Chapter 3 LAND USE PLAN

3.1 Previous Studies

3.1.1 DTCP Structural Plan

The Department of Town and Country Planning (DTCP) of the Ministry of Interior has prepared (provincial-level) structure plans for five provinces in the WSB region (all but Samut Songkhram) as well as a regional structure plan for the Western region based on broad information related to regional planning. In addition, preparation of a structure plan for Samut Songkhram is now underway. The regional-level structure plan covering all provinces in the Western region encompasses all WSB provinces except for Chumphon, which is in the Southern region.

Although the structure plans have no legal force for implementation, the plans suggest an image of the future structure of the WSB region. The structure plans show conservation areas, agricultural areas, urban hierarchies, the future allocation of industrial areas, allocation of major facilities, major transport facilities, the direction of linkages among major urban functions, and so on (Figure 4.3.1). The provincial structure plans prepared by DTCP have been referred to in formulating the land use plan in this Study.

3.1.2 Metropolitan Regional Structure Planning Study

The Metropolitan Regional Structure Planning Study (MRSPS) was completed by NESDB in 1994. The study area covered the BMR, the Upper Central region, the Eastern region, and the Western region. The Western region in this study included Petchaburi, Ratchaburi, Samut Songkhram, and Suphan Buri provinces. In its characterization of the Western region (the so-called Sing Buri to Hua Hin Multipolitan System), agriculture, natural resources, and tourism were considered the backbone of regional economic activity. The new steel mill and port development at Bang Saphan and major tourism complexes in Cha Am-Hua Hin and beyond were conceived as playing major roles in regional economic development. According to the plan, Samut Songkhram-Petchaburi-Hua Hin are to be developed as an agri/seafood and tourism area as well as a conservation area. The MRSPS adopted the following land use classification: (i) natural environmental conservation area; (ii) modified

and built environmental areas; (iii) human settlement areas; (iv) special industrial areas; (v) national interurban transportation and utilities networks areas; and (vi) special zones.

3.1.3 NHA New Town Development Study

Recommendations for new town development have been made in the New Town Development Project, in which the following roles have been proposed for satellite towns of the Bangkok Metropolis: (i) a civic center town, consisting of a civic center, residential area, commercial area, business center, and other components, as well as a "hi-tech" town with convenient and rapid mass transit connections; (ii) a commercial and business center, featuring the financial center of Southeast Asia and comprising various institutions, international hotels, an international commercial and business center, and the Southeast Asian Promotion Center; and (iii) an Asian Games or Olympic town, a sports complex complementing existing recreational areas in the Bangkok Metropolis. Locations have been proposed for satellite towns in five areas within a 50 km radius of central Bangkok.

3.1.4 A Study on an Improvement Plan for Railway Transport in and around the Bangkok Metropolis in Consideration of Urban Development

JICA sponsored a study to formulate a master plan for integrated railway and urban development focusing on railway lines in and around the Bangkok Metropolis (within a radius of 200 km of the center), this study basically followed the recommendations made in the NESDB's Metropolitan Regional Structure Planning Study (MRSP Study). Part of the WSB region was included in what is termed the Extended Bangkok Metropolitan Region (EBMR), which is to developed as the capital region and leading center in Thailand's next stage of development. The manufacturing and distribution industries currently concentrated in Bangkok will begin to shift their locations to the peripheries of the EBMR area and will boost industrial growth in that area. The direction of development in the WSB was briefly mentioned in this study, which completely adopted the findings of the MRSP in this regard. The dimensions of WSB regional structure proposed in this JICA study were determined based on the expected improvement of transport as a consequence of the planned railway and other transport system improvement.

3.1.5 Formulation of Spatial Development Framework for Thailand

NESDB is currently conducting a study for the Formulation of a Spatial Development Framework for Thailand. Emphasis in this study has been put on the reduction of regional disparities of income and living standards. The concept of regional city clusters, the development direction of cities at each level, and east-west corridors were formulated in view of the systems of cities and regions. With such cluster development, communities can develop complementary functions within each cluster contributing to higher overall growth and opportunities for residents. An important advantage of cluster development as formulated is that rural areas are not on the peripheries of development as in traditional stand-alone urban development, but are in the middle of development, occupying "interstitial" areas. Identification of these clusters has been regarded as an important component of planning for New Economic Zones. In the WSB region, Ratchaburi was designated by the government as one of twelve regional centers and was expected to serve as an "anchor" for regional city clusters and a New Economic Zone, if deemed appropriate. These regional cities are to be strengthened based on their comparative advantage in terms of neighboring settlements; this study noted that Ratchaburi has a comparative advantage in the agro-industry, petrochemical, Myanmar-oriented trade services, and manufacturing (e.g., metal working, ceramics) sectors.

3.1.6 DLD Land Use Plans and DTCP Urban Plans

The Land Development Act of 1983 adopted a clear policy on land classification by means of a soil survey, land capability classification, and land use planning to form a basis for the continuing economic and social development of the country. These classifications were made from the viewpoint of agricultural productivity. The Department of Land Development (DLD) began to evaluate land in 1983 using a system developed by the Food and Agricultural Organization (FAO) of the United Nations for land use planning; in the system, land evaluation is undertaken for both rainfed and irrigated agriculture. Such evaluations were carried out for each land unit, with land unit classification primarily based on information on natural resources such as soil, forests, water, minerals, and tourism, and on zoning schemes identifying national parks, wildlife sanctuaries, and industrial zones. This information was used in the evaluation of land quality and formulation of appropriate land use planning with an emphasis on agricultural land use. These land use plans, which DLD prepares for each province, can be characterized as land capability plans because the plans have a rather weak connection with the socioeconomy of an area.

In addition to DLD's land use plans, general plans for specific urban areas have been prepared by DTCP pursuant to the Town Planning Act of 1975. The urban areas for which general plans were prepared are the following:

(i) Muang Kanchanaburi, Tarua Phratan (Kanchanaburi);
(ii) Muang Ratchaburi, Ban Pong, Photharam (Ratchaburi);
(iii) Muang Samut Songkhram, Amphawa (Samut Songkhram);
(iv) Muang Petchaburi, Cha-Am (Petchaburi);
(v) Muang Prachuap Khirikhan, Hua Hin (Prachuap Khirikhan); and
(vi) Muang Chumphon, Lang Suan (Chumphon).

3.2 Land Use Planning Guidelines

3.2.1 Principles for Land Use Planning

Based on the principles of land use planning that have been established by the past development guidelines of National Economic and Social Development Plans, the following considerations have been adopted for land use planning in this Study:

(i) Conservation of land for the natural environment and safety from natural hazards is accorded first priority;
(ii) Land with high potential for agriculture is accorded high priority for agriculture;
(iii) The future regional spatial development pattern is a precondition for land use planning; and
(iv) Optimum land use utilizing the economic potential of each land unit is to be pursued.

Comprehensive land use planning in Thailand is mainly practiced by DLD (Ministry of Agriculture and Cooperatives) and DTCP (Ministry of Interior). Other agencies related to land use are partially involved in land use planning, including designation of land conservation, irrigation areas, and economic mining zones. A review of existing land use planning in Thailand indicates that the following considerations should be incorporated in the land use planning methodology:

(i) Linkages with the socioeconomic framework: The socioeconomic framework and related national and regional goals should be reflected in regional-level comprehensive

master planning. In the overall planning process, land use planning should be targeted toward future economic and social development frameworks and scenarios.

(ii) Conditioning of relevant projects: Land use planning should not be conducted in isolation but rather should be incorporated in projects that can affect future land use.

Land use planning should be undertaken from comprehensive viewpoints covering all related sectors, especially in case of a comprehensive master plan study. For instance, the improvement of infrastructure is most important for land use planning, and therefore infrastructure projects should be well incorporated in the planning process.

A summary of the land use planning principles adopted in this study are set out in Table 4.3.1.

3.2.2 Land Use Planning Procedures

The following procedures and evaluation methodology were adopted in this Study for land use planning:

(1) Staged evaluation

As shown in Figure 4.3.2, a staged evaluation procedure has been adopted to adjust the various sectoral land use demands occurring in the same land area in compliance with the principles of land use planning: (a) identification of conservation areas, (ii) identification of areas that are well suited for agriculture, (c) allocation of urban function areas, and (d) allocation of agricultural areas by farming type.

(2) Evaluation guidelines

Evaluation of future land use suitability in principle involves four steps, namely assessment of land use potential, current land use tendencies, relevant future plans, and suitability with respect to future regional structure as deduced from regional development scenarios. Allocation functions were determined by overlaying the various potentials and constraints.

(3) Evaluation Guidelines for Conservation Areas

The evaluation of land required for conservation has been carried out based on the following concepts: (i) desirability for conservation, identifying areas where conservation is required from the environmental and safety aspects; (ii) the direction of present land use, focusing on areas far from cities, reforested areas, and existing forest areas; and (iii) adaptability to relevant plans, identifying areas with reforestation plans or areas that have been designated as conservation zones. More detailed evaluation criteria are presented below:

(i) Desirability for conservation

- The conservation criterion considers protection against land erosion, in view of requirements for safety and natural resources protection. Areas in mountainous areas with grades of 15 degrees or more should be conserved.
- The conservation criterion also considers the requirement for preserving valuable natural resources (e.g., national parks, wildlife sanctuaries).

(ii) Direction of present land use

- Areas where reforestation efforts have been made should be conserved.
- As a general proposition, present forest areas should be conserved to cope with recent rapid deforestation.

(iii) Adaptability to relevant plans

- Reforestation plans should be taken into account.
- The designation of conservation areas by various governmental agencies should also be respected.

(4) Evaluation Guidelines for Land with High Potential for Agriculture

The evaluation of land with high potential for agriculture has been carried out based on the following considerations: (i) potential for agriculture, identifying areas where soil is fertile, an irrigation system or land consolidation system has been supplied, and/or where the land is flat or gently sloped; (ii) the direction of present land use, focusing on areas where land reform has been implemented; and (iii) adaptability to relevant plans, identifying areas with irrigation plans and land consolidation plans. More detailed evaluation criteria are presented below:

(i) Potential for agriculture

- The fertility of land classified by soil type is a decisive factor for agricultural productivity.
- Another criterion for evaluation of the productivity of agricultural land is its amenability to the use of modern agricultural machinery.
- Irrigated areas may be expected to be productive for agriculture. In Thailand, three types of irrigation systems have been established, classified by scale.
- Use of land consolidation areas for agriculture should be considered because of the land's high agricultural productivity.

(ii) Direction of present land use

- Agricultural land where land reform has been implemented should remain as agricultural land.

(iii) Adaptability to relevant plans

- Land where irrigation or land consolidation is planned should be considered as agricultural land in order to maximize returns from the investment.

(5) Evaluation Guidelines for Industrial Areas

The identification of land that is suitable for industry may be carried out based on the following concepts: (i) potential for industry, identifying areas where such factors are advantageous as the slope of the land, topography, accessibility to transport facilities, accessibility to relevant industries and support services, land prices, water supply, and drainage, (ii) the direction of present land use, identifying areas, where industrial land use activities are active; (iii) adaptability to relevant plans, identifying areas where industrial estates have been developed or are planned by IEAT or areas where DTCP has already designated industrial land use in its structure or general plans, or areas where there is advantageous zoning for industry to promote decentralization; and (iv) suitability for proposed spatial development pattern, referring to the identification of zones to develop industries to support spatial development concepts.

(6) Evaluation Guidelines for Urban Areas

The identification of land that is suitable for urban development has been undertaken by assessing (i) urban land potential, which involves selection of areas that are advantageously endowed with respect to land slope, accessibility to transport facilities, accessibility to existing urban functions, water supply and drainage, and the possibility of forming a conurbation with current urban areas; (ii) the direction of present land use, identifying areas where building activities are active; (iii) adaptability to relevant plans, identifying areas where general plans have been formulated by DTCP or areas where advantageous infrastructure improvement plans such as transport facility proposals are to be implemented; and (iv) adaptability to the proposed spatial development pattern, referring to the identification of zones to develop urban functions to support spatial development concepts.

(7) Evaluation Guidelines for Allocation of Land by Farming Type

The evaluation of land by agricultural farming type has been carried out based on: (i) the potential for agricultural cropping, determined based on assessments of water availability, soil type, and land inclination; (ii) direction of present land use, based on an evaluation of specific existing farming types; and (iii) adaptability to relevant plans, involving identification of areas with irrigation and land consolidation plans.

3.3 Land Use Demand Forecast

3.3.1 Land Required for Conservation

Land required for conservation is considered as part of the planning framework of this Study rather than as forecast demand because future land demand relates to the development of land. Also, the quantity of land required for conservation is an arguable issue in land use planning. In line with the principles adopted in this Study, however, current forests have been regarded as conservation areas.

The National Forest Policy, established in 1985, adopted a system of forest zoning requiring that at least 40 per cent of the country be under forest cover and at least 25 per cent be in conservation forests. In 1992, the Government approved the zoning of 27.5 per cent of the country as conservation forests. These policy determinations were based on several factors.

For instance, a water yield study recommended that 38 per cent of the country should be under forest cover to produce the required annual flows. In addition, a timber trends study in 1972 recommended that 40 per cent of the country should be under forest cover in consideration of the national timber requirement.

The national forest cover goals are currently met in the WSB, since 43.3 per cent of the region was covered by forest in 1995, even excluding the 10.2 per cent of the region's area that was planted with fruit trees and tree crops. Though the numerical goal is satisfied in the WSB region, the land requirements for conservation areas still necessitate some revision to reflect the designation of protected areas and the intricate pattern of current land use and the legal zoning system.[1]

A system of protected areas has been established under a protected area system (PAS), and these areas must be included in the land designated for conservation in the WSB region. Excluding steep watersheds (WCS1), protected areas account for close to 14 per cent of the national land area. Since it has been proposed that at least another 2.4 million ha will be declared protected areas, additional PAS zoning is possible (Tables 4.3.2 and 4.3.3).

Zoning of national forest reserves comprising conservation forests, economic forests, and land for land reform has been completed by the Royal Forestry Department. However, the boundaries of these legal forests overlap with land that is held by farmers; in other words, part of the conservation forest zone has been already encroached and is used for cultivation. Some of these areas used for cultivation including conservation forests and economic forests are located on natural forest land and are not so advantageous for agricultural production because of their poor accessibility to the transport system. Considering the advance of agriculture to a more intensive farming system, a decrease in agricultural land demand is reasonable. Therefore, at least parts of conservation and economic forest zones currently used for cultivation should be converted to forest land.

Most mangrove forests in the WSB region are not included in the national forest reserve. However, the importance of mangrove forests for the ecological system has been stressed in various studies. At the very least, deforested mangrove areas along the region's coastline should be reforested.

[1] Also, it may be argued that certain regions such as the WSB should have greater than the national target level of forest cover to compensate for areas (e.g., metropolitan Bangkok) that cannot realistically meet the target.

In summary, land requirements for conservation may be considered by taking into account the following:

- forests in the PAS;
- existing forests within the national forest reserve and outside the national forest reserve;
- existing mangrove forests;
- conservation and economic forest zone areas with low potential for agriculture; and
- the need to reforest currently deforested mangrove areas to restore the ecological system.

3.3.2 Land Demand for Agriculture

Based on the Moderate Growth Scenario adopted in this Study, the GRP growth rate of the agricultural sector in the WSB region was assumed to be 2.4 per cent. The growth rates of the crop and livestock subsectors, which are closely related to the allocation of land area, were set at 2.0 per cent per annum each. Growth in agricultural production is expected as a consequence of improvements in efficiency and yields, shifts to the production of high-value crops, the strengthening of the production of meat and dairy products, and innovations in agro-processing and marketing. With 2.0 per cent growth rates in the crop and livestock subsectors, other subsectors are expected to grow at 3.2 per cent annually (Table 4.3.4).

The demand for agricultural land has intensified in the past because of population pressure and structural economic changes. However, the recent economic development of Thailand has entailed the beginning of a transition from an agriculture-based to an industry-based economy. This economic shift is resulting in a decrease in employment in farming and an increase in manufacturing employment; one consequence of this shift will be an eventual decrease in demand for agricultural land.

Land and Forest: Projecting Demand and Managing Encroachment, a report by the Thailand Development Research Institute, forecasts that agricultural land demand will decrease by 0.5 per cent annually from 1990 to 2005, and after 2005 decrease by an annual rate of 1.75 per cent. This forecast decrease in agricultural land demand is attributed to following factors: (i) a declining trend in real agricultural prices, (ii) a leveling off of population growth; (iii) an increase in productivity, (iv) growth in the industrial and service

sectors; and (v) diversification towards land-saving crops. Though the TDRI agricultural land demand forecast was based on statistical data that seems to vary considerably from actual land use (because of the large amount of unclassified land), the forecast may still be considered indicative of the direction of future agricultural land demand. Therefore, the planning framework of the current Study has assumed that agricultural land will decrease approximately at the same rate as that forecast by TDRI.

Specific considerations in forecasting agricultural land demand in this Study include the following:

(i) In this study agricultural land demand has been forecast to attain the socioeconomic framework adopted in this regional development master planning study for the WSB. Future agricultural land area should not be the simple result of land demand projections, but should take into account the desirability of reversing recent negative trends such as deforestation. In addition, it is desirable to attain a more intensive agricultural land use through restructuring in line with national guidelines. If there is a decrease in future agricultural land, more intensive agriculture will be required and a higher GRP yield per hectare of farmland will be necessary. For instance, for a total decrease of one per cent annually in farmland and a 3.0 per cent increase in GRP in the crop and livestock subsectors would be required to attain the growth rate forecast in these subsectors. However, this framework seems appropriate as a goal to which restructuring efforts may be targeted.

(ii) As has been stated, forest cover in the WSB region is over 40 per cent of the total land area, which is consistent with the target set by the 1985 National Forest Policy. However, as can be observed from GIS remote sensing data, encroachment in forest areas is occurring especially in mountainous areas of the region. Some of these encroached areas that are remote from existing farmland have limited potential for agriculture in terms of transportation and water availability. Even though such areas in national forest reserves are designated as economic forests, it is preferable that they be reforested. This finding provides a rationale for a future reduction in agricultural land.

(iii) Additional future land demand for urban use until 2011 has been estimated to be less than one per cent of the total land area of the WSB. It may be assumed that urban land demand can be partly absorbed in existing urban areas that are neither densely populated nor intensively used, but it is also likely that some encroachment of

agricultural land near built-up areas will occur. This finding further supports a framework involving reduced agricultural land use in the future.

The demand for agricultural land in the WSB in 2011 would be about 1,220,000 ha if the annual rates forecast by TDRI were strictly applied (Table 4.3.5). Broadly consistent with the TDRI forecast, around 1,300,000 ha has been adopted as the forecast of agricultural land use in 2011 in the current Study.

A provisional allotment of land by farming type has been established as the goal of the agricultural land use plan (Figure 4.3.3). The allotment of farming types and GRP yields by farming type are considered as variables for the function of future agricultural economic output, the GRP.

(i) Policy guidelines and agricultural development strategy

The Ministry of Agriculture and Co-operatives has identified the following three crop production types based on agricultural marketing prospects: (i) a group including crops for which the planted area is to be reduced since the demand at the market has already reached its saturation point (e.g., paddy, pepper, cassava, coffee); (ii) a group including crops for which the planted area is to be maintained since these crops have some degree of marketability (e.g., sugar cane, kenaf, jute, pineapple, cotton, rubber, onion, shallot, garlic); and (iii) crops for which the planted area is to be expanded since market demand is expected to increase (e.g., maize, sorghum, sunflower, wheat, soy beans, mung beans, vegetables, fruit).

(ii) Motivation of Farmers

In spite of the strong inclination of farmers to engage in paddy farming, a policy to move toward a more diversified farming system was adopted, with emphasis on maize, sorghum, sunflower, wheat, soy beans, mung beans, vegetables, and fruit. In this Study, for the expansion of GRP, fruit, cash crops, and livestock are considered as conceivable directions of agricultural diversification. However, the reduction of paddy land is somewhat difficult because of the strong adherence of farmers to paddy cultivation.

A study of the capacity of land to support population can be undertaken from knowledge of the per capita requirements of each output; an estimate can thereby be made of the population that can be supported in each area of the WSB. Current paddy land area may be

considered almost in equilibrium in the WSB region as a whole, though some deficits are found at the provincial level. However it can be estimated that current paddy land area will not be sufficient for the WSB to be self supportive, though more effective agricultural land use would still be required if agricultural GRP is to increase as forecast (Table 4.3.6). Because of the lack of an irrigation system, paddy yields in Prachuap Khirikhan and Chumphon are at minimum levels for the country. Conversion of paddy fields in relatively inferior conditions in those provinces, which account for about 25 per cent of the total paddy area in the WSB, can be sensibly recommended to increase agricultural GRP.

The expansion of fruit and tree crops can contribute to an increase of GRP because of their high yields. However, large-scale expansion of the planted area of these crops cannot be expected because of the large initial investment and the long period before the first year of return. Moreover, as shown in GIS land use analysis undertaken in this Study, fruit crops may be planted to the extent of agricultural land capability; therefore, a large expansion of the area planted with fruit and tree crops can be achieved if agricultural land used for other crops is reduced.

(iii) Assumed yields

Upland crop yields in the WSB region are far below the national average, while those of fruit and tree crops are around the average; this assessment is based on a comparison of the WSB region's GRP yield by farming type with those in whole country. Therefore, a steep increase in upland crop farming can be expected with the implementation of irrigation projects, the diversification of cropping patterns, advanced mechanization, and land consolidation.

An assessment of paddy yields and the yields of fruit and tree crops required to achieve the future economic framework was undertaken (Figure 4.3.4). The future allocation of agricultural land by subsector was made for following cases;

(a) reduction of upland crop fields with fixed paddy land and fruit and tree crop area (Case 1);
(b) reduction of upland crop fields, a 10 per cent decrease of paddy land, and a 10 per cent increase in fruit and tree crop fields (Case 2);
(c) reduction of upland crop fields, a 20 per cent decrease in paddy land, and a 20 per cent increase in fruit and tree crop fields (Case 3).

3.3.3 Land Demand for Industrial Use

Future land demand for industrial use has been estimated on the basis of (i) employment in the industry sector in 2011; (ii) increase in industrial employment until 2011; (iii) increase in industrial employment outside of existing factories until 2011; (iv) increase in industrial employment for new industrial areas; and (v) land requirement for industrial zone in 2011, as shown in figure 4.3.5. Through this formula, land demand for industrial zones in 2011 including industrial estates has been estimated to be around 2,200 ha (Table 4.3.7).

On the other hand, the industrial sector development of this study has separately estimated the demand for manufacturing factory area in the WSB on the basis of the estimated employment in the manufacturing sector (Refer to Volume 7, Chapter 5.4). According to this forecast, land demand for factory sites will be around 1,950 ha in 2011 (Table 4.3.8). Since factory sites account for about 65 per cent of the industrial area, the land demand for industrial use will be around 3,000 ha.

It is therefore forecast that the land demand for industrial use in the WSB would be in the range of 2,200-3,000 ha in 2011.

3.3.4 Land for Urban Land Use

As discussed in Volume 5, there is no one officially recognized definition of an urban area in Thailand; rather, each agency concerned with urban land use (e.g., DTCP, DLD) has adopted its own definition. Also, in various studies of urbanization different definitions have occasionally been adopted. Any definition of an urban area has some drawbacks for forecasting urban land demand. Municipality areas are rather small and have already been built up, and their boundaries do not reflect the expansion of built-up areas because their boundaries have not been expanded (or diminished) in relation to changes in urban population. Other definitions adopted in past studies include municipality areas plus some densely inhabited sanitary districts. However, sanitary districts vary considerably in terms of density; usually, they encompasses large rural areas. For the purposes of land use planning in this Study, urban areas have been considered as the built-up area identified by Landsat satellite data. However, due to the lack of accurate data on urban areas and population, the demand for urban land has been forecast as a trial estimate for reference.

Future urban land use demand has been estimated on the basis of the increase of newly generated employment in the industrial and service sectors and their supporting population until 2011. The demand for urban land use created by the newly generated population (considering both the population employed and their dependents) would be 9,300 hectares in 2011 (Table 4.3.9). (For further detail, refer to Volume 5, Chapter 2, Section 2.3.)

3.4 Land Use Evaluation and Plan

3.4.1 Land for Conservation

As a general proposition, existing forests should be conserved. Considering the topographic features of the WSB region, forests west of the 200 m contour line are referred to as highland forests, while those 200 m east, whether on flat land or in hills, are referred to as upland forests. The only lowland forests in the region are some small mangrove forests and areas planted with fruit trees. The highlands are relatively inaccessible and are still mostly under tree cover except in the Kwai Noi and Kwai Yai river valleys. On the other hand, most upland forests have been or are in the process of being replaced by agriculture and quite little forest now remains. Virgin and mangrove forests are spreading in the southern area of the region. Forests have been severely encroached for decades by traders and slash-and-burn farming.

The WSB region is divided into five broad vegetation regions based on the World Vegetation Map drafted by J. Schmithsen. They are tropical lowland evergreen forest, mangrove forest, tropical evergreen seasonal rain forest, tropical moist deciduous forest, and tropical mountain rain forest.

The major forest zones under the protected area system (PAS; see Table 4.3.10) are summarized as follows:

(i) Watershed classification: Watershed classification is an effort to make land use as compatible as possible with the features of the environment and to mitigate any adverse effects. Watershed Class 1A includes areas of protected forest and headwater source areas, usually at higher elevations with very steep slopes. These areas still remain under permanent forest cover. Class 1B includes areas having similar physical features and environments as Class 1A, but where portions of the area have already been cleared for agricultural use or are occupied by villages. It

should be noted that in protected forests, special soil conservation protection measures are necessary and, where possible, reforestation is recommended.

(ii) National parks, wildlife sanctuaries: The Royal Forestry Department (RFD) has conserved forest areas for recreation in the form of national parks, wildlife sanctuaries, and non-hunting areas. In the WSB region, ten national parks and three wildlife sanctuaries have been designated as of 1996.

(iii) Conservation forests: In accordance with the Government designation of 27.5 per cent of the country as conservation forest in 1992, 83 conservation forests were designated in the WSB totaling 1,968,186 ha (Table 4.3.11). Zoning has been limited to the National Forest Reserves; forested land outside the National Forest Reserves, even those within PAS, have not been zoned (Figure 4.3.7).

After three years of preparation, the Thai Forestry Sector Master Plan was announced in 1993 (Table 4.3.12). The plan adopted macro-level and local-level plans based on the following policy objectives; the policy proposed lays down how state forest land will be allocated for sustainable management. Consistent with this provision, zoning will be updated to cover state forest land outside the National Forest Reserves (NFR); however, the substantiation of the master plan is still forthcoming in the WSB region.

Reforestation projects include reforestation by RFD, reforestation by a concessionaire following an agreement with RFD, and reforestation by the private sector. However, the total reforestation area is small compared with the total need. The Reforestation Campaign in Commemoration of the Royal Golden Jubilee is a noteworthy project being implemented by 1996 to pay tribute to the Fiftieth Anniversary of His Majesty King Bhumibol Adulyadej's Accession to the Throne. In 1994 the Royal Thai Government approved the Reforestation Campaign as proposed by the National Forestry Policy Committee. The target area is 800,000 ha (5,000,000 rai) covering the period of 1994-96. The first and foremost objective of the Campaign is to expand as much as possible the area covered with forest in the shortest period of time by planting indigenous species of plants in about 800,000 ha of degraded land. The project aims at reviving depleted forests, especially in watershed areas. Other target areas are mainly in national parks and wildlife reserves, and in mangrove forests. A key policy component of the plan is that areas to be reforested must be uninhabited.

As a result of growing concern over the rapid rate of destruction of mangroves, a Mangrove Forest Conservation Zone Project was established under a 1991 Cabinet directive and is to

run through 1996. In the WSB region, this project covers Petchaburi, Prachuap Khirikhan, and Chumphon provinces, with a total area of 1,250 ha replanted with mangrove. Many coastal communities have embarked on mangrove replanting programs in the past decades. Under the existing legislation, community forests can be established on public land or in national forest reserves. In practice, existing community mangrove forests have been established through informal agreements with provincial and district forestry officers. Within the WSB, there are 320 ha (2,000 rai) of mangrove replanting area in Ban Khlong and other villages in Samut Songkhram (Table 4.3.13).

Economic forests are composed of forest reserves, plantation or community forests, private tree farms (forests), and timber concession areas. The areas designated as economic forests are located within or adjacent to existing protected areas in mostly mountainous areas (Figure 4.3.7). Although there has been some encroachment in these forests and accordingly they have been designated as economic forests, it is required that they remain as a forest type to attain the national goal with respect to forest cover (Table 4.3.14).

3.4.2 Land for the Primary Use of Agriculture

(1) Irrigation Areas

Four large-scale and 22 medium-scale irrigation projects have been completed in the WSB region, with a collective storage capacity of 14,523 MCM. According to official statistics, the irrigated area in the WSB is 24.9 per cent of all agricultural land; most is located in the Mae Klong Basin (Figure 4.3.8). The irrigation rate varies with water availability in each river basin. The irrigation rates of agricultural land in the Mae Khlong River Basin (including Kanchanaburi, Ratchaburi, and Petchaburi provinces) exceeded 40 per cent in 1994, while irrigation rates in Prachuap Khirikhan and Chumphon provinces were 15 per cent and 4 per cent, respectively.

Due to the scarcity of a proper site for construction of a large-scale storage project as well as many restrictions for reasons of environmental conservation, water resource development on a large-scale basis has slowed in the 1990s (Figure 4.3.8). As stated, irrigated area is considered to have the potential for double cropping and should be considered primarily for the use of agriculture.

(2) Land Consolidation Project Areas

Land consolidation projects in the WSB Region have been carried out in the Mae Klong River Basin, with 17,150 ha in Kanchanaburi, 27,003 ha in Ratchaburi, and 6,757 ha in Petchaburi, totaling 50,911 ha as of 1996. Most of these land consolidation areas have been categorized into the so-called extensive type and have been carried out within irrigation areas (Figure 4.3.9). Generally, since high yields can be expected in land consolidation areas, these areas should primarily be used for agriculture.

(3) Land Reform Areas

In the WSB region, 364,600 ha of public land and 1,674 ha of private land was allocated as land reform area as of April 1995. In addition, land transferred by the Sor Tor Kor Program between 1982 and 1992 amounted to 50,846 ha and land transferred by the SPK Program from 1975 to 1995 amounted to 611,824 ha (Figure 4.3.10). Typically such areas have been located at the edge or inside of existing forests, i.e., often in areas where agricultural infrastructure is insufficiently developed; consequently, agricultural yields are relatively low. However, those areas that have already been transferred to farmers as part of a land reform program cannot be retrospectively returned to forest even though those areas are not particularly productive. Therefore, such land reform areas should generally be used for agriculture.

3.4.3 Land Use Planning

(1) Land potentials

Following the general guidelines for land use planning presented in Section 3.2, overall land potentials in the WSB region have been analyzed by GIS. The results are illustrated in Figure 4.3.11 and summarized by major land potential category and by province in Table 4.3.15.

As seen from Table 4.3.15, the land suitable for conservation forest occupies 12,943 km^2 or 48.4 per cent of the total land, slightly larger than the existing forest area. Potential irrigated paddy area covers 2,824 km^2, significantly larger than the existing rice area at 1,853 km^2. The potential agricultural land totals 11,513 km^2, which is smaller than the demand for agricultural land in the WSB region in 2011 presented in Subsection 3.3.2.

This means some area identified suitable for conservation forest may be utilized for productive purposes to meet the agricultural land requirements.

(2) Land Conversion Rules

The existing land use pattern should be converted to more productive uses to attain the agricultural development targets analyzed in Subsection 3.3.2. For the long-term planning purposes, future land use is broadly classified into the following eight categories:

(i) Forest conservation;
(ii) Irrigated paddy;
(iii) Intensive upland crops;
(iv) Fruit trees and tree crops;
(v) Multi-story farming;
(vi) Forest plantation;
(vii) Pasture; and
(viii) Others.

Future land use is specified, corresponding to each combination of existing and potential land uses. The broad criteria described in Subsection 3.4.1 and 3.4.2 are used to establish such land use conversion rules (Table 4.3.16). Specifically, the following are incorporated in the conversion rules:

(i) Existing undisturbed forest areas shall be protected, irrespective of land use potentials.

(ii) Disturbed forest areas shall be rehabilitated and put to productive use such as forest plantation, multi-story farming, tree crops, and intensive upland crops, depending on land use potentials; this should not preclude possible reforestation in some part of this land use category, if such a policy is adopted.

(iii) Land suitable for conservation forest shall be partly used for productive uses, if it is presently used for tree crops or other agricultural uses; either for multi-story farming or forest plantation, the latter may be substituted with reforestation, depending on the government policies.

(iv) Of areas suitable for irrigated paddy, only such areas that are not used for tree crops at present will be devoted to irrigated paddy; for other areas, multi-story farming will be established.

(v) Areas suitable for upland crops or rainfed paddy shall be used as much as possible for intensive upland crop cultivation.

(vi) Areas suitable for fruits and other tree crops shall continue to be used for fruits and tree crops except the existing sugar cane area and grassland/pasture to be converted to intensive upland crops and the existing forest area to be preserved.

(vii) Areas suitable for pasture shall be used for either managed pasture or forest plantation; the latter may be alternatively used for reforestation.

(viii) Only marginal land less suitable for agriculture shall be used for urban and industrial purposes.

(3) Land Use Plan

Planned land use is summarized by province in Table 4.3.17. The land use planning map of the WSB region is illustrated in Figure 4.3.12, and maps for the six WSB provinces are given in Figure 4.3.13 through Figure 4.3.18. As seen from Table 4.3.17, the area for forest conservation covers 9,310 km^2 or 36 per cent of the total land, slightly smaller than the required 40 per cent coverage. Some portions of forest plantation area covering 1,388 km^2 may be used for reforestation to satisfy the requirement.

The total agricultural land, excluding forest plantation, covers 13,662 km^2, larger than the estimated demand for agricultural land (Subsection 3.3.2). The area designated for multi-story farming may not be wholly devoted to productive uses. The irrigated paddy area will occupy 1,485 km^2, representing a 20 per cent reduction in the existing paddy area. The extensive mixed upland crops area existing in the WSB region will be converted into more orderly farming systems: i.e. intensive upland crops, fruit and other tree crops, or multi-story farming combining tree crops and upland crops, depending on the potentials.

Additional area necessary for urban and industrial uses will be in the order of 500 km^2, while the combined area of all the municipalities and urban sanitary districts is about 1,300 km^2. The proposed land area for "others" category is large enough to accommodate future urban and industrial areas.

3.4.4 Agricultural GDP and Alternative Land Use Plan

(1) Estimate of Land Productivity by Crop/Farming System

Detailed yield data are required to estimate the agricultural GDP corresponding to the existing land use and to forecast the agricultural GDP for alternative land use plans. Estimated crop yields have been converted to unit value-added per hectare for each crop or farming system. Estimates of unit value-added for different crops in the WSB region and in Thailand are summarized in Tables 4.3.18 and 4.3.19, respectively.

Based on the estimated unit value-added by crop, unit value-added per hectare is assumed for different farming practices at present and in the future. These farming practices include single and double cropping of paddy, present and improved practices for selected upland crops, fruits and tree crops, and multi-story farming. The results are summarized in Table 4.3.20.

(2) Agricultural GDP for Proposed Land Use

Agricultural GDP in the WSB region in 2011 has been estimated, corresponding to the proposed land use presented in Subsection 3.4.3. First, value-added of the crop subsector was estimated by applying the present unit value-added per hectare assumed for different farming systems. The crop value-added was projected to increase from 15,444 million Baht in 1994 to 19,307 million Baht in 2011; a 25 percent increase. This represents an average growth rate of 1.3 per cent per annum over the 17-year period.

To increase the crop value-added further, farming practices need to be improved. If the unit value-added assumed for the improved farming practices is applied, the crop value-added is projected to increase to 24,931 million Baht in 2011, representing an average annual growth rate of 2.9 per cent. For other subsectors of agriculture, respective value-added was projected by assuming the average annual growth rates. The results of the agricultural GDP projection are summarized in Table 4.3.21. As

shown, the agricultural GDP may grow at the average growth rate of 2.9 per cent per annum over 1994-2011.

(3) Alternative Land Use Plan

To see if the agricultural GDP may be further increased, an alternative land use plan was prepared. Land use conversion rules for this alternative plan were prepared in such a way as to increase the area with agricultural land use with higher unit value-added (Table 4.3.22). The alternative land use plan is summarized by province in Table 4.3.23. As seen from the table, the area for irrigated paddy would be further reduced and the multi-story farming area increased.

The agricultural GDP corresponding to the alternative land use plan was projected by applying the same unit value-added for the improved farming practices for crop subsector and assuming the same average annual growth rates for other subsectors. As shown in Table 4.3.24, agricultural GDP is projected to increase at 3.0 per cent per annum on an average over 1994-2011 period.

Table 4.2.1 Summary of Distribution of Current Land Use in 1995

Area in Sq.km.

Land Use Categories		Kancha-naburi	Prachaup Kirikhan	Petchaburi	Ratchaburi	Samut Songkhram	Chumphon	WSB Region
Description	Code							
Orchard	AF1	185.14	474.70	61.91	140.40	130.08	293.56	1285.79
Pineapple	AF2	0.00	63.53	6.89	1.23	0.00	0.00	71.64
Coconut	AG2	0.00	660.00	0.00	0.00	0.00	15.93	675.93
Oil Palm	AG4	0.00	18.79	0.00	0.00	0.00	51.47	70.27
Rubber	AG5	0.00	12.63	0.00	0.00	0.00	525.04	537.66
Mixed Upland Crops	AG6	1083.56	1827.71	1946.44	2436.83	115.19	2731.89	10141.63
Rice	AI1	425.50	214.61	351.40	575.60	21.64	264.59	1853.34
Sugar Cane	AI2	92.40	27.11	0.00	61.66	0.00	0.00	181.18
Built-up Areas	BU1	38.92	19.62	43.56	34.39	4.70	14.65	155.84
Evergreen Forest	F01	179.01	2024.12	2788.06	1256.65	12.20	1253.12	7513.16
Deciduous Forest	F02	425.77	63.12	720.91	593.93	0.00	127.09	1930.81
Disturbed Forest	F03	155.85	783.48	169.58	50.04	0.00	379.65	1538.61
Forest Plantation	F04	73.24	58.07	1.12	44.06	0.00	0.00	176.49
Mining	IN1	3.69	11.61	0.00	0.00	0.00	2.96	18.25
Grassland and Pasture	LI1	0.25	1.98	0.00	0.00	0.00	10.48	12.71
Others	OT1	6.78	6.04	1.83	7.73	0.00	0.00	22.38
Salt Farm	WA2	0.00	0.00	32.32	1.14	2.63	0.44	36.54
Shrimp Farm	WA3	0.00	33.39	85.63	49.31	119.21	59.42	346.97
Reservoir / Water Body	WR1	19.61	31.77	56.89	22.12	6.42	0.45	137.27
Sub Total		2689.71	6332.27	6266.56	5275.10	412.07	5730.76	26706.46
Unclassified		1.06	12.44	9.69	0.80	0.01	9.37	33.36
Total		2690.77	6344.70	6276.25	5275.90	412.07	5740.13	26739.82

Source: Remote Sensing Analysis and Classification by Study Team (May 1996)

Table 4.2.2 Changes of Land Use in WSB Region

		Total Land	Forest	Farm Holding Land				Unclassified
				total	paddy	shrimp	others	
Kanchanaburi	1988	1,948,315	1,123,360	426,728	67,857	-	358,872	398,227
	1991	1,948,315	1,083,100	334,728	64,495	-	270,233	530,487
Ratchaburi	1988	519,646	142,419	294,236	98,706	4	195,527	82,991
	1991	519,646	133,675	222,259	83,101	-	139,158	163,809
S. SongKhram	1988	41,671	-	18,653	1,181	8,636	8,836	23,017
	1991	41,671	-	17,943	1,116	2,654	14,173	23,728
Phetchaburi	1988	622,514	223,560	180,675	78,664	4,532	97,480	218,278
	1991	622,514	222,025	106,827	52,687	3,410	50,730	293,662
P. Khirikhan	1988	636,762	137,624	263,395	19,977	1,387	242,031	235,743
	1991	636,762	132,700	224,044	13,694	1,151	209,199	280,018
Chumphon	1988	600,901	142,475	240,871	23,718	992	216,162	217,555
	1991	600,901	120,500	254,682	22,432	2,086	230,164	225,719
WSB Region	1988	4,369,808	1,769,438	1,424,559	290,103	15,550	1,118,906	1,175,811
	1991	4,369,808	1,692,000	1,160,483	237,524	9,300	913,658	1,517,422
Thailand	1988	51,311,502	14,380,829	21,083,641	11,332,426	-	-	15,847,032
	1991	51,311,502	13,669,805	21,292,190	11,090,080	-	-	16,349,507

Source: Royal Thai Survey Department and Center for Agricultural Statitics, Ministry of Agriculture and Cooperatives

Table 4.2.3 Changes in Forest Cover in WSB Region

	Total Area (sq.km.)	Forest Cover					
		1961	1973	1985	1988	1991	1993
Thailand	513,115	273,629	221,725	150,866	143,803	136,698	133,521
		53.3%	43.2%	29.4%	28.0%	26.6%	26.0%
WSB Region	42,549	35,074	25,002	18,149	17,695	16,920	16,622
		82.4%	58.8%	42.7%	41.6%	39.8%	39.1%
Kanchanaburi	19,483	17,793	13,549	11,562	11,234	10,831	10,742
		91.3%	69.5%	59.3%	57.7%	55.6%	55.1%
Ratchaburi	5,275	3,368	1,876	1,462	1,424	1,337	1,317
		63.8%	35.6%	27.7%	27.0%	25.3%	25.0%
Samut Songkhram	412	0	60	0	0	0	0
		0.0%	14.6%	0.0%	0.0%	0.0%	0.0%
Petchaburi	5,677	4,731	3,626	2,272	2,236	2,220	2,188
		83.3%	63.9%	40.0%	39.4%	39.1%	38.5%
Prachuap Khirikhan	6,332	5,038	3,189	1,391	1,376	1,327	1,271
		79.6%	50.4%	22.0%	21.7%	21.0%	20.1%
Chumphon	5,370	4,144	2,702	1,462	1,425	1,205	1,104
		77.2%	50.3%	27.2%	26.5%	22.4%	20.6%

Source: JICA Study Team and Forest Resources Assessment Division, Forest Research Office, Royal Forestry Department, Ministry of Agriculture and Cooperattives

Table 4.2.4 Land Holding by Size (unit: rai)

	Land holding size								
	Under 2	2 - 5	6 - 9	10 - 19	20 - 39	40 - 59	60 - 139	140 and over	Total
Thailand	2.1	15.6	12.9	28.6	26.8	8.7	4.8	0.5	100.0
Central	3.6	15.4	9.7	24.5	27.7	10.7	7.1	1.3	100.0
Southern	1.6	17.7	14.9	29.0	24.6	7.2	4.4	0.6	100.0

Source: Advanced Report 1993 Agricultural Census, National Statistical Office, Office of the Prime Minister

Table 4.2.5 Land Holding by Tenure Type

	Operated under one tenure form			Operated under two or more tenure forms				Total
	Owned	Rented	Others	Owned & rented	Owned & others	Rented & others	Owned, rented & others	
Thailand	76.9	7.0	5.7	7.8	2.0	0.4	0.2	100.0
Central	65.6	14.7	5.5	12.9	0.7	0.5	0.1	100.0
Southern	81.6	1.6	7.5	5.4	3.5	0.2	0.2	100.0

Source: Advanced Report 1993 Agricultural Census, National Statistical Office, Office of the Prime Minister

Table 4.3.1 Principles for Land Use Planning

Land Use	Land use potential	Direction of current land use	Consistency to relevant plans	Consistency to the spatial development pattern
Industry	- Area with advantageous potentials, such as transport conditions, accessibility to materials, consumers, etc.	- Area with tendency of industrial establishment.	- Area with industrial area development plans or projections - Area where future increase of land use potential because of implementation of infrastructure plans	- Correspondence to the future regional development pattern (Free trade zone is inclusive.)
Urban area	- Flat or undulating area with good accessibility to urban functions	- Area where urbanization can be observed (or population increase can be observed)	- Area where housing development plans are proceeding. - Area where improvement of urbanization potential can be expected owing to the improvement of infrastructures.	- Correspondence to the future regional development pattern (including Science park)
Agriculture	- Area where high agricultural potential can be expected.	- Land reform areas - Present agricultural land	- Area where land reform is planned. - Area where irrigation system improvement is planned.	-
Conservation	- Area where conservation is required from the environmental and safety aspects.	- Area far from urban areas. - Reforestation areas	- Area with reforestation plan - Area where conservation zones are designated.	-

Table 4.3.2 Forest Reserve and Existing Forest by Province in WSB Region, 1993

	Total Land (ha)	National Forest Reserve (ha)	Existing Forest (ha)
Kanchanaburi	1,948,315	802,300	1,074,200
	100.0%	41.2%	55.1%
Ratchaburi	527,510	186,500	131,700
	100.0%	35.4%	25.0%
S. SongKhram	41,207	0	0
	100.0%	0.0%	0.0%
Petchaburi	567,664	383,600	218,800
	100.0%	67.6%	38.5%
P. Khirikhan	633,227	281,400	127,100
	100.0%	44.4%	20.1%
Chumphon	537,076	311,100	110,400
	100.0%	57.9%	20.6%
WSB Region	4,254,999	1,964,900	1,662,200
	100.0%	46.2%	39.1%
Thailand	51,311,502	23,018,600	13,352,100
	100.0%	44.9%	26.0%

Source: "Forestry Statistics of Thailand 1993", Data Center, Information Office, Royal Forest Department, Ministry of Agriculture and Cooperatives

Table 4.3.3 Protected Area System in Thailand

National parks	National parks include land with beautiful landscapes, important history, and rare plant or animal species, preserved in its natural state for the benefit of public education and enjoyment.
Wildlife sanctuaries	Wildlife sanctuaries are on land reserved for the conservation of wildlife, so the wildlife can freely breed and increase their populations in a natural environment.
Forest parks	Forest parks include land with attractive scenery, developed for public recreation, but too small to be declared as a national park.
Non-hunting areas	Non-hunting areas are those that have been designated as such for the protection of specific wildlife species. Non-hunting areas are generally smaller than wildlife sanctuaries.
Biosphere reserves	Biosphere reserves are intended to conserve the diversity and integrity of biotic communities of plants and animals within natural ecosystems, and to safeguard the genetic diversity of species on which their continuing evolution depends. Biosphere reserves are declared as such by the Man and the Biosphere International Coordination Committee.
World Heritage Sites	World Heritage Sites are places with unique natural and cultural values which are considered to have outstanding universal significance. World Heritage Sites are nominated by countries that are party to the World heritage Convention.
Watershed Class 1 areas	Watershed Class 1 (WCS 1) areas are those designated to have permanent forest cover because of their steep slopes, high susceptibility to soil erosion, and importance as a head-watershed.
Botanical gardens	Botanical gardens are areas established to contain collections of indigenous and exotic species, which are considered rare or to have economic value, planted in taxonomic order for purposes of research, dissemination of knowledge, and conservation.
Arboreta	Arboreta are smaller than botanical gardens and are established to collect various plant species, especially the economically useful plants and flowering plants, which are indigenous to the area.
Conservation mangrove forest	Conservation mangrove forests are mangrove forests excluded from utilization to protect fragile ecosystems and serve as shelter and nursery ground for marine flora and fauna.
Natural conservation areas	Natural conservation areas comprise islands, mountains, swamps, lakes, fossils, and interesting land forms, which should be protected from economic and social exploitation.

Table 4.3.4 Required Growth Rates for Future Agricultural GRP in WSB Region

Case 1 (units: 1,000 baht in 1994 constant prices)

	GRP		Average Annual growth rate	
	1994 Actual	2011 Projection	1984-1994 Actual	1995-2011 Projection
Agriculture	27,211,659	40,997,906	1.5%	2.44%
Crops (WSB Region)	15,179,214	21,254,564	0.9%	2.00%
Livestock (WSB Region)	2,467,479	3,455,066	0.9%	2.00%
Others (WSB Region)	9,564,966	16,288,276	2.8%	3.18%
Fisheries	5,556,096			
Forestry	689,349			
Agricultural Services	489,109			
Simple agricultural processing	2,830,412			

Case 2 (units: 1,000 baht in 1994 constant prices)

	GRP		Average Annual growth rate	
	1994 Actual	2011 Projection	1984-1994 Actual	1995-2011 Projection
Agriculture	27,211,659	40,997,906	1.5%	2.44%
Crops (WSB Region)	15,179,214	21,254,564	0.9%	2.00%
Livestock (WSB Region)	2,467,479	3,631,945	0.9%	2.30%
Others (WSB Region)	9,564,966	16,111,397	2.8%	3.11%
Fisheries	5,556,096			
Forestry	689,349			
Agricultural Services	489,109			
Simple agricultural processing	2,830,412			

Case 3 (units: 1,000 baht in 1994 constant prices)

	GRP		Average Annual growth rate	
	1994 Actual	2011 Projection	1984-1994 Actual	1995-2011 Projection
Agriculture	27,211,659	40,997,906	1.5%	2.44%
Crops (WSB Region)	15,179,214	22,342,669	0.9%	2.30%
Livestock (WSB Region)	2,467,479	3,631,945	0.9%	2.30%
Others (WSB Region)	9,564,966	15,023,292	2.8%	2.69%
Fisheries	5,556,096			
Forestry	689,349			
Agricultural Services	489,109			
Simple agricultural processing	2,830,412			

Table 4.3.5 Future Agricultural Land by Increase Rate in the Study Area

(unit: ha)

	Increase rate	Agricultural land	
		1996	2011
Case 1	No change	1,424,023	1,424,023
Case 2	-0.5% (1995-2005), -1.75%(2006-2011)	1,424,023	1,218,269

Source: JICA Study Team

Table 4.3.6 Self-supporting Paddy Land Demand in the Study Area

	1995		2011				
	Population (pers.)	Paddy land (ha)	Population (pers.)	Paddy food demand (tons)	Required paddy production (tons)	Paddy yield (kg/ha)	Land demand for paddy (ha)
Kanchanaburi	494,854	42,550	580,255	121,854	143,357	2,603	55,084
Ratchaburi	798,086	57,560	935,819	196,522	231,202	3,263	70,867
S. Sonkhram	206,979	2,164	242,699	50,967	59,961	3,615	16,587
Petchaburi	447,094	35,140	524,253	110,093	129,521	3,218	40,255
P.Khirikhan	461,016	21,461	540,578	113,521	133,554	2,033	65,709
Chumphon	432,867	26,459	507,571	106,590	125,400	2,213	56,678
Study Area	2,840,896	185,334	3,331,174	699,547	822,996	2,880	285,800

Source: Agricultural Statistics of Thailand Crop Year 1994/95, Office of Agricultural Economics, Ministry of Agriculture and Cooperatives.

Note: 130 kg of white rice/inhabitant/year or 210kg of paddy /inhabitant/year.
Paddy food demand is assumed 85% of paddy production; 8% for seeds, 2% for animal feeds, 5% for post-harvest losses.

Table 4.3.7 Estimated Result of Land Demand for Industrial Use in WSB Region

	Industrial (manufacturing) GRP (at 1994 constant prices)	(1)		baht	209,000,000,000
	Annual average growth rate	(2)			11.60%
	Average productivity per worker in 2011	(3)		baht/worker	368,960
i)	Industrial employment in 2011	(4)	(1)/(3)	workers	566,457
	Industrial employment in 1994	(5)		workers	234,794
ii)	Increase in industrial employment until 2011	(6)	(4)-(5)	workers	331,663
	Absorption capacity of industrial employment in existing industrial areas	(7)			1.4
	Industrial employment within existing industrial areas until 2011	(8)	(5)x(7)	workers	328712
iii)	Increase in industrial employment other than existing areas until 2011	(9)	(4)-(8)	workers	237,745
	Concentration rate of industrial employment to new industrial zones	(10)			0.5
iv)	Increase in industrial employment for new industrial zones until 2011	(11)	(9)x(10)	workers	118,873
	density of workers per ha	(12)		workers/ha	60
	Adjustment coefficient for new industrial zones	(13)			1.125
v)	Land demand for new industrial zone	(14)	((11)/(12))x(13)	ha	2,229

Source: JICA Study Team

Table 4.3.8 Land Demand for Factory Site in the WSB

(By Category of Industry)

TSIC		Land Demand (ha) 2001	2006	2011
	Total	708.70	1,171.80	1,876.85
311-4	Food, Beverage and Tobacco	74.40	118.05	209.95
321	Textiles	33.00	56.00	81.60
322	Wearing Apparel			
323-4	Leather, leather Products and Footwear	1.70	2.70	3.30
331-2	Wood, Wood Products and Furniture	70.55	96.25	134.30
341	Paper and Paper Products	36.10	43.50	72.25
342	Printing and Publishing			
351-4	Chemical and Petroleum Products	32.50	50.30	189.80
355-6	Rubber and Plastic Products	7.00	11.20	13.50
361-9	Non-Metallic Mineral Products	62.80	134.50	209.50
371-2	Basic Metal Products	133.30	251.70	401.45
381	Fabricated Metal Products	51.00	81.70	98.40
382-5	Machinery and Equipment	195.75	303.20	428.60
390	Other Manufacturing Industries	10.60	22.70	34.20

Source: Volume 7, Table 7.5.14

(By Province)

	Factory Site (ha)	Workers (persons)	GPMP (mill. Baht)
Total	1,876.85	143,773	100,250
1. Kanchanaburi	165.40	16,143	5,585
2. Ratchaburi	363.90	36,052	13,777
3. Ban Pong	120.00	12,167	5,030
4. Other Ratchaburi	243.90	23,885	8,747
5. Samut Songkhram	65.70	6,915	2,780
6. Free Trade Area	40.00	4,550	1,994
7. Other Songkhram	25.70	2,365	786
8. Petchaburi	299.10	29,133	10,760
9. Khao-Yoi	180.00	17,500	6,500
10. Other Petchaburi	119.10	11,633	4,260
11. Prachuap Khirikhan	697.45	26,193	56,647
12. Bang Saphan	617.85	16,613	53,394
13. Other Khirikhan	79.60	9,580	3,253
14. Chumphon	285.30	29,336	10,701
(by Subarea)			
Total	1,876.85	143,773	100,250
Upper WSB (1+2+5+9)	775.00	76,610	28,642
Central WSB (10+13)	198.70	21,214	7,513
Lower WSB (12+14)	903.15	45,949	64,095

Source: Volume 7, Table 7.5.19

Table 4.3.9 Urban Population Projection and Urban Land Use Demand in the WSB Region

	Unit	1994	2001	2006	2011
1. Manufactural Employment in Existing Industries	person	234,794	252,405	267,410	284,978
2. Manufactural Employment in New Industries	person	---	119,806	173,045	250,132
3. Total Manufactural Employment	person	234,794	372,211	440,455	535,110
4. Generated Number of Manufactural Employment	person		137,417	205,661	300,316
5. Generated Number of Manufactural Employment who lives in Urban Area (50% of Generated Numbers by Manu.)	person		68,709	102,831	150,158
6. Coefficient for Service Sector Employment			0.47	0.76	1.07
7. Generated Number of Service Sector Employment in Urban Area	person		32,293	78,151	160,669
8. Generated Total Number of Employment in Urban Area	person		101,001	180,982	310,827
9. Coefficient for Family Member Support (1.5person/employm.)			2.5	2.5	2.5
10.Generated Total Number who lives in Urban Area	person		**252,504**	**452,454**	**777,068**
11.Coefficient of Housing Land Demand by Person			(100 person/ha)		
12.Additional Housing-related Land Demand by Generated Urban Population Increase	hectare		2,525.0	4,524.5	7,770.7
13.Land Demand for Public Land Use(roads, parks, public facilities) : 20% of Housing Land Use Demand	hectare		505.0	904.9	1,554.1
14.Total Land Demand for Urban Land Use ((14)=(12)+(13))	hectare		**3,030.0**	**5,429.5**	**9,324.8**
(Average Population Density between 1994 and 2011)	pop/ha.		(83.3 person/ha)		
15.Additional Land Demand for Urban Land Use by Subarea					
Upper WSB (52.3 % share)	hectare		1,612.0	2,888.5	4,960.8
Central WSB (14.8 % share)	hectare		448.4	803.6	1,380.1
Lower WSB (32.0 % share)	hectare		969.6	1,737.4	2,983.9

	Unit	1994	2001	2006	2011
Total Urban Population in Urban Center Areas (Municipality Population + Sanitary District Population)	person	948,000 (existing)	1,200,000 (projected)	1,400,000 (projected)	1,725,000 (projected)
Projected Total Regional Population in WSB region	person	2,896,000	3,060,000	3,234,000	3,433,000
Share of Urban Population to Total WSB Population	percent	32.7%	39.2%	43.3%	50.2%

Source: JICA Study Team

Notes: 1. The area of urban land use or urban centers in this sector are defined as the combined area of municipalities and sanitary districts.
2. The estimation method of above table is described in Volume 5, Rural and Urban Development, Chapter 2, Section 2.3 (3).

Table 4.3.10 Protected Areas in WSB Region

Province	Name	Area (ha)			Year of Establishment
		Land area	Waterbody	Total	
Kanchanaburi	Chalerm Ratanakosin National Park	5,900	-	5,900	1980
	Sri Nakarin National Park	108,907	44,293	153,200	1981
	Triyoke National Park	50,000	-	50,000	1980
	Erawan National Park	55,000	-	55,000	1975
	Khao Laem National Park	106,148	43,552	149,700	1991
	Tungyai Wildlife Sanctuary	364,720	-	364,720	1974
	Salak Pra Wildlife Sanctuary	85,855	-	85,855	1966
Ratchaburi	Mae Nam Pachi Wildlife Sanctuary	48,931	-	48,931	1978
Petchaburi	Kang Krachan National Park	263,860	2,440	266,300	1981
P. Khirikhan	Khao Samroiyod National Park	7,720	2,088	9,808	1966
	Khaeng Krachang National Park	25,200	-	25,200	1981
	Nam Tok Huaiyang National Park	16,100	-	16,100	1991
	Hard Vanakorn National Park	3,800	-	3,800	1991
Chumphon	Kromloung Chumphon Wildlife Sanctuary	45,400	-	45,400	1988
WSB Region		1,187,541	92,373	1,279,914	

Source: Royal Forestry Department, Ministry of Agriculture and Cooperatives

Table 4.3.11 Conservation Forests in WSB Region

Province	Number of Consevation Forests	Area (ha)
Kanchanaburi	15	805,650
Ratchaburi	7	186,495
Petchaburi	15	383,616
P. Khirikhan	20	281,369
Chumphon	26	311,055
WSB Region	83	1,968,186

Source: Royal Forestry Department, Ministry of Agriculture and Cooperatives

Table 4.3.12 Proposed Allocation of National Forest Reserves

(unit: 1,000ha)

Item	North	Northeast	Central	South	Thailand	%
Protected Area System	8,170	1,938	2,474	1,536	14,117	27.5
Forests in good condition	6,963	1,579	2,154	1,144	11,840	23.1
Forests for rehabilitation	726	59	138	333	1,256	2.4
Other land uses	480	299	182	59	1,021	2.0
Community forestry	1,720	1,003	950	912	4,586	8.9
Forests in good condition	750	600	277	202	1,829	3.6
Forests for rehabilitation	952	394	664	701	2,710	5.3
Other land uses	18	10	10	10	46	0.0
Leasehold forestry	477	2,274	906	61	3,717	7.2
Under various land uses	477	2,274	906	61	3,717	7.2
Land reform	182	1,043	475	467	2,168	4.2
Under various land uses	182	1,043	475	467	2,168	4.2
Total for forestry	10,366	5,214	4,330	2,509	22,419	43.7
% of land area	61.1	30.9	41.7	35.5	43.7	

Source: "Thai Forestry Sector Master Plan, vol.6, Subsectoral Plan for Production and Utilization", 1993, Royal Forest Department, Ministry of Agriculture and Cooperatives

Table 4.3.13 Mangrove Forest Development of Conservation Zone Project

(unit: ha)

Province	1991	1992	1993	1994	Total	% of area lost
Petchaburi	-	144	192	160	496	NA
P. Khirikhan	-	16	48	96	160	NA
Chumphon	-	160	160	272	592	NA
Total	-	320	400	528	1,248	NA

Source: Royal Forestry Department, Ministry of Agriculture and Cooperatives

Note: Planted aea as a percentage of area lost between 1978 and 1993.

The planted areas and the areas lost are generally in quite different locations.

Table 4.3.14 Land Use Zoning of Mangrove Area in the Study Area, 1993

(unit: ha)

Province	Land Use	Preservation Zone	Economic Zone A	Economic Zone B	Total
S. Songkhram	Total	851	131	9,952	10,934
	Mangrove forest	102	-	822	924
	Shrimp field	137	-	7,107	7,244
	Community area	51	-	108	158
	Others	561	131	1,915	2,608
Petchaburi	Total	850	302	10,736	11,888
	Mangrove forest	217	-	1,851	2,068
	Shrimp field	81	-	2,728	2,809
	Community area	25	-	139	164
	Others	527	302	6,018	6,846
P. Khirikhan	Total	186	27	1,087	1,300
	Mangrove forest	7	10	24	40
	Shrimp field	5	17	358	380
	Community area	-	-	8	8
	Others	174	-	698	872
Chumphon	Total	915	5,816	3,901	10,632
	Mangrove forest	243	2,285	765	3,293
	Shrimp field	124	1,497	1,145	2,766
	Community area	-	42	29	71
	Others	548	1,993	1,961	4,502
Total	Total	2,802	6,276	25,676	34,754
	Mangrove forest	568	2,295	3,463	6,325
	Shrimp field	347	1,514	11,337	13,199
	Community area	76	42	284	402
	Others	1,810	2,426	10,592	14,828

Source: S. Aksornkoae, "Ecology and Management of Mangroves", 1993
Note: 1 ha=6.25 rais

Table 4.3.15 Summary of Distribution of Land Potential in 1991

Area in Sq.km.

Potential Categories		Kancha-naburi	Prachaup KiriKhan	Petchaburi	Ratchaburi	Samut Songkhram	Chumpon	WSB Region
Description	Code							
Conservation Forest	F1	801.60	2858.23	4099.58	2531.03	71.95	2580.99	12943.38
Irrigated Areas								
Paddy	I1	321.54	303.95	708.09	1025.17	21.80	443.46	2824.01
Upland Crops	I2	413.47	78.03	16.70	398.61	3.21	106.17	1016.19
Fruits and Tree Crops	I3	0.00	155.15	274.48	10.71	236.65	1388.55	2065.54
Rainfed Areas								
Paddy	R1	134.60	35.65	128.20	432.73	0.00	528.43	1259.61
Upland Crops	R2	662.18	770.07	292.40	327.32	0.00	142.29	2194.25
Fruits and Tree Crops	R3	5.96	1683.59	27.73	433.46	0.00	2.25	2152.98
Pasture	R4	172.95	85.14	552.27	61.82	62.05	472.70	1406.93
Swamp Areas	S1	0.00	106.55	73.91	0.00	2.01	0.00	182.46
Urban Areas	U1	174.75	0.00	0.00	0.00	1.34	39.23	215.32
Water Body	W1	0.00	185.16	82.19	0.04	8.96	0.00	276.35
Others	O1	0.00	9.86	0.00	0.00	0.00	0.00	9.86
Sub Total		2687.05	6271.36	6155.54	5220.88	407.98	5704.07	26546.89
Unclassified		3.72	73.34	20.70	55.02	4.09	36.06	190.13
Total		2690.77	6344.70	6276.25	5275.90	412.07	5740.13	26739.82

Source: GIS Database prepared after consolidation of DLD Maps by Study Team (May 1996)

Table 4.3.16 Land Use Conversion Rules for Planned Landuse (Alternative 1)

Existing Land Use / Land Use Potential		Description and Code											
		Orchard	Pine Apple	Coconut	Oil Palm	Rubber	Mixed Upland Crops	Rice	Sugar Cane	Evergreen Forest	Disturbed Forest	Grassland and Pasture	Others
Description	Code	AF1	AF2	AG2	AG4	AG5	AG6	AI1	AI2	FO1,F02	FO3,F04	LI1	Others
Forest Conservation	F1	5	5	5	5	5	5	5	5	1	6	6	8
Irrigated Paddy	I1	5	2	5	5	5	3	2	2	1	5	2	8
Rainfed Paddy	R1	3	3	4	3	4	3	2	3	1	3	3	8
Upland Crops	I2,R2	3	3	5	3	5	3	2	3	1	5	3	8
Fruit Trees and Tree Crops	I3,R3	4	4	4	4	4	4	4	3	1	4	3	8
Pasture	I4, R4	6	7	6	6	6	7	7	7	1	6	7	8
Water body and Others	S1,U1, M1, W1, O1	8	8	8	8	8	8	8	8	6	6	8	8

Legend:
1 = Forest Conservation
2 = Irrigated Paddy
3 = Intensive Upland Crops
4 = Fruit Trees & Tree Crops
5 = Multi-storey Farming
6 = Forest Plantation
7 = Pasture
8 = Others

Table 4.3.17 Summary of Distribution of Planned Land Use (Alternative 1)

Area in Hectares

Planned Categories		Kancha-naburi	Samut Songkhram	Ratchaburi	Petchaburi	Prachaup KhriKhan	Chumphon	WSB Region
Description	Code							
Forest Conservation	1	57,072	958	184,890	347,282	204,257	136,552	931,011
Irrigated Paddy	2	40,348	1,879	55,966	20,742	8,707	20,865	148,507
Intensive Upland Crops	3	98,628	321	144,902	80,906	87,838	67,695	480,289
Fruit Trees & Tree Crops	4	590	22,682	41,051	25,464	174,722	137,750	402,259
Multi-storey Farming	5	23,379	551	73,106	62,065	52,062	123,958	335,121
Forest Plantation	6	19,642	442	6,498	18,608	58,588	35,038	138,816
Pasture	7	13,586	176	4,429	43,887	6,980	37,240	106,298
Others	8	15,832	14,198	16,748	28,672	41,316	14,914	131,681
Total		269,077	41,207	527,590	627,626	634,470	574,012	2,673,982

Source: GIS Analysis by Study Team (Aug 96)

Table 4.3.18 Estimated Value-added for Agricultural Products in WSB Region

Products	1989			1994e				
	GRP (1,000 baht) (at 1988 proce	Planted area (ha)	GRP Yield (baht/ha) (at 1989 prices)	GRP (1,000 baht) at 1988 proce	t 1994 price	Planted area (ha)	GRP Yield (baht/ha) (at 1989 prices)	GRP Yield (baht/ha) (at 1994 prices)
Paddy	2,096,546	302,615	6,928	2,000,234	1,848,407	273,975	7,301	6,747
Upland food crops	3,888,703	385,175	10,096	2,878,444	4,109,553	324,396	8,873	12,668
Maize	309,151	83,888	3,685	232,246	294,433	69,109	3,361	4,260
Mungbean	18,674	4,315	4,328	5,263	2,625	2,029	2,593	1,293
Cassava	517,684	77,653	6,667	392,997	557,034	64,203	6,121	8,676
Sugar cane	3,041,309	217,285	13,997	2,245,595	3,254,401	187,032	12,006	17,400
Sorghum	1,885	2,035	926	2,343	1,060	2,023	1,158	524
Oil seeds	1,595,643	191,926	8,314	1,258,608	1,167,011	197,044	6,387	5,923
Castor beans	41,799	5,864	7,129	28,258	22,797	1,326	21,315	17,195
Groundnuts	38,347	2,812	13,638	24,725	23,765	2,908	8,501	8,171
Soybeans	26,352	3,227	8,166	18,944	16,648	982	19,287	16,949
Sesame seeds	7,998	1,737	4,605	8,036	8,774	2,054	3,913	4,272
Coconuts	1,074,853	159,096	6,756	968,538	885,247	150,793	6,423	5,871
Oil palm	406,294	19,192	21,170	210,107	209,780	38,980	5,390	5,382
Fibers	115,257	12,546	9,186	95,156	114,415	10,673	8,915	10,720
Cotton	79,050	8,132	9,721	68,766	65,657	6,101	11,271	10,762
Kapok	36,207	4,414	8,202	26,390	48,758	4,539	5,814	10,742
Kenaf	0	0	0	0	0	34	-	-
Jute	0	0	0	0	0	0	0	0
Other crops	1,412,119	39,784	35,495	1,551,452	1,536,509	47,982	32,334	32,023
Chili	44,878	9,076	4,945	52,674	60,192	12,119	4,347	4,967
Pepper	267,569	306	875,095	258,085	306,655	251	1,026,754	1,219,983
Shallot	5,193	378	13,729	5,459	19,470	373	14,643	52,226
Garlic	2,467	0	-	1,166	943	0	-	-
Tobacco	40,285	0	-	0	0	80	-	-
Coffee	1,051,727	29,274	35,927	1,234,068	1,149,249	33,530	36,805	34,275
Cocoa	0	750	-	0	0	1,629	-	-
Tea	0	0	0	0	0	0	0	0
Vegetables	1,281,405	17,230	74,371	1,733,267	2,764,328	36,966	46,889	74,781
Fruits	1,542,020	122,866	12,550	2,117,037	3,121,213	183,204	11,556	17,037
Pineapples	-	49,918	-	-	-	70,347	-	-
Watermelon	-	896	-	-	-	2,205	-	-
Other fruits	-	72,052	-	-	-	110,652	-	-
Rubber	254,673	37,480	6,795	268,475	269,242	66,002	4,068	4,079
Flowers	-	-	-	-	-	-	-	-
Orchid	-	-	-	-	-	-	-	-
Other flowers	-	-	-	-	-	-	-	-
Others	186,852	-	-	167,358	248,166	-	-	-

Source: Agricultural Statistics of Thailand Crop Year 1994/95, Ministruy of Agriculture and Cooperatives
National Statistics Office, NESDB

Note: 1.197 was adopted as deflator for the estimate of 1994 prices.

Table 4.3.19 Estimated Value-added for Agricultural Products in Thailand

Products	1989			1994e				
	GDP (mil. baht) (at 1988 prices)	Planted area (1,000ha)	GDP Yield (baht/ha) (at 1988 prices)	GDP (mil. baht) (at 1988 prices)	(at 1994 prices)	Planted area (1,000ha)	GDP Yield (baht/ha) (at 1988 prices)	GDP Yield (baht/ha) (at 1994 prices)
Paddy	69,775	10,348	6,743	61,124	73,165	9,480	6,448	7,718
Upland food crops								
Maize	8,543	1,835	4,655	7,753	9,280	1,339	5,789	6,930
Mungbean	1,765	474	3,722	1,123	1,344	344	3,269	3,913
Cassava	10,269	1,622	6,332	8,241	9,864	1,411	5,842	6,993
Sugar cane	9,740	661	14,729	10,176	12,181	857	11,877	14,216
Sorghum	280	180	1,554	274	328	176	1,561	1,869
Oil seeds								
Castor beans	181	61	2,969	112	134	48	2,310	2,765
Groundnuts	985	123	7,985	762	912	96	7,898	9,454
Soybeans	4,504	401	11,224	3,213	3,846	416	7,724	9,245
Sesame seeds	187	50	3,722	202	242	60	3,349	4,009
Coconuts	3,006	397	7,573	3,039	3,638	388	7,842	9,387
Oil palm	2,721	129	21,152	4,494	5,379	149	30,234	36,190
Fibers								
Cotton	785	71	11,100	675	808	52	12,862	15,396
Kapok	225	48	4,703	239	286	53	4,527	5,418
Kenaf	521	130	4,020	386	462	92	4,188	5,013
Jute	54	8	7,145	56	67	9	6,558	7,850
Other crops								
Chili	574	22	26,379	1,086	1,300	20	54,738	65,521
Pepper	3,038	5	643,797	2,637	3,156	3	822,952	985,073
Shallot	432	13	33,471	562	673	14	40,359	48,310
Garlic	1,111	37	29,750	1,165	1,395	25	47,158	56,449
Tobacco (Virginia	421	22	19,109	430	515	14	30,785	36,849
Coffee	1,839	79	23,173	2,066	2,473	78	26,624	31,869
Cocoa	19	2	8,252	52	62	3	15,864	18,989
Tea	25	-	-	28	34	6	4,374	5,236
Vegetables	9,720	109	88,839	13,221	15,826	304	43,425	51,979
Fruits	14,847	1,047	14,175	20,136	24,103	1,054	19,110	22,875
Pineapples	1,562	78	20,087	1,265	1,514	99	12,731	15,240
Watermelon	657	-	-	989	1,184	-	-	-
Other fruits	12,628	-	-	17,882	21,405	-	-	-
Rubber	26,174	1,732	15,116	38,021	45,511	1,921	19,791	23,690
Flowers	664	-	-	722	864	-	-	-
Orchid	425	-	-	462	553	-	-	-
Other flowers	239	-	-	260	311	-	-	-
Others	1,966	-	-	955	1,143	-	-	-

Source: Agricultural Statistics of Thailand Crop Year 1994/95, Ministruy of Agriculture and Cooperatives
National Statistics Office, NESDB

Note: 1.197 was adopted as deflator for the estimate of 1994 prices.

Table 4.3.20 Unit Value-Added by Agricultural Land Use for Estimate and Projection of Crop Value-Added

		Unit VA (Baht/ha)	Explanation
Paddy			
Present	Single crop	6,500	Average per planted area in the WSB
	Double crop	13,500	Source (1) (HYV)
	Gross average	8,500	30% of area under double cropping
Improved	Single crop	8,000	Slightly higher than present national average
	Double crop	13,500	Source (1) (HYV)
	Gross average	11,500	60% double cropping
		12,500	80% double cropping
Maize			
Present		4,500	Average in the WSB
Improved		7,000	Present national average
Sugarcane			
Present		17,500	Average in the WSB
Improved		20,000	Source (1)
Other upland crops			
Present		8,500	Average for cassava in the WSB
Improved	Vegetables	51,000	Source (1)
	Others	9,000	Source (1)
	Gross average	13,000	10% vegetables
Pineapple			
Present		20,000	Source (2)
Improved		25,500	Source (1)
Coconut			
Present		11,500	Source (2)
Improved		14,000	Source (1)
Other fruits and tree crops			
Present		17,000	Average for fruits in the WSB
Improved		25,000 nationally	Highest value at present
Multi-story farming	13,000		
	Upland crops	45,000	
	Tree crops	20,000	
	Tree crops + vegetables	24,000	30% upland crops: no reduction in tree crop area

Source: (1) Western Region Planning Study, Final Report, June 1981
(2) Agricultural Statistics by Province

Table 4.3.21 Projection of Agricultural GRP in the WSB Region Proposed Land Use in 2011 Corresponding to (Alternative 1)

Subsector/crop	GRP in 1994	2011 Area (1000 ha)	2011 Unit VA (Baht/ha)	2011 VA	Explanation
Crop					
Paddy	1,776	148.5	11,500	1,708	20% reduction in area 60% double cropping
Upland crops					
Maize	463	132.5	7,000	928	20% increase in area
Sugarcane	3,707	175	20,000	3,500	30% reduction in area
Others	618	172.8	13,000	2,246	
Subtotal	4,788	480.3		6,674	
Fruits and tree crops					
Pineapple	1,081	56	25,500	1,428	10% increase in area
Coconut	1,853	144	14,000	2,000	No change in area
Others	5,946	203	25,000	5,070	
Subtotal	8,880	402.3		8,507	
Multi-story farming					
Tree crops+upland crops		335.1	24,00	8,042	
Crop Total	15,444	24,931			Average growth at 2.86% p.a.
Livestock	2,778			5,411	4.0% p.a. growth
Fisheries	4,871			6,274	1.5% "
Forestry	1,063			1,259	1.0% "
Agricultural services	487			577	1.0% "
Simple agro-process	2,569			5,888	5.0% "
Agricultural GRP	27,212			44,340	2.91% p.a. growth

VA: Value Added

Table 4.3.22 Land Use Conversion Rules for Planned Landuse (Alternative 2)

Existing Land Use / Land Use Potential		Description and Code											
Description	Code	Orchard AF1	Pine Apple AF2	Coconut AG2	Oil Palm AG4	Rubber AG5	Mixed Upland Crops AG6	Rice AI1	Sugar Cane AI2	Evergreen Forest FO1,F02	Disturbed Forest FO3,F04	Grassland and Pasture LI1	Others Others
Forest Conservation	F1	5	5	5	5	5	5	5	5	1	6	6	8
Irrigated Paddy	I1	5	2	5	5	5	3	2	2	1	5	3	8
Rainfed Paddy	R1	4	3	4	4	4	3	3	3	1	5	3	8
Upland Crops	I2,R2	5	3	5	5	5	3	3	3	1	5	3	8
Fruit Trees and Tree Crops	I3,R3	4	4	4	4	4	4	4	4	1	4	4	8
Pasture	I4, R4	6	7	6	6	6	7	7	7	1	6	7	8
Water body and Others	S1,U1, M1, W1, O1	8	8	8	8	8	8	8	8	6	6	8	8

Legend:

1 = Forest Conservation
2 = Irrigated Paddy
3 = Intensive Upland Crops
4 = Fruit Trees & Tree Crops
5 = Multi-storey Farming
6 = Forest Plantation
7 = Pasture
8 = Others

Table 4.3.23 Summary of Distribution of Planned Land Use (Alternative 2)

Area in Hectares

Planned Categories		Kancha-naburi	Samut Songkhram	Ratchaburi	Petchaburi	Prachaup KiriKhan	Chumpon	WSB Region
Description	Code							
Forest Conservation	1	57,072	958	184,890	347,282	204,257	136,552	931,011
Irrigated Paddy	2	18,404	1,879	48,998	16,177	1,342	13,269	100,070
Intensive Upland Crops	3	105,900	299	142,192	85,251	84,591	65,849	484,081
Fruit Trees & Tree Crops	4	621	22,682	41,319	25,470	177,053	142,907	410,051
Multi-storey Farming	5	38,020	573	82,515	62,279	60,344	128,243	371,974
Forest Plantation	6	19,642	442	6,498	18,608	58,588	35,038	138,816
Pasture	7	13,586	176	4,429	43,887	6,980	37,240	106,298
Others	8	15,832	14,198	16,749	28,672	41,315	14,914	131,680
Total		269,077	41,207	527,590	627,626	634,470	574,012	2,673,982

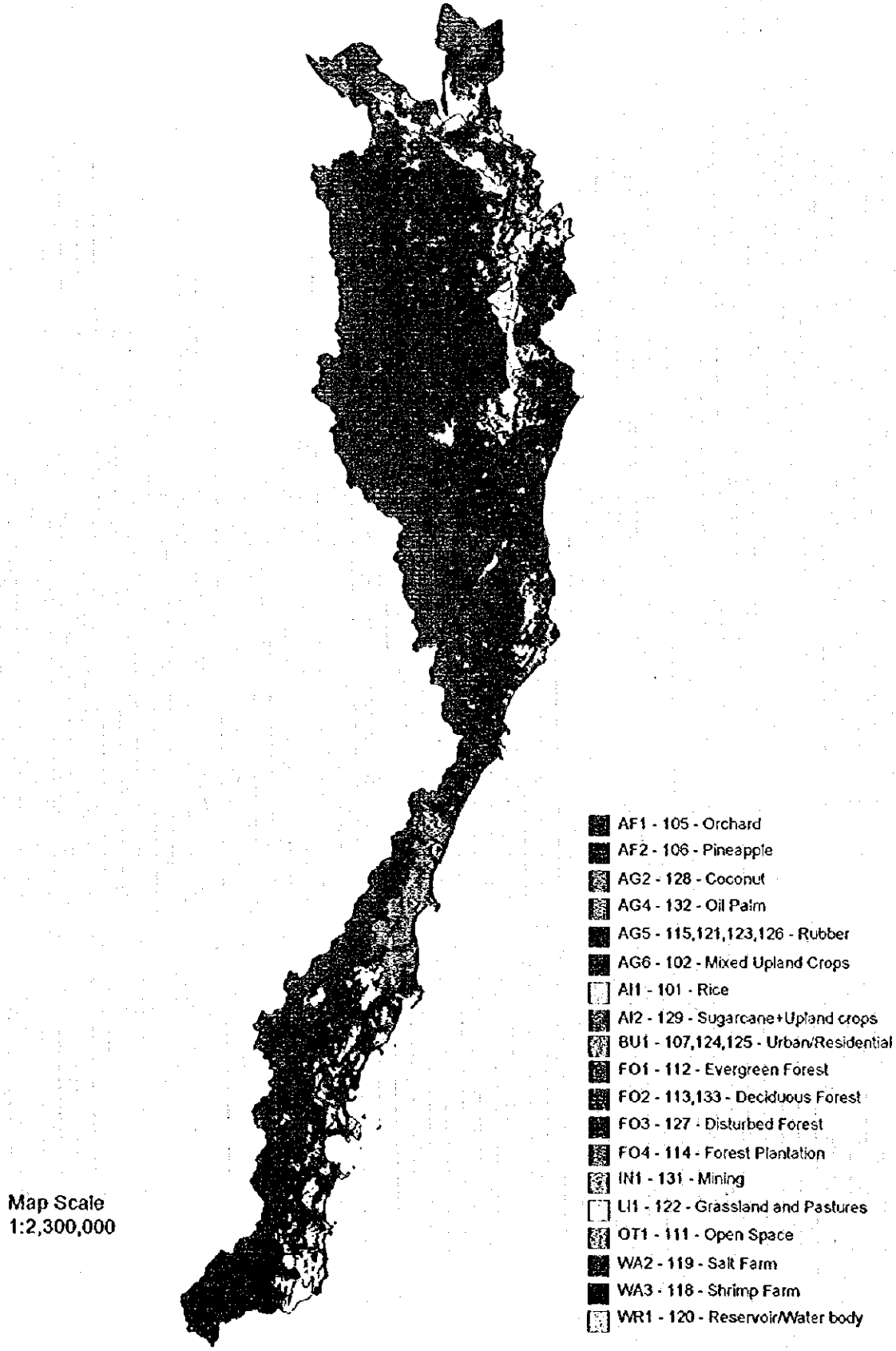
Source: GIS Analysis by Study Team (Aug 1996)

Table 4.3.24 Projection of Agricultural GRP in The WSB Region Corresponding to Proposed Land Use in 2011 (Alternative 2)

Subsector/crop	GRP in 1994	2011 Area (1,000ha)	2011 Unit VA (Baht/ha)	2011 VA	Explanation
Crop					
Paddy		100.1	12,500	1,251	80% double cropping
Upland crops					
Maize		132.5	7,000	928	20% increase in area
Sugarcane		175.0	20,000	3,500	30% reduction in area
Others		176.6	13,000	2,296	
Subtotal		484.1		6,724	
Fruits and tree crops					
Pineapple		56.0	25,500	1,428	10% increase in area
Coconut		143.5	14,000	2,009	No change in area
Others		210.6	25,000	5,265	
Subtotal		410.1		8,702	
Multi-story farming					
Tree crops+upland crops		372.0	24,000	8,928	
Crop Total	15,444			25,605	Average growth at 3.02% p.a.
Livestock	2,778		5,411		4.0% p.a. growth
Fisheries	4,871		6,274		1.5% "
Forestry	1,063		1,259		1.0% "
Agricultural services	487		577		1.0% "
Simple agro-process	2,569		5,888		5.0% "
Agricultural GRP	27,212		45,014		3.00% p.a. growth

Source: JICA Study Team

Figure 4.2.1 **Current Landuse for the Study Area Derived from Landsat TM Data 1995**



Map Scale
1:2,300,000

Figure 4.3.1 Regional Structure Proposed by DTCP

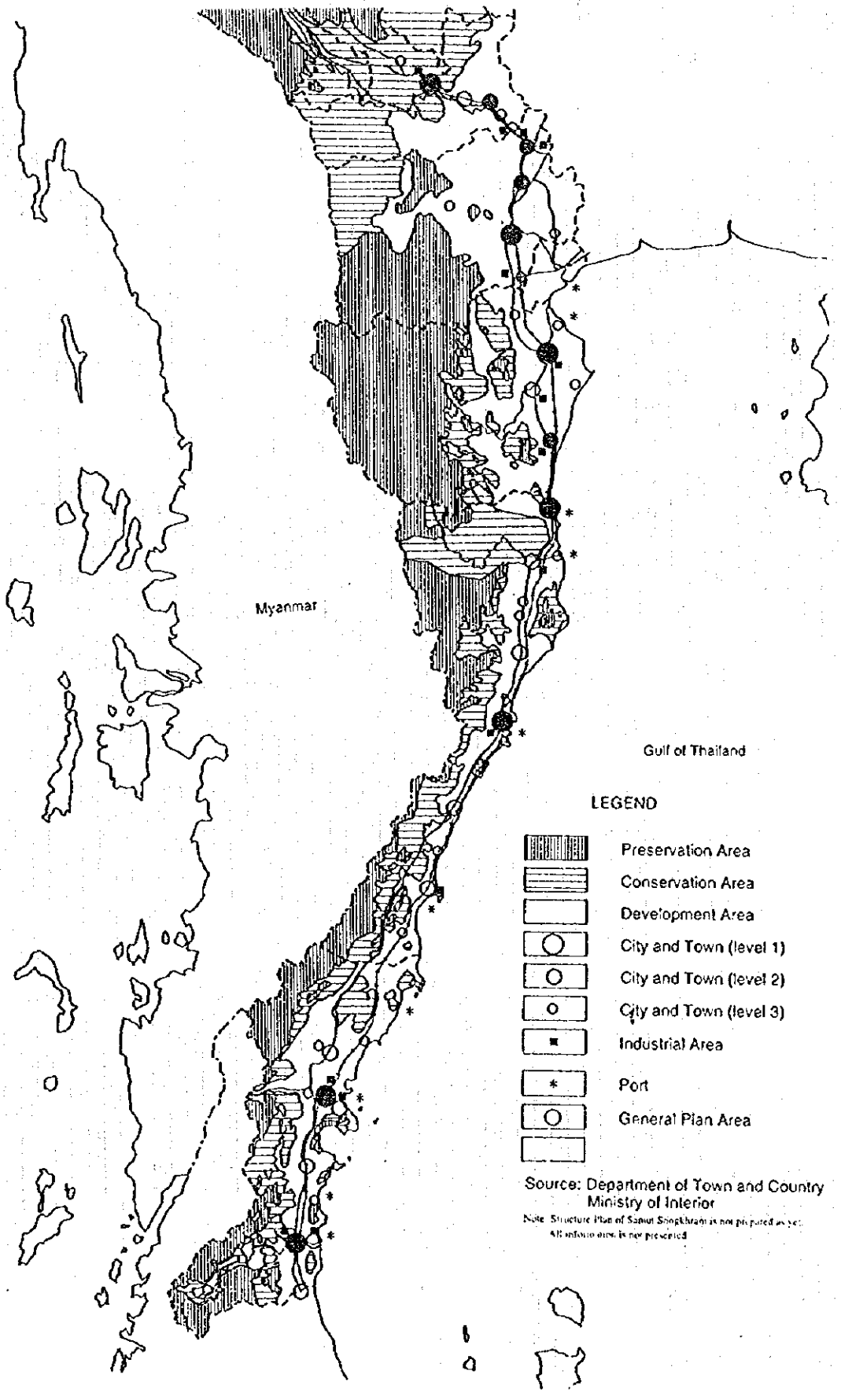


Figure 4.3.2 Staged Evaluation Procedure

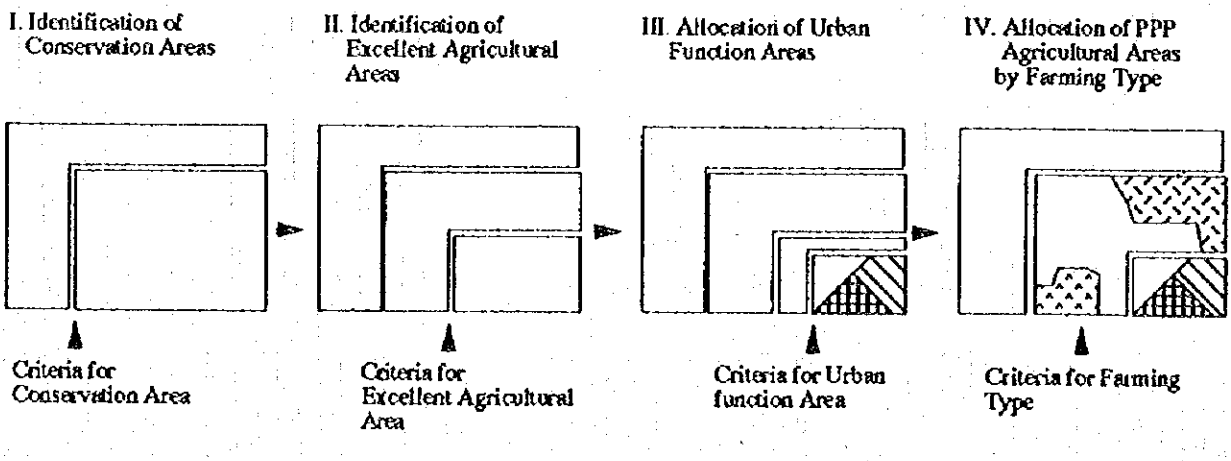


Figure 4.3.3 **Forecast Method for Agricultural Land Demand by Marming Type**

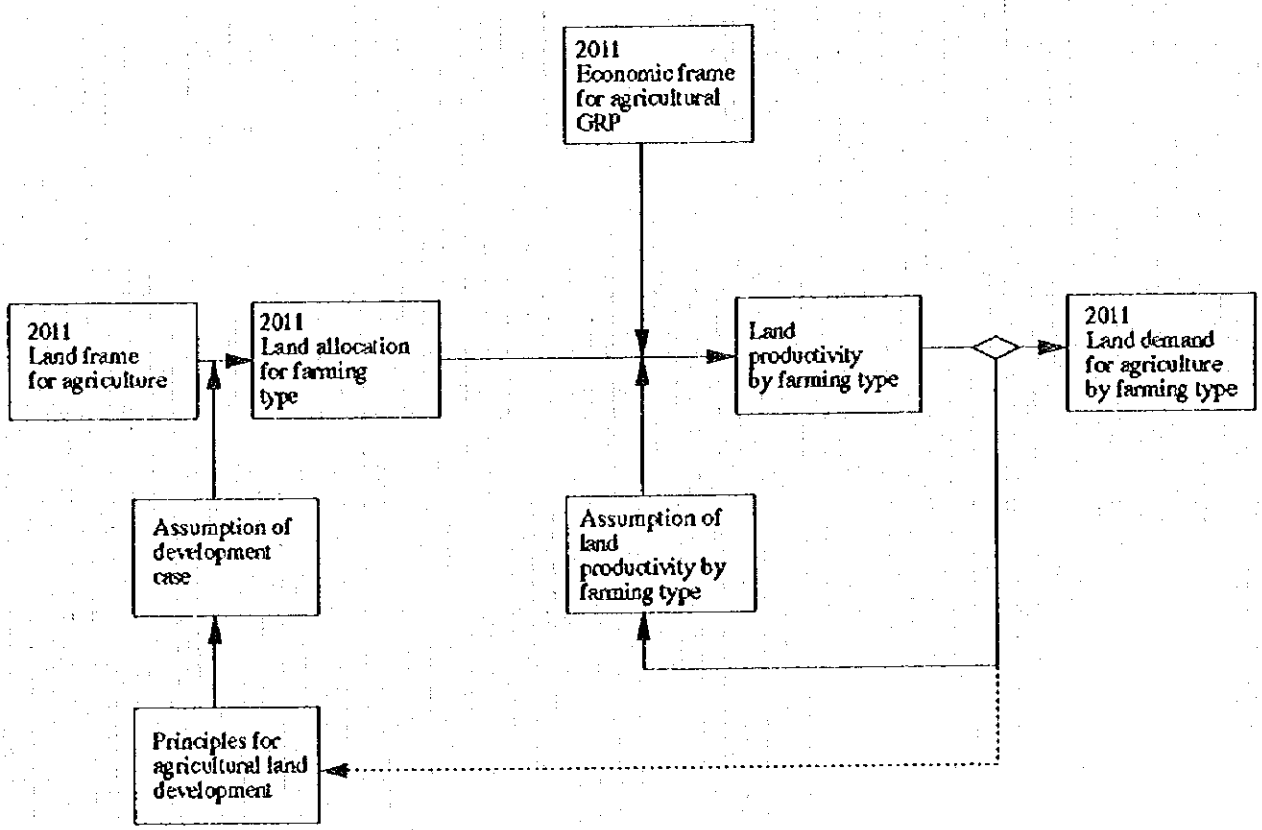


Figure 4.3.4 **Relation between Required Average Paddy Yield and Yield of Upland Crops for 2011 Agricultural GRP**

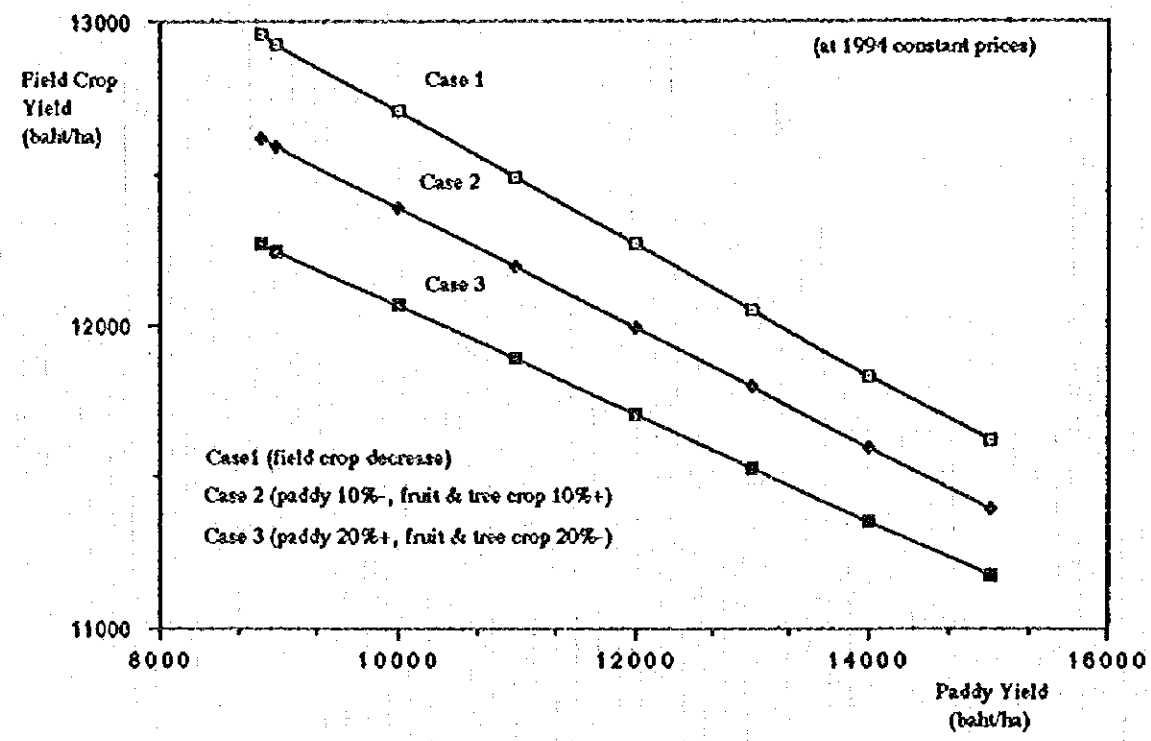


Figure 4.3.5 Forecast Method for Industrial Land Demand

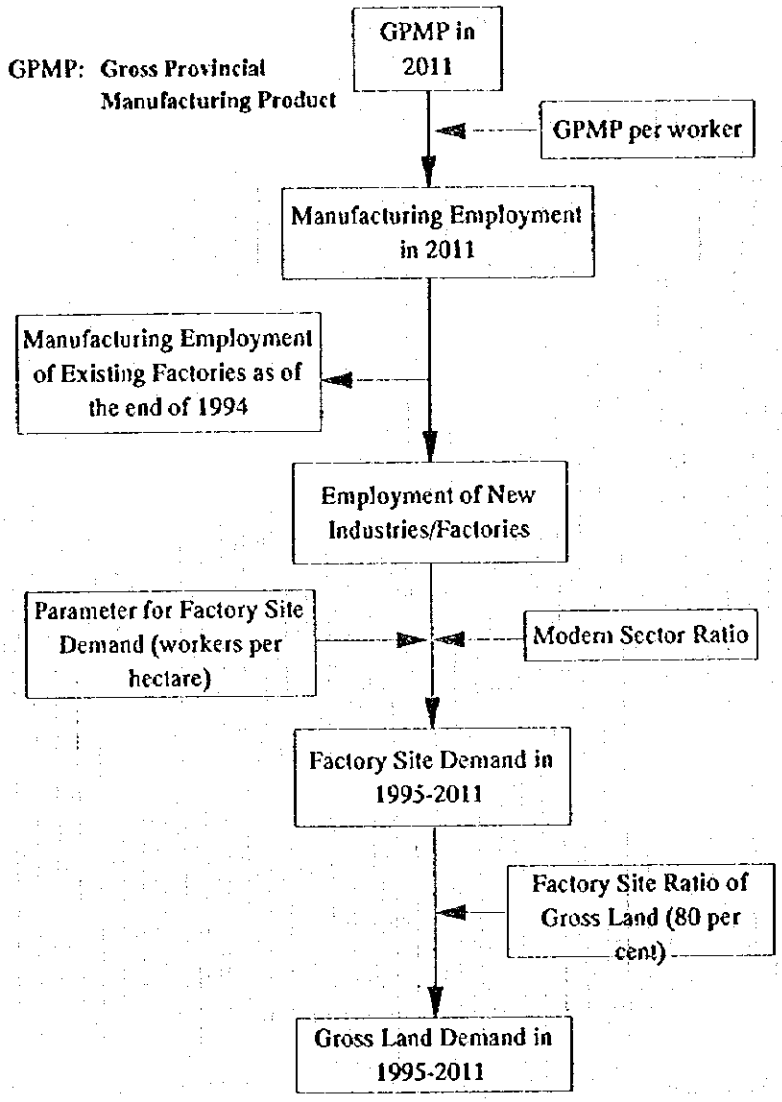


Figure 4.3.6 Estimation Method for Additional Urban Land Use Demand in the WSB Region

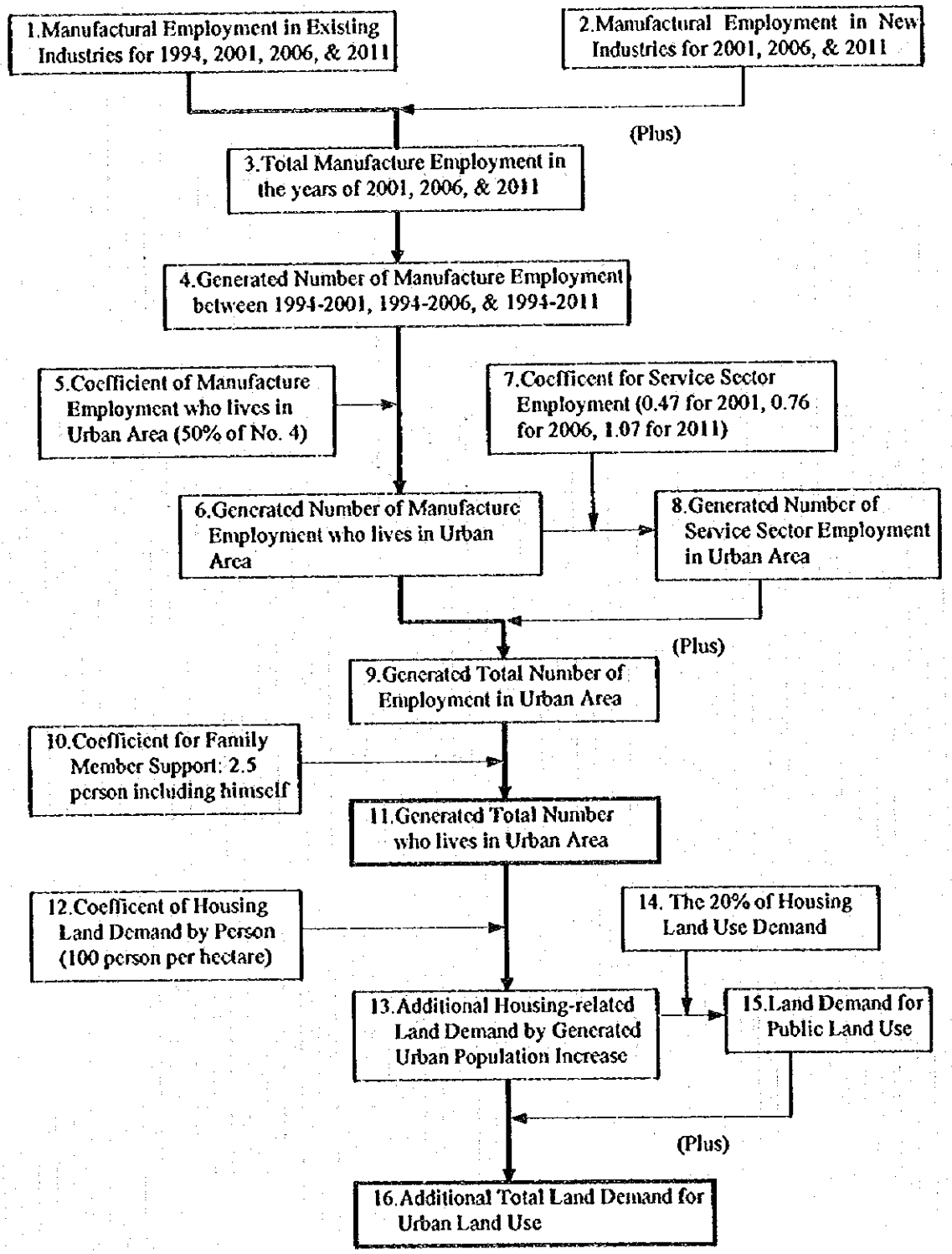


Figure 4.3.7 **Forests in the WSB Region**

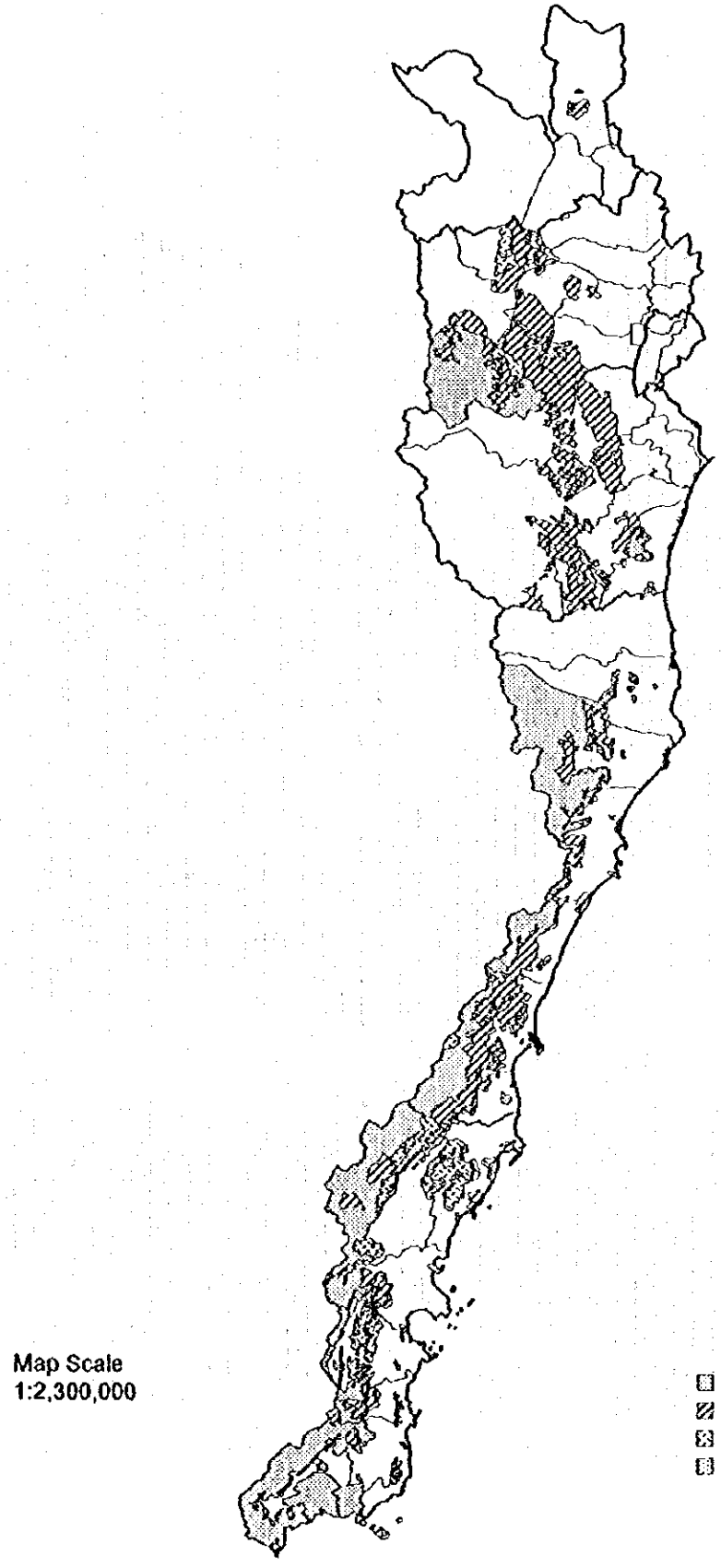


Figure 4.3.8 Irrigated Areas in the WSB

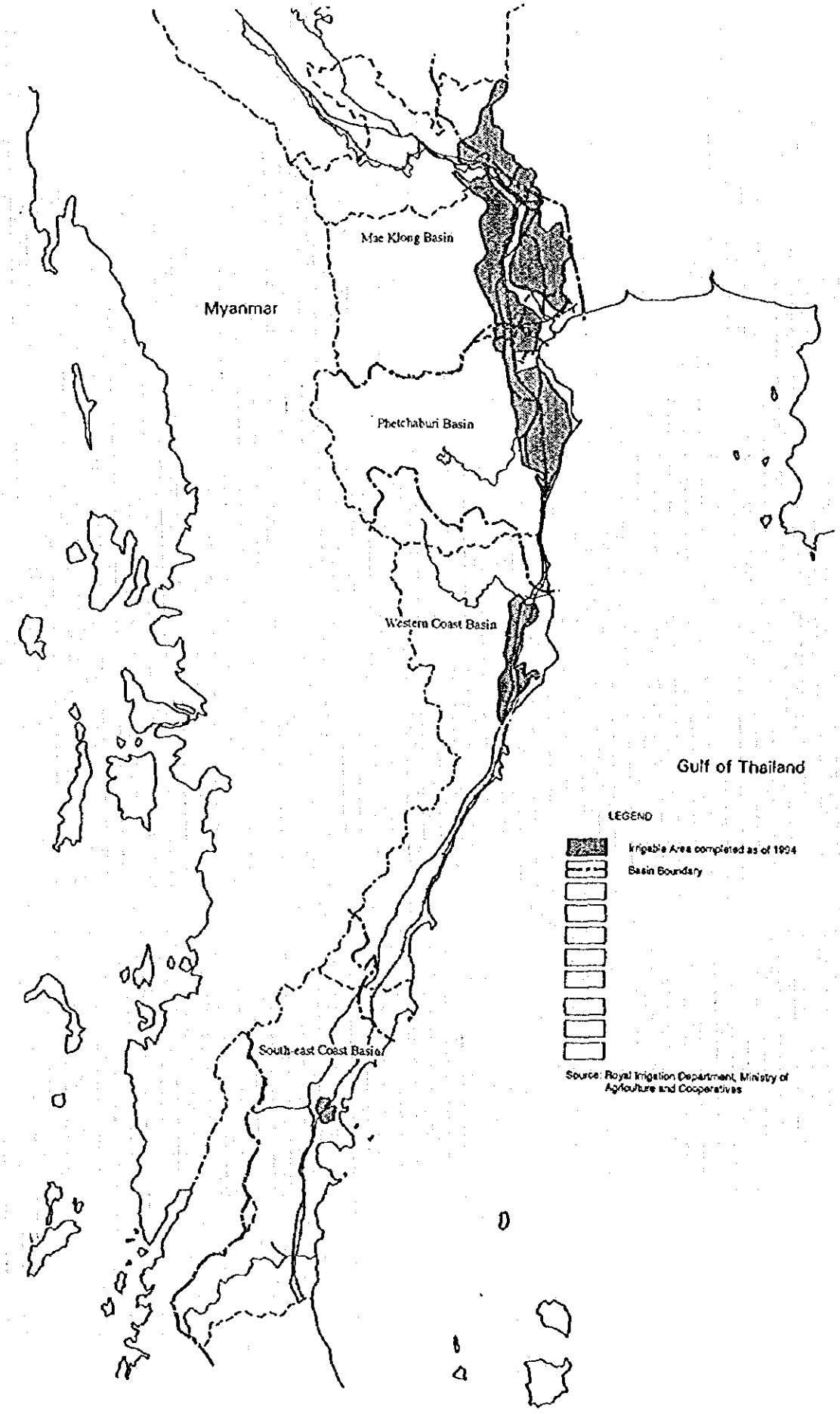


Figure 4.3.9 Land Consolidation Area in the WSB

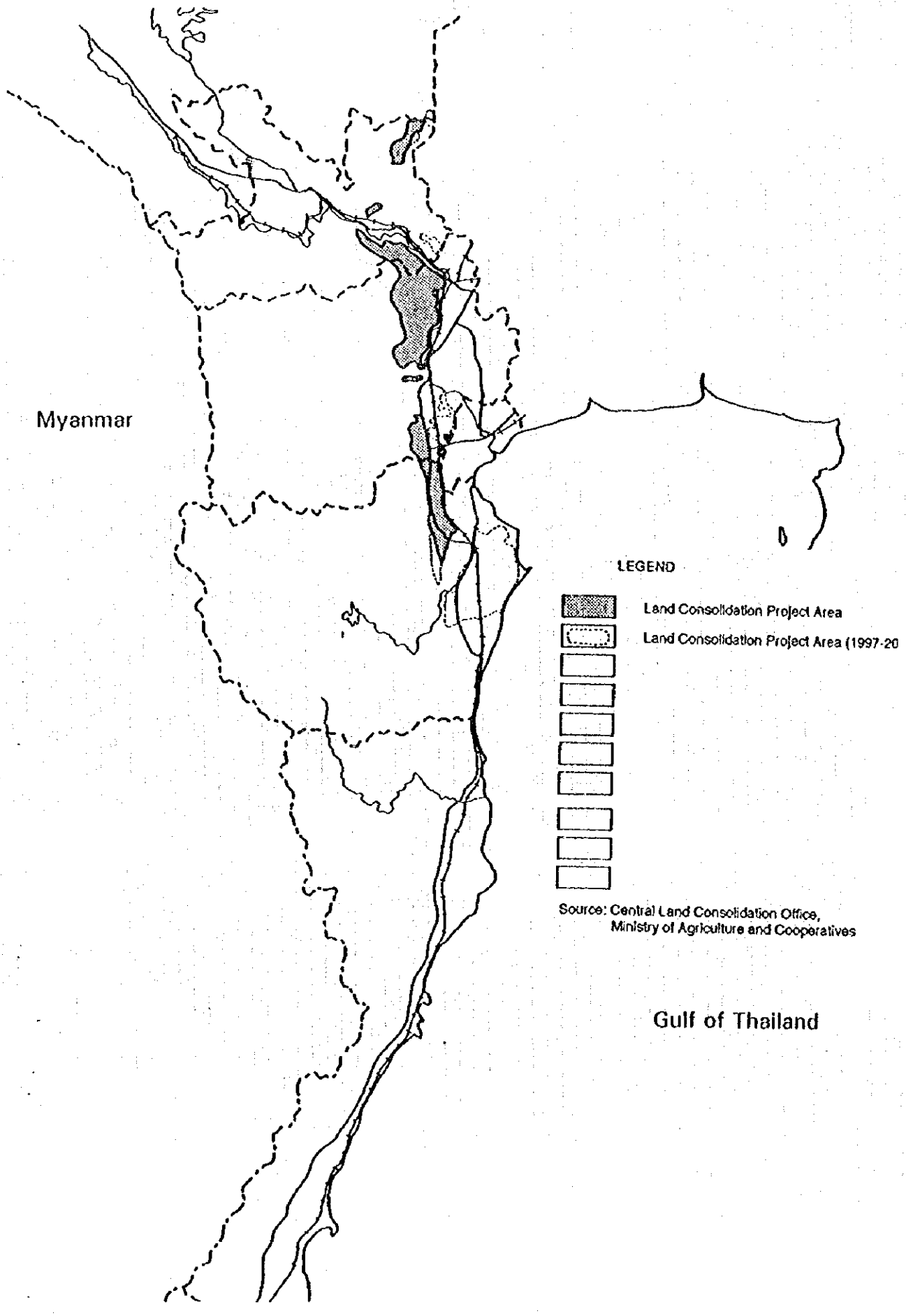


Figure 4.3.10 **Land Reform Area in Ratchaburi**

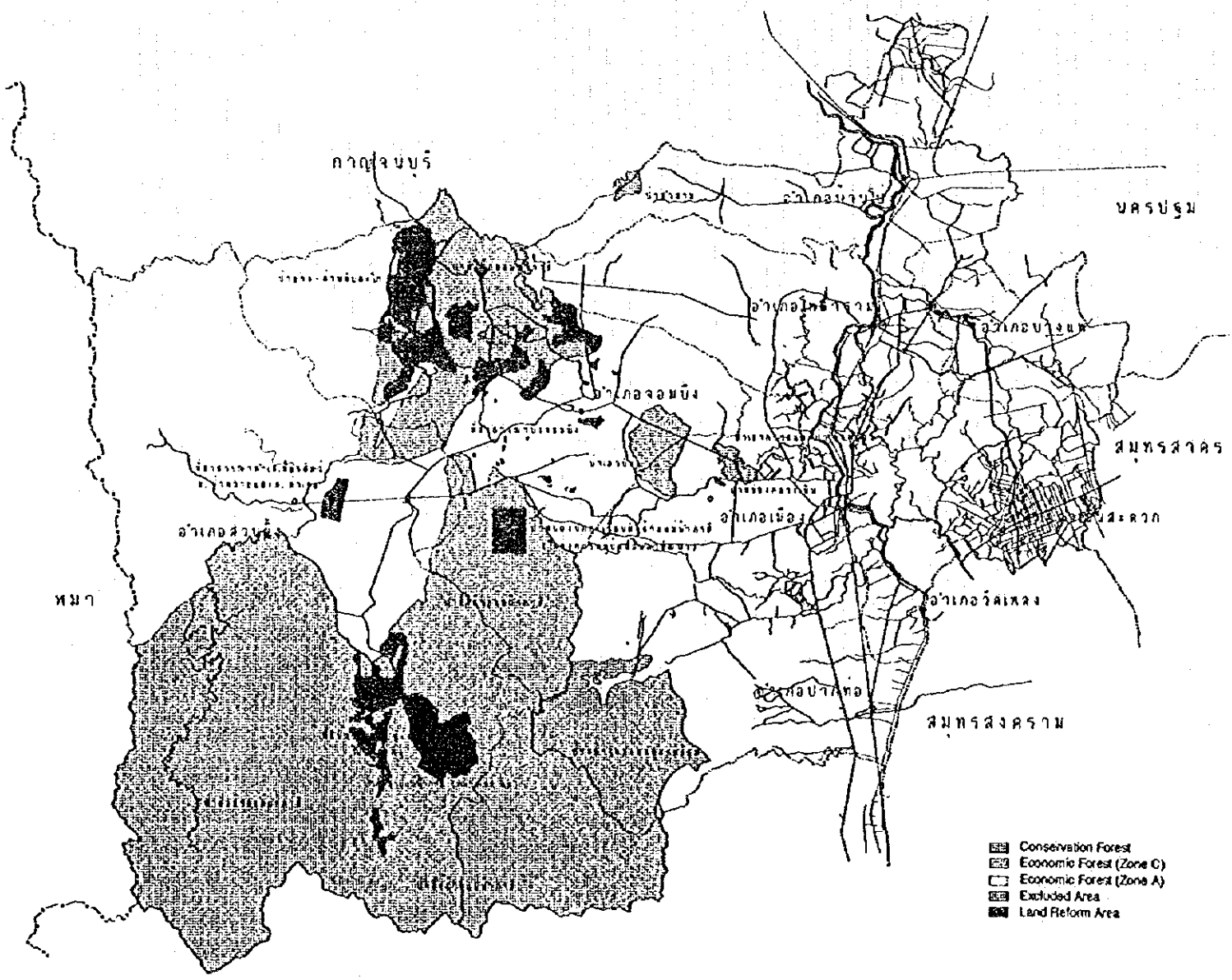


Figure 4.3.11 **Landuse Potential for the Study Area**

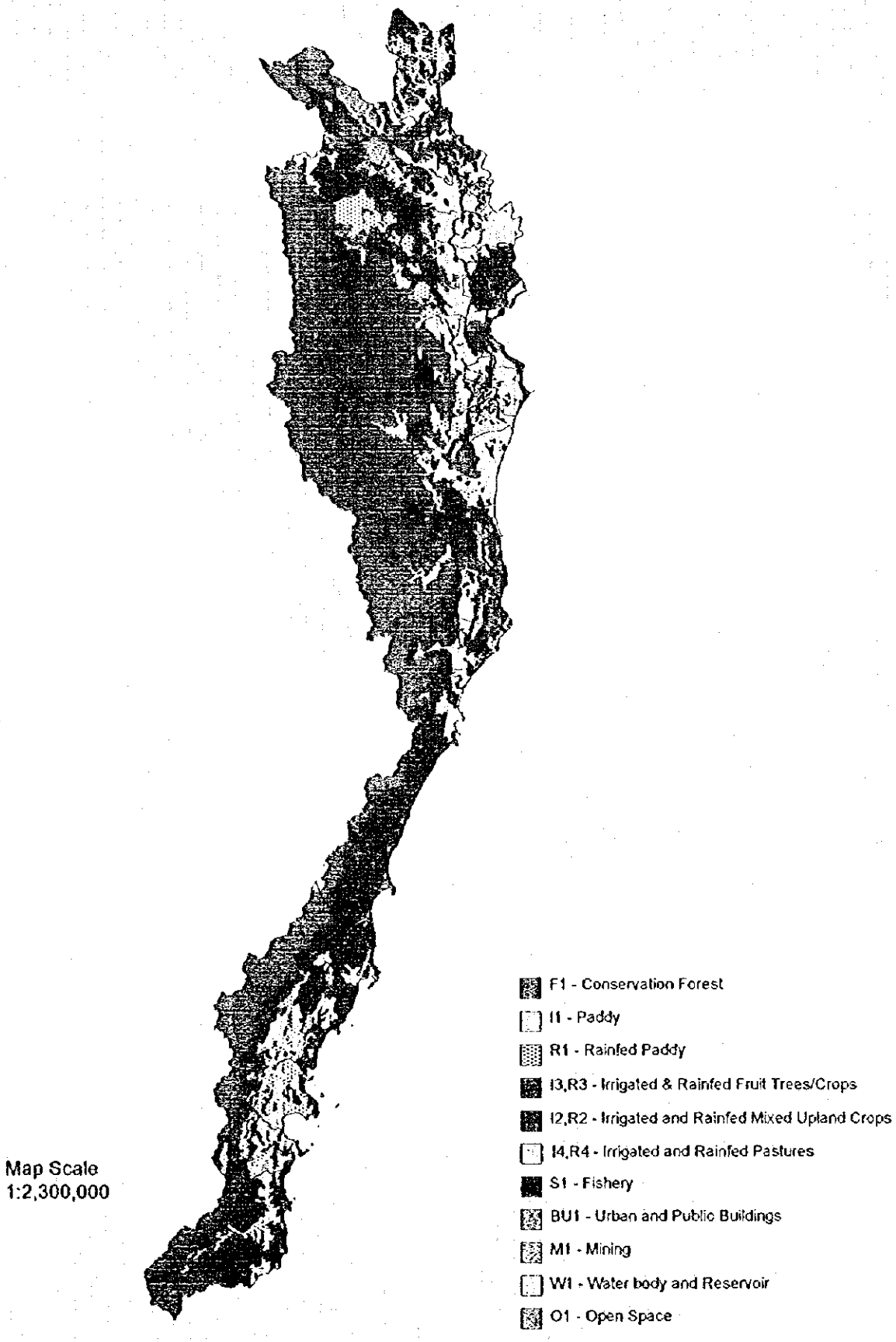


Figure 4.3.12 **Planned Landuse for the Study Area**

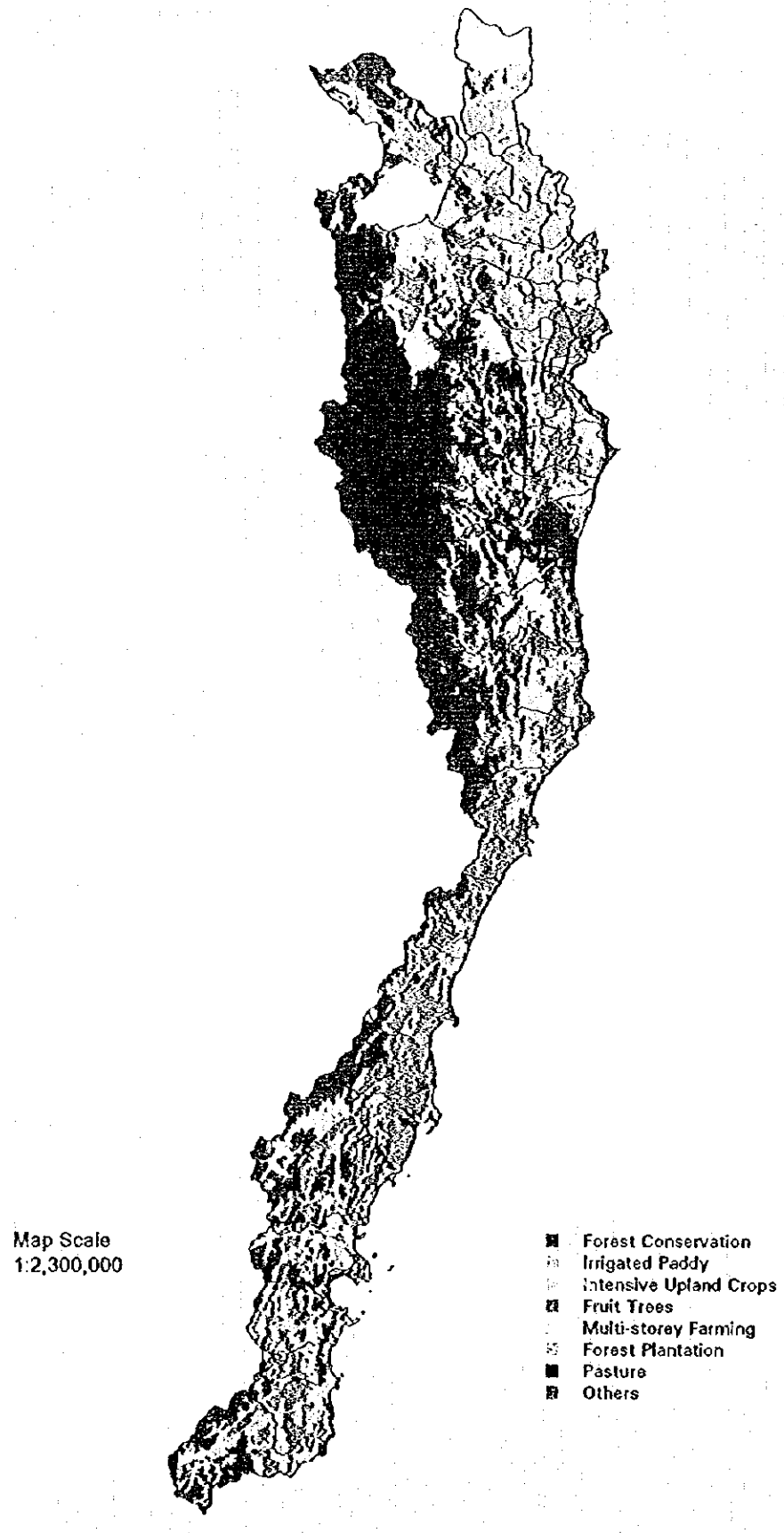
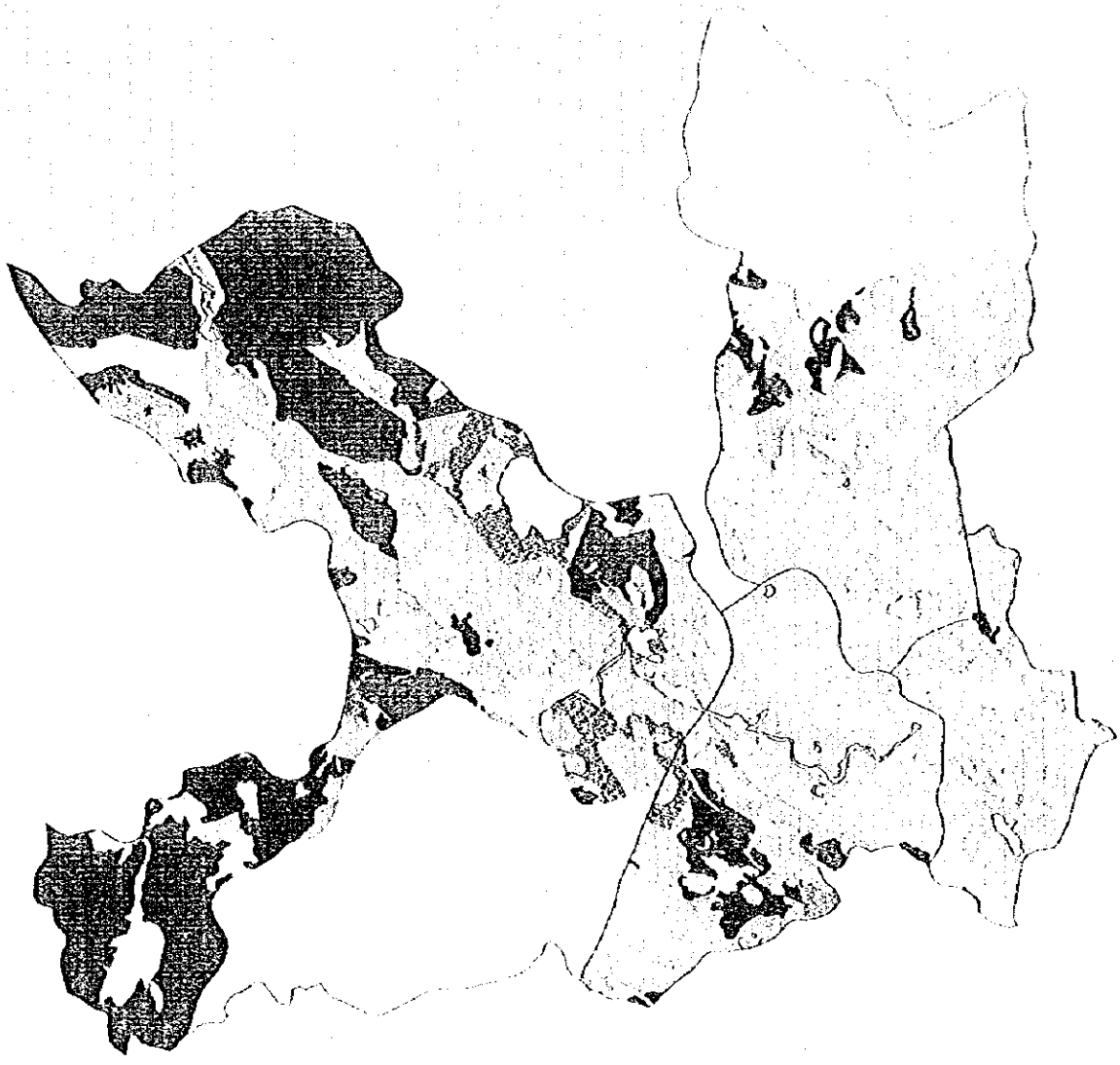


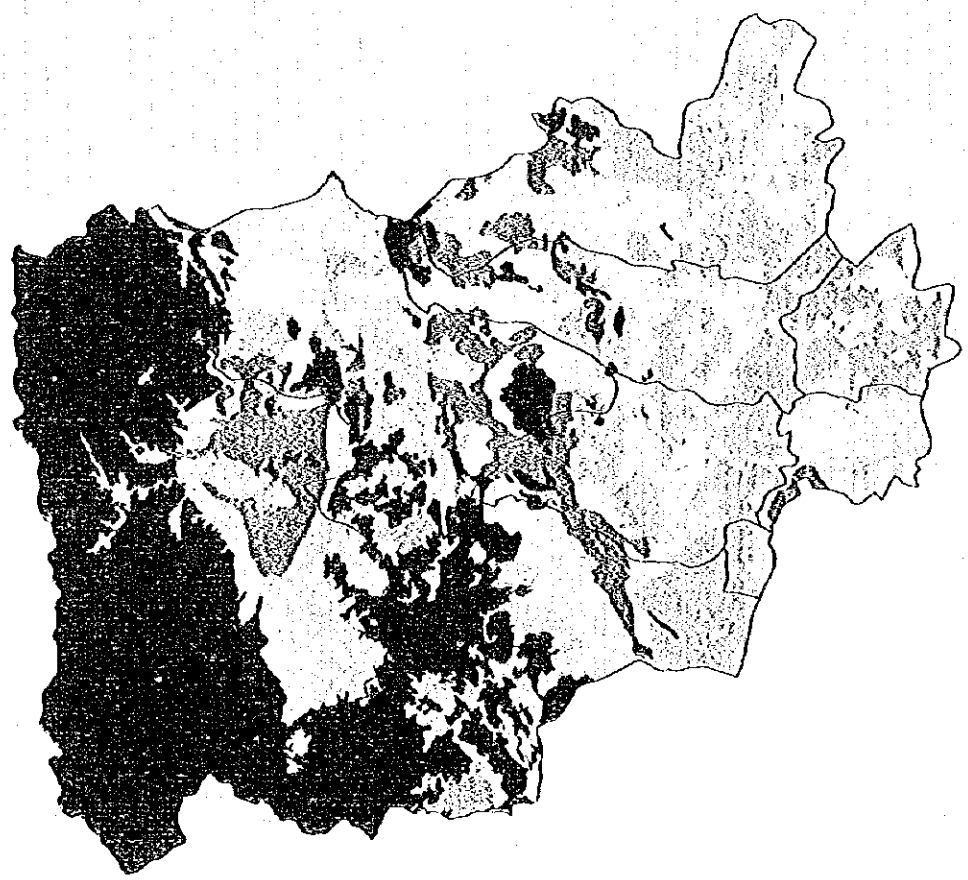
Figure 4.3.13 **Planned Landuse for Kanchanaburi (Alternative 1)**



Map Scale
1:550,000

- Forest Conservation
- Irrigated Paddy
- Intensive Upland Crops
- Fruit Trees & Tree Crops
- Multi-storey Farming
- Forest Plantation
- Pasture
- Others

Figure 4.3.14 **Planned Landuse for Ratchaburi (Alternative 1)**



Map Scale
1:750,000

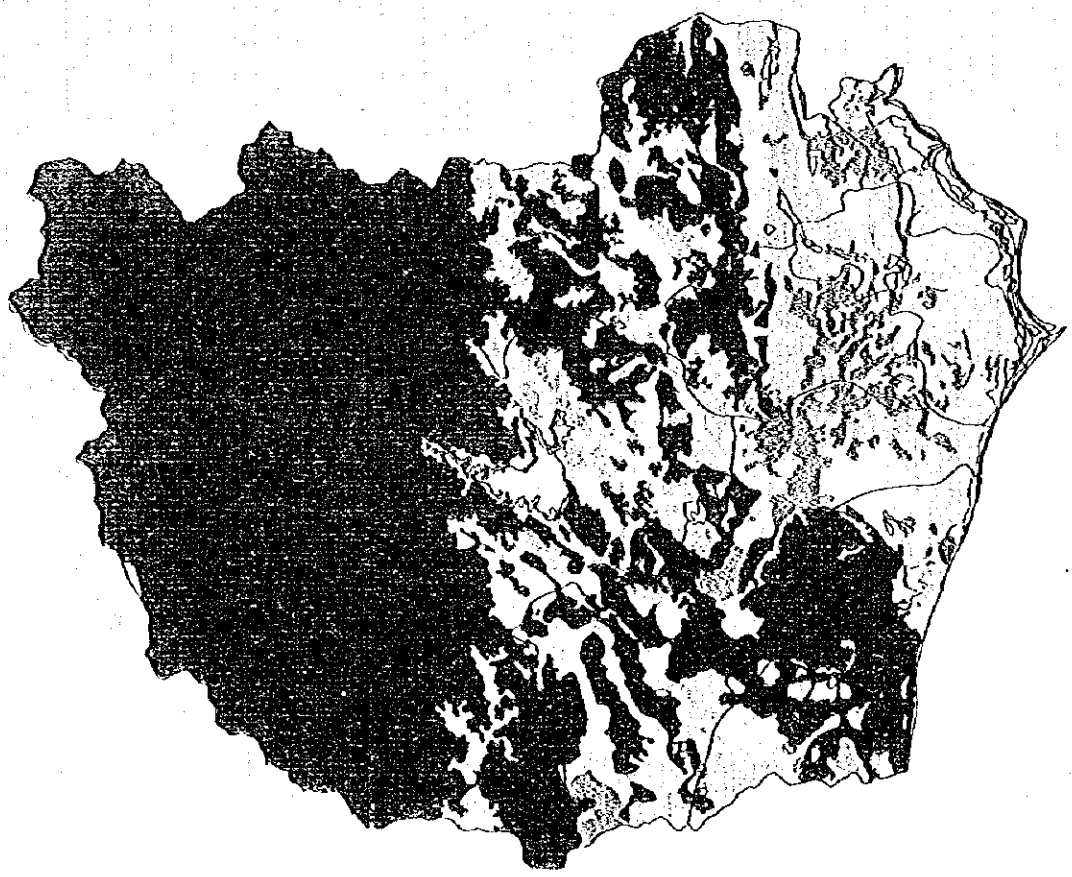
- Forest Conservation
- Irrigated Paddy
- Intensive Upland Crops
- Fruit Trees
- Multi-storey Farming
- Forest Plantation
- Pasture
- Others

Figure 4.3.15 **Planned Landuse for Samut Songkhram (Alternative 1)**

Map Scale
1:250,000

- Forest Conservation
- Irrigated Paddy
- Intensive Upland Crops
- Fruit Trees
- Multi-storey Farming
- Forest Plantation
- Pasture
- Others

Figure 4.3.16 **Planned Landuse for Petchaburi (Alternative 1)**



Map Scale
1:750,000

- Forest Conservation
- Irrigated Paddy
- Intensive Upland Crops
- Fruit Trees
- Multi-storey Farming
- Forest Plantation
- Pasture
- Others

Figure 4.3.17 **Planned Landuse for Prachuap Khirikhan (Alternative 1)**

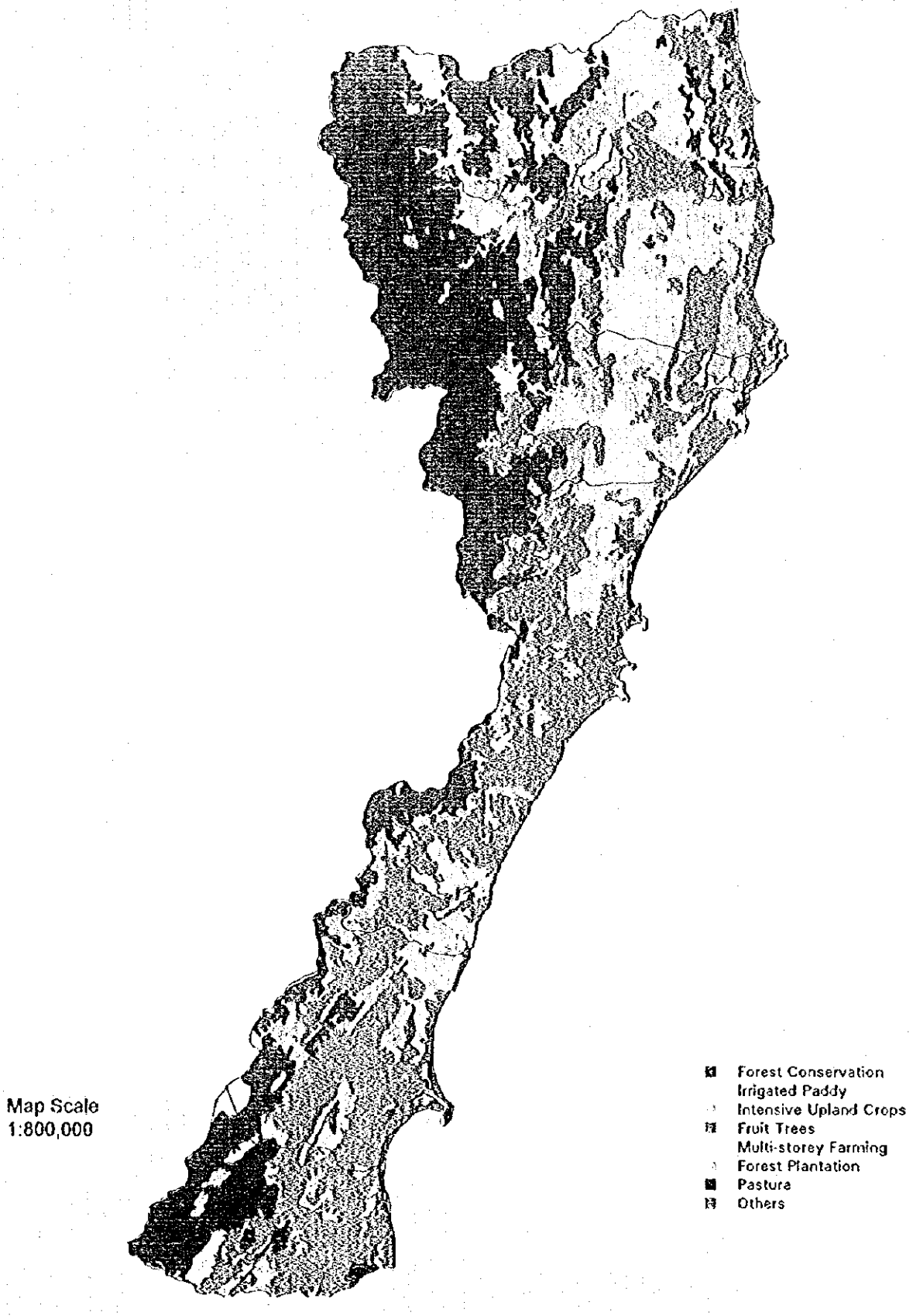


Figure 4.3.18 **Planned Landuse for Chumpon (Alternative 1)**