Baht of the average farm household cash net income in Amphoe level, those of large and medium farmers which have land over 5.0 rai are higher, but, the small farmers under 5.0 rai is 39,000 Baht.

B.2.3 Agriculture

(1) In the cultivated land, mixed cropping with mangosteen, rambutan, banana and coconut, etc., are practiced. Besides such fruit trees, sweet corn, sweet potato, groundnut, chili, eggplant, cucumber and watermelon, etc. are also planted as the intercrops.

(2) In accordance with the farming practice condition and damaged level caused by the flood, the area is classified into five categories, Ⅰ) Flood affected area not planted to fruit trees, Ⅱ) Flooded area but not damaged and still planted to fruit trees, Ⅲ) Swamp not planted to any crops, Ⅳ) Low and wet land, grass, mixed fruit trees, and Ⅴ) Highland planted to mixed fruit trees.

Out of them, the class Ⅰ occupies more than half, 323 rai or 56% of the total deposited area.

(3) Thrift and credit group exists in each village, which is informal farmer's organization. The farmers prefer to get short term credit service through this group rather than Agricultural Cooperatives or BAAC. Demand for agricultural input materials such as fertilizers and chemical products is very low, due to mixed cropping.

B.2.4 Agricultural and Rural Infrastructures

(1) There exists no major irrigation facility and irrigation is not a common practice, because 1) most of the surviving crops are mature crops and do not require severe soil moisture control, 2) some rainfall can be expected in the dry months, and 3) groundwater level is relatively high, within the reach of root of the tree crops.

(2) Flooding is a frequent event in rainy season. Due to the steep topography, flood velocity is very high, and this has caused heavy sand deposition and drifting wood on farmland. Flooding period is generally short, within a day.

(3) The conditions of the major village roads in the right and left bank and the farm roads connecting them are relatively bad with deteriorated road surface. The bridge in the lower area which was destroyed by the flood in 1994 should be restored. Larger flow area is required.

B.3 DEVELOPMENT PLANS IN THE BAN NA SAN F/S AREA

B.3.1 Basic Approach

(1) For development plan formulation, the constraints can be summarized as; ① The growth of fruit trees in the flood-affected fields is generally poor due to low soil fertility, ② It is difficult to introduce crops into the low-lying land along the river due to the thick sediment and the flood intrusion, ③ Infrastructural facilities at farm level are not provided, and ④ Supporting services are not active.

(2) Based on the above constraints, two development alternative plans were studied; for preventing flood intrusion, complete embankment construction along the Chawang river (case-1), and limited embankment construction, considering the topography, frequency of flooding and the deposited soil (case-2).

B.3.2 Land Use

(1) For the present planted trees, farming technique is improved by each field based on the growing stages of the trees. In the waste land between the present plantations, fruit trees are introduced. For those land along the river, trees are planted with soil/soil layer improvement for in case-1. In case-2, however, the area for fruit tree is limited.

(2) Based on the above, land use area is planned as follows.

Unit : rai

Land Use Area	Case-1	Case-2
Fruit tree plantation with farm improvement	411	411
New plantation of fruit trees in the waste land	220	157

Note: Land for infrastructural facilities is not included.

B.3.3 Drainage Improvement

(1) Non-uniform flow analysis is applied on the 1/10 probability discharge of 425 m^3/s to estimate the flood level of the Chawang river. The embankment is planned on the flood plain as close as possible to the river while taking advantage of the natural terrace. The height will be 0.5 m - 2.5 m and will occupy a width of 6 m - 20 m. The material for construction will be mainly the stones and sand found in the flood plain. Gabion protection is designed up to the level of high water level. In case-2, embankment construction is limited at the upper end and at the marsh land. The length comes to 2,200 m in case-1, 1,150 m in case-2.

(2) To drain off more swiftly excess surface water in the farmlands and to prevent water erosion, five (5) drainage canals, total length 2,045 m, are planned. They are designed as grassed waterways.

B.3.4 Agriculture

(1) For the present fruit trees under poor or fair growth condition, soil/soil layer improvement and application of fertilizer have to be carried out to ensure a normal growth level. In case the growth of a tree is poor due to low soil fertility, for example, filling with clayey soil around the tree and application of fertilizer are required.

(2) Rambutan trees are planted in the reclaimed land. To ensure proper growth, fertilizer management and soil improvement have to be carried out.

B.3.5 Soil and Soil Layer Improvement

(1) Since the fertility of deposited soil is low, soil improvement such as mulching by organic material residuum, application of calcareous material to correct soil acidity, input of organic compost and slow release fertilizer, seeding of leguminous crops, are required.

(2) In addition, soil layer improvement such as removal of rock and debris, soil mixing with the original soil and soil dressing with clayey soil have to be carried out, considering the conditions of each field.

(3) The above improvement methods are applied to each field based on soil properties and land use plan.

B.3.6 Irrigation Development

(1) Low-head sprinkler system is applied to the area planted to fruit tree. Small pumps are used individually to lift water from the pipeline and/or the river. According to the water balance study, water quantity at the confluence of Mui and Chawang rivers is sufficient to irrigate even during 1/10 probability dry year.

(2) However, farmer's group to ensure access of water in the pipeline and to allocate water to all farmers during dry months should be organized.

B.3.7 Agricultural and Rural Infrastructural Improvement

(1) Farm roads, total length 1.2 km and consisting of four routes, are planned for rehabilitation of rural infrastructural facilities. The effective width is designed at 2.0 m. The road on the

dike will be used as farm road and O & M road and will form a network by linking to the existing roads.

(2) In addition to road construction, deteriorated pipe crossing structures are rehabilitated.

B.3.8 Farm Land Conservation

(1) In and around the area, Centrosime, Caloapsgonium and Kudzu species are available as the local covering crop. In practice, these species are mix-seeded around the fruit trees.

(2) Ditch is not planned in the farm field, since the soil surface will be protected. The drainage canals are planned as mentioned in (2), B.3.3, along the boundary of the existing farm plots.

B.3.9 Agricultural Supporting Services

(1) In order to strengthen the present farmer's groups, the followings should be programed; ① to campaign for establishment of farmer's group in accordance with the specific kind of activities such as, rambutan plantation, handicraft and marketing, ② to promote training services for creation of qualified leaders, and ③ to formulate strong back-up by governmental agencies.

(2) Necessary agricultural supporting services are summarized as; ① to carry out intensive consultation and/or extension services on modern agricultural technology including soil improvement, ② to encourage provision of special long term credit for rehabilitation and conservation programs, and ③ to formulate updated marketing information system.

(3) For an effective implementation and strengthening of farmers' organization, a technical advisory group should be staffed with specialists of different fields such as, horticulture, soil improvement and conservation, farmer's organization, marketing and agricultural credit. Technical service activities advised by these specialists should be planned as an agricultural supporting project.

B.3.10 Project Cost

(1) Project cost is consisted of construction, project administration, consulting services, agricultural supporting activity, physical contingencies and price escalation.

(2) Project implementation is programed for four years after this feasibility study. The cost is as follows.

Case-1 : 60,865,000 Baht

Case-2 : 45,974,000 Baht

B.3.11 Project Implementation Program and Operation and Maintenance

(1) The proposed project is consisted of many components, and therefore, under the committee organized by government agencies concerned, DLD is fully responsible for project implementation.

(2) Besides construction of facilities, promotion of farming practice including soil/soil layer improvement is one of the most important factor for successful project implementation. For the promotion, therefore, various activities for setting up farmer's organization aiming to encourage the related farmers to participate in the project are required in parallel with the project coordination works. Agricultural supporting service project is initiated early in the implementing stage.

(3) Farmer's group for O & M at farm level should be organized in the agricultural supporting service project under the support from DLD.

B.3.12 Environmental Impact

(1) The proposed projects will not have any negative impact on present natural and social environment in and around the area, considering the project objectives such as rehabilitation, conservation of land and water resources, and resumption of farming activities, and scale of the projects.

(2) With the spread of farming practice, however, environmental conditions such as soil fertility, capability of land conservation and water quality may change by improper farm management. To perceive these conditions and to take measures quickly to meet the situation, environmental change have to be monitored in the O & M works by the farmer's group under the supervision by DLD.

B.3.13 Project Evaluation

(1) Project evaluation has been examined based on the incremental agricultural production benefits and social impact or effect which will be brought by restoring the farmland. The economic analysis based on the quantitative production benefits shows that Economic Internal Rate of Returns (EIRR) of both cases are about 6.0%, which is lower than the rate of opportunity cost of capital (12 %) in Thailand.

(2) By implementing case-1, more non-quantitative social effects can be expected. Also, social demand for complete land restoration is stronger. Therefore, case-1 (full embankment construction) is recommended as the agricultural land rehabilitation and conservation project.

(3) Although EIRR is low, it is still higher than 5.0% which is generally applied to specific small scale government projects. Therefore, the proposed project is considered to be feasible.

B.4 DEVELOPMENT PLANS IN THE LAN SAKA F/S AREA

B.4.1 Basic Approach

(1) Development constraints for plan formulation are summarized as 1) flood intrusion causes erosion, sediment and soil loss in the field, 2) present land is covered with thick sediment of sandy soil and 3) lack of infrastructural facilities and insufficient agricultural supporting activities. For crop production, therefore, soil/soil layer improvement have to be carried out.

(2) For plan formulation, the F/S area is divided into upstream and downstream areas, based on the present land use and topographical conditions. Alternative development plans are studied by the divided area, considering the following flood prevention measures.

Alternative Case	Measure for upstream		Measure for downstream	
	①	②	③	④
Case - 1	applied	-	applied	-
Case - 2	applied	-	-	applied
Case - 3	-	applied	applied	-
Case - 4	-	applied	-	applied

Note : - Measure ① and ③ are complete embankment construction.
- Measure ② is vegetative protection, without embankment.
- Measure ④ is semi-ring embankment at the upper part of the area and vegetative protection at the lower part.

Vegetative protection will help to retard intruding velocity and reduce damage caused by sedimentation and drifting woods.

B.4.2 Land Use Classification and Area

(1) Based on the above development alternatives, land use is planned as follows.

Fruit tree (direct planting) : Fruit tree is planted in the higher elevation land where flood damage can be mitigated by construction of embankment.

Fruit tree (raising bed) : Fruit tree is planted on raising bed which keeps groundwater table lower than 1.0 m below surface. The maximum height of the bed is 0.5 m, considering construction cost and difficulty in maintenance works.

Upland crop : Upland crop is planned in the lower elevation land with prolonged inundation and groundwater less than 1.0 m below surface during wet season.

Inland fishery : Small fishery pond is planned in the class Ⅲ land.

(2) Based on the above land use methods, land use area is planned as follows.

Land Use	Case - 1	Case - 2	Case - 3	Case - 4
Fruit tree (direct planting)	225	135	179	88
Fruit tree (raising bed)	29	46	29	46
Upland crop	77	172	151	247
Inland fishery	24	24	24	24
Mixed cropping *1	139	139	139	139
Public use land *2	85	63	57	35
Total	579	570	579	579

Note : *1 : Land use is the same as the present.
*2 : Area for roads, canals and embankment.

B.4.3 Drainage Improvement

(1) Non-uniform flow is used to estimate flood level of 1/10 probability discharge of 757 m^3/s. With Fb = 1 m, the dike can withstand a discharge of 1/50 probability. In the upstream area the embankment is 1.0 - 4.0 m above the hinterland and will occupy a width of 15 - 30 m. The materials for embankment will come mainly from the flood plain. Gabion protection will prevent erosion and bank scouring.

(2) In case-1 and 3, in the downstream area, with enclosed embankment, inside farmland is protected from flood intrusion. However, inundation is caused by surface runoff inside the dike. Inundation analysis shows that the elevation 31 m M.S.L and below will be affected for a couple of hours in a normal year.

(3) In case of semi-ring embankment, it is planned to prevent overflowing of river discharge at the upper part while tolerating flood intrusion from the middle and lower parts. With this embankment, supply of sediment will cease by stopping the overtopping. The farmland, however, is inundated by water intrusion and backwater effect from downstream. In this

case, raising bed is effective for fruit trees cultivation. Total length of embankment is planned with 5.0 km (case-1), 3.0 km (case-2), 3.0 km (case-3) and 1.0 km (case-4).

(4) To enhance drainage in the depression and the swampy area and to control water erosion, a network of drainage canals consisting of four routes are planned. Total length of grassed waterways comes to 2,525 m.

B.4.4 Farming Practice

(1) Mangosteen is planted in the area, taking account of the social and natural characteristics of this region. A rotation of sweet corn, mungbean and chili are proposed as cash crop. These are cropped except during the rainy season.

(2) Banana is intercropped as shading trees. The above mentioned upland crops are also cropped between the mangosteen trees. These crops are the source of income until the mangosteen trees start to bear fruits.

(3) Fish culture is practiced in the swampy area. The major fish in this region is Tilapia. The fish will be raised two times in a year except for rainy season, if water supply, feeds and procurement of fry are well-managed by farmers.

B.4.5 Soil and Soil Layer Improvement

(1) The methods of soil and soil layer improvement are the same as in Ban Na San. The necessary amount of soil dressing for fruit tree is less than in Ban Na San, since the fertility of the deposited soil is higher.

(2) Improvement area is estimated based on the land use method for the alternative plans.

B.4.6 Irrigation Improvement

(1) In the area, irrigation is not a common practice. However, irrigation should be introduced on the restored land, especially while the root of a young tree is developing. Low head sprinklers and spraying hoses for orchard and upland field irrigation, both fed by portable pumps, are proposed.

(2) Water balance analysis shows that discharge of Tha Di river is abundant and is enough for the irrigation. Shallow wells may be planned as alternative water source.

B.4.7 Agricultural and Rural Infrastructure Development

(1) Four routes of farm road, 1,100 m of total length, are planned. The road on the dike will be used as farm road and O & M road. For the existing roads, the road surface has to be rehabilitated with sediment pavement at deteriorated points.

(2) In addition, rehabilitatation is planned for road crossing structures and bridges.

B.4.8 Farm Land Conservation

(1) Ground surface has to be kept green if possible with covering crops. In addition to the cover crops in Ban Na San, vertiver grass is available. It is planted in strips at moderate intervals in sloped ground surface. As another crop, bamboo is also available in the area. The root is strong enough for soil erosion. It should be planted on erosive slope and field, as a guard fence against sand and debris flows.

(2) The drainage canals, as mentioned in (4), B.4.3, are planned for soil and water conservation.

B.4.9 Agricultural Supporting Services

(1) The basic plan for strengthening program for farmer's organization and agricultural supporting services are similar to that of Ban Na San.

(2) A technical advisory group should be organized, same as in Ban Na San. This group provides technical services for the project implementation body and farmer's groups, under the full support of DLD's station in Nakhon Si Thammarat.

B.4.10 Project Cost

(1) The above-mentioned plans were complied as agricultural land rehabilitation and conservation projects. Total project cost including price escalation for five years implementation was estimated as follows.

Unit: 1,000 Baht

Case	Cost
1	154,965
2	91,708
3	111,083
4	47,915

B.4.11 Project Implementation and Operation and Maintenance

(1) The project should be implemented under the same concepts as in Ban Na San, and full support from DLD's Nakhon Si Thammarat station.

(2) Basic ideas of operation and maintenance works for constructed facilities are the same as in Ban Na San. In the area, however, it is emphasized that farmer's group for O & M plays a vital role in maintenance of the dike. O & M groups shall be organized by the beneficiaries.

B.4.12 Environmental Impact

(1) The proposed projects will not have any negative impact on existing social and natural environment, considering the construction scale of engineering works and soil/soil layer improvement.

(2) Establishment of a monitoring organization is needed to observe the environmental changes and to plan conservation works against the negative environmental impacts. It shall be organized by the staff from DLD's station and farmer's groups. The sediment in Tha Di river has to be monitored and removed regularly.

B.4.13 Project Evaluation

(1) Project evaluation has been examined by the same approach as in Ban Na San. The economic analysis shows that economic internal rate of return (EIRR) of case-3 is the highest, 8.7%.

(2) Besides the quantitative benefits, many non-quantitative social benefits will be produced through the implementation of the project. Therefore, case-3 is recommended as the agricultural land rehabilitation and conservation project, which is considered to be feasible. Promoting activities to implement the project are strongly expected.

B.5 CONCLUSION AND RECOMMENDATIONS

B.5.1 Conclusion

(1) The concepts of the proposed projects meet the aims of natural resources conservation and proper land use policy of the agricultural development plan which is one of the National Economic and Social Development Plans. The development plan has been studied considering improvement and conservation technique of soil/soil layer and farmland. The

projects have been formulated based on the institutional system and engineering capability of DLD and other governmental agencies concerned.

(2) The projects will produce many social benefits, although the economic viability, in a quantitative sense, is low. As a conclusion, therefore, the proposed projects are feasible.

B.5.2 Recommendations

It is recommended to implement the proposed projects with due attention to the following.

(1) For smooth and successful implementation of the projects, it is a prerequisite to carry out the agricultural supporting service project for propagation of improvement and conservation methods of soil/soil layer and farming practice, in addition to the provision of infrastructure.

(2) Improper management of farmland may cause deterioration of land resources. To ensure sustainable agriculture and soil/water conservation, it is a prerequisite to have positive participation of the related farmers.

(3) For successful implementation of the proposed project, it is required to operate and manage the infrastructural facilities well, and to monitor environmental changes to prevent flood disasters. For that purpose, adequate measures to strengthen the present farmer's groups should be taken in parallel with the provision of the facilities.

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ABBREVIATIONS AND ACRONYMS USED

ABBREVIATION

ACs	:	Agricultural Cooperatives
AMC	:	Agricultural Marketing Cooperatives
BAAC	:	Bank of Agriculture and Agricultural Cooperatives
CDD	:	Community Development Department, MOI
CPD	:	Cooperatives Promotion Department, MOAC
CRI	:	Chulaporn Research Institute
DOA	:	Department of Agriculture, MOAC
DLD	:	Department of Land Development, MOAC
DOAE	:	Department of Agricultural Extension, MOA
DOF	:	Department of Fisheries, MOAC
DOH	:	Department of Highway, MOC
DOL	:	Department of Lands, MOI
DOLA	:	Department of Local Administration, MOI
EIA	:	Environmental Impact Assessment
FAO	:	Food and Agriculture Organization of the United Nations
HD	:	Harbor Department, MOC
IEE	:	Initial Environmental Examination
JICA	:	Japan International Cooperation Agency
LDD	:	Department of Livestock, MOAC
MD	:	Meteorological Department, MOC
MRD	:	Department of Mineral Resources
MOAC	:	Ministry of Agriculture and Cooperatives
MOC	:	Ministry of Communications
MOF	:	Marketing Organizations for Farmers, MOAC
MOI	:	Ministry of Interior
MOPH	:	Ministry of Public Health
NEA	:	National Energy Authority
NEB	:	National Environmental Board
NESDB	:	National Economics and Social Development Board
NSO	:	National Statistical Office
OAE	:	Office of Agriculture Economy, MOAC
PER	:	Provincial Electricity Authority
RFD	:	Royal Forestry Department, MOAC
RID	:	Royal Irrigation Department, MOAC

UNIT

B	:	Baht
BM	:	Bench Mark

EL	:	Elevation Above Mean Sea Level
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GPP	:	Gross Provincial Product
GRP	:	Gross Regional Product
M.	:	Million
NPV	:	Net Present Value
WL	:	Water Level
cu.m	:	Cubic Meter
MCM	:	Million Cubic Meter
Kw	:	Kilowatt
l	:	liter
ha	:	Hectare
m	:	Meter
kg	:	kilogram
km	:	kilometer
sq.m	:	Square meter
ton	:	Metric ton
hr	:	Hour
min	:	Minute
sec	:	Second
°C	:	Degree Celsius

GLOSSARY

Changwat	:	Province
Amphoe	:	District
Tambon	:	Sub-District
Muban	:	Village
Mae Nam	:	A large river
Khlong	:	A tributary of the large river

UNIT OF MEASUREMENT

1 rai	:	0.16 ha, 1,600 m^2
1 ha	:	6.25 rai, 10,000 m^2

THAI FISCAL YEAR

October 1 to September 30
Thai year 2538: AD 1995

CURRENCY

¥	:	Japanese Yen(s) (0.2799 Baht, July of 1995)
Baht	:	Thai currency (¥ 3.57, July of 1995)

PART 1

MASTER PLAN FOR THE AGRICULTURAL LAND REHABILITATION AND CONSERVATION IN THE BAN NA SAN AND LAN SAKA DISTRICTS

CHAPTER 1

INTRODUCTION

PART 1 MASTER PLAN FOR THE AGRICULTURAL LAND REHABILITATION AND CONSERVATION IN THE BAN NA SAN AND LAN SAKA DISTRICTS

CHAPTER 1 INTRODUCTION

1.1 Background

The northeast monsoon carried heavy rainfall at the end of November 1988, which suddenly and brutally attacked the fourteen (14) provinces of southern Thailand. This monsoon caused serious landslides and soil erosion and claimed several hundreds of lives, devastated property and destroyed agricultural facilities and land. It especially caused tremendous damage to the Surat Thani and Nakhon Si Thammarat Provinces. Consequently, many people have lost their houses and agricultural lands. Socio-economic activities have definitely been paralyzed.

The Government of Thailand set up a Central Committee immediately to restore the affected area. The Department of Land Development (DLD), under the Ministry of Agriculture and Cooperatives (MOAC), has been assigned as a task force responsible for soil and land restoration of the area. DLD has been making efforts to rehabilitate the devastated land and conserve the agricultural land and still needs to find out the most suitable rehabilitation and conservation techniques for the affected area.

Under such circumstances, in compliance with the official request by the Thai Government in October 1989, the Japanese government conducted a preliminary survey in April 1993, and a Scope of Works (S/W) for the Study on the Agricultural Land Rehabilitation and Conservation Project in Surat Thani and Nakhon Si Thammarat Provinces was concluded. Based on the S/W, Japan International Cooperation Agency (JICA) dispatched a study team on March 18, 1994 to perform the survey. This report presents the study results of the work.

1.2 Objectives and Scope of the Study

The objectives of the study are 1) to prepare a master plan for agricultural land rehabilitation and conservation for Ban Na San and Lan Saka districts in Surat Thani and Nakhon Si Thammarat provinces, respectively, and 2) to conduct a feasibility study for priority project area(s) selected in the process of the master plan study.

In order to achieve the above objectives, the study consists of the following two (2) phases.

Phase I study involves (1) collection and review of existing data and information, (2) understanding general conditions of flood affected area and causes of flood disaster, (3)

formulation of a master plan for agricultural land rehabilitation and conservation in Ban Na San and Lan Saka districts, (4) selection of the priority project areas for succeeding the phase II study.

Phase II study involves (1) additional survey and data collection for the selected priority project areas, (2) formulation of agricultural land rehabilitation and conservation plans through feasibility study.

Study results are presented in the following reports.

- Final Report and Appendices
- Technical Guideline for Agricultural Land Rehabilitation and Conservation

CHAPTER 2

SOCIO-ECONOMIC BACKGROUND

CHAPTER 2 SOCIO-ECONOMIC BACKGROUND

2.1 National Economy

2.1.1 Population and Land Utilization

(1) Population

In 1992, Thailand had a total population of about 57.8 million and a population density of 112 people/km^2. The annual growth rate of population is decreasing. Under the Seventh National Development Plan, the rate is set to be less than 1.2% per year which will bring the total population to 61 million by the end of the Plan.

The majority of Thai have been working in the agricultural sector. In 1961, the agricultural population was about 74% of the total population and the agricultural labour force was about 82% of the total of the country. According to the agricultural statistics, the ratio of the agricultural population to the total population is decreasing. In 1991, it was 62%.

(2) Land utilization

Thailand has a total land area of about 320.7 million rai. In 1992, 130.64 million rai (or 41%) was classified under farm holding land, 85.44 million rai (or 27%) forest land and the rest unclassified land.

Out of the total farm holding land about 71.04 million rai is being utilized for paddy cultivation, 29.97 million rai for growing upland crops, 17.05 million rai for fruits and tree crops and 12.58 million rai for others (refer to A-2, Appendix A). Over the past three decades, agricultural development has been achieved based almost exclusively on expansion of the volume of agricultural production through major increases in cultivated area. From the beginning of the First National Development Plan (1961) to the Sixth Plan (1991), the farm holding land area has increased from 20% to 41% of the total land area, while during the same period, the forest land area has declined from 53% to 27% (refer to Table K.1.1, Appendix K).

2.1.2 National Economy

Until the Sixth National Development Plan (1987-1991), the overall national economy of Thailand marked a substantial growth. The growth is expected to continue for at least the period of the Seventh National Development Plan (1992-1996).

The outcome of past development during NESDB Plans 1-6 indicates that the growth of non-agricultural sectors such as industrial and service sectors is more significant compared with that of agricultural sector. The share of GDP in agricultural sector against overall GDP during the past six 5-year plans is shown in the following table.

GDP at Current Prices (1961-1991)

Year	GDP (million Baht)		Percentage of agriculture
	Overall	Agriculture	
1961	58,970	23,111	39.2
1967	108,224	35,143	32.5
1972	170,076	43,130	25.4
1977	403,529	99,570	24.7
1982	820,002	156,839	19.1
1987	1,253,147	205,592	16.4
1990	2,051,208	258,904	12.6
1991	2,289,258 *	284,489 *	12.4

Source : Office of NESDB
Notes : The first year of the National Plans are
1961, 1967, 1972, 1977, 1982, 1987 and 1991.
* : Estimated by Office of Agricultural Economics

Although the share of agricultural sector is decreasing, from 39.2% in 1961 to 12.4% in 1991, it still plays a vital role in national economy as there are still more than 19 million labour forces engaging in the agricultural production.

2.1.3 National Socio-Economic Development Plan

(1) Agricultural development during NESDB Plans 1-6

The first Plan was prepared in 1961 which covered a 6-year implementation period until 1966. Subsequent Plans were prepared every 5 years, and the 7th Plan is currently under implementation. The target and actual growth rates of the whole national plans as well as those in the agricultural sector during the past six 5-year plans are shown as follows.

Target and Actual Growth Rates of the National Plans
and Those in the Agricultural Sector

Unit : %

Items	NESDB Plan					
	Plan 1 1961-66	Plan 2 1967-71	Plan 3 1972-76	Plan 4 1977-81	Plan 5 1982-86	Plan 6 1987-91
National Plan						
Target	6.0	8.5	7.0	7.0	6.6	6.0
Actual	8.1	7.8	7.1	7.1	5.4	10.5
Agricultural Sector						
Target	3.3	4.3	5.1	5.0	4.5	2.9
Actual	7.6	4.2	4.2	4.0	3.9	3.4

Source : NESDB

(2) The Seventh National Development Plan (1992-1996)

During the Seventh National Economic and Social Development Plan, the main agricultural policy can be summarized as follows.

- Maintain agricultural economic stability and promote agricultural and agro-industrial growth
- Increase farmers' income
- Improve the administrative system of agricultural development
- Improve the management and administrative system for natural resources
- Improve the quality of life

Under the Seventh Plan, the target of average economic growth rate is set at 8.2% per year, and in agricultural sector 3.4% was targeted.

2.2 Southern Region

2.2.1 Physiography and Population

The area of the southern region is approximately 44.2 million rai, sharing about 14% of the national area. The rainfall is plenty and rainy season is longer compared to the other region. The average annual rainfall in the southern region is about 1,800 mm on the East Coast and 2,700 mm on the West Coast. The geographical feature is hilly with various small watersheds of torrential rivers.

The southern region is consisted of 14 provinces with total population of 7,409,000 in 1992. The total area of Surat Thani is the largest, while Nakhon Si Thammarat has the largest population in the South.

2.2.2 Socio-Economy

The southern region's economy is mainly based on agriculture. In 1992, 16.68 million rai (or 38% of total) were farm holding land, 8.41 million rai (or 19%) forest land, and 19.12 million rai (or 43%) unclassified land.

In 1992, average farm holding size in the South was about 23.71 rai with a total number of 703,339 farm households. Farm size between 10 to 20 rai was the largest (32%), followed by 2 to 10 rai and 20 to 30 rai holding. The national average for farm holding size is about 25.57 rai (refer to A-2, Appendix A). About 42% of the farm holding land in the South belongs to owner-cultivators while about 24% belongs to common owners. About 34% is under cultivation by tenant farmers.

According to the survey in 1988 by the Office of Agricultural Economics, socio-economic condition of southern region is summarized as follows.

- The family members of the age groups 15 to 40 years old shared the majority, about 40%, followed by the age group less than 15 years, about 32%.
- About 49% of the family members only received compulsory education while about 41% did not even finish the primary education.
- The main crops which bring about the most income are fruit trees and tree crops. Most of the off-farm income come from employment, trade and household handicraft production. The ratio of the off-farm income to the total net income of the farm household was about 63%.

2.2.3 Agriculture

Rubber and fruit trees are the popular crops in the southern region. Out of the total farm holding land of 16.68 million rai, about 3.34 million rai is being utilized for paddy land, 0.13 million rai for growing upland crops, 10.74 million rai for fruits and tree crops and 2.47 million rai for vegetables, pasture land and others (refer to A-2, Appendix A).

Agricultural development in the south achieved in the past is partly a result of intensive exploitation of forest land. Over the past three decades, the forest area in the South has decreased

by about 10.1 million rai or 23% of the total area of the southern region. In 1991 the forest area in the South is accounted for 8.4 million rai (refer to Table K.1.1, Appendix K).

At present, about 79% of the total farm holding lands are under rainfed cultivation. On the other hand, the total irrigated areas served by large and medium scale and other small scale projects amounts to about 3.5 million rai as of 1993.

Besides para rubber and fruit tree production, marine fishery and coastal aquiculture are the main fishery production. Coastal aquiculture is active along the sea shore, estuarine area, canal, lake inundation area, mangrove area and shallow area near the sea shore. Coastal fishery, especially the culture of giant tiger prawn has expanded rapidly.

CHAPTER 3

PRESENT CONDITIONS OF THE GENERAL STUDY AREA

CHAPTER 3 PRESENT CONDITIONS OF THE GENERAL STUDY AREA

3.1 Physical Conditions

3.1.1 Location and Climate

(1) Location

The flood affected area (5,170 km^2) is located mostly at Amphoe Kanchanadit, Ban Na San, and Wiang Sa in Surat Thani Province and Amphoe Thung Song, Tha Sara, Phrom Ki Ri, Ronpiboon, Chawang, and Lan Saka in Nakhon Si Thammarat Province. The area is close to the Gulf of Thailand, and Khao Luang mountain range runs north to south in the central of the area. It is surrounded by routes 41, 4009, 401, and 403.

(2) Climate

(2)-1 Rainfall

The area is affected by Northeast and Southwest Monsoons, and annual rainfall is above 2,000 mm. The surrounding of Nakhon Si Thammarat city has the largest amount of rainfall. Annual rainfall shows a tendency to decrease northward and westward from Nakhon Si Thammarat city (refer to Table B.1.3, Appendix B).

1) Monsoon

The area is affected by the Northeast Monsoon and depressions coming from southeast from November through January. This monsoon originated in inner continental China and brings cold and dry air masses. When it flows over the South China Sea and the Gulf of Thailand, it becomes hot and humid maritime air masses, which causes much rainfall in the area. The flood disaster at the end of November 1988 was caused by the monsoon and the developed depression. This area is also under the influence of the Southwest Monsoon and Bengal cyclones from May through October. This monsoon comes from the Indian Ocean and Andaman Sea.

2) Rainfall pattern

To understand the rainfall distribution, topographic factor should be taken into consideration. From that viewpoint, the area can be divided into the following three zones.

- Zone (A)

This zone is strongly affected by the Northeast Monsoon. Total rainfall of October to

December occupies 55% of annual rainfall. On the other hand, this zone is also influenced slightly by the Southwest Monsoon from May to October.

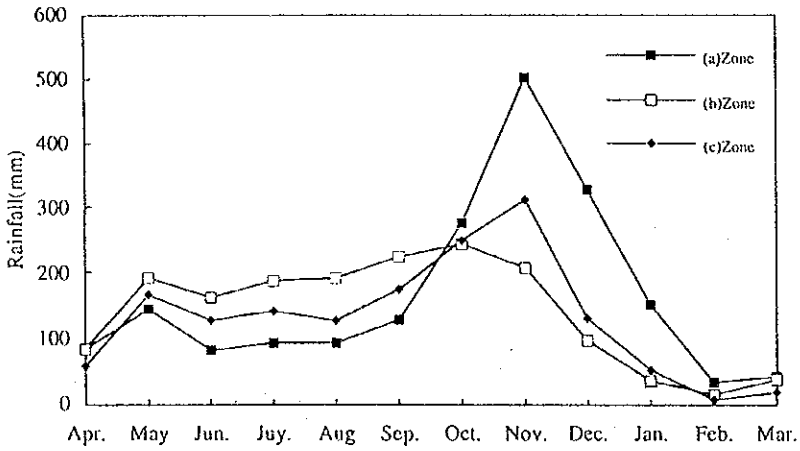
- Zone (B)

  This zone receives well-distributed rainfall from May to December, and has much rainfall during May to September owing to the influence of the Southwest Monsoon. But annual rainfall is less than that of the Zone (A) due to less influence of the Northeast Monsoon.

- Zone (C)

  Since the Monsoons are not interrupted by the mountain ranges in this zone, rainfall amount is the least.

Distribution of Rainfall in the General Study Area



3) Rainfall intensity

Comparing with rainfall intensity of each zone, it is obvious that Zone (A) has the largest intensity (refer to Table B.1.3, Appendix B).

Rainfall Intensity

Zone	Daily Max. Rainfall (mm)	2 days Max. Rainfall (mm)	3 days Max. Rainfall (mm)	Month of Occurrence
(A)	155.7	229.7	277.4	Nov. to Dec.
(B)	94.2	126.8	150.5	May to Dec.
(C)	118.6	162.2	184.2	May to Dec.

3.1.2 Topography and Geology

Topography of the area is classified into the following four types, high, steep mountains, and pediments, alluvial fans and alluvial plains which surround the mountain (refer to Figure C-1, Appendix C).

(1) Mountains

The mountain ranges known as the Khao Luang are underlain mostly by granite and are quite steep with an average slope gradient of 27°-33°. Surrounding the granite underlain mountains there are the lower mountains which are underlain by Cambrian and Permian quartzite, limestone, slate, phyllite and chert. These rocks are very hard and, compact but are deeply weathered during long geological time. These are also cut by several sets of geological discontinuities such as joints and faults.

(2) Lower hills, terraces and alluvial fans

Surrounding these mountains, low lying hills, terraces and talus are distributed ranging in altitude less than 200 m. Lower hills are underlain by deeply weathered granite and Cambrian and Permian sedimentary rocks forming red soil at the surface. Terraces are widely distributed north of Surat Thani province and are formed in the exit of the valley where river and stream flow out from mountain to plain. The terrace deposits consists of Pleistocene sediments such as sand and gravel. The terraces distributed at north of Surat Thani province were exceedingly weathered and top of the sediment was altered to red soil. The terraces which are formed in the exit of the valley are a few meters higher than present fluvial plain, and the thick soil is formed at the top of the terrace but has not been formed into red soil. Alluvial fans are formed along rivers and streams. The surface of them was overlain by thick deposits of the 1988 disaster.

(3) Alluvial plains, (4) Coastal plains

Alluvial plains are distributed most widely at the eastern part of the Khao Luang mountain range in front of alluvial fans and also at the western part of the mountains in the basins alongside the Ta Pi river. Coastal plains are formed in the eastern part of Khao Luang mountain range reaching the beach of the Gulf of Thailand.

3.2 Surat Thani Province

3.2.1 Socio-Economy

(1) Society

(1)-1 Division of administration

The administrative area of Surat Thani province is divided into 17 districts (Amphoes), two (2) king districts, 129 sub districts (Tambons), and 937 villages (Mubans), which covers 12,891 km^2.

(1)-2 Population and household

The total population is 791,259 as of 1992 in the province. The population density is 61 people/km^2, which is considerably sparse compared with 112 of the country and 105 of the southern region.

According to the 1990 Population and Housing Census, the average annual population growth rate of the province during the last decade (1980-90) was 2.42%, which is rather high compared with 1.56% of the country and 1.55% of the southern region. Farm household population is 467,543 which occupies 63% of the total population in the province. The number of farm household is 100,819. The family size per household is 4.6 people for farm household.

(1)-3 Labor force

According to the 1990 Population and Housing Census, the population group aged 13 years and above was 553,473 or 74% of the total population, out of which 419,225 or 56% are economically active labor force. Out of which, 95% (the nation, 95%) hold some jobs. Five (5) percent of the employed people, are the seasonal farm workers (the nation, 3%), or preliminary unemployed people. Besides, including the seasonal farm workers, 69% (the nation, 60%) of the economically active population or 287,679 are estimated to work in agricultural activities.

(1)-4 Education

Since the government's policy to make compulsory education free, the diffusion of school education in the province has been remarkable. The percentage of those finishing compulsory education in the population is 70. Consequently, the prevalence of literacy is very high, namely, that of percentage is 96.

(1)-5 Public health

According to the Public Health Statistics in 1988, the number of persons per bed, per physician and per nurse are 727 (the southern region, 694), 8,596 (5,717) and 2,394 (1,801), respectively. The public health situation in the province is poorer than that of the southern region.

(2) Economy

(2)-1 General

The economic status of the province and the southern region in terms of GDP fell from 9.9% and 1.1% in 1986 to 8.3% and 1.0% in 1991, respectively. As same as the national trend, the gross provincial product (GPP) grew at a high average annual rate (real) of 11.1% (the region, 8.3%) during the last 5 years (1986-1991). Accordingly, the economic status of the province in the southern region rose from 11% in 1986 to 12% in 1991.

The GPP (nominal) of the province accounts for 25,027,000 Baht in 1991. The GPP per capita is estimated to be 31,442 Baht, which is considerably low compared with 44,055 of the nation, but, it is high compared with 27,084 of the southern region.

(2)-2 Agricultural production value

The status of the agricultural sector in the province hold the first position, occupying 35% of the gross provincial product (GPP) in 1991. Namely, agriculture is still the fundamental industry. The average annual growth rate was 19% during the last 5 years (1986-1991), contributing to 11.1% of the GPP. The participation rate of the crops production in the agricultural sector is 71% (25% of the GPP). Both the fishery and the agro-processing product are 11% (4%).

(2)-3 Farm economy

(2)-3-1 Average farm size

According to the Agricultural Statistics of Thailand, Crop Year 1992/93, the total farm holding land as of 1991 in the province covers 2,251,640 rai, and there are 72,584 farm households. Consequently, the farm size per farm household is 31.0 rai, being rather large compared with 25.9 rai of the nation and 22.6 rai of the southern region. An average farm size is estimated to be mainly comprised of 9.0 rai of fruit, 13.7 rai of rubber and 5.2 rai of paddy.

(2)-3-2 Farm household economy

According to the Office of Agricultural Economics, the net cash income of an average size farm household in the province as of 1991 is 78,165 Baht, out of which 37,697 Baht or 48% are net farm income. Both of these incomes are considerably high compared with an average size farm household in the central region which gets the highest cash net income in the country. The farm household cash expenditures are also mostly high, 73,238 Baht, the central region, 66,370 Baht. An average sized farm household in the province is apparently wealthy. However, it is a problem that 58% of the gross cash farm income comes from rubber.

(3) Farm land holding

As of 1991, out of the total farm holding land, 93% or 2,083,106 rai are owned land, only 0.5% or 11,724 rai are rented land and the remaining 156,810 rai are free of charge land. Besides, 10% of the owned land are mortgaged land which will fall out from owned land in the near future.

3.2.2 Land Use and Agriculture

(1) Utilization of farm holding land

The forest land occupies 26% of the whole province with an area of 3,400 km^2, and farm land with 37%. Land for fruit tree and tree crops occupies 73% of whole farm land in the province. Most of the area is covered with rubber plantation. The share of paddy field is about 17%, and idle land, housing area, field crop area, livestock farm land, and vegetable and flower area come after with a share of 10%.

Agricultural Land	Area (rai)	Rate (%)
Housing area	69,355	3.0
Paddy field	373,454	16.6
Under field crop	35,957	1.6
Under fruit tree and tree crops	1,644,110	73.0
Under vegetable and flower	8,213	0.4
Livestock farm land	11,427	0.5
Idle land	76,898	3.4
Others	32,226	1.4
Total	2,251,640	100.0

Source : Agricultural Statistics of Thailand, Crop Year 1992/93

(2) Agriculture production

In 1992, the total production of rice in this province was 106,363 ton. The planted area is one-third of that of Nakhon Si Thammarat. Planted area and production of maize and mungbean are becoming less. Groundnut shows almost no increase. Coffee planting is active, and Surat Thani has the second largest production after Chum Phon. The production is 10,578 ton which is equal to 13.2% of the national amount (refer to Table H-1-2, H-2, H-3 and H-4, Appendix H).

Crops	Planted area (rai)	Harvested area (rai)	Production (ton)	Yield (kg/rai)	Year
Major rice	348,861	343,018	103,263	301	1991/92
Second rice	6,370	6,370	3,100	487	1992
Maize	5,796	5,735	1,375	240	1991/92
Mungbean	247	243	24	99	1991/92
Groundnut	4,986	4,914	974	198	1991/92
Coffee bean	68,132	65,297	10,578	162	1991/92

Source : Agricultural Statistics of Thailand, Crop Year 1991/92

(3) Perennial crops

Para rubber production is 293,186 ton which is one-fifth as much as national production. Since its market price fluctuates and has relatively been low, farmers tend to divert it into fruit planting which is profitable. Production of coconut is 225,489 ton which is equal to 16% of national production. Production of oil palm is 31% of national production.

Crop	Planted area (rai)	Fruitage area (rai)	Production (ton)	Yield (kg/rai)
Para rubber	1,513,067	983,847	293,186	298
- Local V.	(19,555)	-	-	-
- Improved V.	(1,493,512)	-	-	-
Coconut	343,683	332,580	225,489	678
Oil palm	309,143	232,559	416,700	1,792
Rambutan	54,037	45,593	47,430	1,040
Durian	16,598	8,437	11,430	1,355
Cashewnut	9,106	6,648	1,516	228
Coffee	96,131	91,608	14,840	162

Source : Office of Agricultural Extension, Surat Thani, 1993

(4) Livestock

In the past trend of Thailand, the number of cattle and pig has been on the upward while buffalo has been decreasing. The province is showing the same tendency, but the number of buffalo and cattle is much smaller than that of Nakhon Si Thammarat. There were 26,000 of buffalo, 32,000 of cattle, etc, according to the statistics in 1992 (refer to Table H-6-2, Appendix H).

(5) Number of cooperatives and members

There exists some cooperatives for various socio-agricultural activities, as follows.

Cooperatives	Number of Cooperatives	Number of Members
Agriculture	26	14,764
Land Settlement	5	4,507
Thrift and Credit	8	11,502
Consumer	5	2,176
Services	4	732

Source : Cooperative Promotion Department

(6) Registered agricultural groups

Some agricultural groups have been organized based on the agricultural activities of each crop. Total number of registered groups is 90, 22 paddy, four (4) upland crop, 52 horticulture, five (5) livestock and seven (7) fishery, according to the data in 1993 from Department of Agricultural Extension. Horticultural group is the most active in the province.

3.3 Nakhon Si Thammarat Province

3.3.1 Socio-Economy

(1) Society

(1)-1 Division of administration

The administrative area of Nakhon Si Thammarat province is divided into 17 districts, one (1) king district, 165 sub districts, and 1,361 villages, which covers 9,942 km^2.

(1)-2 Population and household

There is a total population of 1,477,417 as of 1992 in the province. The population density is 149 people/km^2, which is considerably dense.

According to the 1990 Population and Housing Census, the average annual population growth rate of the province during the last decade (1980-90) was 1.44%, which is rather low compared with 1.55% of the region, and 1.56% of the nation. Farm household population is 946,915 which occupies 68% of the total population. The number of farm household is 194,460. The family size per farm household is 4.9 people.

(1)-3 Labor force

According to the 1990 Population and Housing Census, the population group aged 13 years and above was 994,477 or 71% of the total population, out of which 737,993 is economically active labor force. Out of which, 93% hold some jobs and 49,559 are unemployed. Fifteen (15) percent of the employed were seasonal farm workers. Including the seasonal farm workers, 501,536 or 68% of the economically active population are estimated to work in agricultural activities.

(1)-4 Education

The diffusion of school education in the province has been remarkable. Accordingly, the percentage of those finishing compulsory education is 71. Consequently, the prevalence of literacy is very high, namely, that of percentage is 93.

(1)-5 Public health

According to the Public Health Statistics in 1988, the number of people per bed, per physician and per nurse are 953, 11,259 and 3,516, respectively. The public health situation in the province is poorer than those of the southern region and the Surat Thani province.

(2) Economy

(2)-1 General

As same as the national trend, the gross provincial product (GPP) in the province grew at a high average annual rate (real) of 9.4% during the last 5 years (1986-1991). Although the economic status of the province in terms of the GDP fell from 1.5% in 1986 to 1.3% in 1991, that of the province in the southern region rose from 15% to 16%.

The GPP (nominal) of the province accounts for 32,038,000 Baht in 1991. The GPP per capita is estimated to be 20,926 Baht, which is low compared with 27,084 of the southern region, 31,442 Baht of the Surat Thani province.

(2)-2 Agricultural production value

The status of the agricultural sector in the province has held the first position, occupying 24% of the gross provincial product (GPP) in 1991. The average annual growth rate of agricultural sector is 11.0% during the last 3 years (1988-1991), being equal to 11.6% of the GPP of the province.

The participation rate of the crops production in the agricultural sector is 53% (25% of the GPP), followed by, 18% (4%) of the fishery, 13% (3%) of the agro-processing product, and 13% (3%) of the livestock.

(2)-3 Farm economy

(2)-3-1 Average farm size

According to the Agricultural Statistics of Thailand, Crop Year 1992/93, the total farm holding land as of 1991 in the province covers 3,064,478 rai, and there are 133,518 farm households. Consequently, the farm size per farm household is 23.0 rai. The average farm size is estimated to be mainly comprised of 5.5 rai of fruit, 6 rai of rubber, and 9 rai of paddy.

(2)-3-2 Farm household economy

According to the Office of Agricultural Economics, the net cash income of an average size farm household in the province as of 1991 is 52,688 Baht, out of which 23,948 Baht or 45% are net farm income. Comparing with those of the central plain, the farm income is high. However, comparing with those of Surat Thani province, both cash and farm incomes are considerably low. Like the Surat Thani province, it is a problem that 27% of the gross cash farm income, 49,215 Baht, or 62% of the crop cash income are based on the rubber.

(3) Farm land holding

The area of the farm holding land in the province as of 1991 is 3,064,478 rai, out of which 88% or 2,707,249 rai are owned land, 6.6% or 201,456 rai are rented land, and the remaining 4% or 128,717 rai are land free of charge. Besides, 9% of the owned land is mortgaged land which will fall out from owned land in the near future.

3.3.2 Land Use and Agriculture

(1) Utilization of farm holding land

Forest land occupies 15% of the whole province with an area of 1,400 km^2, and farm land with 53%. Land for fruit and tree crops occupies about 50% of whole farm land, of which rubber plantation shares 73%, followed by coconut 12%, fruit tree 12%, and coffee 3%.

Agricultural Land	Area (rai)	Rate (%)
Housing area	99,204	3.2
Paddy field	1,206,734	39.4
Under field crop	20,270	0.7
Under fruit tree and tree crops	1,522,518	49.7
Under vegetable and flower	8,553	0.3
Livestock farm land	8,065	0.2
Idle land	135,764	4.4
Others	63,370	2.1
Total	3,064,478	100.0

Source : Agricultural Statistics of Thailand, Crop Year 1992/93

(2) Agriculture production

Paddy cultivation is active, and the planted area and the production are about three times as much as in Surat Thani province. Upland crops are few.

Crops	Planted area (rai)	Harvested area (rai)	Production (ton)	Yield (kg/rai)	Year
Major rice	928,319	875,924	267,356	305	1991/92
Second rice	17,221	17,221	6,821	396	1992
Mungbean	22,674	17,509	2,305	132	1991/92
Groundnut	5,730	5,674	900	159	1991/92

Source : Agricultural Statistics of Thailand, Crop Year 1991/92

(3) Perennial crops

The production of para rubber is 204,247 ton, which is 13% of national production. The production of coconut occupies 9% of national production. As for fruit tree plantation, durian, rambutan and mangosteen are active. Farming of coffee is also active, and Nakhon Si Thammarat is included in the province with higher production.

Crop	Planted area (rai)	Fruitage area (rai)	Production (ton)	Yield (kg/rai)
Para rubber	1,114,835	786,483	204,247	259
- Local V.	(7,923)	(7,923)	(1,046)	(132)
- Improved V.	(1,106,912)	(778,560)	(203,201)	(261)
Coconut	175,758	152,036	128,827	847
Durian	26,492	17,874	29,576	1,654
Mangosteen	28,625	16,638	12,241	735
Rambutan	27,557	17,517	20,900	1,193
Lemon	9,768	8,832	17,134	1,939
Sato	11,067	8,685	3,925	451
Cashewnut	13,818	11,293	1,959	173
Coffee	47,732	47,600	5,675	119

Source : Office of Agricultural Extension, Nakhon Si Thammarat

(4) Livestock

From the past and present figures, the number of cattle is upward and pig remains at the same level. According to the Agricultural Statistics in Thailand (1991/92), there were about 30,000 of buffalo, 230,000 of cattle, 180,000 of pig. The number of duck and chicken are increasing (refer to Table H-6-3, Appendix H).

(5) Number of cooperatives and members

There exists some cooperatives for various socio-agricultural activities, as follows.

Cooperatives	Number of Cooperatives	Number of Members
Agriculture	26	28,994
Land Settlement	2	1,242
Thrift and Credit	12	22,218
Consumer	11	12,079
Fishery	3	284
Services	3	892

Source : Cooperative Promotion Department

(6) Registered agricultural groups

The total number of registered groups are 115, which consists 62 of paddy, one (1) of upland crop, 35 of horticulture, seven (7) of livestock and 10 of fishery, according to the data in 1993, from Department of Agricultural Extension. Horticultural group is the most active in the province.

3.4 Flood Damage

3.4.1 Flood Damage

The total area affected by the flood in November, 1988 extended to about 12 provinces, and Nakhon Si Thammarat, Surat Thani and Song-Khla are the most affected provinces (refer to Table G.1.1, Appendix G).

(1) Damage in agriculture and fisheries

From the report of MOAC, total damaged areas are 1,662,444 rai, of which 1,318,032 rai is paddy fields, 147,412 rai rubber trees, and others. Damaged crop areas in the three provinces, Nakhon Si Thammarat, Surat Thani and Song-Khla are about 1,385,770 rai or 83% of the total damaged crop areas.

Nakhon Si Thammarat province was the most severely hit area in the southern region. The total damaged area is 895,948 rai, of which 711,867 rai is rice field, 107,174 rai rubber plantation, 56,915 rai fruit tree plantation and others. In Surat Thani the total farmland affected by the flood is 215,343 rai, of which 117,529 rai is rice field, 31,603 rai fruit tree plantation, 22,000 rai rubber plantation and others (refer to Table G.1.5, Appendix G).

The total number of livestock and poultries died in the flood affected area are about 1.5 million. Speaking of assessment of fishery in the South, total affected farmers are 13,383 households covering the areas of 105,591 rai or equal to 839 million Baht in damage. Nakhon Si Thammarat is the most serious province with about 425 million Baht in damage or 51% of the total, followed by Surat Thani with about 308 million Baht or 37% of the total (refer to Table G.1.7, Appendix G).

(2) Damage in buildings and loss of lives

According to the report of the Ministry of Interior, the total flood victims are 204,541 families consisting of 1,118,799 people, of which 458 people died, 2,007 people were injured and 271 people were reported missing. About 9,460 families or 48,334 people were evacuated to a safe place and the report indicated that about 55,051 houses were damaged.

The most seriously damaged areas are in Amphoe Phi Pun, Amphoe Chawang, and Amphoe Lan Saka of Nakhon Si Thammarat province and Amphoe Phun Phin and Amphoe Ban Na San of Surat Thani. The number of the death and missing in Nakhon Si Thammarat is the highest, 557 people or 76% of the total deaths (refer to Table G.1.1, Appendix G).

3.4.2 Causing Factors

(1) Meteorology and hydrology

(1)-1 Meteorology

The developed depression brought by the Northeast Monsoon caused heavy rainfall in the whole of Southern Thailand. The following table shows the rainfall record of November, 1988. The record and the year of return period indicates clearly that the storm was severe and is not a frequent event.

Rainfall Record of November 1988

Unit: mm

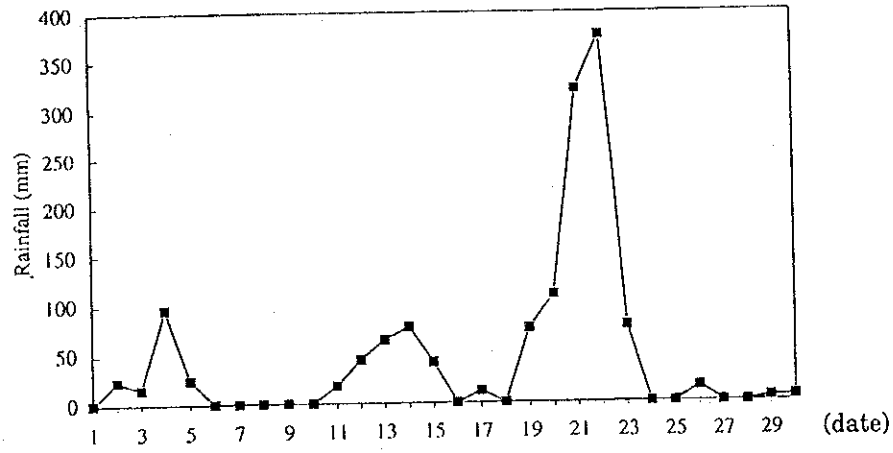
Observation Station	Place Name	Daily Max. Rainfall	3 Days Max. Rainfall	Nov. Total Rainfall	Zone
2701	Nakhon Si Thammarat	447.8(53)	884.5(56)	1,640.5(132)	(A)
2703	Ron Phibun	398.5(111)	822.7(337)	1,235.6(91)	(A)
2704	Tha Sala	297.5(12)	624.8(19)	1,226.5(35)	(A)
2708	Lan Saka	376.0(82)	805.3(212)	1,393.4(137)	(A)
2709	Thung Yai	207.9(70)	319.0(44)	470.2(18)	(B)
2711	Chandi Rubber Exp. Sta.	283.0(127)	620.6(167)	746.7(100)	(B)
6108	Phra Saeng	90.2(3)	265.3(16)	612.1(67)	(B)
6101	Surat Thani	283.3(32)	748.0(50)	750.5(39)	(C)

Note: Observation stations and zones are refer to Figure B.1.1, Appendix B.
( ) means year of return period

According to the record of Zone (A), rainfall occurred near the mountain range is heavier than in the area along the east coast, except Nakhon Si Thammarat. Zone (B) has the same distribution pattern. In the area nearer to the mountain range, heavier rainfall occurred. This is one of the meteorological factor.

As the other factor, in case of Lan Saka, rainfall has reached 400 mm before 21, 22 November and a tremendous disaster occurred. This means that the soil was already saturated, and runoff was at the peak before the heavy rain came down.

Rainfall Record in November 1988 in Lan Saka



(1)-2 Hydrology

The junction of mountain range and plain received the heaviest damage by debris flow. The slope of the river is very steep in the mountainous area. This means that concentration time of rainwater flow from mountain to the flat area is very short. The short time also means increase in intensity of rainfall during the flood concentration time. It brings bigger flood discharge. The catchment area of the river contains the steep mountains, and rainwater flows out in short time. This is the hydrological factor of disaster.

(2) Land use

In 1955, the Royal Forestry Department (RFD) reported that about 70% of the total area in Thailand was covered with forest vegetation. According to recent information of the same Department in 1989, the percentage of forest land reduced to 28% (refer to Table F.1, Appendix F). The estimated rate of deforestation of Thailand in the period of 1961-1989 is approximately reduced to 50 percent. The share of forest land is 26% and 15% of total area in Surat Thani and Nakhon Si Thammarat province, respectively. This percentage of area is lower than average of the whole country (refer to Table F.13, Appendix F).

In the area, the older rubber plantations are mainly situated in the transitional zone between the fluvial plain and the hills, further in the hills the rubber plantations tend to get younger in age. Higher up in the mountains natural forests are still present. But, it is being disturbed by socio-economic activities.

The change of this land use is a serious problem for forest land conservation. Since there is a difference in root system of rubber and natural tropical evergreen forest. The roots of natural vegetation can extend to depth of several meters while as for rubber trees, its roots only penetrate

the upper soil layers, mostly less than two(2) meters in depth. The roots of rubber trees are more extending into side-way. This is seen as a reason why rubber trees are more vulnerable to slope failure.

(3) Geological factors

(3)-1 Mechanism of landslide

During heavy rainfall, infiltration through residual and colluvial soil exceeds the transmission capacity of the subsoil, thereby causing a perched water table in the slope mantle parallel to the slope. When the long heavy rain continues, the piezometric head rises higher and pore pressure increases near the base of the mantle. Failure occurs when pore pressure exceeds some critical value that depends on the steepness of the slope and properties of the materials.

In the flood affected area, almost all of the landslides occurred on residual and colluvial soil, and weathered surface of underlain bed rocks. Since most of the area is underlain by granite, to explain the causing factor of landslide, it is important to make clear the characteristics of weathering process of granite. The factor to further weathering process is lithological and structural characteristics of granite. The lithological characteristics are grain size and chemical components of constituent minerals. The structural characteristics are geological discontinuities such as joints and faults.

The thickness of residual and colluvial soil, and weathered zone of base rocks are important factors causing landslides. Slope steepness is also an important factor to determine the place, form and scale of landslides.

(3)-2 The distribution of landslides

The distribution of landslides in the area was made clear by topographical analysis using a SPOT data of 1988 December 30th at Ban Na San and 1989 February 9th at Lan Saka (refer to Appendix D). According to the before mentioned analysis, many landslides are found in all over the basin which is underlain by granite (refer to Figure C-2, C-3, Appendix C, Table D-11, D-17, Appendix D). The landslide occurred near the ridge line of the mountain and flowed down to the down stream, turning into debris flow. The debris flows are found in almost all of the valley where landslide was caused violently.

(3)-3 Causing factor of landslides

Vegetation map of the area was made by analyzing LANDSAT false color image on 30th of March 1988 and 28th of March 1993. Maps of land elevation, slope steepness, slope direction and geology were also prepared by 1/50,000 map. Overlaid these maps to the

land slide distribution map, causing factor was studied by computer analysis method. As a result, it has been considered as follows (refer to Appendix D).

- In Ban Na San area, there are many straight valleys which extend from north northeast to south southwest and northwest to southeast, in the mountainous area. It was presumed that these valleys were formed alongside the faults which cut the granite. Landslides occurred remarkably in such sheared granite area. In such areas, the weathering process has been accelerated and has formed thick sub-soil zone and facilitated landslide occurrence.

- Landslides occurred frequently in the elevation between 200 m to 900 m in Ban Na San and 500 m to 900 m in Lan Saka, and also slope steepness between 8° to 30° in Ban Na San and 15° to 30° in Lan Saka (refer to Table D-10, D-16, D-7, and D-13, Appendix D). Weathering process has been accelerated in such slopes, but at steeper slopes in higher elevation areas, weathering products and sub-soil have already slid down.

- Almost all of the vegetation in the mountain on which landslides occurred frequently is native forest (refer to Table D-9, D-15, Appendix D). Some landslides occurred in rubber, orchard, grassland and upland fields in low hills.

3.4.3 Restoration Programs

After the flood disaster, all concerned government agencies and private sectors together launched the restoration programs. At the early stage, most of the activities were for providing foods, consumption goods, medical aid and temporary shelters.

MOAC established a committee for rehabilitation and restoration of agriculture. Sub-Committees for both Surat Thani and Nakhon Si Thammarat provinces were also established for coordination of the activities by the various agencies at the provincial level. The Committee formulated short and long term improvement and development plans for 1989 and during 1989-1995, respectively (refer to Appendix G.2).

The short term plans for urgent assistance under MOAC are summarized as follows.

- The agencies concerned in the operation provided seeds, seedlings, animal breeds, aquatic animal, feedstuff, animal vaccination, pumps, and suggestions on taking care of fruit trees.

- The agencies concerned removed sediment/silt from an area of about 2,800 rai deposited on fruit plantation in Amphoe Ban Na San, Surat Thani province.

The total expenditure for urgent assistance of MOAC was mounted to about 233 million Baht, of which about 69.84 million Baht is the expense on agriculture, 54.88 million Baht on fisheries and others. The long term plans under MOAC have been carried out by the Departments concerned. The activities may be classified into the following four categories.

(1) Agricultural infrastructural improvement;
Irrigation and drainage structure, road, redredging and rehabilitation of river/canal, etc.

(2) Agricultural land resources rehabilitation;
Removal of sediment on farm land, reforestation, soil improvement, etc.

(3) Agricultural development;
Supply of agricultural input (seed, chemical fertilizer, etc.), agricultural research, etc.

(4) Land conservation;
Land survey, forest land settlement, land use plan, water conservation and management, etc.

DLD is responsible for the plans related to the (2) and (4). Agricultural infrastructural improvement of the (1) is carried out by Royal Irrigation Department (RID).

Besides the above, Chulaporn Research Institute (CRI) was established after the disaster, which is a leading agency on projects aiming at stabilizing livelihood of flood affected people. The projects consist of settlement, housing, public health, welfare, farming practice, training and other related infrastructures.

3.5 Environmental Conditions

3.5.1 Environmental Law and Regulation

As an international treaty for environmental fields related to agricultural development, Thailand affiliated with the Washington Convention (Convention on International Trade in Endangered Species of Wild Fauna and Flora) in 1981. As the domestic regulations in Thailand, there is the National Park Act (1961), Enhancement and Conservation of National Environmental Quality Act (1992), The State Irrigation Act (1954), The People Irrigation Act (1941), Land Reform for Agriculture Act (1975), Agricultural Land Consolidation Act (1974) and rules and regulations of Royal Forest Bureau. In addition to the above, there are Wild Elephant Conservation Law (1921), Wild Animal Conservation Law (1960) and Wild Life Conservation Law

(1991) for protection of wild life and habitat environment. According to the regulation of the Enhancement and Conservation of National Environmental Quality Act, it is required to submit environmental impact assessment reports to the National Environmental Board (NEB) and get its approval before the implementation of development project (refer to Appendix K.3).

Since this study is for rehabilitation and conservation on the flood affected area, regulation on watershed management should be concerned for the project implementation. It was performed by the NEB. It categorizes national land into 5 classes for conservation of natural resources, especially water resources, and for appropriate land use. Each class indicates the scope of development. Class 1 is the conservation area for natural forest and wild animal. Implementation of development and economic activity is prohibited in this area. Some part of the flood affected area belongs to the class 1, and a part of Khao Luang mountainous area is delineated as the National Park (refer to Figure K.1.2-5, Appendix K).

3.5.2 General Condition of the Flood Affected Area

Related agencies have provided rural infrastructure such as electricity and water supply, and housing and resettlement area for the suffered people. Consequently, their living condition was restored up to the level of the unaffected area.

Considering the natural environment of the flood affected area, decrease in forest area is the main problem. Excessive deforestation for commercial use and diversion of forest to cultivated land have caused reduction of natural forest, and have directly or indirectly brought flood and landslide damage after rain. Thailand has numerous species of animals and plants. However, those species and their numbers are decreasing because of 1) indiscriminate collection, hunting and fishing, 2) destruction of habitat environment, and 3) illegal trade of wild animals. The flood affected area may be in the same situation.

Six years have passed since the disaster occurred in 1988. New habitat environment has been formed in the area.

CHAPTER 4

GENERAL CONDITIONS OF THE BAN NA SAN AREA

CHAPTER 4 GENERAL CONDITIONS OF THE BAN NA SAN AREA

4.1 Physical Features

4.1.1 Location, Topography, and Geology

Ban Na San area is located on Amphoe Ban Na San of the southern part of Surat Thani province with a latitude from 8°46' to 8°49' North and longitude from 99°19' to 99°28' East. The Chawang river runs from east to west in the central part of the area.

East end of the area consists of high, steep slopes, Khao Luang mountains and in the central area, steep sloped low mountains called Khao Na Daeng and Khao Sam Yot rise ranging from north to south. West of Khao Na Daeng is a flat alluvial plain (refer to Figure C-2, Appendix C).

In the basins situated between these low mountains and hills, there are river terraces and fluvial plains of the present Chawang river. The terrace has formed the plain which is from two to five meters higher than the present fluvial plain of the river. In the Khao Luang mountains, the basin is underlain by granite, while low mountains and hills are underlain Silurian and Permian groups of limestone, shale, sandstone and quartizite. The rocks of the hill were deeply weathered and were altered to clay, and a top of them is formed red soil.

The terrace is underlain by unconsolidated sand and gravel of Pleistocene and a top of this deposit more than 2 meters thick of brown soil was formed. Alluvial fan deposit is composed of granite origin sand and gravel derived from mountains.

The debris flow deposit of the 1988 disaster is accumulated in the present fluvial plain of Chawang river, while most of the terraces were not overlain.

4.1.2 Meteorology

(1) Observation station

RID has the following observation stations to record the data of rainfall, water level and discharge around the study area.

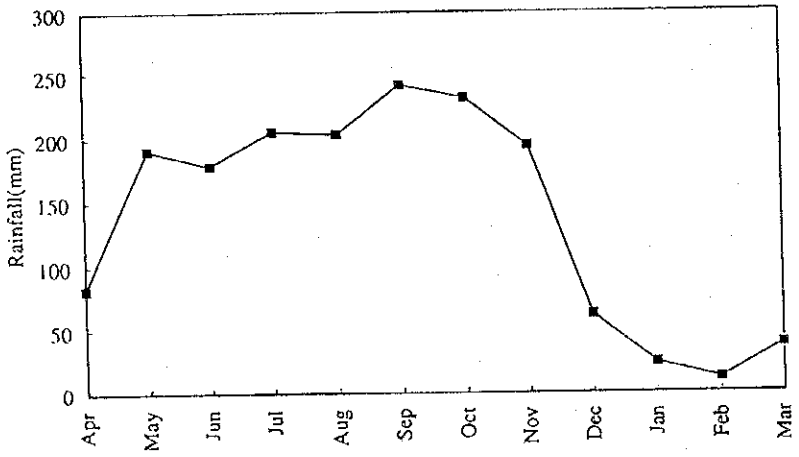
Item	Observation Station (Station No.)	Period	Catchment Area	Location (N. Lat, E. Long.)
Daily Rainfall	Ban Na San (6107)	1954-1992		8-47-57N 99-22-05E
Water Level Discharge	Khlong Chawang (X.81)	1981-1990	219 (km^2)	8-48-16N 99-22-27E
Water Level Discharge	Khlong Chawang (X81A)	1990-1992	220 (km^2)	8-48-23N 99-22-18E

(2) Rainfall

(2)-1 Rainfall pattern

According to the rainfall data of Ban Na San (6107), monthly average rainfall is as follows.

Monthly Average Rainfall in Ban Na San Area (1954-1992)



The figure indicates that the study area has a typical rainfall pattern affected by the Southwest Monsoon. Annual rainfall is 1,660 mm and monthly rainfall is nearly 200 mm during May to November, but it rains scarcely during January to March. The maximum daily rainfall which is affected by both the Northeast and Southwest Monsoons occurs from July to November.

(2)-2 Design rainfall

The design rainfall based on the data of Ban Na San (6107) is shown in the following table. It was determined by Iwai method which is popularly used in Japan.

Unit: mm

Item	Return Period					
	2 years	5 years	10 years	25 years	50 years	100 years
1 Day	85.9	118.8	138.3	161.1	177.0	192.2
2 Days	107.5	151.4	180.9	218.4	246.0	275.1
3 Days	129.4	183.2	218.3	262.0	294.3	326.5

(3) River condition

Chawang river, flowing through the center of the study area, originates in the Khao Luang mountain range, and is one of the tributaries of the Tapi river which flows from south to north. The catchment area, length and average river bed slope at the extreme downstream point of the study area are 210 km^2, 28.3 km, 1/30 respectively. It is very steep.

(4) Flood discharge

There are two methods to estimate flood discharge which corresponds to each return period. One is to estimate directly from the frequency analysis of long term records on flood discharge. The other is to estimate indirectly based on the long term rainfall record and characteristics of flood discharge. Since discharge data is observed in Chawang river in the study area, it is logical that the observated discharge data be used to estimate flood discharge. However, the observation period is too short to analyze frequency statistically, and the data is observed only a few times per day by using stuff gauge. This river is very steep and the duration of peak discharge is very short. Therefore it is rare that real peak discharge is observed. If these observation data are used to estimate flood discharge, it is likely to be too small.

Unit hydrograph method is suitable to estimate characteristics of flood discharge for such a scanty observation, using information on catchment areas such as topography, river length, and river bed slope. This method adapts well to short term direct runoff. Therefore flood discharge is estimated by using the unit hydrograph method and design rainfall based on the data of Ban Na San (6107). The result of estimation of flood discharge corresponding to the return periods is shown in the following table (refer to Figure B.2.5~B.2.9, Appendix B).

Flood Discharge in Each Return Period (Chawang river)

Unit : m^3/s

Location	Catchment Area (km^2)	Return Period				
		2 years	5 years	10 years	25 years	50 years
A	104	172	237	354	412	453
B	133	225	312	464	541	594
C	173	287	397	591	689	757
D	210	331	458	682	794	873

Note : Locations are shown in Figure 1-1.

4.1.3 Soil and Sediment

(1) Soil

Chawang river basin including the study area has mountainous slope complex soil which is most common, followed by alluvial deposits soil. This alluvial deposit area and Chawang river basin are most damaged by debris flow. Sediment deposited soil reached to a thickness of 50-150 cm.

Before the disaster, Chawang river basin was covered by alluvial deposits. This soil is classified as Ruso and Tha Khun series in Thailand. They have deep layers and are well-drained. This land is suitable for fruit tree and vegetable (refer to Table F-2~F-6 and Figure F.1, Appendix F).

(2) Sediment

Based on the survey results conducted by DLD and the Study Team, the depth and features of deposited soil are classified as follows (refer to Figure 1-2).

Class of Depth	Feature	Deposited Condition	
		Area (rai)	Rate (%)
I . <25cm	Depth is moderate plow layer, and sediment is consisted of coarse sand	5,680	57.8
II . 25~50cm	Depth is moderate subsoil layer, and sediment is consisted of coarse sand	1,146	11.6
III . 50~100cm	Depth is moderate root zone, and sediment is consisted of coarse sand and, fine sand and/or silt	725	7.4
IV . >150cm	Depth is deep, and sediment is consisted of coarse sand.	65	0.7
V . River bed	This contains river bed, and is consisted of coarse sand	2,209	22.5
Total		9,825	100.0

In the above classification, classes I and II occupy 69.4% of the total sediment deposited area. Class III and IV occupy a small area with a narrow shape.

4.1.4 Land Use

The land use condition of Chawang river basin is roughly divided into two areas, forest land of tropical everygreen trees including rubber and high trees and agricultural land (refer to Table F.14 and Figure F.3, Appendix F). The agricultural land is larger than the forest land. Most of the agricultural land is mixed orchards and rubber plantation.

Rubber plantation is observed widely in the hills and mountainous area. Land slides occurred in the hill side where rubber trees are younger than 10 years. These rubber plantations are sometimes observed on the steep slope of more than 30 degrees.

In the area, there are the fruit tree plantation, e.g. rambutan, mangosteen, durian or coconut and the area of reclaimed forest, in which land slide is likely to happen. Some areas are evergreen forests in where landslides hardly occur.

4.2 Socio-Economy

4.2.1 Administration

(1) Division of administration

Amphoe Ban Na San covers an area of 521,825 rai. The administrative area is divided into 11 sub districts (Tambons) and 76 villages (Mubans). The administrative organization is composed of one Municipality and one Sanitary. There had been one Sanitary, but Tambon Na San was approved of the independence from the Sanitary as a Municipality with 13 villages after the disaster.

(2) Rural development plan in the sanitary area

A survey of fundamental data at village level was carried out by NESDB for the Seventh National Economic and Social Development Plan. According to the results, the level for development of the villages in the Amphoe (Sanitary area) is classified into three kinds, backward, second, and progressive levels. Villages of backward and second levels are supposed to be developed by the government rural development plan of the province. In the Amphoe, as the targeted village for rural development plan, five villages are listed up, and 280,000 Baht of financial support per village are given by the government.

4.2.2 Population and Farm Land Holding

(1) Population and household

According to the Amphoe Office, the total population is 59,442 as of 1994, out of which 18,576 are in the municipality area and 40,866 are in the sanitary area. The population density of the amphoe is 71 people/km^2, and is rather dense compared with 61 of the province, but that of the sanitary area is only 54.

According to the Fundamental Data of Village Level Survey by the Community Development Department of Ministry of Interior (CDD, MOI), the family size per household of the sanitary area is estimated at 5.2 people and it is a little larger compared with 4.6 people of the province. On the other hand, the occupation of family head is almost all (96%) agriculture. Compulsory education is prevailing as a matter of course, consequently, the percentage of those who finished compulsory education in the age 12 years and above is 84 which is higher than the province of 70%. Accordingly, illiteracy in the villages is extremely low.

(2) Farm land holding

The total farm holding land of the amphoe is 234,634 rai, in which sanitary area is 206,254 rai. The ratio of owned land is 64% and 62%, for the amphoe and sanitary area, respectively. These are relatively low compared to the province. There are 8,601 farm households in amphoe, in which 7,341 are in the sanitary area. The percentage of the farm household in amphoe and sanitary area is 91% and 92%, respectively. Accordingly, the average farm size per farm household in the amphoe is 27.3 rai. That of the sanitary area is 30.3 rai.

Besides, according to the land utilization by crop in the amphoe, the average farm size in the sanitary area is estimated to be mainly comprised of rubber 24.1 rai, rambutan 3.3 rai, rice 2.3 rai, and durian and mangosteen 0.6 rai.

4.3 Agriculture

4.3.1 Agricultural Land Use

The land for fruit trees and tree crops occupies 83% of farm holding land. In the land utilization of tree crops, para rubber is dominant, 166,532 rai, or about 86% of fruit tree and tree crops. Following that, the area of rambutan is 22,589 rai. The remaining is occupied by durian, mangosteen, oil palm, coffee, etc. Land for upland crops and vegetable are small.

Land	Area (rai)	Rate (%)
Fruit tree and tree crops	194,438	82.9
Paddy field	16,813	7.2
Upland crops	3,125	1.3
Vegetable and flower	37	0.0
Housing area and others	20,221	8.6
Farm holding total	234,634	100.0

Source : Agricultural Extension Office, Amphoe Ban Na San, 1992

4.3.2 Agricultural Production

(1) Crop production

In the Amphoe Ban Na San, the production of rice in 1992 is 2,381 ton. The production of para rubber with improved variety is 30,152 ton, and 288 ton with local variety. Production of improved variety is likely to increase in future, since the un-bearing potential area is 67,667 rai.

The second crop is rambutan, followed by oil palm. Durian is only 779 ton in 1992, but it will increase more than twice since 1,470 rai of the planted area are still in the un-bearing stage. Production of mangosteen and coffee is in the same condition (refer to Table H-5-1, Appendix H).

Crops	Area			Average yield (kg/rai)	Yearly production (ton/year)
	Planted area (rai)	Harvested area (rai)	Un-bearing fruit (rai)		
Rice	15,830	7,781	-	304	2,381
Rubber					
- Local V.	1,600	1,600	-	180	288
- Improved V.	164,932	97,265	67,667	310	30,152
Oil palm	672	611	61	1,995	1,219
Coffee	656	496	140	147	73
Rambutan	22,536	22,536	-	1,470	33,128
Durian	2,453	983	1,470	792	779
Mangosteen	815	337	478	525	177

Source : Agricultural Extension Office, Amphoe Ban Na San, 1992

(2) Livestock

As mentioned in 3.2.2, the number of cattle and pig has been on the upward trend while buffalo has been decreasing. The number of duck and chicken is also increasing (refer to Table H-6-4, Appendix H).

Elephant	Horse	Cattle	Buffalo	Swine	Sheep	Duck	Chicken
1	18	3,971	216	8,453	12	4,791	46,664

Source : Commercial Office of Surat Thani Province, 1992

4.3.3 Marketing

The main agricultural products in Amphoe Ban Na San are rubber, rambutan and rice, out of which rubber plantation occupies the largest area. However, rambutan surpasses rubber in

production volume and there is no difference in production value. Moreover, the amphoe is well-known as the development promotion area of fruit trees, especially, rambutan. Accordingly, marketing system of rambutan is described as a representative products.

For rambutan, there are various marketing routes, but there is no central market at present. Generally, farmers are self-willed and aim at short-run profit. It is difficult for them to be organized and aim at long-run profit. Accordingly, it is usual that private market is crushed before it can grow bigger into central market. However, based on the market development promotion plan in amphoe level prepared under the support of the branch offices of Commerce and Agricultural Economics of the province, public market has been projected to be built in the area producing rambutan. The representative one is in Khoan Suban Tambon.

The market was started in 1994. The management is dealt with through farmer's committee consisted of 12 members selected from the related 6 villages, 2 persons per village. Both farmers and merchants are registered. The grade is classified into three ranks by measuring fruit number per kg and color of rind. (A) rank is the number of 20-25 and red color. (B) rank is from 26 to 28, light red and (C) is blue and from 29 to 30. Rank (A) is shipped to Bangkok, and exported to overseas market through Bangkok, (B) rank to local market and (C) rank to canning plant. The market price of rank (A) is 9.5-10 Baht/kg, (B) is 8.5-9.5 and (C) is 8.5 in 1994.

Besides, for farmers having no transportation means, the committee transports their fruits into the market by committee owned wagons. The committee gets 0.5 Baht per kg as marketing fee from merchants.

Thai people are advised to absorb 25kg/year of fruits per capita.

The amount of fruits exportation has been increasing with fresh, breezed or processed conditions. In 1993, 893,000 ton (15.4 billion Baht) of fruits was exported. The rambutan exportation to Taiwan, Malaysia, Singapore, Hong Kong, the United States, etc. has been increasing year by year. It was 6,937 ton and made 195,000 Baht of foreign money in 1993.

4.3.4 Farm Household Economy

According to the Office of Agricultural Economics, the net cash income of an average farm household in the Amphoe Ban Na San as of 1991 is 92,756 Baht, out of which 39,466 Baht is net farm income. As compared with those of the province, the former is 20,000 Baht and the latter is 2,000 Baht more than the province. And also, farm household expenditure and that of per capita are 99,327 Baht and 19,101 Baht, being much higher compared with those of the province,

respectively. However, for high household expenditures, farm household economic surpluses becomes 6,571 in the red.

As mentioned in 4.2.2 (2), it is a problem that out of gross cash farm income (58,937 Baht), 88% comes from rubber. The income from fruit tres occupies only 5%. The fruit tree income should be increased to mitigate inclination of rubber income.

Table 1-1 Farm Household Economy in Ban Na San and Lan Saka

(Unit : Baht)

Items	Amphoe Ban Na San	Amphoe Lan Sake
1. Farm Income	58,937	23,066
1.1 Crop	55,324	19,786
1.1.1 Fruit Tree	54,891	19,129
1.1.1.1 Rambutan	2,030	1,383
1.1.1.2 Durian	66	242
1.1.1.3 Mangosteen	630	1,280
1.1.1.4 Rubber	51,957	9,798
1.1.1.5 Others	208	6,426
1.1.2 Others	433	657
1.2 Livestock	2,105	3,280
1.3 Others	1,508	-
2. Farm Expenses	19,471	10,056
2.1 Crop	14,218	4,780
2.2 Livestock	1,220	706
2.3 Others	4,033	4,570
3. Farm Net Income	39,466	13,010
4. Non-farm Net Income	53,290	29,650
5. Farm Household Net Income	92,756	42,660
6. Farm Household Expenditure	99,327	44,096
7. Farm Economic Surplus	−6,571	−1,436

Source : Agricultural Household Income - Expenditure 1991/92 (OAE of MOAC)

According to the CDD, MOI village survey, the average annual income of farm household in the sanitary area of the amphoe is 42,000 Baht for full-time farmers and 46,000 Baht for part-time farmers. The highest of full-time farmers is 73,000 Baht, whereas the lowest is 19,000 Baht.

4.3.5 Farming Practices

In the area, para rubber and fruit tree cultivation are common. Para rubber is grown especially in the downstream of the sediment deposited area. It is generally planted at intervals of 7 m × 3 m. In a standard, fertilizer for tree over seven years should be applied at a rate of one (1) kg per tree. It is tapped for nine months except in April for shoot sprouting and from November to December due to rainy season.

Most of the farmers plant only rambutan tree in their own orchards. Some farmers plant the trees mixed with other crops. The Rong Rian of rambutan is the most popular variety and grows best in Ban Na San. The farmers have long experience, and have tried to apply new and modern technology to their trees. The technologies that the farmers apply generally are the followings (refer to Table H-8-1, Appendix H).

- Planted the trees at spacing of 8 m × 8 m or 10 m × 10 m. Tree thinning is carried out by the required growing stage, when the trees are planted densely at first.
- Use chemical to control diseases and insect pests such as powdery mildew, leaf eating caterpillar, inflorescence eating caterpillar, thrips, etc. and also using hormone (planofire) spray to the inflorescence before flowers open to produce active male flowers.
- The farmers usually prune the trees after harvesting in September. After pruning, fertilizer (15:15:15) is applied as follows.

  1st year (after planting young tree)

  In the first twenty days, a handful of fertilizer is applied to each tree and after that, it is applied once a month at the same volume.

  2nd year

  Apply two handful per tree in August to October.

  3rd year

  Apply one (1) kg per tree in August to October. For the bearing trees, the farmers apply fertilizer three (3) kg per tree in August, in October at the same amount, and in January to February before flowering, with three (3) kg per tree. No organic fertilizer is applied generally.

- Irrigation ;

  Farmers usually irrigate their trees in case of no-rain for three days. For a grown tree, water is given by a sprinkler for about 30 minutes a day and not exceeding about 150 liters per tree. The young tree is given only 10 liters per tree. During dry season, water is applied every two days.
- Harvesting and yield ;

  90 to 120 days after the full bloom of flowers, the fruits are ready to be harvested. In the

area, flowering usually begin in March to April and harvest in July to September. The peak of production is in August. The average yield per tree is expected to increase from 40-50 kg in four (4) years to 300-400 kg or more in 12 years.

In some parts of the sediment deposited area, fruit trees have been replanted. But, the growth is very slow due to no soil improvement. Durian and mangosteen are also planted with the above methods, but not as popular as rambutan (refer to Table H-8-2 and H-8-3, Appendix H).

Most farmers in the area do not grow intercrop in their orchards. Only few farmers begin to grow watermelon, sweet corn, banana, chilli or egg plant as intercrop.

4.3.6 Farmer's Organization

The farmers organizations in Thailand are officially acknowledged by the government and can be classified mainly into two types, namely, cooperatives and farmers groups. There are six major kinds of cooperatives at present; Agricultural, Land Settlement, Fishery, Consumers', Thrift and Credit, and Service Cooperatives,

The Cooperative Promotion Department (CPD) of MOAC is responsible for every kind of cooperative activities. The farmers' group is an intermediate organization for further development to become full scale cooperatives. It allows registration of the farmers' groups as preliminary form of agricultural cooperatives. The Department of Agricultural Extension (DOAE) will be responsible for promotion, control and supervision of farmers' groups activities.

The farmer's organization in Amphoe Ban Na San at present consists of;

- Registered farmer's organization
  - Agricultural Cooperatives at amphoe and tambon level
  - Farmers groups

- Informal farmer's organization
  - Farmers' housewives groups
  - Young farmers groups
  - Other groups for specific occupation such as livestock, fishery and handicraft marketing, etc.

The total farmers' organizations in Amphoe Ban Na San may be summarized in the following table.

No.	Type of organization	Number of organization	Number of member	Remark
1	Agricultural Coop. amphoe level	1	1,091	Established in 1970
2	Agricultural Coop. tambon level	2	-	
3	Farmer's group	5	541	
4	Farmers' housewives group	15	923	
5	Young farmer's group	5	83	
6	Farmers' group for specific occupation	25	397	

Source : Amphoe Ban Na San Agricultural Extension Office

Ban Na San Agricultural Cooperative is the main farmer's organization. The main purpose is to run multipurpose businesses for its members and to increase farm products and income. The actual activities at present mainly deal with provision of credit service and supply of agricultural inputs. One new type of cooperative at tambon level, namely cooperatives for rubber replanting aid fund has been established in Amphoe Ban Na San in 1994. The main activity is marketing for rubber and products.

Generally speaking, all farmers' groups are divided in accordance with the specific kind of occupation or activity.

Most of the farmers' organizations in Amphoe Ban Na San lack of qualified staff with proper management capability and business development experience. The capital of agricultural credit of farmers' organizations does not meet the total demand. Most of farmers organizations are not active in marketing agricultural products.

4.3.7 Agricultural Supporting Services

Agricultural supporting services cover quite broad scopes of activities such as credit, certified seeds, fertilizer and pesticides. In order to increase farm productivity and quality to meet the market demand and to sell their products with proper profit, need of agricultural credit and supporting services will be, therefore, further increased in future. Present status of agricultural supporting services in Amphoe Ban Na San can be summarized as follows.

(1) Agricultural credit

a) At present, aside from the credit services provided through BAAC which is the most essential agricultural credit financier in Amphoe Ban Na San, Agricultural Cooperatives, Commercial Banks and private sectors are also performing. Fifty-eight

(58) percent and 24% of total household are financed by BAAC and Commercial Bank, respectively (refer to Table J.1, Appendix J).

b) The number of BAAC client farmers have increased from 3,970 farm households in 1988 to 4,450 households in 1993, as well as a substantial increase in lending amount. It can be observed that the repayment to the principal maturity was higher than 90 percent of total at present (refer to Table J.2, Appendix J).

c) BAAC - AMC (BAAC initiated agricultural marketing cooperatives) provides services for supply of agricultural inputs, mostly fertilizer and pesticide. In 1994, BAAC - AMC Ban Na San provided credit in-kind to the members amounted to 5.76 million Baht.

d) In 1993, Ban Na San Agricultural Cooperatives had an operating fund of about 20 million Baht. In general, the cooperatives in Ban Na San provided the credit 50% of the total fund for short-term repayment and the remaining for medium-term.

(2) Fertilizer

Supply of fertilizer is made either through the credit-in-kind programs of BAAC and Agricultural Cooperatives, under the government's low price fertilizer supply scheme.

(3) Pesticide

Supply of pesticide is carried out mostly by the private sector. Unless damage to crops by blight and insects occurs in large area, DOAE will not involve directly in supply of pesticide and operation for plant protection.

(4) Seed

Supply of fruit seedlings is carried out by the private sector. Ban Na San is one of the biggest and well-known seedling supply areas of fruit trees, particularly, rambutan.

4.4 Agricultural and Rural Infrastructures

4.4.1 Agricultural Infrastructure

In Ban Na San, low-head sprinkler has been used to irrigate fruit tree crops, mainly rambutan and durian. Generally, irrigation is conducted on farm household basis by utilizing small pumps to lift water from sources such as Chawang river, its tributaries and farm ponds. Water pumped from the rivers or ponds is either fed directly to the sprinkler system or into small

canals conducting water to the ponds. Before the flood disaster in 1988 paddy was cultivated in the flat low-lying alluvial fan in the upper part of the middle stream. The thick sediment deposit brought by the flood had destroyed not only paddy cultivation but also all the irrigation facilities. Distinct irrigation system such as the contemporary irrigation block does not exist. Except for the irrigation pumps and sprinkler network owned individually by the respective farmers, operation and maintenance of irrigation facilities are not performed.

The farmers have acquired a complex, though elementary, soil moisture control practice through years of experience, mainly by observing the conditions of the flower buds. Most of them are convinced that proper irrigation management, especially during and after flowering, is the only way to ensure a good crop/harvest, and are covetous for a more stable water supply.

A small scale weir constructed by DLD to extract water from Mui river, a tributary of Chawang river, is about the only major irrigation structure in the alluvial fan (refer to E-29, Appendix E). Water diversion is regulated by a gate at the weir and flows freely down a pipeline. The pipeline is 950 m long. The farmers are pumping water from the turn-outs to irrigate the orchards in left bank of Chawang river.

Except for the natural river system, no major drainage facility is observed at farm level. Drainage capacity of these natural streams has been largely reduced due to sediment deposit and rise in bed elevation. Since most of the crop cultivated can withstand short inundation, drainage is not a common practice.

4.4.2 Rural Infrastructure

The major village road (9012), which runs along or close to Chawang river, is a "two-lane" paved road with about 6 m road width and running speed of about 50 km/hr. This major road is connected to route 4009 which goes through the town of Ban Na San. In some parts of the road, pot-holes are retarding trafficability, and should be rehabilitated. Single-lane unpaved laterite roads, branching from the major road, lead either to the villages or rubber plantation. Road density is small and should be increased when planning for land rehabilitation.

Electricity supply is available even in the most remote village. Except for Ban Na San township, no drinking water pipeline (tap water) system exists in the area. Rain water is collected by the roof of the houses and is stored mainly for drinking purposes. Shallow wells are used to supplement drinking water and house chore use. The natural rivers are used for bathing, dipping and washing clothes.