

occupy perhaps 25 % of the Indonesia and still largely under forest.

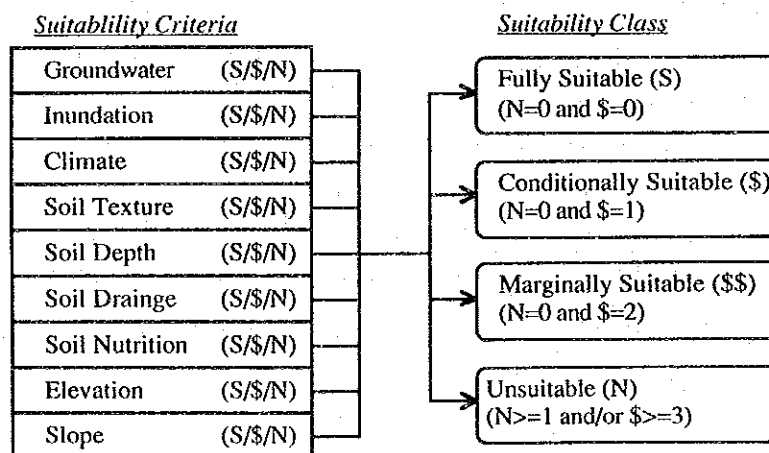
The majority of soils have developed on rolling plains and dissected hills on a mixture of sedimentary and old igneous rocks. These soil range from strongly weathered and acid Ultisols to young Inceptisols. For sustained use they require conservation of topsoil organic matter with the aid of erosion control, balanced fertilizer and good management.

### 3. Land Suitability

#### 3.1 Land Suitability Analysis

Land suitability for wetland agriculture development (paddy cultivation) is assessed on the basis of nine suitability criteria out of eleven criteria of the RePPPProT study. The nine suitability factors define the land suitability class of each land system. Each factor is classified into three suitability classes by certain criteria; suitable, conditionally suitable and unsuitable for its difficulty of development. The concept of the land suitability analysis in the FIDP study is illustrated in the following figure, and the criteria and evaluation process are explained in this section.

General Concept of Land Suitability Analysis



Although land suitability for this type development is mentioned in Regional Reviews of the RePPPProT, but some parts of suitability criteria are different between regional studies. So that, the land suitability assessment in the FIDP applies uniformed criteria on land system

description summaries of RePPPProT National Overview<sup>1</sup>.

Items and limitations of land suitability criteria are explained in Table 3.1 and briefly described as follows. The items of Potable water and Fragmentation, which are used for specified development potential analyses of the RePPPProT, are excluded from the criteria as the FIDP study is focused on wetland agriculture development and those two criteria are not important factors.

#### Groundwater quality (G):

A distinction is made between: not available, fresh, brackish/sulphurous and saline. Presence of brackish/sulphurous or saline groundwater is considered to limit the suitability of the land system for paddy cultivation for its excessive salinity.

#### Inundated land (I):

The parameters are given in the data sets: the risk of flooding, the sediment load of the flood water and the risk of inundation. Areas commonly or frequently flooded by waters containing high sediment loads or subject to permanent or tidal inundation are thought to be unsuitable for paddy cultivation.

#### Climate (C):

The climate classification is based on the average annual amount of rainfall and the number of wet (> 200 mm) and dry (< 100 mm) months, in combination with the length of the growing period and the minimum and maximum temperature. Paddy cultivation is possible if the average annual rainfall ranges between 1,000 and 5,000 mm. The dry period should be no more than 7 months and there have to be at least 4 wet months. The growing period has to be more than 100 days and the temperature is allowed to range among 15 and 34 C°.

#### Soil texture (T):

Six soil texture classes of the top 25 cm of the soil are distinguished, which are fine, moderately fine, medium, moderately coarse, coarse, and organic textures. Only soils having a coarse texture are considered not suitable for paddy cultivation in relation to excessive drainage and low nutrient holding capacity.

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<sup>1</sup> Land suitability classes of Land Systems are sometimes different among Regional Reviews of RePPPProT, because the assessment is depend on individual land system descriptions within Regional Reviews. For Kalimantan, suitability criteria of each Land System is unified by dominance of its area and data quality from three regional reviews of East, Central and East/South Kalimantan.

#### Soil depth (D):

Although both peat and mineral soil are classified according to their depth for the suitability assessment, separate criteria are used for the two types of soil. Peat soils deeper than 75 cm from surface are considered unsuitable for paddy cultivation because of formidable difficulties to be reclaimed. Mineral soils less than 25 cm deep are considered unsuitable because such shallow rooting zone often cause water and nutrition stresses.

#### Soil drainage (W):

A distinction between excessively, well to moderately well, imperfectly, poorly and very poorly drained soils is made. For paddy cultivation soils have to be imperfectly to very poorly drained.

#### Soil nutrition (N):

The soil nutrient status of the top 25 cm of the soil is described with the following parameters: exchangeable potassium (K), available and total phosphorus (P) and the cation exchange capacity (CEC). Furthermore a number of potentially limiting soil chemical characteristics is given: the pH(H<sub>2</sub>O) value, Aluminum (Al) saturation, the depth to acid sulphate layer, the salinity of the soil and whether or not the parent material of the soil is ultrabasic. Land systems suitable for paddy cultivation should have CEC values higher than 5 meq/100g soil, pH values lower than 7.9 and a salinity (EC) below 4.0 mS/cm. The presence of an acid sulphate layer within 25 cm from the soil surface, and quartzic or ultrabasic parent material makes the soil unsuitable for paddy cultivation. Land systems with low exchangeable K, available P or total P or with high Al saturation or exchangeable Al are considered as conditionally suitable.

#### Elevation (L):

Elevation above 1500 m (annual average temperature below 18.7 C°) are thought to be unsuitable for paddy cultivation for its cool.

#### Slope (S):

Land slope classes are distinguished as flat (< 2 %), very gentle (2-8 %), gentle (9-15 %), moderately steep (16-25 %), steep (26-40 %), very steep (41-60 %) and extremely steep (> 60 %). Only flat areas are considered to be suitable for paddy cultivation. Very gentle to moderately steep areas are considered as conditionally suitable areas. As for volcanic soils of Jawa, even steep and very steep areas are also included in conditionally suitable areas because high population pressure has

already enforced cultivation on some parts of such lands.

The nine characteristics of each land system are examined and categorized as suitable (S), conditionally suitable (\$), unsuitable (N) or not relevant (#). After that, each land system is classified into four groups, i.e., fully suitable (S), conditionally suitable (\$), marginally suitable (\$\$) and unsuitable (N).

As a result of combination of the nine suitability examinations, land suitability orders on land systems are defined as follows.

**Fully suitable (S):**

Land on which sustained use of the type considered is expected to yield benefits sufficient to justify the required inputs without unacceptable risk of damage to land resources. "Suitable" indicates that 60 to 100 % of the land systems is suitable for the specified land utilization type. Suitable land systems may include up to 40 % of unsuitable land. The type of land systems does not have any N or \$ factors within the nine suitability criteria.

**Conditionally suitable (\$):**

Land which requires additional inputs to make it suitable for sustained use of the types under consideration inputs may include soil and water conservation measures, bench terracing, water control, estate management, fertilizer, infrastructure etc. Conditionally suitable land systems may also include up to 40 % of unsuitable land. The land systems are distinguished as one \$ character of the nine suitability criteria.

**Marginally suitable (\$\$):**

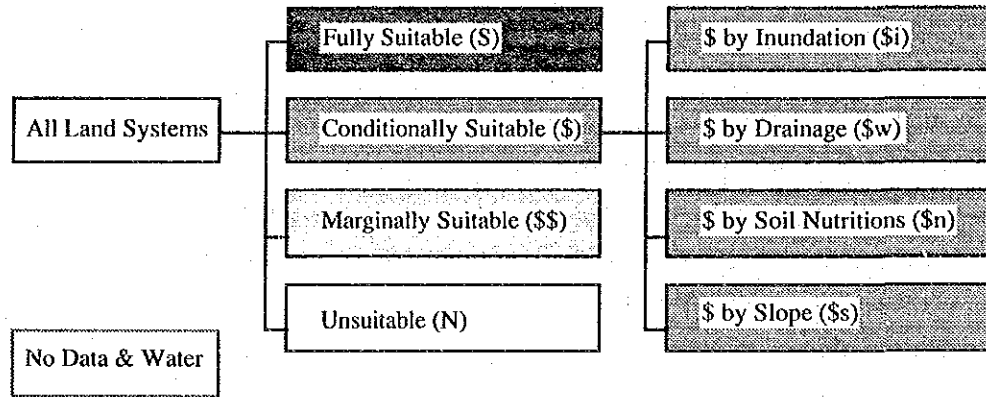
Land which requires more inputs to solve double constraints for wetland arable agriculture development. Marginally suitable land systems may also include up to 40 % of unsuitable land. The land systems distinguished as two \$ factors of the nine suitability criteria.

**Unsuitable (N):**

Land with qualities that appear to preclude sustained use types under consideration. "Unsuitable" indicates that 60 % to 100 % of the land system is unsuitable for the specified land utilization type. Unsuitable land systems may include up to 40 % of suitable land. In the land systems, at least one N factor and/or more than three \$ factors are founded out.

Conditionally suitable land systems can be divided into four sub-classes by a kind of conditionally suitable factors, which are inundation (i), drainage (w), soil nutrients (n) and slope (s). The sub-division roughly shows amounts of land with moderate constraints for wetland agriculture development.

Schematic of Land Suitability Classes



### 3.2 Results of Land Suitability Analysis

Through the methods and criteria of land suitability classification, whole land of Indonesia<sup>2</sup> is defined into four suitability classes for rice cultivation, even though there are some uncertain limiting factors and areas without any land data.

#### 3.2.1 Results of Factor Analysis

The nine characteristics of land system are key factors of land suitability as mentioned above. Each factor shows some differences in land features among provinces (refer to Table 3.2).

#### Groundwater:

Unsuitable groundwater quality occurs in only 4 % of the national land, and land with suitable or not relevant covers 94 % land in Indonesia.

<sup>2</sup> Total areas of provinces are not same as authorized CBS data, which the FIDP study basically adopts. Only for land potential assessment the RePPPProT area data are used, because all land suitability and availability analyses are based on the RePPPProT land evaluation data. The total area of Indonesia is 1,909,049 km<sup>2</sup> of the RePPPProT against 1,919,317 km<sup>2</sup> of CBS, and the difference is 1.5 %.

**Inundation:**

Sedimentation and permanent/tidal inundation risks are founded out in 6 % area in Indonesia, and Irian Jaya and Sumatera Selatan have highest ratio of such inundation risk area as 16 % and 9 %, respectively. Other provinces are not heavily suffered by flood and inundation.

**Climate:**

Very few area faces unsuitable climate condition for rice cultivation except Nusa Tenggara area. About 10 % area of Nusa Tenggara region, including Nusa Tenggara Barat, Nusa Tenggara Timur and Timor Timur, is too dry to harvest rice enough under rainfed condition.

**Soil Texture:**

Soil texture is not considered as strict limitation in most area except Kalimantan Tengah and Irian Jaya. For Nusa Tenggara area reliable data are not enough for land suitability analysis.

**Soil Depth:**

Eleven percent of the national land is classified as unsuitable in terms of soil depth condition, such as very deep peat soils or shallow mineral soils. Especially Riau, Kalimantan Barat and Tengah, Sulawesi Tenggara, and Irian Jaya widely have unsuitable areas.

**Soil Drainage:**

For soil drainage condition, conditionally suitability class, same as well/moderately well drainage class, occupies two-third of the national land. Southeastern provinces of Sumatera show high suitable ratio due to poor drainage conditions of wide swampy areas. Unsuitable areas on drainage are very few.

**Soil Nutrition:**

Since soil nutrition factor includes ten sub items for suitability analysis, many land systems are short in data availability at 30 % area of the national land. Especially in Maluku and Irian Jaya region and also Bali and Nusa Tenggara region, more than 50 % areas are not known enough on soil nutrition conditions. Obviously unsuitable areas cover 14 % of the national land.

#### Elevation:

Unsuitable land system area by high elevation covers very small part of the national land, because each land system unit has a wide range of elevation from low level enough to rice cultivation. For only Bali and Nusa Tenggara region, 16 % of land is considered not to be suitable by high elevation.

#### Slope:

Land slope is the most strict limiting factor for land suitability analysis in terms of areas. Percentage of unsuitable area in Indonesia comes to 44 %, on the other hand that of suitable area, which has slope less than 2 % gradient, counts as only 24 %.

### 3.2.2 Results of Land Suitability Analysis

As shown in Table 3.3 and the following table, about 13.6 million ha or 7 % of the national land is classified as fully suitable area to cultivate wetland paddy. When conditionally suitable area is taken into account, 26.0 million ha is able to be use as wet paddy field without low productivity or high investment. The areas exceed the present wet paddy field area of about 8 million ha. It suggests field extension possibility for paddy cultivation, although the land within suitable categories is not able to be completely transformed into wet paddy field.

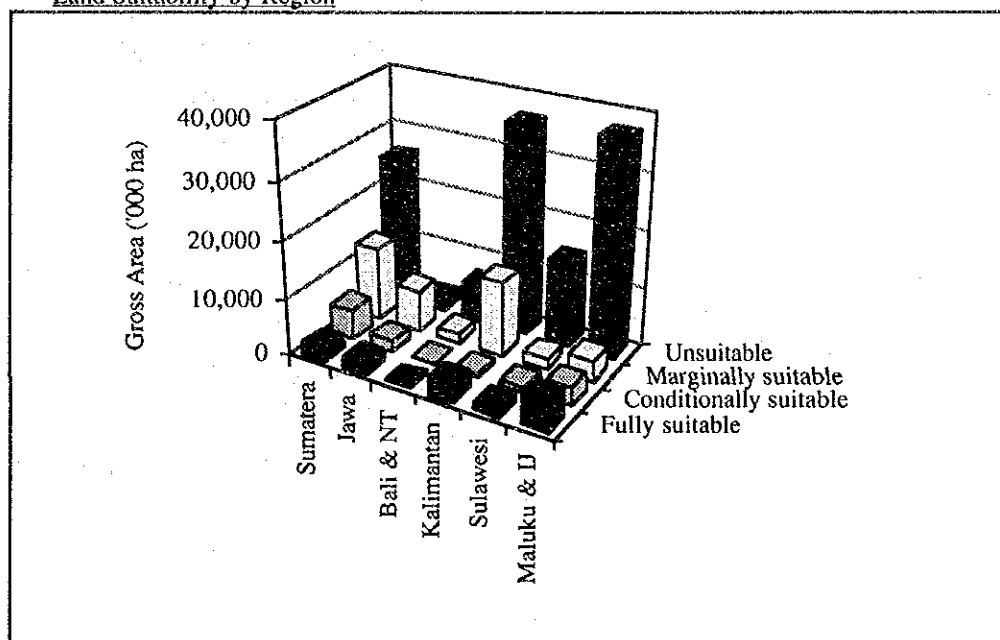
Regionally, Maluku and Irian Jaya occupies the widest area of the fully suitable land at about 4.72 million ha, followed by Kalimantan at 3.07 million ha, Sumatera at 2.20 million ha, and Jawa at 2.02 million ha in order. Jawa shows the highest ratio of the fully suitable land to total land at about 15 %, and also fully and conditionally suitable land at nearly 30 %.

Land Suitability for Paddy Cultivation by Region

Region	('000 ha)					
	Total	Fully suitable	Conditionally suitable	Marginally suitable	Unsuitable	Unclassified
Sumatera	47,531	2,195	5,355	12,976	25,856	1,148
Jawa	13,257	2,019	1,932	7,310	1,855	140
Bali & NT	8,657	392	309	1,652	6,275	29
Kalimantan	53,583	3,067	676	12,918	36,355	568
Sulawesi	18,615	1,200	920	1,602	14,723	170
Maluku & IJ	49,263	4,717	3,201	3,744	37,143	458
Indonesia	190,905	13,590	12,394	40,202	122,207	2,513

Source: JICA-FIDP Team calculation based on RePPPProT Regional Reviews.

Land Suitability by Region



Most land of the conditionally suitable class is caused by soil nutrients and slope factors. Conditionally suitable lands with nutrient factor (\$n\$) and with slope factor (\$s\$) are about 5.33 million ha and 6.45 million ha, respectively. In other words, land of \$n\$ and \$s\$ holds 95 % of the total conditionally suitable area. Generally, \$s\$ requires reclamation of terraced paddy fields for field extension while \$n\$ requires high inputs of fertilizers and/or soil improvement materials for paddy cultivation.

In discussions in this chapter, the suitable areas include a certain extent of unsuitable areas and some suitable areas within unsuitable land systems are left out of count, due to the nature of the analysis method. This matter is discussed in the Land Availability chapter below.

### 3.3 Swamp Areas

The low lands in Indonesia is widely covered by swamp areas, which are classified into tidal (or coastal) swamps and inland (or fresh water) swamps. Swamp are mainly located in southeastern part of Sumatera, lower river basins of Kalimantan and southern part of Irian Jaya.

The definition of "swamp" is not clear, and the area of "swamp" is also not confirmed due to its definition and objective of survey although many surveys were carried out in Indonesia. Directorate of Swamp, DGWRD, Ministry of Public Works defined "swamp"



as "a land which is naturally submerged or permanently or seasonally inundated, and shows specific physical, chemical and biological circumstances". And four categories of tidal swamp are defined depend on a relative level of land and sea water, three types of inland swamp are distinguished by an inundation condition. As for actual areas of swamps, however, an inventory survey just started for Sumatera island by the Directorate in the fiscal year of 1992/93.

In this land resources assessment, swamp areas are estimated with suitability for paddy cultivation according to land system descriptions of the RePPPProT Regional Reviews. Physiographic classification of land systems mentioned above shows roughly swamp areas in Indonesia. This FIDP study estimates swamp areas by taken in account of facet and vegetation conditions within each land system. The results may shows swamp areas more realistically, although there are still uncertain factors of the definition (see the following table and also Table 3.4).

Tidal and Inland Swamp Area by Region

Region	Total swamp	Tidal swamp	Inland swamp	Inland swamp with suitability*	
				S	\$
Sumatera	10,545	879	9,667	1,375	1,949
Jawa	1,514	165	1,350	1,309	0
Bali & NT	326	50	276	94	3
Kalimantan	9,280	1,098	8,182	1,811	113
Sulawesi	1,348	241	1,107	855	0
Maluku & IJ	7,708	2,064	8,340	1,799	91
Indonesia	30,721	4,015	26,707	7,243	2,157

Note: Suitability classes in inland swamps are fully suitable (S) and conditionally suitable (\$) for wetland paddy cultivation.

Source: JICA-FIDP Team calculation based on RePPPProT Regional Reviews.

Total swamp area is estimated at 30.7 million ha or 16 % of total area in Indonesia, and 90 % of the swamp area is located in Sumatera, Kalimantan and Irian Jaya. The extensive provinces of swamp are Irian Jaya at 7.2 million ha, Riau at 4.7 million ha, Kalimantan Tengah at 4.0 million ha, Sumatera Selatan at 2.6 million ha, Kalimantan Barat at 2.4 million ha, Kalimantan Timur at 1.9 million ha and Jambi at 1.0 million ha. Most swamp area is classified into inland swamp at 26.7 million ha in Indonesia. Tidal swamp area is estimated at 4.0 million ha in the country.

Further, land suitability is examined separately for tidal swamp and inland swamp. For tidal swamps, tidal irrigation development criteria described in RePPPProT National

Overview are adopted to all regions. However, as long as using the criteria and land system descriptions, tidal swamp area suitable for tidal irrigation development is not founded out in all regions.

For inland swamps, suitability classes for wetland paddy cultivation are examined by the same criteria as the land suitability analysis mentioned in the section 3.1. Fully and conditionally suitable inland swamp areas are estimated at about 7.2 and 2.2 million ha, respectively. The areas are included in the suitability class areas described in the section 3.2.1. Therefore, some half area of fully suitable land for paddy cultivation can be said as inland swamps.

Swamp areas can be analyzed for land suitability, but can not for land availability, because data for land availability are not enough in the RePPPProT. In the next discussions of land availability and land potential, therefore, swam and non swamp areas can not be distinguished.

## **4. Land Availability**

### **4.1 Land Availability Analysis**

Available land area for new wetland development is derived by subtracting current used land area from each land system area, based on matrix data of land system area and specified land use area provided by National Overview of the RePPPProT<sup>3</sup>. The land use types consist of 12 great categories, which are forest, bush/scrub, grassland, shifting cultivation, upland permanent cultivation, wetland cultivation, tree crops/estates, agroforestry, reforestation, water (river, lake, etc.), unvegetated and settlements. Lands which currently used as lowland paddy field (sawah) and other specified purposes are considered as no potential area for wetland extension development. Current used areas and still available areas are distinguished as follows.

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<sup>3</sup> National Overview shows that matrix for island groups, not provinces. The data are broken into province by ratio of provincial land system areas.

Classification of Land Availability

<u>Available Land for Field Extension</u>	<u>Not Available Land for Field Extension</u>
Conversion Forest	Present Paddy Field
Bush/Scrub	Forest excl. Conversion Forest
Grassland	Estate
Shifting Cultivation	Agroforestry
Upland	Reforestation
	Water
	Unvegetated Land
	Settlement
	No Data

Basic data on land availability analysis are land use data are provided RePPPProT National Overview, as shown in Table 4.1 and summarized in the following table<sup>4</sup>. This data show that forest land covers 120 million ha or more than 60 % of the national land area. Wetland paddy field is about 8 million ha in Indonesia.

Land Use by Region

('000 ha)

Land Use	Sumatera	Jawa	Bali & NT	Kalimantan	Sulawesi	Maluku & IJ	Total
Forest	23,324	1,245	2,570	39,986	11,269	41,306	119,701
Bush/scrub	7,675	1,567	2,316	4,322	2,179	816	18,875
Grassland	2,759	60	1,435	1,425	1,114	3,482	10,275
Shifting cultivation	3,429	289	491	5,460	527	1,504	11,699
Upland	1,707	2,273	525	3	760	53	5,322
Wetland	2,156	3,161	498	930	829	92	7,666
Estate, reforest, etc.	3,550	2,509	195	619	782	33	7,687
Water	465	220	21	399	201	875	2,182
Unvegetated	12	32	81	0	29	416	571
Settlements	1,359	1,765	201	129	306	82	3,842
No data	1,096	135	304	310	619	623	3,087
<b>Total</b>	<b>47,531</b>	<b>13,257</b>	<b>8,637</b>	<b>53,583</b>	<b>18,615</b>	<b>49,282</b>	<b>190,905</b>

Source: RePPPProT National Overview.

In planning land conversion to paddy fields, environmental aspects should be concerned

<sup>4</sup> Since land use by RePPPProT was studied on the basis of relatively old airphotografy for several years, data are not same as recent CBS land use data. To overlay land system and land use, however, it would be difficult to updata land use data using CBS issues.

sensitively. In this study forest areas are divided into two groups, i.e., conservation forest and convertible forest. The classification method of forest land is described in following section.

#### 4.2 Forest Classification

Forest lands in Indonesia are classified by a method known as Consensus Forest Land Use Plan (Tata Guna Hutan Kesepakatan, TGHK). In the RePPProT study, TGHK boundaries were extensively revised in line with the existing identical index for forest classification. Each land system was classified into one TGHK category area, and the most reasonable category areas in forest were determined by using the relevant land system boundaries. Adjustments were made to take account of actual land use and land status with respect to actual or firmly planned large-scale developments.

A land is classified into five TGHK categories by using of site index. Classification index of forest land consists of three identification items, which are land slope, soil erodibility and rainfall intensity. A rainfall intensity index comprises the mean annual rainfall (mm) divided by mean annual raindays.

Forest Land Classification Index

1. Land slope		2. Soil erodibility		3. Rainfall intensity	
Class	Point	Class	Point	Class	Point
0-8 %	20	None	15	< 13.6	10
9-15 %	40	Low	30	13.6-20.7	20
16-25 %	60	Medium	45	20.8-27.7	30
26-45 %	80	High	60	27.8-34.8	40
> 45 %	100	Very High	75	> 34.8	50

Source: Forestry Inventory and Land Use Planning (INTAG), MOF

This site index is calculated by summing the number of points attributable in respect of each of the three criteria and is used to determine the forest land category as follows:

<u>Site Index</u>	<u>Forest Land Category</u>
< 125	Normal Production Forest (HPB) or Conversion Forest (HPK)
125-174	Limited Production Forest (HPT)
> 175	Protection Forest (HL)

Furthermore, all land above 45 % slope is classified as Protection Forest, also land which has a Soil Erodibility of Very High and a slope that exceeds 15 %. In addition, provincial authorities may restrict normal logging activities to areas where the slope is less than 25 % and the altitude is below 500 m.

TGHK category consists of following five, each having its own purpose and permitted form of exploitation.

Forest Use Category, Purpose and Permitted Exploitation

Category	Symbol	Purpose	Permitted exploitation
Nature reserve	PPA/HSA	Gene conservation	None
Protection forest	HL	Watershed protection	None
Limited production forest	HPT	Timber production	Selective felling
Normal production forest	HPB	Timber production	Selective or clear felling
Conversion forest	HPK	Conversion to agriculture	Clear felling

Source: Ministry of Forestry

Normal Production Forest area is managed under the Indonesian Selective Felling System (TPI). The cutting cycle is set at 35 years and the minimum log diameter is 50 cm. In those areas classified as Limited Production Forest, the minimum diameter of the logs extracted is raised to 60 cm. For Protection Forest no felling is allowed. On the other hand, Conversion Forest can be included within the area of a concessionaire. The above diameter restrictions do not apply and complete clearing of the site is allowed.

In the FIDP study, only Conversion Forest is considered to be convertible to paddy field in future planning<sup>5</sup>. For Jawa and Bali, this TGHK classification is not applied because almost all forest area in these islands is considered to be developed for specified purposes. Therefore, all forest areas in Jawa and Bali are determined to be impossible to convert to paddy fields.

The results of TGHK classification revised by the RePPPProT study are summarized in Table 4.2 and the following table. The area of Conversion Forest in outer Jawa and Bali is estimated at about 25.8 million ha or 22 % of total forest area. Kalimantan occupies the most extensive Conversion Forest area of 11.4 million ha, and Sulawesi and Maluku and

<sup>5</sup> Regional Reviews of the RePPPProT study represent forest categorization of each land system in the regions, but do not distinguish between Normal Production Forest and Conversion Forest. To estimate the Conversion Forest area, therefore, land system areas of HPB/HPK category are multiplied by percentage of the provincial HPK forest area to HPB/HPK forest area.

Nusa Tenggara do not have so wide area of Conversion Forest.

Forest Area within Each Revised TGHK Category by Region

(million ha)

Region	Nature reserve	Protection forest	Limited production forest	Normal production forest	Conversion forest	Unclass	Total
Sumatera	4.29	7.71	0.63	5.01	5.50	0.05	23.19
Kalimantan	5.99	9.41	7.39	5.80	11.44	0.01	40.04
Sulawesi	2.21	7.97	0.10	0.09	0.85	0.00	11.22
Maluku & NT	1.86	5.45	0.37	0.43	0.73	0.02	8.85
Irian Jaya	6.77	14.47	1.98	4.57	7.24	0.00	35.03
Total	21.10	45.01	10.47	15.89	25.77	0.08	118.33

Note: Jawa and Bali is excluded from TGHK classification.

Source: RePPProT National Overview.

### 4.3 Results of Land Availability Analysis

Land is divided into two groups: one is already used land including present paddy field, and the other is available land for transformation into lowland paddy field. Therefore, paddy field reclamation shall be planned in only the latter land, although not all area in the land can be converted into paddy field.

The potential land is considered as gross area because the land includes unsuitable lands partly (at maximum 40 %) and planning loss areas. A planning losses are caused by scattering of small size areas and/or difficulty in identification of these smaller areas. To estimate the net potential development area, a reduction factor has to be applied to account for those unsuitable facets in the suitable land systems. The reduction factor, called as Identification Efficiency Index, is 36 % according to RePPProT Regional Review of Central Kalimantan. Therefore, only 36 % of the gross suitable area is identified as extension potential of lowland paddy field. In the FIDP study, the same identification efficiency index is applied to whole Indonesia to estimate the ultimate wetland development areas.

The results of land availability study are shown on Table 4.3 and regionally summarized as below:

Land Availability by Region

('000 ha)

Region	Gross total area	Present paddy field	Other used area	Gross available area	Net available area
Sumatera	47,530.7	2,088.9	24,924.2	20,517.6	7,386.3
Jawa	13,256.5	3,131.6	6,004.1	4,120.8	1,483.5
Bali & NT	8,656.9	444.5	3,596.1	4,616.3	1,661.9
Kalimantan	53,583.4	1,142.5	33,733.1	18,707.8	6,734.8
Sulawesi	18,614.5	831.3	12,182.2	5,601.0	2,016.4
Maluku & IJ	49,262.9	122.7	33,394.4	15,745.8	5,668.5
Indonesia	190,904.9	7,761.5	113,834.1	69,309.3	24,951.3

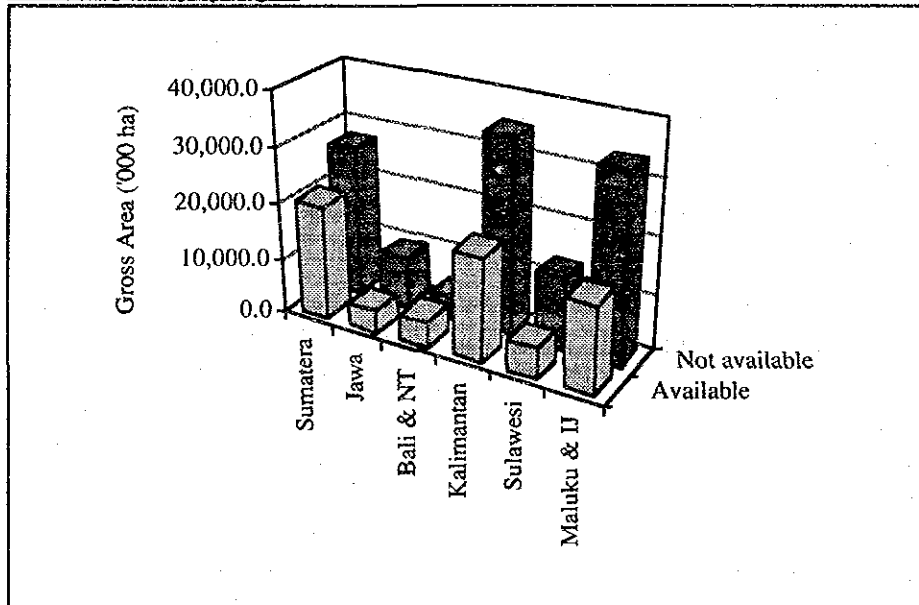
Notes: Other used area includes water-covered area and no data area.

Net available area is calculated by multiplying 36% by gross available area.

Source: JICA-FIDP Team calculation based on RePPPOT Regional Reviews.

Gross land area available for paddy field extension is estimated at 69.31 million ha in Indonesia, and net available area counts to 24.95 million ha in Indonesia. Large portion of the available land is distributed in Sumatera, Kalimantan and Maluku and Irian Jaya region. On the other hand, Jawa (and Bali) region has already been developed well in agricultural land use, so that available area is not large.

Land Availability by Region



## 5. Land Potential

### 5.1 Land Potential for Wetland Agriculture Development

Land potential of wetland agriculture development is derived from land suitability and availability study. In other words, a land which is suitable for paddy cultivation and convertible to paddy field is defined as a potential area of paddy field extension. The available lands with highly suitable conditions should be primarily considered as planning areas of field extension. Lands with lower suitability have only lower priority of development, and available but unsuitable lands are not recommended to be developed.

Net potential areas by suitability classes and by province are presented on Table 5.1 and regionally summarized as below:

Land Potential for Wetland Agriculture Development within Net Available Land by Region  
(’000 ha)

Region	Total	Fully suitable	Conditionally suitable	Marginally suitable	Unsuitable
Sumatera	7,386.3	341.9	681.2	2,931.8	3,431.4
Jawa	1,483.5	27.0	54.7	1,086.0	315.8
Bali & NT	1,661.9	70.2	40.2	419.8	1,131.7
Kalimantan	6,734.8	529.3	166.0	2,740.0	3,299.5
Sulawesi	2,016.4	170.8	123.6	374.5	1,347.4
Maluku & IJ	5,668.5	1,293.2	725.3	565.1	3,084.9
Indonesia	24,951.3	2,432.4	1,790.9	8,117.2	12,610.8

Source: JICA-FIDP Team calculation based on RePPPProT

Net land potential with land suitability classes is summarized in following table and Table 4.3 in detail. Fully suitable potential area is 10 % of total available land, and conditionally suitable potential area is 7 % in Indonesia. Marginally suitable potential area, which is considered as costly land for reclamation and/or paddy cultivation, is 33 % of total. And unsuitable area occupies about half area of total available land.

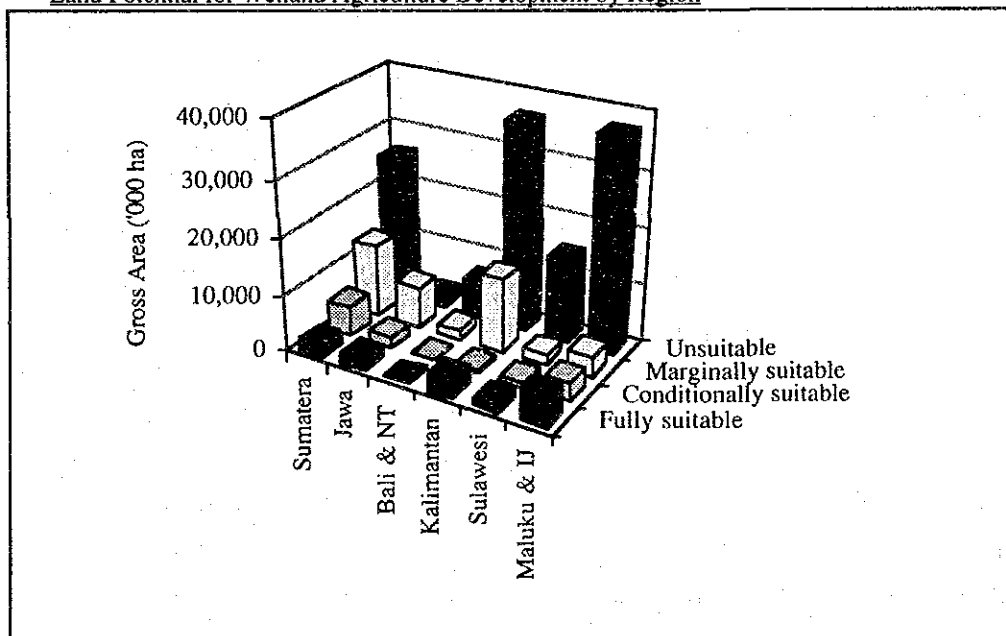
Net potential area in fully suitable lands, which is given first priority of paddy field extension, is estimated at about 2.43 million ha in Indonesia. Regionally, Maluku and Irian Jaya occupies more than half of the area at 1.29 million ha. Kalimantan and Sumatera also have still big potential for field extension. On the contrary, Jawa and also Bali and Nusa Tenggara regions are not very extensive as far as land potential is concerned. The



provinces which have more than 0.1 million ha of fully suitable land potential are Irian Jaya (1.16 million ha), Kalimantan Tengah (0.18 million ha), Riau (0.15 million ha), Kalimantan Selatan (0.14 million ha), Maluku (0.13 million ha) and Kalimantan Barat (0.12 million ha). The provincial distribution of fully suitable potential land is illustrated in a map as shown on Figure 4.1.

A conditionally suitable land is considered to have potential of relatively low cost/input development, although development priority should be lower than that of a fully suitable land. Land development potential in fully and conditionally suitable areas in Indonesia is estimated at about 4.22 million ha in terms of net area. The three regions of Maluku and Irian Jaya, Sumatera and Kalimantan occupy about 89 % of the area or 3.77 million ha. The provinces in which more than 0.2 million ha of the fully and conditionally suitable lands extend are Irian Jaya (1.82 million ha), Riau (0.31 million ha), Sumatera Selatan (0.26 million ha) and Kalimantan Tengah (0.24 million ha).

Land Potential for Wetland Agriculture Development by Region



In conclusion, Sumatera has relatively big potential for wetland agriculture development, and most potential area is located in eastern plains of the island, such as Sumatera Utara, Riau, Jambi and Sumatera Selatan. Land potentials for paddy field extension in Jawa and Bali and Nusa Tenggara are not so extensive, because suitable land in Jawa and Bali has widely been developed for intensive land uses. Kalimantan is the second extensive region

of fully suitable potential land and it is distributed to all four provinces. Most suitable potential land in Sulawesi is concentrated in Sulawesi Selatan and Sulawesi Tengah, so rest two provinces have not so much potential. Maluku and Irian Jaya have physically the biggest potential of paddy field extension in Indonesia.

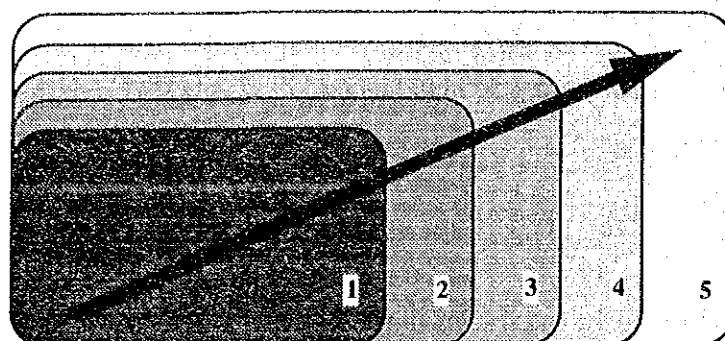
## **5.2 Land Potential for Irrigation Development**

As a final output of the FIDP land resources assessment, irrigation development potential in Indonesia is discussed in this chapter. Physical potential for irrigation development shows further extents of irrigated paddy field area. Irrigation development potential is physically limited by not only land availability but also irrigation water availability. One of them determines a upper limit of irrigation development potential of a region. To estimate irrigation development potential, therefore, water resources assessment comes to another key factor.

Water resources are assessed for major river basins, which amounts to 136 divisions in Indonesia. Irrigation water availability analysis takes into account many factors, such as monthly rainfall amount and distribution, river discharge, water consumption for other purposes, and so on. On the other hands, water demand of irrigated paddy field is also computed on the basis of a present (irrigated) paddy field area and a typical cropping pattern, which comes from CBS data. As a result of that, maximum irrigable area is determined by river basin from a viewpoint of physical water availability (refer to FIDP Technical Note of Water Resources Assessment).

Water to be used for irrigation is primarily consumed in present irrigated field. Then surplus water can irrigate rainfed paddy field at a certain portion. The ratio of irrigable rainfed field is assumed to be the ratio of paddy field with suitable condition (S + \$) to total paddy field, by province. Still remaining water can be used in newly reclaimed paddy field, form higher suitable areas to lower suitable areas.

### Schematic of Irrigation Development Process



- 1: Present Irrigated Area
- 2: Irrigation Development Area in Present Paddy Field
- 3: Irrigation Development Area with Paddy Field Extension in Fully Suitable Land
- 4: Irrigation Development Area with Paddy Field Extension in Conditionally Suitable Land
- 5: Irrigation Development Area with Paddy Field Extension in Marginally Suitable Area

For matching to the water resources assessment, results of land resources assessment are proportionally broken down into each river basin by its own areas. Then, irrigation potential areas derived from water potential analyses are compared with those from land suitability and availability analyses. The smaller area of two should be irrigation development potential in each river basin. The results are shown in Table 5.2 and summarized in the following table.

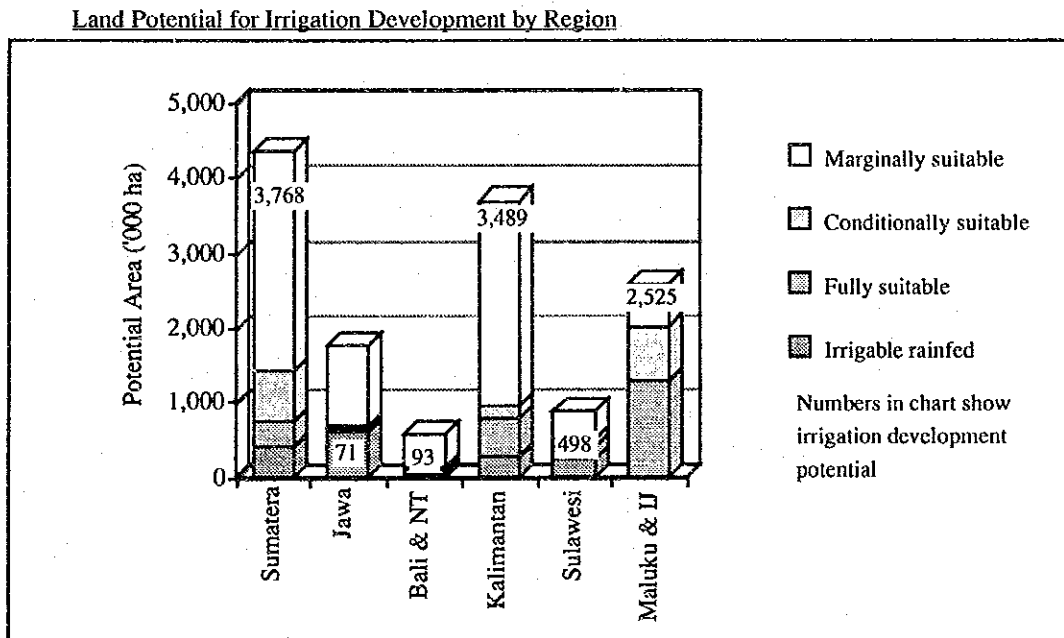
Land Potential for Irrigation Development by Region

Region	Water potential	Land potential					Irrigation development potential
		Total	Irrigable rainfed field	Fully suitable	Conditionally suitable	Marginally suitable	
Sumatera	10,089	4,342	388	342	681	2,932	3,768
Jawa	71	1,769	602	27	55	1,086	71
Bali & NT	94	559	29	70	40	420	93
Kalimantan	13,683	3,693	258	529	166	2,740	3,489
Sulawesi	1,215	889	220	171	124	375	498
Maluku & IJ	13,813	2,584	0	1,293	725	565	2,525
Indonesia	38,965	13,836	1,496	2,432	1,791	8,117	10,443

Note: Water potential area is an estimation at the year of 1990, taking into consideration the increase of domestic, municipal and industrial water demand.

Source: JICA-FIDP Team calculation.

Irrigation development potential is estimated at 10.1 million ha in Indonesia, and it concentrates upon Sumatera, Kalimantan and Maluku and Irian Jaya regions. Provinces having more than 0.5 million ha of irrigation development potential are Irian Jaya (2.2 million ha), Kalimantan Timur (1.2 million ha), Sumatera Selatan (1.2 million ha), Kalimantan Barat (1.1 million ha), Riau (0.9 million ha) and Kalimantan Selatan (0.7 million ha). As for Jawa region and Bali and Nusa Tenggara region, there is a very little potential which is strictly limited by irrigation water availability.

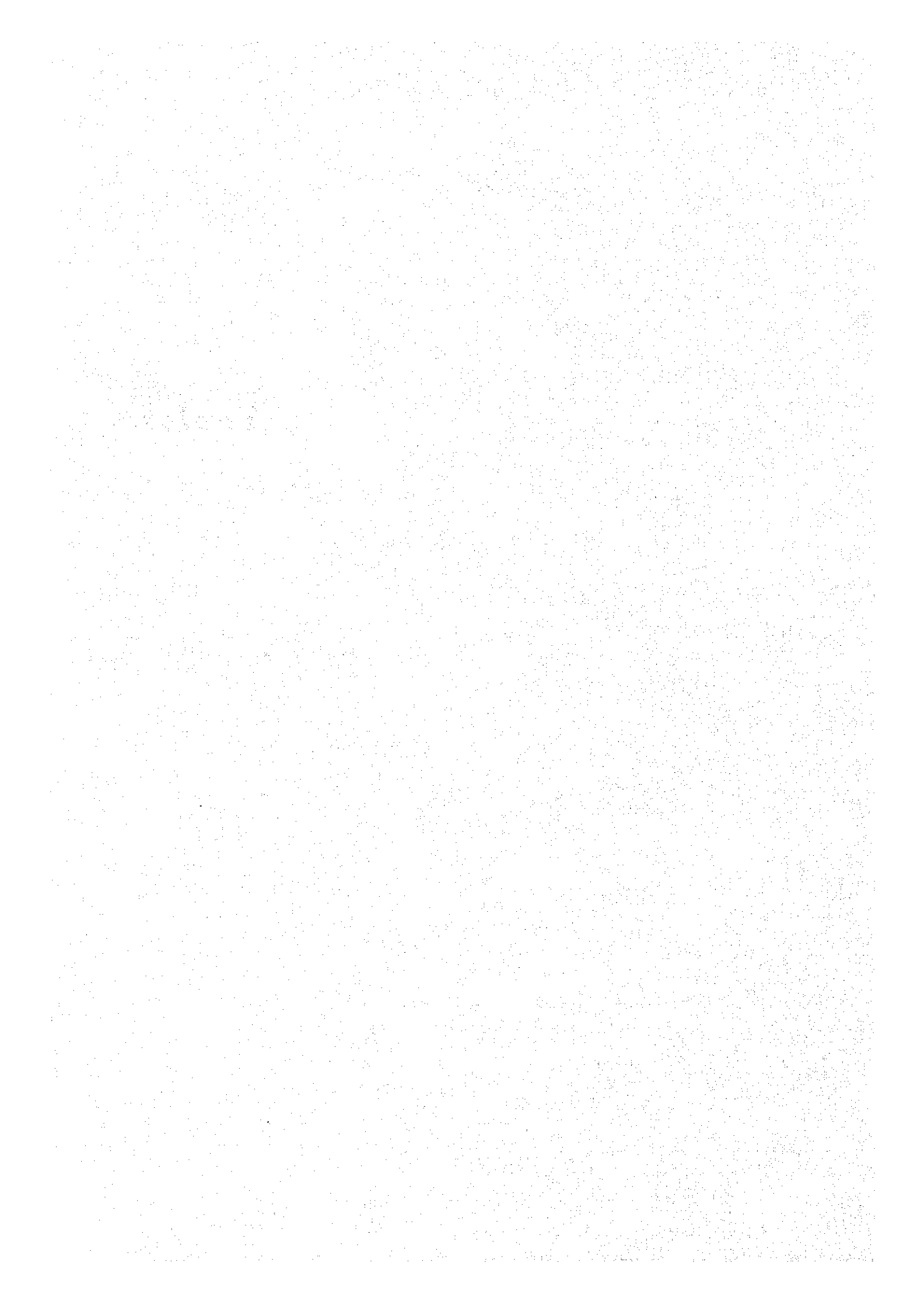


For the whole Indonesia, land potentials for wetland agriculture development and irrigation development are assessed from a viewpoint of physical conditions of land and water. The results of the assessments provide basic and fundamental information for large scale planning of national irrigation development program. For identification of individual irrigation projects, more detailed survey should be required at sites.

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## ***Tables***



**Table 2.1 General Description and Distribution of Major Soil Great Groups in Indonesia**

Order	Suborder	Great Group	General Descriptions	Distribution
Histosols	Hemists	Tropohemists	Swampy, half-decomposed organic soils of hot climates	Common peat swamps
Entisols	Aquepts	Tropaquepts	Undeveloped, permanently saturated mineral soils of hot climates	Flat and poorly drained alluvial plains, Subcoastal swamps in southeast Irian Jaya
		Fluvaquepts	Undeveloped, permanently saturated, layered soils of floodplains	Low-lying backplains
		Hydraquepts	Undeveloped, permanently saturated, soft muddy soils	Tidal swamps
	Orthents	Troporthents	Undeveloped rocky soils of hot climates	Eroded sites in upland areas in the humid zone
		Ustorthents	Undeveloped rocky soils subject to seasonal moisture stress	Eroded sites in upland areas in the seasonal dry eastern areas
	Psamment	Tropopsamment	Undeveloped sandy soils of hot climates	Beaches in the west climatic zone
		Ustipsamment	Undeveloped sandy soils subject to seasonal moisture stress	Beaches in the seasonally dry eastern climatic zone
	Fluvents	Tropofluvents	Undeveloped, layered soils riverine floodplains of hot climates	Larger river floodplains
		Ustifluvents	Undeveloped, layered soils riverine floodplains subject to seasonal moisture stress	Larger river floodplains in the dryer eastern regions
	Inceptisols	Aquepts	Tropaquepts	Slightly weathered, permanently saturated soils of hot climates
Andepts		Dystrandeps	Slightly weathered volcanic ash soils with low base saturation and thick black topsoil	Young volcanic areas in Sumatera
		Eutrandeps	Slightly weathered volcanic ash soil with high base saturation and thick black topsoil	Young volcanic areas in eastern Jawa, Nusa Tenggara and Sulawesi
		Vitrandeps	Slightly weathered volcanic ash soils with dominantly coarse texture and thick black top soil	Youngest volcanoes
Trobepts		Dystrobepts	Slightly weathered soils of hot climates with low base saturation	Hilly/mountainous areas in wetter zone in Sumatera, Kalimantan, Maluku, Irian Jaya
		Eutrobepts	Slightly weathered soils of hot climates with high base saturation	Hilly/mountainous areas in the volcanic island arcs
		Ustrobepts	Slightly weathered soils subject to seasonal moisture stress, or with soft, powdery fine concentrations, and with high base saturation	Hilly/mountainous areas in seasonally dry areas in Jawa, Nusa Tenggara and Sulawesi
		Humitrobepts	Slightly weathered soils of hot climates with high organic matter and low base saturation	Central mountain ranges of Irian Jaya, Around lake Toba in northern Sumatera
Mollisols	Ustolls	Calcicustolls	Moderately weathered, weakly acid to neutral soils subject to seasonal moisture stress	Drier eastern part of the country with carbonate rocks, such as in Nusa Tenggara
	Rendolls		Moderately weathered, shallow soils on calcareous parent materials	Wetter climatic zones with carbonate rocks in Kalimantan, Sulawesi, Maluku, Irian Jaya
Vertisols	Usterts	Pellusterts	Moderately weathered, dark clay craking soils of seasonal climates	Subrecent estuarine and riverine plains in South Sulawesi
Aridisols	Orthids	Calciorthids	Slightly to strongly weathered calcareous soils subject to prolonged moisture stress	Driest coastal areas of northern Timor, Ator and Lombok
Alfisols	Udalfs	Tropudalfs	Well weathered soils of hot climates with finer-texture subsoil and high base saturation	Humid zone on gently to moderately sloping site
		Paleudalfs	Well weathered soils with thick, uniform finer-texture subsoil and high base saturation subject to seasonal moisture stress	Humid zone on gently to moderately sloping site
	Ustalfs	Rhodustalfs	Well weathered, reddish soils with finer-textured subsoil and high base saturation subject to seasonal moisture stress	Young coastal terraces in Nusa Tenggara
		Haplustalfs	Well weathered soils with finer-texture subsoil and high base saturation subject to seasonal moisture stress	Seasonally dry zone on gently to moderately sloping site
Ultisols	Udults	Paleudults	Strongly weathered acid soils with thick, uniform, finer-texture subsoil and low base saturation	Wetter regions, Most extensive
		Tropudults	Strongly weathered acid soils of hot climates with finer-texture subsoil and low base saturation	Wetter regions, Extensive
	Ustults	Paleustults	Strongly weathered acid soils subject to seasonal moisture stress with thick, uniform, finer-texture subsoil and low base saturation	Seasonally dry areas of eastern islands
		Haplustults	Strongly weathered acid soils subject to seasonal moisture stress with low base saturation	Seasonally dry areas of eastern islands
Spodosols	Aquods	Placaquods	Strongly weathered, permanently saturated and acid soils with cemented iron- or humus-enriched subsoil	Cooler areas of central Kalimantan, central Irian Jaya, northern Sumatera, Riau
		Tropaquods	Strongly weathered, permanently saturated and acid soils with iron- or humus-enriched subsoil	Cooler areas of central Kalimantan, central Irian Jaya, northern Sumatera, Riau
Oxisols	Orthox	Haploorthox	Very strongly weathered soils with very low base saturation	Sulawesi, Maluku, Timor
	Ustox	Haplustox	Very strongly weathered soils with very low base saturation subject to seasonal moisture stress	Sulawesi, Maluku, Timor

Classification Method: USDA Soil Taxonomy, 1985  
 Source: JICA-FIDP Team modified on the basis of RePPProT National Overview



**Table 3.1 Land Suitability Criteria for Wetland Agriculture Development**

Criteria Sub-criteria	Suitable (S)	Conditionally Suitable (C)	Unsuitable (N)
Groudwater Quality (g)	Fresh	-	Blackish/Sulphurous, Saline
Inundation (i)			
Flood water risk only	None - High	-	-
Sedimentation	Low	-	Medium - High
Inundation	None - Seasonal	-	Permanant - Tidal
Climate (c)			
Annual Rainfall	1000 - 5000 mm	-	< 1000 mm, > 5000 mm
Wet month (>200 mm)	>= 4 months	-	< 4 months
Dry month (< 100 mm)	< 7 months	-	>= 7 months
Dry month (< 60 mm)	<= 3 months	-	> 3 months
Growing days (food crops)	>= 100 days	-	< 100 days
Mean temperature	15 - 34 C°	-	< 15 C°, > 34 C°
Soil Texture (t) (top 25 cm)	Fine - Moderately coarse, Organic	-	Coarse
Soil Depth (d)			
Peat	0 - 75 cm	-	>= 75 cm
Mineral soil	> 25 cm	-	<= 25 cm
Soil Drainage (w)	Imperfect Very poor	Well - Moderately well	Excessive
Soil Nutritions (n)			
Exchangeable K (meq/100g)	>= 0.1	< 0.1	-
Available P (ppm P2O5) (Bray 1)	>= 10	< 10	-
Total P (mg/100g P2O5)	>= 10	< 10	-
CEC (meq/100g)	>= 5	-	< 5
pH(H2O)	< 7.8	-	> 7.9
Al Saturation (%)	< 40	> 41	-
Exchangeable Al (meq/100g)	<= 2	> 2	-
Depth to acid Sulphate (cm)	< 25	-	> 26
Salinity (EC mS/cm)	<= 4.0	-	> 4.0
Parent material	-	-	Quartzic or ultrabasic
Elevation (l)	< 1500 m	-	> 1500 m
Slope (s)	< 2 %	2 - 25 % *	> 25 % *

Remark: \* For volcanic soils in Jawa, 2 - 60 % is conditionally suitable and > 60 % is unsuitable.  
Source: RePPPProT National Overview.

Table 3.2 Land Limitation for Wetland Agriculture Development (1/3)

Province	(1) Groundwater					(2) Inundation					(3) Climate					?	?	?	?		
	S	N	#	?	O	S	N	#	?	O	S	N	#	?	O					S	N
D.I. Aceh	1,204	0	197	3,851	389	33	5,523	11	109	0	0	0	0	0	33	5,117	0	0	525	0	33
Sumatera Utara	1,927	0	161	4,389	595	179	6,881	16	174	0	0	0	0	179	6,014	0	0	1,058	0	179	
Sumatera Barat	834	0	114	3,022	172	27	3,911	174	56	0	0	0	0	27	3,823	0	0	319	0	27	
Riau	7,903	0	269	1,069	25	593	8,799	0	467	0	0	0	0	593	4,710	0	0	4,556	0	593	
Jambi	3,217	0	22	1,532	56	47	4,772	9	47	0	0	0	0	47	3,823	0	0	1,004	0	47	
Sumatera Selatan	7,046	0	386	2,447	91	256	9,044	29	898	0	0	0	0	256	6,998	0	0	2,972	0	256	
Bengkulu	216	0	34	1,832	7	2	2,048	20	20	0	0	0	0	2	1,971	0	0	118	0	2	
Lampung	1,842	0	99	1,423	11	12	3,155	20	201	0	0	0	0	12	3,023	0	0	352	0	12	
Sumatera	24,190	0	1,283	19,565	1,345	1,148	44,133	278	1,972	0	0	0	0	1,148	35,580	0	0	10,903	0	1,148	
D.K.I. Jakarta	64	0	2	0	0	0	65	0	1	0	0	0	0	0	66	0	0	0	0	0	
Jawa Barat	3,573	0	85	825	139	22	4,554	0	68	0	0	0	0	22	4,622	0	0	0	0	22	
Jawa Tengah	2,715	0	91	482	105	20	3,345	0	49	0	0	0	0	20	3,393	0	0	0	0	20	
D.I. Yogyakarta	283	0	2	23	0	6	308	0	1	0	0	0	0	6	309	0	0	0	0	6	
Jawa Timur	3,653	0	74	848	152	92	4,665	0	61	0	0	0	0	92	4,726	0	0	0	0	92	
Jawa	10,282	0	254	2,178	395	140	12,937	0	180	0	0	0	0	140	13,116	0	0	0	0	140	
Bali	462	0	2	80	14	6	556	0	2	0	0	0	0	6	558	0	0	0	0	6	
Nusa Tenggara Barat	430	0	17	1,486	20	1	1,943	0	10	0	0	0	0	1	1,745	0	0	197	11	1	
Nusa Tenggara Timur	1,768	0	79	2,659	117	10	4,575	0	48	0	0	0	0	10	3,953	0	0	599	71	10	
Timor Timur	509	0	1	967	17	13	1,486	0	8	0	0	0	0	13	1,309	0	0	135	49	13	
Bali & NT	3,162	0	92	5,192	167	22	8,559	0	62	0	0	0	0	22	7,566	0	0	930	132	22	
Kalimantan Barat	5,220	0	235	9,142	0	156	14,194	0	403	0	0	0	0	156	14,466	0	0	131	0	156	
Kalimantan Tengah	7,739	0	163	7,421	0	38	15,112	0	210	0	0	0	0	38	15,296	0	0	26	0	38	
Kalimantan Selatan	2,266	0	132	1,270	0	81	3,510	0	157	0	0	0	0	81	3,660	0	0	8	0	81	
Kalimantan Timur	3,917	0	703	14,810	0	292	18,610	0	820	0	0	0	0	292	19,429	0	0	1	0	292	
Kalimantan	19,141	0	1,233	32,642	0	568	51,427	0	1,582	0	0	0	0	568	52,851	0	0	165	0	568	
Sulawesi Utara	299	0	42	2,268	38	8	2,605	0	42	0	0	0	0	8	2,550	0	0	0	96	8	
Sulawesi Tengah	1,371	0	92	4,320	211	60	5,904	0	90	0	0	0	0	60	5,657	0	0	31	305	60	
Sulawesi Selatan	1,638	0	108	4,299	84	101	6,038	0	90	0	0	0	0	101	5,337	0	0	0	792	101	
Sulawesi Tenggara	1,218	0	140	2,226	93	1	3,565	0	112	0	0	0	0	1	3,412	0	0	1	265	1	
Sulawesi	4,526	0	382	13,112	426	170	18,111	0	334	0	0	0	0	170	16,955	0	0	32	1,458	170	
Maluku	2,763	0	331	4,601	0	88	7,483	0	212	0	0	0	0	88	7,065	0	0	35	595	88	
Irian Jaya	17,102	0	3,677	20,233	98	370	34,108	0	6,716	0	0	0	0	370	39,094	0	0	534	0	370	
Maluku & IJ	19,864	0	4,009	24,834	98	438	41,521	0	6,927	0	0	0	0	438	46,152	0	0	569	595	438	
Indonesia	81,178	0	7,259	97,523	2,432	2,513	176,257	278	11,071	0	0	0	0	2,513	172,126	0	0	1,696	13,088	1,483	2,513

Note: S = Suitable, N = Conditionally suitable, O = Unsuitable, # = Not relevant, ? = Not enough data, O = Lake, river, etc. and No data.  
For definition and identification criteria, refer to Table 3.1 and Text.  
Source: JICA-FIDP Team calculation.

Table 3.2 Land Limitation for Wetland Agriculture Development (2/3)

Province	(4) Soil Texture										(5) Soil Depth										(6) Soil Drainage										(000 ha)
	S	N	#	?	O	S	N	#	?	O	S	N	#	?	O	S	N	#	?	O	S	N	#	?	O						
	D.I. Aceh	5,612	0	30	0	0	33	5,369	0	273	0	0	33	1,119	4,417	107	0	0	0	0	0	0	0	0	0	33					
Sumatera Utara	6,798	0	9	0	265	179	6,471	0	335	0	265	179	1,783	5,107	57	0	125	179	0	0	0	0	0	0	179						
Sumatera Barat	4,085	0	27	0	31	27	3,942	0	169	0	31	27	760	3,275	76	0	31	27	0	0	0	0	0	0	27						
Riau	9,258	0	0	0	9	593	5,960	0	3,298	0	9	593	7,317	1,938	3	0	9	593	0	0	0	0	0	0	593						
Jambi	4,827	0	0	0	0	47	4,206	0	621	0	0	47	2,566	2,258	3	0	0	47	0	0	0	0	0	0	47						
Sumatera Selatan	9,934	0	5	0	32	256	9,249	0	689	0	32	256	6,790	3,121	27	0	32	256	0	0	0	0	0	0	256						
Bengkulu	2,076	0	13	0	0	2	2,048	0	40	0	0	2	172	1,898	19	0	0	2	0	0	0	0	0	0	2						
Lampung	3,360	0	6	0	9	12	3,355	0	12	0	9	12	1,852	1,478	37	0	9	12	0	0	0	0	0	0	12						
Sumatera	45,948	0	90	0	345	1,148	40,601	0	5,437	0	345	1,148	22,359	23,491	328	0	205	1,148	0	0	0	0	0	0	1,148						
D.K.I. Jakarta	66	0	0	0	0	66	0	0	0	0	0	0	31	33	1	0	0	0	0	0	0	0	0	0	0						
Jawa Barat	4,617	0	0	0	6	22	4,581	0	25	0	6	22	1,140	3,452	25	0	6	22	0	0	0	0	0	0	22						
Jawa Tengah	3,393	0	0	0	0	20	3,342	0	51	0	0	20	1,177	2,174	43	0	0	20	0	0	0	0	0	0	20						
D.I. Yogyakarta	309	0	0	0	0	6	230	0	79	0	0	6	101	206	2	0	0	6	0	0	0	0	0	0	6						
Jawa Timur	4,726	0	0	0	0	92	4,555	0	172	0	0	92	1,677	3,027	22	0	0	92	0	0	0	0	0	0	92						
Jawa	13,111	0	0	0	6	140	12,774	0	337	0	6	140	5,126	8,892	94	0	6	140	0	0	0	0	0	0	140						
Bali	558	0	0	0	0	548	0	0	10	0	0	6	133	419	6	0	0	6	0	0	0	0	0	0	6						
Nusa Tenggara Barat	341	0	0	0	1,612	1	1,860	0	73	0	0	1	367	1,569	8	0	10	1	0	0	0	0	0	0	1						
Nusa Tenggara Timur	1,796	0	0	0	2,827	10	4,098	0	440	0	85	10	409	4,143	52	0	20	10	0	0	0	0	0	0	10						
Timor Timur	810	0	0	0	685	13	1,254	0	9	0	232	13	84	1,393	1	0	16	13	0	0	0	0	0	0	13						
Bali & NT	3,504	0	0	0	5,124	29	7,759	0	532	0	337	22	992	7,524	56	0	46	22	0	0	0	0	0	0	22						
Kalimantan Barat	13,833	0	402	0	362	156	12,741	0	1,818	0	38	156	3,443	11,131	23	0	0	156	0	0	0	0	0	0	156						
Kalimantan Tengah	12,030	0	2,688	0	605	38	13,301	0	2,021	0	0	38	5,946	9,285	84	0	7	38	0	0	0	0	0	0	38						
Kalimantan Selatan	3,623	0	45	0	0	81	3,403	0	265	0	0	81	1,216	2,340	19	0	93	81	0	0	0	0	0	0	81						
Kalimantan Timur	18,936	0	184	0	310	292	18,001	0	1,151	0	277	292	2,798	16,362	17	0	252	292	0	0	0	0	0	0	292						
Kalimantan	48,420	0	3,318	0	1,277	568	47,446	0	5,256	0	315	568	13,402	39,118	143	0	352	568	0	0	0	0	0	0	568						
Sulawesi Utara	2,646	0	0	0	0	8	2,603	0	43	0	0	8	284	2,350	12	0	0	8	0	0	0	0	0	0	8						
Sulawesi Tengah	5,983	0	11	0	0	60	5,249	0	744	0	0	60	659	5,285	49	0	0	60	0	0	0	0	0	0	60						
Sulawesi Selatan	6,128	0	0	0	0	101	5,817	0	312	0	0	101	1,276	4,805	48	0	0	101	0	0	0	0	0	0	101						
Sulawesi Tenggara	3,666	0	11	0	0	1	2,951	0	726	0	0	1	402	3,224	51	0	0	1	0	0	0	0	0	0	1						
Sulawesi	18,423	0	22	0	0	170	16,620	0	1,824	0	0	170	2,621	15,664	160	0	0	170	0	0	0	0	0	0	170						
Maluku	6,767	0	0	0	928	88	5,707	0	493	0	1,495	88	1,006	6,439	170	0	0	88	0	0	0	0	0	0	88						
Irian Jaya	37,234	0	3,404	0	473	370	34,296	0	6,341	0	473	370	16,071	21,804	2,762	0	473	370	0	0	0	0	0	0	370						
Maluku & I	44,000	0	3,404	0	1,401	458	40,003	0	6,834	0	1,969	458	17,077	28,243	2,932	0	1,969	458	0	0	0	0	0	0	458						
Indonesia	173,406	0	6,834	0	8,153	2,513	165,202	0	20,219	0	2,971	2,513	60,577	122,931	3,723	0	2,971	2,513	0	0	0	0	0	0	2,513						

Note: S = Suitable, \$ = Conditionally suitable, N = Unsuitable, # = Not relevant, ? = Not enough data, O = Lake, river, etc. and No data.

For definition and identification criteria, refer to Table 3.1 and Text.

Source: JICA-FIDP Team calculation.

Table 3.2 Land Limitation for Wetland Agriculture Development (3/3)

Province	(7) Soil Nutrition			(8) Elevation			(9) Slope			(10) Area						
	S	N	#	?	O	S	N	#	?	O	S	N	#	?	O	One or More "r" Area
D.I. Aceh	705	226	0	1,994	33	5,642	0	0	0	0	33	3,895	0	0	33	2,042
Sumatera Utara	737	193	0	3,475	179	7,071	0	0	0	0	179	3,992	0	0	179	3,574
Sumatera Barat	282	129	0	1,179	27	4,142	0	0	0	0	27	2,912	0	0	27	1,270
Riau	1,907	273	0	420	593	9,267	0	0	0	0	593	872	0	0	593	439
Jambi	967	22	0	482	47	4,827	0	0	0	0	47	1,280	0	0	47	535
Sumatera Selatan	1,010	386	0	841	256	9,970	0	0	0	0	256	1,283	0	0	256	929
Bengkulu	460	34	0	411	2	2,088	0	0	0	0	2	1,502	0	0	2	416
Lampung	166	99	0	311	12	3,375	0	0	0	0	12	870	0	0	12	321
Sumatera	5,233	1,362	0	9,112	1,148	46,383	0	0	0	0	1,148	16,606	0	0	1,148	9,526
D.K.I. Jakarta	64	2	0	0	0	66	0	0	0	0	0	0	0	0	0	0
Jawa Barat	4,474	89	0	59	22	4,622	0	0	0	0	22	3,190	0	0	22	199
Jawa Tengah	3,285	91	0	17	20	3,393	0	0	0	0	20	2,070	0	0	20	122
D.I. Yogyakarta	307	2	0	1	6	309	0	0	0	0	6	192	0	0	6	1
Jawa Timur	4,653	66	0	8	92	4,726	0	0	0	0	92	3,806	0	0	92	160
Jawa	12,782	249	0	85	140	13,116	0	0	0	0	140	2,291	0	0	140	481
Bali	549	5	0	4	6	558	0	0	0	0	6	532	0	0	6	18
Nusa Tenggara Barat	197	18	0	1,738	1	1,301	0	0	0	0	1	1,338	0	0	1	2,818
Nusa Tenggara Timur	1,002	78	0	3,524	10	4,120	0	0	0	0	10	1,065	0	0	10	3,878
Timor Timur	581	2	0	769	13	1,304	0	0	0	0	13	374	0	0	13	727
Bali & NT	2,328	104	0	5,034	22	7,283	0	0	0	0	22	2,289	0	0	22	7,440
Kalimantan Barat	4,210	5,582	0	2,456	156	14,597	0	0	0	0	156	6,233	0	0	156	3,056
Kalimantan Tengah	2,613	6,447	0	3,273	38	15,322	0	0	0	0	38	5,858	0	0	38	279
Kalimantan Selatan	1,931	16	0	727	81	3,668	0	0	0	0	81	1,372	0	0	81	952
Kalimantan Timur	8,722	7,683	0	2,746	292	19,429	0	0	0	0	292	10,938	0	0	292	467
Kalimantan	17,475	20,707	0	9,201	568	53,016	0	0	0	0	568	21,508	0	0	568	4,754
Sulawesi Utara	2,395	13	0	241	8	2,646	0	0	0	0	8	335	0	0	8	224
Sulawesi Tengah	4,365	887	0	741	60	5,993	0	0	0	0	60	5,042	0	0	60	1,750
Sulawesi Selatan	5,300	445	0	384	101	6,128	0	0	0	0	101	4,275	0	0	101	3,584
Sulawesi Tenggara	3,084	463	0	131	1	3,677	0	0	0	0	1	855	0	0	1	989
Sulawesi	15,141	1,807	0	1,497	170	18,445	0	0	0	0	170	14,002	0	0	170	6,547
Maluku	4,139	392	0	2,210	88	7,523	0	0	0	0	88	1,106	0	0	88	3,732
Irian Jaya	4,767	1,362	0	28,858	370	29,278	0	0	0	0	370	12,815	0	0	370	28,956
Maluku & I	8,906	1,754	0	31,068	458	36,801	0	0	0	0	458	13,921	0	0	458	32,688
Indonesia	62,866	25,983	0	55,997	2,513	175,044	0	0	0	0	2,513	85,005	0	0	2,513	61,436

Note: S = Suitable, N = Conditionally suitable, U = Unsuitable, # = Not relevant, ? = Not enough data, O = Lake, river, etc. and No data.

For definition and identification criteria, refer to Table 3.1 and Text.

Source: JICA-FIDP Team calculation.

**Table 3.3 Land Suitability for Wetland Agriculture Development by Province**

('000 ha)

Province	Area by Land Suitability Class						Subdivision of \$ Land			
	Total	S	\$	\$\$	N	Unclass	\$i	\$w	\$n	\$s
D.I. Aceh	5,675	217	393	592	4,440	33	11	6	310	67
Sumatera Utara	7,250	246	862	1,368	4,596	179	16	1	557	287
Sumatera Barat	4,169	105	388	384	3,264	27	174	0	91	123
Riau	9,860	879	1,189	2,479	4,720	593	0	181	998	10
Jambi	4,874	279	452	2,042	2,055	47	9	108	323	12
Sumatera Selatan	10,226	359	1,775	4,177	3,659	256	29	22	1,661	63
Bengkulu	2,090	60	64	296	1,668	2	20	1	8	34
Lampung	3,387	49	234	1,637	1,455	12	20	6	189	20
<u>Sumatera</u>	<u>47,531</u>	<u>2,195</u>	<u>5,355</u>	<u>12,976</u>	<u>25,856</u>	<u>1,148</u>	<u>278</u>	<u>324</u>	<u>4,137</u>	<u>616</u>
D.K.I. Jakarta	66	30	0	33	2	0	0	0	0	0
Jawa Barat	4,645	779	299	2,891	654	22	0	0	0	299
Jawa Tengah	3,413	743	385	1,683	582	20	0	0	0	385
D.I. Yogyakarta	315	14	86	105	103	6	0	0	0	86
Jawa Timur	4,818	454	1,162	2,598	513	92	0	0	0	1,162
<u>Jawa</u>	<u>13,257</u>	<u>2,019</u>	<u>1,932</u>	<u>7,310</u>	<u>1,855</u>	<u>140</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1,932</u>
Bali	564	4	127	396	31	6	0	0	0	127
Nusa Tenggara Barat	1,954	153	82	209	1,508	1	0	0	0	82
Nusa Tenggara Timur	4,633	159	100	765	3,599	10	0	0	20	80
Timor Timur	1,507	75	0	282	1,137	13	0	0	0	0
<u>Bali &amp; NT</u>	<u>8,657</u>	<u>392</u>	<u>309</u>	<u>1,652</u>	<u>6,275</u>	<u>29</u>	<u>0</u>	<u>0</u>	<u>20</u>	<u>290</u>
Kalimantan Barat	14,753	701	132	3,892	9,872	156	0	0	100	32
Kalimantan Tengah	15,360	1,001	276	2,037	12,008	38	0	0	276	0
Kalimantan Selatan	3,749	848	0	1,345	1,475	81	0	0	0	0
Kalimantan Timur	19,721	517	268	5,644	13,000	292	0	0	100	168
<u>Kalimantan</u>	<u>53,583</u>	<u>3,067</u>	<u>676</u>	<u>12,918</u>	<u>36,355</u>	<u>568</u>	<u>0</u>	<u>0</u>	<u>476</u>	<u>200</u>
Sulawesi Utara	2,655	60	183	211	2,192	8	0	1	0	182
Sulawesi Tengah	6,053	229	302	150	5,313	60	0	6	0	296
Sulawesi Selatan	6,229	747	330	539	4,513	101	0	4	0	326
Sulawesi Tenggara	3,678	164	106	703	2,704	1	0	0	0	106
<u>Sulawesi</u>	<u>18,615</u>	<u>1,200</u>	<u>920</u>	<u>1,602</u>	<u>14,723</u>	<u>170</u>	<u>0</u>	<u>10</u>	<u>0</u>	<u>910</u>
Maluku	7,783	507	270	1,358	5,560	88	0	0	26	244
Irian Jaya	41,480	4,210	2,931	2,386	31,583	370	0	0	674	2,257
<u>Maluku &amp; IJ</u>	<u>49,263</u>	<u>4,717</u>	<u>3,201</u>	<u>3,744</u>	<u>37,143</u>	<u>458</u>	<u>0</u>	<u>0</u>	<u>700</u>	<u>2,502</u>
<u>Indonesia</u>	<u>190,905</u>	<u>13,590</u>	<u>12,394</u>	<u>40,202</u>	<u>122,207</u>	<u>2,513</u>	<u>278</u>	<u>334</u>	<u>5,333</u>	<u>6,449</u>

Note: S = Fully suitable; \$ = Conditionally suitable; \$\$ = Marginally suitable; N = Unsuitable; and Unclassified = Lakes, rivers, no data areas, etc.

\$i = Conditionally suitable by inundation; \$w = Conditionally suitable by soil drainage;

\$n = Conditionally suitable by soil nutrients; and \$s = Conditionally suitable by slope.

Source: JICA-FIDP Team calculation based on RePPProT

**Table 3.4 Swamp Area and Suitability for Wetland Agriculture Development by Province**

Province	('000 ha)									
	Total Swamp (%)		Swamp Area				Inland Swamp by Suitability for Paddy Cultivation			
			Tidal Swamp (%)		Inland Swamp (%)		S	\$	\$\$	N
D.I. Aceh	578	10%	65	1%	513	9%	155	151	0	207
Sumatera Utara	905	12%	97	1%	808	11%	162	236	0	409
Sumatera Barat	331	8%	16	0%	315	8%	61	41	0	213
Riau	4,659	47%	267	3%	4,392	45%	453	499	0	3,440
Jambi	1,017	21%	19	0%	999	20%	201	155	0	643
Sumatera Selatan	2,631	26%	355	3%	2,276	22%	261	790	0	1,226
Bengkulu	92	4%	3	0%	89	4%	43	4	0	42
Lampung	333	10%	57	2%	275	8%	39	74	0	163
<b>Sumatera</b>	<b>10,545</b>	<b>22%</b>	<b>879</b>	<b>2%</b>	<b>9,667</b>	<b>20%</b>	<b>1,375</b>	<b>1,949</b>	<b>0</b>	<b>6,342</b>
D.K.I. Jakarta	24	37%	1	2%	23	35%	23	0	0	0
Jawa Barat	567	12%	63	1%	504	11%	493	0	0	11
Jawa Tengah	551	16%	46	1%	505	15%	487	0	0	17
D.I. Yogyakarta	12	4%	0	0%	12	4%	10	0	0	1
Jawa Timur	361	7%	55	1%	306	6%	296	0	0	11
<b>Jawa</b>	<b>1,514</b>	<b>11%</b>	<b>165</b>	<b>1%</b>	<b>1,350</b>	<b>10%</b>	<b>1,309</b>	<b>0</b>	<b>0</b>	<b>41</b>
Bali	6	1%	2	0%	4	1%	3	0	0	0
Nusa Tenggara Barat	131	7%	11	1%	120	6%	23	0	0	98
Nusa Tenggara Timur	150	3%	37	1%	114	2%	33	3	0	78
Timor Timur	38	3%	0	0%	38	3%	36	0	0	2
<b>Bali &amp; NT</b>	<b>326</b>	<b>4%</b>	<b>50</b>	<b>1%</b>	<b>276</b>	<b>3%</b>	<b>94</b>	<b>3</b>	<b>0</b>	<b>178</b>
Kalimantan Barat	2,360	16%	216	1%	2,144	15%	70	15	0	2,059
Kalimantan Tengah	4,024	26%	79	1%	3,945	26%	726	83	0	3,137
Kalimantan Selatan	983	26%	115	3%	867	23%	651	0	0	216
Kalimantan Timur	1,914	10%	688	3%	1,226	6%	364	15	0	847
<b>Kalimantan</b>	<b>9,280</b>	<b>17%</b>	<b>1,098</b>	<b>2%</b>	<b>8,182</b>	<b>15%</b>	<b>1,811</b>	<b>113</b>	<b>0</b>	<b>6,259</b>
Sulawesi Utara	81	3%	31	1%	50	2%	36	0	0	14
Sulawesi Tengah	258	4%	48	1%	210	3%	144	0	0	66
Sulawesi Selatan	767	12%	64	1%	703	11%	564	0	0	139
Sulawesi Tenggara	242	7%	98	3%	144	4%	112	0	0	32
<b>Sulawesi</b>	<b>1,348</b>	<b>7%</b>	<b>241</b>	<b>1%</b>	<b>1,107</b>	<b>6%</b>	<b>855</b>	<b>0</b>	<b>0</b>	<b>252</b>
Maluku	485	6%	222	3%	264	3%	246	4	0	15
Irian Jaya	7,223	17%	1,361	3%	5,862	14%	1,553	88	29	4,192
<b>Maluku &amp; IJ</b>	<b>7,708</b>	<b>16%</b>	<b>2,064</b>	<b>4%</b>	<b>8,340</b>	<b>17%</b>	<b>1,799</b>	<b>91</b>	<b>29</b>	<b>4,207</b>
<b>Indonesia</b>	<b>30,721</b>	<b>16%</b>	<b>4,015</b>	<b>2%</b>	<b>26,707</b>	<b>14%</b>	<b>7,243</b>	<b>2,157</b>	<b>29</b>	<b>17,278</b>

Note: S = Fully suitable, \$ = Conditionally suitable, \$\$ = Marginally suitable, N = Unsuitable - for paddy cultivation  
 Source: Team calculation based on RePPProT.

**Table 4.1 Land Use by Province in RePPPOT Study**

Province	('000 ha)											
	Forest	Bush/ Scrub	Grass- land	Shifting Cultiva- tion	Upland	Wetland	Estates Agroforest Reforest	Water	Unvege- tated	Settle- ments	No Data	Total
D.I. Aceh	3,882	548	293	70	46	241	258	24	2	96	216	5,675
Sumatera Utara	2,812	997	624	386	513	457	1,160	135	1	148	16	7,250
Sumatera Barat	2,590	553	190	122	151	302	77	25	0	141	18	4,169
Riau	5,937	1,292	201	491	39	417	557	109	0	149	669	9,860
Jambi	2,766	873	77	201	83	226	504	56	0	81	8	4,874
Sumatera Selatan	3,562	2,226	1,063	1,457	470	419	410	109	5	435	72	10,226
Bengkulu	1,127	353	99	215	33	37	169	0	3	15	41	2,090
Lampung	648	835	213	489	373	58	417	7	0	293	55	3,387
<b>Sumatera</b>	<b>23,324</b>	<b>7,675</b>	<b>2,759</b>	<b>3,429</b>	<b>1,707</b>	<b>2,156</b>	<b>3,550</b>	<b>465</b>	<b>12</b>	<b>1,359</b>	<b>1,096</b>	<b>47,531</b>
D.K.I. Jakarta	0	0	0	0	4	9	2	2	0	10	40	66
Jawa Barat	500	845	12	197	771	996	781	78	5	433	29	4,646
Jawa Tengah	203	311	11	36	607	950	615	43	12	617	21	3,424
D.I. Yogyakarta	1	46	0	19	45	84	44	1	5	55	6	304
Jawa Timur	541	366	38	37	847	1,123	1,067	97	11	651	40	4,817
<b>Jawa</b>	<b>1,245</b>	<b>1,567</b>	<b>60</b>	<b>289</b>	<b>2,273</b>	<b>3,161</b>	<b>2,509</b>	<b>220</b>	<b>32</b>	<b>1,765</b>	<b>135</b>	<b>13,257</b>
Bali	101	63	7	5	131	108	102	4	8	32	2	563
Nusa Tenggara Barat	933	312	111	64	133	229	33	1	45	93	1	1,954
Nusa Tenggara Timur	979	1,553	962	324	254	129	35	7	20	72	299	4,633
Timor Timur	557	388	354	99	8	32	26	10	8	4	2	1,488
<b>Bali &amp; NT</b>	<b>2,570</b>	<b>2,316</b>	<b>1,435</b>	<b>491</b>	<b>525</b>	<b>498</b>	<b>195</b>	<b>21</b>	<b>81</b>	<b>201</b>	<b>304</b>	<b>8,637</b>
Kalimantan Barat	8,701	2,846	340	2,085	0	146	437	166	0	30	2	14,753
Kalimantan Tengah	11,614	505	271	2,486	3	224	42	7	0	2	207	15,360
Kalimantan Selatan	1,796	495	616	237	0	426	88	27	0	61	4	3,749
Kalimantan Timur	17,875	476	198	652	0	135	52	200	0	36	97	19,721
<b>Kalimantan</b>	<b>39,986</b>	<b>4,322</b>	<b>1,425</b>	<b>5,460</b>	<b>3</b>	<b>930</b>	<b>619</b>	<b>399</b>	<b>0</b>	<b>129</b>	<b>310</b>	<b>53,583</b>
Sulawesi Utara	1,554	264	33	35	107	108	305	8	5	54	183	2,656
Sulawesi Tengah	4,359	431	230	157	91	158	168	41	10	43	345	6,033
Sulawesi Selatan	2,879	1,077	495	216	434	505	289	152	14	146	38	6,245
Sulawesi Tenggara	2,478	406	357	119	128	58	20	0	1	63	53	3,681
<b>Sulawesi</b>	<b>11,269</b>	<b>2,179</b>	<b>1,114</b>	<b>527</b>	<b>760</b>	<b>829</b>	<b>782</b>	<b>201</b>	<b>29</b>	<b>306</b>	<b>619</b>	<b>18,615</b>
Maluku	6,348	439	269	216	49	18	18	34	19	2	390	7,802
Irian Jaya	34,958	378	3,214	1,287	4	74	15	841	398	79	233	41,480
<b>Maluku &amp; IJ</b>	<b>41,306</b>	<b>816</b>	<b>3,482</b>	<b>1,504</b>	<b>53</b>	<b>92</b>	<b>33</b>	<b>875</b>	<b>416</b>	<b>82</b>	<b>623</b>	<b>49,282</b>
<b>Indonesia</b>	<b>119,701</b>	<b>18,875</b>	<b>10,275</b>	<b>11,699</b>	<b>5,322</b>	<b>7,666</b>	<b>7,687</b>	<b>2,182</b>	<b>571</b>	<b>3,842</b>	<b>3,087</b>	<b>190,905</b>

Source: RePPPOT National Overview

**Table 4.2 Revised Forest Category (THGK) Areas in Forest Land by Province**

Province							(000 ha)
	Nature Reserve PPA/HSA	Protect Forest HL/HB	Limited Product HPT	Normal Product HPB/HP	Convert Forest HPK/HK	Unclass /Reserve UNC/HPP	Total Area
D.I. Aceh	914	2,410	72	158	295	29	3,877
Sumatera Utara	424	1,520	161	286	383	11	2,784
Sumatera Barat	622	1,391	98	71	376	1	2,559
Riau	604	573	76	2,869	1,771	11	5,904
Jambi	483	565	138	434	1,115	0	2,734
Sumatera Selatan	577	530	74	1,189	1,169	0	3,539
Bengkulu	397	566	5	7	162	0	1,136
Lampung	268	157	3	0	233	0	661
<b>Sumatera</b>	<b>4,287</b>	<b>7,711</b>	<b>626</b>	<b>5,013</b>	<b>5,505</b>	<b>52</b>	<b>23,194</b>
Nusa Tenggara Barat	226	597	60	8	60	1	953
Nusa Tenggara Timur	172	672	67	1	65	0	977
Timor Timur	53	477	0	0	22	0	552
<b>Nusa Tenggara</b>	<b>452</b>	<b>1,746</b>	<b>128</b>	<b>9</b>	<b>147</b>	<b>1</b>	<b>2,482</b>
Kalimantan Barat	1,623	1,978	1,013	1,916	2,214	0	8,743
Kalimantan Tengah	581	1,404	2,994	3,011	3,614	11	11,614
Kalimantan Selatan	233	522	165	19	840	0	1,780
Kalimantan Timur	3,550	5,506	3,220	857	4,767	1	17,901
<b>Kalimantan</b>	<b>5,987</b>	<b>9,409</b>	<b>7,392</b>	<b>5,803</b>	<b>11,436</b>	<b>12</b>	<b>40,038</b>
Sulawesi Utara	403	1,060	2	0	108	0	1,573
Sulawesi Tengah	1,277	2,790	42	39	196	0	4,343
Sulawesi Selatan	264	2,270	26	22	276	0	2,858
Sulawesi Tenggara	262	1,854	35	22	274	0	2,448
<b>Sulawesi</b>	<b>2,206</b>	<b>7,974</b>	<b>105</b>	<b>83</b>	<b>854</b>	<b>0</b>	<b>11,220</b>
Maluku	1,404	3,700	240	417	587	16	6,364
Irian Jaya	6,767	14,466	1,983	4,569	7,245	0	35,030
<b>Maluku &amp; IJ</b>	<b>8,171</b>	<b>18,166</b>	<b>2,223</b>	<b>4,986</b>	<b>7,832</b>	<b>16</b>	<b>41,394</b>
<b>Indonesia ex. Jawa &amp; Bali</b>	<b>21,102</b>	<b>45,005</b>	<b>10,474</b>	<b>15,893</b>	<b>25,773</b>	<b>81</b>	<b>118,328</b>

Note 1: This table shows TGHK areas in only forest land, although whole land is classified into TGHK category  
 Note 2: There is no TGHK classification in Jawa & Bali, because almost all forest land there has been developed  
 Source: RePPPProT National Overview



**Table 4.3 Land Availability for Wetland Agriculture Development by Province  
(1) All Suitability Classes**

Province	Gross total area ('000 ha)	Actually used area for Sawah ('000 ha)	(%)	Actually used area for other purposes ('000 ha)	(%)	Gross available area for wetland development ('000 ha)	(%)	Net available area ('000 ha)
D.I. Aceh	5,674.8	215.2	4%	3,774.6	67%	1,685.0	30%	606.6
Sumatera Utara	7,250.1	341.0	5%	4,087.9	56%	2,821.2	39%	1,015.6
Sumatera Barat	4,169.0	210.0	5%	2,647.2	63%	1,311.8	31%	472.2
Riau	9,859.5	384.5	4%	5,083.2	52%	4,391.8	45%	1,581.0
Jambi	4,873.9	194.6	4%	2,427.9	50%	2,251.4	46%	810.5
Sumatera Selatan	10,226.3	585.5	6%	4,299.2	42%	5,341.6	52%	1,923.0
Bengkulu	2,090.4	47.6	2%	1,224.4	59%	818.4	39%	294.6
Lampung	3,386.7	110.5	3%	1,379.8	41%	1,896.4	56%	682.7
<b>Sumatera</b>	<b>47,530.7</b>	<b>2,088.9</b>	<b>4%</b>	<b>24,924.2</b>	<b>52%</b>	<b>20,517.6</b>	<b>43%</b>	<b>7,386.3</b>
D.K.I. Jakarta	65.8	26.7	41%	33.4	51%	5.7	9%	2.1
Jawa Barat	4,644.6	923.5	20%	2,078.5	45%	1,642.6	35%	591.3
Jawa Tengah	3,412.8	877.5	26%	1,467.5	43%	1,067.8	31%	384.4
D.I. Yogyakarta	315.1	81.0	26%	121.5	39%	112.6	36%	40.5
Jawa Timur	4,818.2	1,222.9	25%	2,303.2	48%	1,292.1	27%	465.2
<b>Jawa</b>	<b>13,256.5</b>	<b>3,131.6</b>	<b>24%</b>	<b>6,004.1</b>	<b>45%</b>	<b>4,120.8</b>	<b>31%</b>	<b>1,483.5</b>
Bali	563.9	104.3	18%	252.9	45%	206.7	37%	74.4
Nusa Tenggara Barat	1,953.7	181.7	9%	893.5	46%	878.5	45%	316.3
Nusa Tenggara Timur	4,632.5	141.7	3%	1,757.1	38%	2,733.7	59%	984.1
Timor Timur	1,506.8	16.8	1%	692.6	46%	797.4	53%	287.1
<b>Bali &amp; NT</b>	<b>8,656.9</b>	<b>444.5</b>	<b>5%</b>	<b>3,596.1</b>	<b>42%</b>	<b>4,616.3</b>	<b>53%</b>	<b>1,661.9</b>
Kalimantan Barat	14,753.0	279.2	2%	8,926.8	61%	5,547.0	38%	1,996.9
Kalimantan Tengah	15,360.4	363.2	2%	8,393.8	55%	6,603.4	43%	2,377.2
Kalimantan Selatan	3,749.0	296.0	8%	1,816.4	48%	1,636.6	44%	589.2
Kalimantan Timur	19,721.0	204.1	1%	14,596.1	74%	4,920.8	25%	1,771.5
<b>Kalimantan</b>	<b>53,583.4</b>	<b>1,142.5</b>	<b>2%</b>	<b>33,733.1</b>	<b>63%</b>	<b>18,707.8</b>	<b>35%</b>	<b>6,734.8</b>
Sulawesi Utara	2,654.5	86.5	3%	1,657.5	62%	910.5	34%	327.8
Sulawesi Tengah	6,053.2	188.9	3%	4,432.4	73%	1,431.9	24%	515.5
Sulawesi Selatan	6,229.1	460.0	7%	3,775.3	61%	1,993.8	32%	717.8
Sulawesi Tenggara	3,677.7	95.9	3%	2,317.0	63%	1,264.8	34%	455.3
<b>Sulawesi</b>	<b>18,614.5</b>	<b>831.3</b>	<b>4%</b>	<b>12,182.2</b>	<b>65%</b>	<b>5,601.0</b>	<b>30%</b>	<b>2,016.4</b>
Maluku	7,782.9	56.5	1%	5,294.5	68%	2,431.9	31%	875.5
Irian Jaya	41,480.0	66.2	0%	28,099.9	68%	13,313.9	32%	4,793.0
<b>Maluku &amp; NT</b>	<b>49,262.9</b>	<b>122.7</b>	<b>0%</b>	<b>33,394.4</b>	<b>68%</b>	<b>15,745.8</b>	<b>32%</b>	<b>5,668.5</b>
<b>Indonesia</b>	<b>190,904.9</b>	<b>7,761.5</b>	<b>4%</b>	<b>113,834.1</b>	<b>60%</b>	<b>69,309.3</b>	<b>36%</b>	<b>24,951.3</b>

Note: Actually used area for other purposes includes water-covered area and no data area.  
Source: JICA-FIDP Team calculation based on RePPPProT

**Table 4.3 Land Availability for Wetland Agriculture Development by Province  
(2) Fully Suitable Land**

Province	Gross total area ('000 ha)	Actually used area for Sawah ('000 ha)	(%)	Actually used area for other purposes ('000 ha)	(%)	Gross available area for wetland development ('000 ha)	(%)	Net available area ('000 ha)
D.I. Aceh	217.4	52.5	24%	74.1	34%	90.8	42%	32.7
Sumatera Utara	245.8	52.2	21%	81.2	33%	112.4	46%	40.5
Sumatera Barat	105.2	27.1	26%	25.9	25%	52.2	50%	18.8
Riau	879.1	108.8	12%	365.3	42%	405.0	46%	145.8
Jambi	279.1	73.2	26%	104.7	38%	101.2	36%	36.4
Sumatera Selatan	359.3	89.2	25%	132.2	37%	137.9	38%	49.6
Bengkulu	60.3	15.1	25%	13.4	22%	31.8	53%	11.4
Lampung	49.1	14.2	29%	16.4	33%	18.5	38%	6.7
<b>Sumatera</b>	<b>2,195.3</b>	<b>432.3</b>	<b>20%</b>	<b>813.2</b>	<b>37%</b>	<b>949.8</b>	<b>43%</b>	<b>341.9</b>
D.K.I. Jakarta	30.3	20.8	69%	9.5	31%	0.0	0%	0.0
Jawa Barat	778.6	515.8	66%	240.6	31%	22.2	3%	8.0
Jawa Tengah	743.1	455.2	61%	235.7	32%	52.2	7%	18.8
D.I. Yogyakarta	13.7	8.7	64%	4.3	31%	0.7	5%	0.3
Jawa Timur	453.5	311.4	69%	142.1	31%	0.0	0%	0.0
<b>Jawa</b>	<b>2,019.2</b>	<b>1,311.9</b>	<b>65%</b>	<b>632.2</b>	<b>31%</b>	<b>75.1</b>	<b>4%</b>	<b>27.0</b>
Bali	4.3	3.0	70%	1.3	30%	0.0	0%	0.0
Nusa Tenggara Barat	153.4	64.6	42%	44.5	29%	44.3	29%	15.9
Nusa Tenggara Timur	159.1	41.6	26%	20.0	13%	97.5	61%	35.1
Timor Timur	75.2	9.1	12%	13.0	17%	53.1	71%	19.1
<b>Bali &amp; NT</b>	<b>392.0</b>	<b>118.3</b>	<b>30%</b>	<b>78.8</b>	<b>20%</b>	<b>194.9</b>	<b>50%</b>	<b>70.2</b>
Kalimantan Barat	701.3	203.6	29%	167.2	24%	330.5	47%	119.0
Kalimantan Tengah	1,000.9	267.6	27%	235.3	24%	498.0	50%	179.3
Kalimantan Selatan	848.0	283.8	33%	176.8	21%	387.4	46%	139.5
Kalimantan Timur	516.7	153.0	30%	109.3	21%	254.4	49%	91.6
<b>Kalimantan</b>	<b>3,066.9</b>	<b>908.0</b>	<b>30%</b>	<b>688.6</b>	<b>22%</b>	<b>1,470.3</b>	<b>48%</b>	<b>529.3</b>
Sulawesi Utara	60.3	18.8	31%	12.6	21%	28.9	48%	10.4
Sulawesi Tengah	228.5	74.8	33%	48.9	21%	104.8	46%	37.7
Sulawesi Selatan	746.9	292.0	39%	186.6	25%	268.3	36%	96.6
Sulawesi Tenggara	163.9	54.2	33%	37.2	23%	72.5	44%	26.1
<b>Sulawesi</b>	<b>1,199.6</b>	<b>439.8</b>	<b>37%</b>	<b>285.3</b>	<b>24%</b>	<b>474.5</b>	<b>40%</b>	<b>170.8</b>
Maluku	506.5	32.5	6%	109.2	22%	364.8	72%	131.3
Irian Jaya	4,210.0	0.0	0%	982.6	23%	3,227.4	77%	1,161.9
<b>Maluku &amp; NT</b>	<b>4,716.5</b>	<b>32.5</b>	<b>1%</b>	<b>1,091.8</b>	<b>23%</b>	<b>3,592.2</b>	<b>76%</b>	<b>1,293.2</b>
<b>Indonesia</b>	<b>13,589.5</b>	<b>3,242.8</b>	<b>24%</b>	<b>3,589.9</b>	<b>26%</b>	<b>6,756.8</b>	<b>50%</b>	<b>2,432.4</b>

Note: Actually used area for other purposes includes water-covered area and no data area.  
Source: JICA-FIDP Team calculation based on RePPPOT

**Table 4.3 Land Availability for Wetland Agriculture Development by Province  
(3) Conditionally Suitable Land**

Province	Gross total area ('000 ha)	Actually used area for Sawah ('000 ha)	(%)	Actually used area for other purposes ('000 ha)	(%)	Gross available area for wetland development ('000 ha)	(%)	Net available area ('000 ha)
D.I. Aceh	392.6	96.7	25%	141.0	36%	154.9	39%	55.8
Sumatera Utara	861.7	194.7	23%	407.4	47%	259.6	30%	93.5
Sumatera Barat	388.2	132.3	34%	124.6	32%	131.3	34%	47.3
Riau	1,188.6	247.0	21%	479.3	40%	462.3	39%	166.4
Jambi	451.5	90.3	20%	175.2	39%	186.0	41%	67.0
Sumatera Selatan	1,774.8	448.8	25%	730.2	41%	595.8	34%	214.5
Bengkulu	63.5	19.4	31%	12.6	20%	31.5	50%	11.3
Lampung	234.4	68.8	29%	94.9	40%	70.7	30%	25.5
<b>Sumatera</b>	<b>5,355.3</b>	<b>1,298.0</b>	<b>24%</b>	<b>2,165.2</b>	<b>40%</b>	<b>1,892.1</b>	<b>35%</b>	<b>681.2</b>
D.K.I. Jakarta	0.0	0.0		0.0		0.0		0.0
Jawa Barat	298.8	141.8	47%	110.8	37%	46.2	15%	16.6
Jawa Tengah	385.0	189.6	49%	161.3	42%	34.1	9%	12.3
D.I. Yogyakarta	86.4	45.7	53%	36.3	42%	4.4	5%	1.6
Jawa Timur	1,161.9	586.6	50%	508.1	44%	67.2	6%	24.2
<b>Jawa</b>	<b>1,932.1</b>	<b>963.7</b>	<b>50%</b>	<b>816.5</b>	<b>42%</b>	<b>151.9</b>	<b>8%</b>	<b>54.7</b>
Bali	127.2	63.7	50%	48.9	38%	14.6	11%	5.3
Nusa Tenggara Barat	82.2	28.3	34%	30.3	37%	23.6	29%	8.5
Nusa Tenggara Timur	99.6	8.9	9%	17.5	18%	73.2	73%	26.4
Timor Timur	0.3	0.0	0%	0.0	0%	0.3	100%	0.1
<b>Bali &amp; NT</b>	<b>309.3</b>	<b>100.9</b>	<b>33%</b>	<b>96.7</b>	<b>31%</b>	<b>111.7</b>	<b>36%</b>	<b>40.2</b>
Kalimantan Barat	132.0	19.1	14%	25.4	19%	87.5	66%	31.5
Kalimantan Tengah	275.8	52.5	19%	49.9	18%	173.4	63%	62.4
Kalimantan Selatan	0.0	0.0		0.0		0.0		0.0
Kalimantan Timur	268.3	19.3	7%	48.9	18%	200.1	75%	72.0
<b>Kalimantan</b>	<b>676.1</b>	<b>90.9</b>	<b>13%</b>	<b>124.2</b>	<b>18%</b>	<b>461.0</b>	<b>68%</b>	<b>166.0</b>
Sulawesi Utara	182.8	55.8	31%	74.4	41%	52.6	29%	18.9
Sulawesi Tengah	301.5	87.1	29%	99.5	33%	114.9	38%	41.4
Sulawesi Selatan	329.5	128.1	39%	69.6	21%	131.8	40%	47.4
Sulawesi Tenggara	106.0	28.1	27%	33.9	32%	44.0	42%	15.8
<b>Sulawesi</b>	<b>919.8</b>	<b>299.1</b>	<b>33%</b>	<b>277.4</b>	<b>30%</b>	<b>343.3</b>	<b>37%</b>	<b>123.6</b>
Maluku	269.9	7.8	3%	83.9	31%	178.2	66%	64.2
Irian Jaya	2,931.4	63.3	2%	1,031.7	35%	1,836.4	63%	661.1
<b>Maluku &amp; NT</b>	<b>3,201.3</b>	<b>71.1</b>	<b>2%</b>	<b>1,115.6</b>	<b>35%</b>	<b>2,014.6</b>	<b>63%</b>	<b>725.3</b>
<b>Indonesia</b>	<b>12,393.9</b>	<b>2,823.7</b>	<b>23%</b>	<b>4,595.6</b>	<b>37%</b>	<b>4,974.6</b>	<b>40%</b>	<b>1,790.9</b>

Note: Actually used area for other purposes includes water-covered area and no data area.  
Source: JICA-FIDP Team calculation based on RePPPOT

**Table 4.3 Land Availability for Wetland Agriculture Development by Province  
(4) Marginally Suitable Land**

Province	Gross total area (‘000 ha)	Actually used area for Sawah (‘000 ha)	(%)	Actually used area for other purposes (‘000 ha)	(%)	Gross available area for wetland development (‘000 ha)	(%)	Net available area (‘000 ha)
D.I. Aceh	592.4	45.8	8%	243.4	41%	303.2	51%	109.2
Sumatera Utara	1,367.9	56.3	4%	636.8	47%	674.8	49%	242.9
Sumatera Barat	384.4	32.1	8%	174.3	45%	178.0	46%	64.1
Riau	2,479.2	14.7	1%	873.1	35%	1,591.4	64%	572.9
Jambi	2,041.9	21.0	1%	775.5	38%	1,245.4	61%	448.3
Sumatera Selatan	4,177.2	26.8	1%	1,330.5	32%	2,819.9	68%	1,015.2
Bengkulu	296.4	4.8	2%	138.6	47%	153.0	52%	55.1
Lampung	1,636.8	16.4	1%	442.1	27%	1,178.3	72%	424.2
<b>Sumatera</b>	<b>12,976.2</b>	<b>217.9</b>	<b>2%</b>	<b>4,614.3</b>	<b>36%</b>	<b>8,144.0</b>	<b>63%</b>	<b>2,931.8</b>
D.K.I. Jakarta	33.4	5.5	16%	22.2	66%	5.7	17%	2.1
Jawa Barat	2,890.9	245.6	8%	1,435.0	50%	1,210.3	42%	435.7
Jawa Tengah	1,682.7	200.4	12%	767.8	46%	714.5	42%	257.2
D.I. Yogyakarta	105.3	23.8	23%	44.2	42%	37.3	35%	13.4
Jawa Timur	2,598.0	297.4	11%	1,251.8	48%	1,048.8	40%	377.6
<b>Jawa</b>	<b>7,310.3</b>	<b>772.7</b>	<b>11%</b>	<b>3,521.0</b>	<b>48%</b>	<b>3,016.6</b>	<b>41%</b>	<b>1,086.0</b>
Bali	396.1	34.6	9%	174.5	44%	187.0	47%	67.3
Nusa Tenggara Barat	209.4	7.8	4%	43.9	21%	157.7	75%	56.8
Nusa Tenggara Timur	764.8	11.2	1%	145.6	19%	608.0	79%	218.9
Timor Timur	281.6	0.4	0%	67.9	24%	213.3	76%	76.8
<b>Bali &amp; NT</b>	<b>1,651.9</b>	<b>54.0</b>	<b>3%</b>	<b>431.9</b>	<b>26%</b>	<b>1,166.0</b>	<b>71%</b>	<b>419.8</b>
Kalimantan Barat	3,891.7	9.4	0%	1,388.7	36%	2,493.6	64%	897.7
Kalimantan Tengah	2,037.2	5.0	0%	891.3	44%	1,140.9	56%	410.7
Kalimantan Selatan	1,344.7	3.0	0%	333.2	25%	1,008.5	75%	363.1
Kalimantan Timur	5,644.1	11.9	0%	2,664.1	47%	2,968.1	53%	1,068.5
<b>Kalimantan</b>	<b>12,917.7</b>	<b>29.3</b>	<b>0%</b>	<b>5,277.3</b>	<b>41%</b>	<b>7,611.1</b>	<b>59%</b>	<b>2,740.0</b>
Sulawesi Utara	210.9	4.4	2%	94.8	45%	111.7	53%	40.2
Sulawesi Tengah	149.9	1.6	1%	47.9	32%	100.4	67%	36.1
Sulawesi Selatan	538.5	24.3	5%	161.5	30%	352.7	65%	127.0
Sulawesi Tenggara	702.8	8.7	1%	218.5	31%	475.6	68%	171.2
<b>Sulawesi</b>	<b>1,602.1</b>	<b>39.0</b>	<b>2%</b>	<b>522.7</b>	<b>33%</b>	<b>1,040.4</b>	<b>65%</b>	<b>374.5</b>
Maluku	1,358.2	3.0	0%	722.3	53%	632.9	47%	227.8
Irian Jaya	2,385.7	2.2	0%	1,446.7	61%	936.8	39%	337.2
<b>Maluku &amp; NT</b>	<b>3,743.9</b>	<b>5.2</b>	<b>0%</b>	<b>2,169.0</b>	<b>58%</b>	<b>1,569.7</b>	<b>42%</b>	<b>565.1</b>
<b>Indonesia</b>	<b>40,202.1</b>	<b>1,118.1</b>	<b>3%</b>	<b>16,536.2</b>	<b>41%</b>	<b>22,547.8</b>	<b>56%</b>	<b>8,117.2</b>

Note: Actually used area for other purposes includes water-covered area and no data area.

Source: JICA-FIDP Team calculation based on RePPPProT

**Table 4.3 Land Availability for Wetland Agriculture Development by Province  
(5) Unsuitable Land**

Province	Gross total area	Actually used area for Sawah		Actually used area for other purposes		Gross available area for wetland development		Net available area
	('000 ha)	('000 ha)	(%)	('000 ha)	(%)	('000 ha)	(%)	('000 ha)
D.I. Aceh	4,439.6	20.2	0%	3,283.3	74%	1,136.1	26%	409.0
Sumatera Utara	4,595.9	37.8	1%	2,783.7	61%	1,774.4	39%	638.8
Sumatera Barat	3,264.2	18.5	1%	2,295.4	70%	950.3	29%	342.1
Riau	4,719.7	14.0	0%	2,772.6	59%	1,933.1	41%	695.9
Jambi	2,054.5	10.1	0%	1,325.6	65%	718.8	35%	258.8
Sumatera Selatan	3,659.1	20.7	1%	1,850.4	51%	1,788.0	49%	643.7
Bengkulu	1,668.2	8.3	0%	1,057.8	63%	602.1	36%	216.8
Lampung	1,454.8	11.1	1%	814.8	56%	628.9	43%	226.4
<b>Sumatera</b>	<b>25,856.0</b>	<b>140.7</b>	<b>1%</b>	<b>16,183.6</b>	<b>63%</b>	<b>9,531.7</b>	<b>37%</b>	<b>3,431.4</b>
D.K.I. Jakarta	2.1	0.4	19%	1.7	81%	0.0	0%	0.0
Jawa Barat	653.9	20.3	3%	269.7	41%	363.9	56%	131.0
Jawa Tengah	582.4	32.3	6%	283.1	49%	267.0	46%	96.1
D.I. Yogyakarta	103.3	2.8	3%	30.3	29%	70.2	68%	25.3
Jawa Timur	512.9	27.5	5%	309.3	60%	176.1	34%	63.4
<b>Jawa</b>	<b>1,854.6</b>	<b>83.3</b>	<b>4%</b>	<b>894.1</b>	<b>48%</b>	<b>877.2</b>	<b>47%</b>	<b>315.8</b>
Bali	30.5	3.0	10%	22.4	73%	5.1	17%	1.8
Nusa Tenggara Barat	1,507.9	81.0	5%	774.0	51%	652.9	43%	235.0
Nusa Tenggara Timur	3,599.3	80.0	2%	1,564.3	43%	1,955.0	54%	703.8
Timor Timur	1,136.9	7.3	1%	598.9	53%	530.7	47%	191.1
<b>Bali &amp; NT</b>	<b>6,274.6</b>	<b>171.3</b>	<b>3%</b>	<b>2,959.6</b>	<b>47%</b>	<b>3,143.7</b>	<b>50%</b>	<b>1,131.7</b>
Kalimantan Barat	9,871.7	47.1	0%	7,189.2	73%	2,635.4	27%	948.7
Kalimantan Tengah	12,008.1	38.1	0%	7,178.9	60%	4,791.1	40%	1,724.8
Kalimantan Selatan	1,475.1	9.2	1%	1,225.2	83%	240.7	16%	86.7
Kalimantan Timur	13,000.2	19.9	0%	11,482.1	88%	1,498.2	12%	539.4
<b>Kalimantan</b>	<b>36,355.1</b>	<b>114.3</b>	<b>0%</b>	<b>27,075.4</b>	<b>74%</b>	<b>9,165.4</b>	<b>25%</b>	<b>3,299.5</b>
Sulawesi Utara	2,192.4	7.5	0%	1,467.6	67%	717.3	33%	258.2
Sulawesi Tengah	5,313.2	25.4	0%	4,176.0	79%	1,111.8	21%	400.2
Sulawesi Selatan	4,513.3	15.6	0%	3,256.7	72%	1,241.0	27%	446.8
Sulawesi Tenggara	2,704.4	4.9	0%	2,026.8	75%	672.7	25%	242.2
<b>Sulawesi</b>	<b>14,723.3</b>	<b>53.4</b>	<b>0%</b>	<b>10,927.1</b>	<b>74%</b>	<b>3,742.8</b>	<b>25%</b>	<b>1,347.4</b>
Maluku	5,560.0	13.2	0%	4,290.8	77%	1,256.0	23%	452.2
Irian Jaya	31,583.3	0.7	0%	24,269.3	77%	7,313.3	23%	2,632.8
<b>Maluku &amp; NT</b>	<b>37,143.3</b>	<b>13.9</b>	<b>0%</b>	<b>28,560.1</b>	<b>77%</b>	<b>8,569.3</b>	<b>23%</b>	<b>3,084.9</b>
<b>Indonesia</b>	<b>122,206.9</b>	<b>576.9</b>	<b>0%</b>	<b>86,599.9</b>	<b>71%</b>	<b>35,030.1</b>	<b>29%</b>	<b>12,610.8</b>

Note: Actually used area for other purposes includes water-covered area and no data area.

Source: JICA-FIDP Team calculation based on RePPProT

**Table 4.3 Land Availability for Wetland Agriculture Development by Province  
(6) Fully and Conditionally Suitable Land**

Province	Gross total area ( <sup>'000</sup> ha)	Actually used area for Sawah ( <sup>'000</sup> ha)	(%)	Actually used area for other purposes ( <sup>'000</sup> ha)	(%)	Gross available area for wetland development ( <sup>'000</sup> ha)	(%)	Net available area ( <sup>'000</sup> ha)
D.I. Aceh	610.0	149.2	24%	215.1	35%	245.7	40%	88.5
Sumatera Utara	1,107.5	246.9	22%	488.6	44%	372.0	34%	133.9
Sumatera Barat	493.4	159.4	32%	150.5	31%	183.5	37%	66.1
Riau	2,067.7	355.8	17%	844.6	41%	867.3	42%	312.2
Jambi	730.6	163.5	22%	279.9	38%	287.2	39%	103.4
Sumatera Selatan	2,134.1	538.0	25%	862.4	40%	733.7	34%	264.1
Bengkulu	123.8	34.5	28%	26.0	21%	63.3	51%	22.8
Lampung	283.5	83.0	29%	111.3	39%	89.2	31%	32.1
<b>Sumatera</b>	<b>7,550.6</b>	<b>1,730.3</b>	<b>23%</b>	<b>2,978.4</b>	<b>39%</b>	<b>2,841.9</b>	<b>38%</b>	<b>1,023.1</b>
D.K.I. Jakarta	30.3	20.8	69%	9.5	31%	0.0	0%	0.0
Jawa Barat	1,077.4	657.6	61%	351.4	33%	68.4	6%	24.6
Jawa Tengah	1,128.1	644.8	57%	397.0	35%	86.3	8%	31.1
D.I. Yogyakarta	100.1	54.4	54%	40.6	41%	5.1	5%	1.8
Jawa Timur	1,615.4	898.0	56%	650.2	40%	67.2	4%	24.2
<b>Jawa</b>	<b>3,951.3</b>	<b>2,275.6</b>	<b>58%</b>	<b>1,448.7</b>	<b>37%</b>	<b>227.0</b>	<b>6%</b>	<b>81.7</b>
Bali	131.5	66.7	51%	50.2	38%	14.6	11%	5.3
Nusa Tenggara Barat	235.6	92.9	39%	74.8	32%	67.9	29%	24.4
Nusa Tenggara Timur	258.7	50.5	20%	37.5	14%	170.7	66%	61.5
Timor Timur	75.5	9.1	12%	13.0	17%	53.4	71%	19.2
<b>Bali &amp; NT</b>	<b>701.3</b>	<b>219.2</b>	<b>31%</b>	<b>175.5</b>	<b>25%</b>	<b>306.6</b>	<b>44%</b>	<b>110.4</b>
Kalimantan Barat	833.3	222.7	27%	192.6	23%	418.0	50%	150.5
Kalimantan Tengah	1,276.7	320.1	25%	285.2	22%	671.4	53%	241.7
Kalimantan Selatan	848.0	283.8	33%	176.8	21%	387.4	46%	139.5
Kalimantan Timur	785.0	172.3	22%	158.2	20%	454.5	58%	163.6
<b>Kalimantan</b>	<b>3,743.0</b>	<b>998.9</b>	<b>27%</b>	<b>812.8</b>	<b>22%</b>	<b>1,931.3</b>	<b>52%</b>	<b>695.3</b>
Sulawesi Utara	243.1	74.6	31%	87.0	36%	81.5	34%	29.3
Sulawesi Tengah	530.0	161.9	31%	148.4	28%	219.7	41%	79.1
Sulawesi Selatan	1,076.4	420.1	39%	256.2	24%	400.1	37%	144.0
Sulawesi Tenggara	269.9	82.3	30%	71.1	26%	116.5	43%	41.9
<b>Sulawesi</b>	<b>2,119.4</b>	<b>738.9</b>	<b>35%</b>	<b>562.7</b>	<b>27%</b>	<b>817.8</b>	<b>39%</b>	<b>294.4</b>
Maluku	776.4	40.3	5%	193.1	25%	543.0	70%	195.5
Irian Jaya	7,141.4	63.3	1%	2,014.3	28%	5,063.8	71%	1,823.0
<b>Maluku &amp; NT</b>	<b>7,917.8</b>	<b>103.6</b>	<b>1%</b>	<b>2,207.4</b>	<b>28%</b>	<b>5,606.8</b>	<b>71%</b>	<b>2,018.4</b>
<b>Indonesia</b>	<b>25,983.4</b>	<b>6,066.5</b>	<b>23%</b>	<b>8,185.5</b>	<b>32%</b>	<b>11,731.4</b>	<b>45%</b>	<b>4,223.3</b>

Note: Actually used area for other purposes includes water-covered area and no data area.  
Source: JICA-FIDP Team calculation based on RePPPOT

**Table 5.1 Land Potential for Wetland Agriculture Development by Province**

Province	Net potential area				
	Total	Fully suitable	Conditionally suitable	Marginally suitable	Unsuitable
	('000 ha)				
D.I. Aceh	606.6	32.7	55.8	109.2	409.0
Sumatera Utara	1,015.6	40.5	93.5	242.9	638.8
Sumatera Barat	472.2	18.8	47.3	64.1	342.1
Riau	1,581.0	145.8	166.4	572.9	695.9
Jambi	810.5	36.4	67.0	448.3	258.8
Sumatera Selatan	1,923.0	49.6	214.5	1,015.2	643.7
Bengkulu	294.6	11.4	11.3	55.1	216.8
Lampung	682.7	6.7	25.5	424.2	226.4
<u>Sumatera</u>	<u>7,386.3</u>	<u>341.9</u>	<u>681.2</u>	<u>2,931.8</u>	<u>3,431.4</u>
D.K.I. Jakarta	2.1	0.0	0.0	2.1	0.0
Jawa Barat	591.3	8.0	16.6	435.7	131.0
Jawa Tengah	384.4	18.8	12.3	257.2	96.1
D.I. Yogyakarta	40.5	0.3	1.6	13.4	25.3
Jawa Timur	465.2	0.0	24.2	377.6	63.4
<u>Jawa</u>	<u>1,483.5</u>	<u>27.0</u>	<u>54.7</u>	<u>1,086.0</u>	<u>315.8</u>
Bali	74.4	0.0	5.3	67.3	1.8
Nusa Tenggara Barat	316.3	15.9	8.5	56.8	235.0
Nusa Tenggara Timur	984.1	35.1	26.4	218.9	703.8
Timor Timur	287.1	19.1	0.1	76.8	191.1
<u>Bali &amp; NT</u>	<u>1,661.9</u>	<u>70.2</u>	<u>40.2</u>	<u>419.8</u>	<u>1,131.7</u>
Kalimantan Barat	1,996.9	119.0	31.5	897.7	948.7
Kalimantan Tengah	2,377.2	179.3	62.4	410.7	1,724.8
Kalimantan Selatan	589.2	139.5	0.0	363.1	86.7
Kalimantan Timur	1,771.5	91.6	72.0	1,068.5	539.4
<u>Kalimantan</u>	<u>6,734.8</u>	<u>529.3</u>	<u>166.0</u>	<u>2,740.0</u>	<u>3,299.5</u>
Sulawesi Utara	327.8	10.4	18.9	40.2	258.2
Sulawesi Tengah	515.5	37.7	41.4	36.1	400.2
Sulawesi Selatan	717.8	96.6	47.4	127.0	446.8
Sulawesi Tenggara	455.3	26.1	15.8	171.2	242.2
<u>Sulawesi</u>	<u>2,016.4</u>	<u>170.8</u>	<u>123.6</u>	<u>374.5</u>	<u>1,347.4</u>
Maluku	875.5	131.3	64.2	227.8	452.2
Irian Jaya	4,793.0	1,161.9	661.1	337.2	2,632.8
<u>Maluku &amp; IJ</u>	<u>5,668.5</u>	<u>1,293.2</u>	<u>725.3</u>	<u>565.1</u>	<u>3,084.9</u>
<u>Indonesia</u>	<u>24,951.3</u>	<u>2,432.4</u>	<u>1,790.9</u>	<u>8,117.2</u>	<u>12,610.8</u>

Source: JICA-FIDP Team calculation based on RePPProT

Table 5.2 Irrigation Development Potential Area by Province in 1990

Province	Potential Area by Water	Potential Area by Land					Irrigation Development Potential	
		Total	Irrigable Rainfed	Fully suitable	Conditionally suitable	Marginally suitable	(Province)	(River basin)
		<2>=sum(3:6)	<3>	<4>	<5>	<6>	<7>=min(1:2)	<8>
								(000 ha)
D.I. Aceh	1,346	277	80	33	56	109	277	266
Sumatera Utara	1,034	505	128	40	93	243	505	380
Sumatera Barat	1,191	175	45	19	47	64	175	164
Riau	2,266	922	36	146	166	573	922	865
Jambi	1,183	574	22	36	67	448	574	495
Sumatera Selatan	1,518	1,314	35	50	214	1,015	1,314	1,263
Bengkulu	1,183	85	7	11	11	55	85	85
Lampung	369	490	34	7	25	424	369	251
<b>Sumatera</b>	<b>10,089</b>	<b>4,342</b>	<b>388</b>	<b>342</b>	<b>681</b>	<b>2,932</b>	<b>4,221</b>	<b>3,768</b>
D.K.I. Jakarta	0	3	1	0	0	2	0	0
Jawa Barat	64	636	176	8	17	436	64	64
Jawa Tengah	7	517	229	19	12	257	7	7
D.I. Yogyakarta	0	22	7	0	2	13	0	0
Jawa Timur	0	591	189	0	24	378	0	0
<b>Jawa</b>	<b>71</b>	<b>1,769</b>	<b>602</b>	<b>27</b>	<b>55</b>	<b>1,086</b>	<b>71</b>	<b>71</b>
Bali	0	73	0	0	5	67	0	0
Nusa Tenggara Barat	7	101	19	16	8	57	7	7
Nusa Tenggara Timur	53	289	9	35	26	219	53	53
Timor Timur	35	96	0	19	0	77	35	33
<b>Bali &amp; NT</b>	<b>94</b>	<b>559</b>	<b>29</b>	<b>70</b>	<b>40</b>	<b>420</b>	<b>94</b>	<b>93</b>
Kalimantan Barat	5,089	1,155	106	119	32	898	1,155	1,133
Kalimantan Selatan	3,455	681	29	179	62	411	681	676
Kalimantan Tengah	512	602	100	139	0	363	512	428
Kalimantan Timur	4,627	1,255	23	92	72	1,069	1,255	1,251
<b>Kalimantan</b>	<b>13,683</b>	<b>3,693</b>	<b>258</b>	<b>529</b>	<b>166</b>	<b>2,740</b>	<b>3,603</b>	<b>3,489</b>
Sulawesi Utara	258	78	8	10	19	40	78	68
Sulawesi Tengah	530	122	7	38	41	36	122	119
Sulawesi Tenggara	240	473	202	97	47	127	240	173
Sulawesi Selatan	187	216	3	26	16	171	187	138
<b>Sulawesi</b>	<b>1,215</b>	<b>889</b>	<b>220</b>	<b>171</b>	<b>124</b>	<b>375</b>	<b>627</b>	<b>498</b>
Maluku	1,225	423	0	131	64	228	423	365
Irian Jaya	12,588	2,160	0	1,162	661	337	2,160	2,160
<b>Maluku &amp; IJ</b>	<b>13,813</b>	<b>2,584</b>	<b>0</b>	<b>1,293</b>	<b>725</b>	<b>565</b>	<b>2,584</b>	<b>2,525</b>
<b>Indonesia</b>	<b>38,965</b>	<b>13,836</b>	<b>1,496</b>	<b>2,432</b>	<b>1,791</b>	<b>8,117</b>	<b>11,199</b>	<b>10,443</b>

Notes:

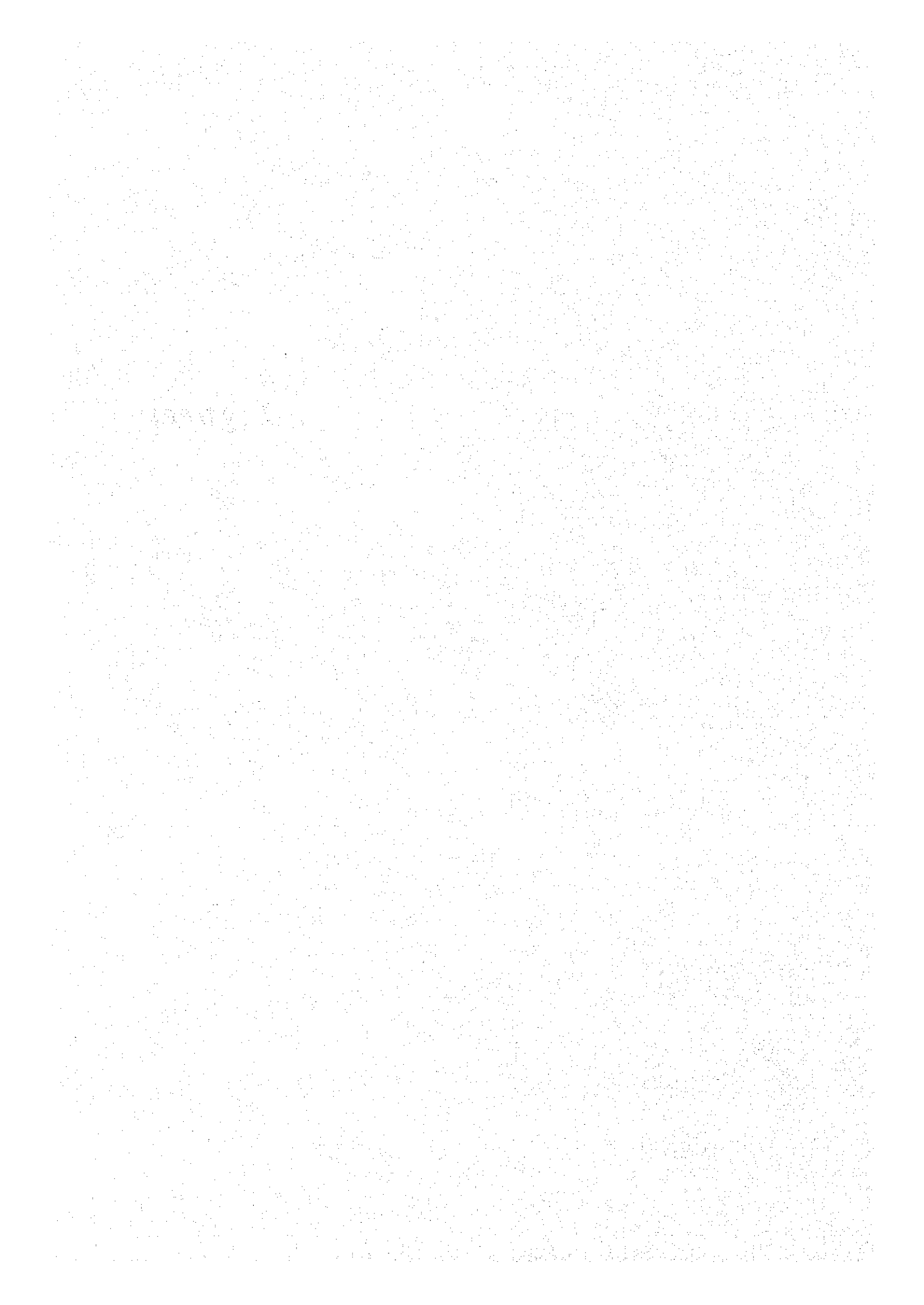
- (1): Irrigation development potential in 1990 from FIDP water resources assessment.
- (3): Estimated irrigable area within present rainfed paddy field, based on CBS data and FIDP land suitability study.
- (4), (5), (6): Paddy field extension potential by FIDP land potential study.
- (7): Irrigation development potential from viewpoint of water and land potential, calculated on provincial basis.
- (8): Irrigation development potential from viewpoint of water and land potential, calculated on river basin basis.

Source: JICA-FIDP Team calculation.





## *Figures*



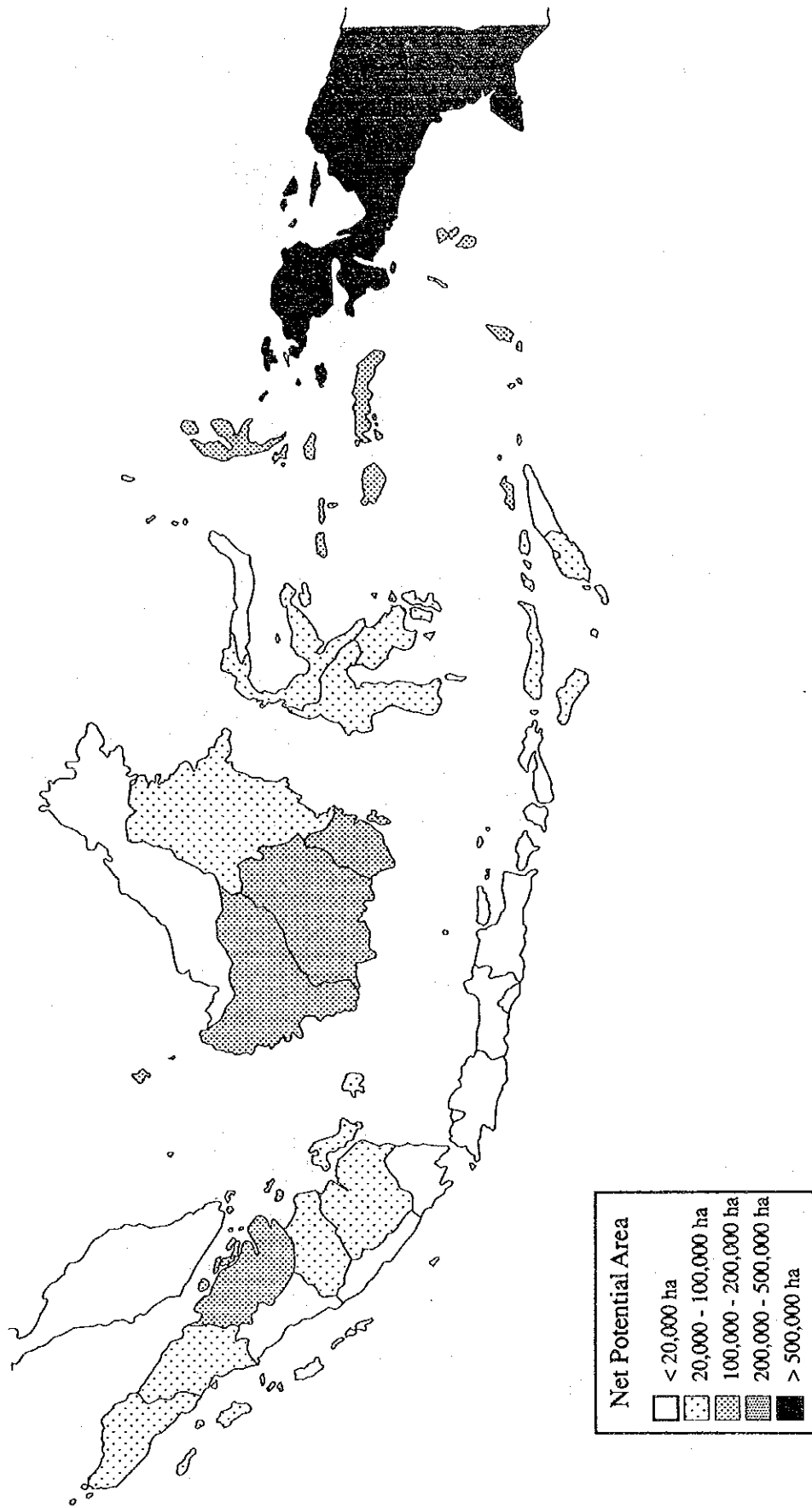


Figure 5.1 Land Potential for Wetland Agriculture Development by Province (Fully Suitable Land)

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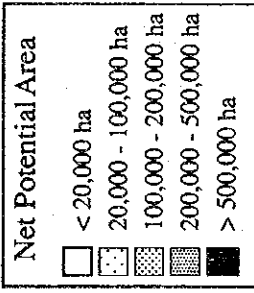
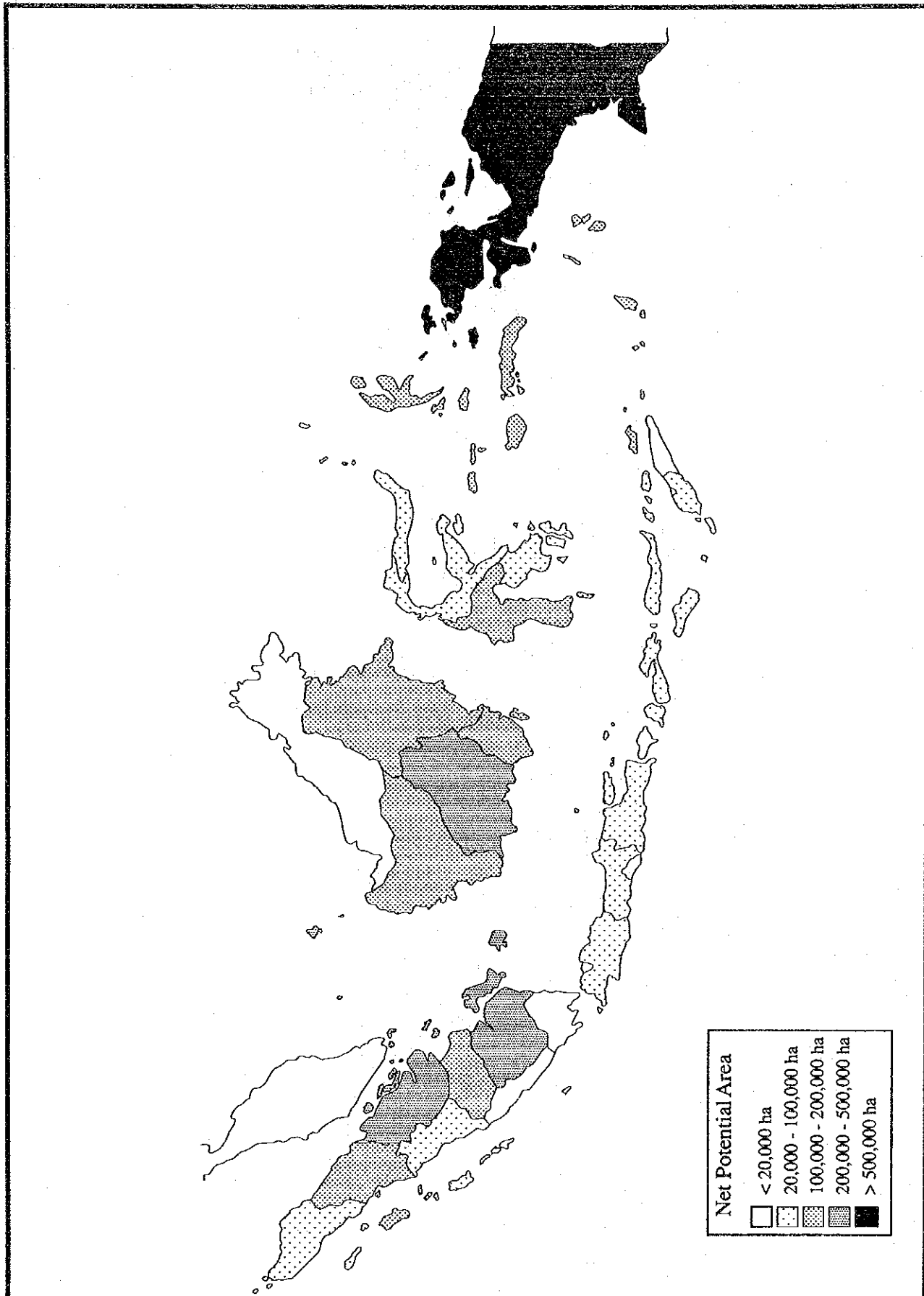


Figure 5.2 Land Potential for Wetland Agriculture Development by Province (Fully and Conditionally Suitable Land)

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 IRRIGATION DEVELOPMENT PROGRAM  
 JAPAN INTERNATIONAL COOPERATION AGENCY

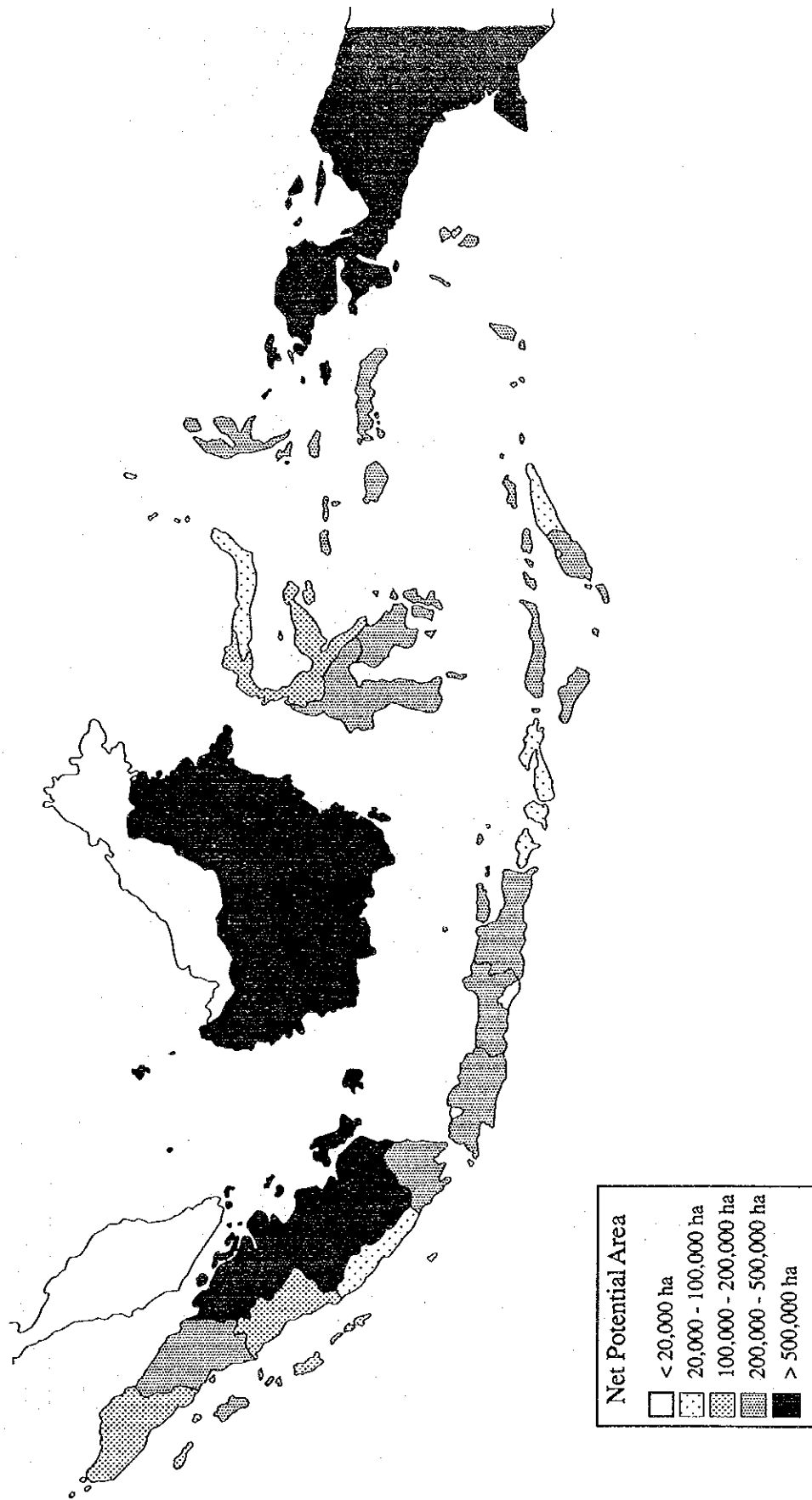


Figure 5.3 Land Potential for Wetland Agriculture Development by Province (All Suitable Land)

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FORMULATION OF IRRIGATION DEVELOPMENT PROGRAM
JAPAN INTERNATIONAL COOPERATION AGENCY

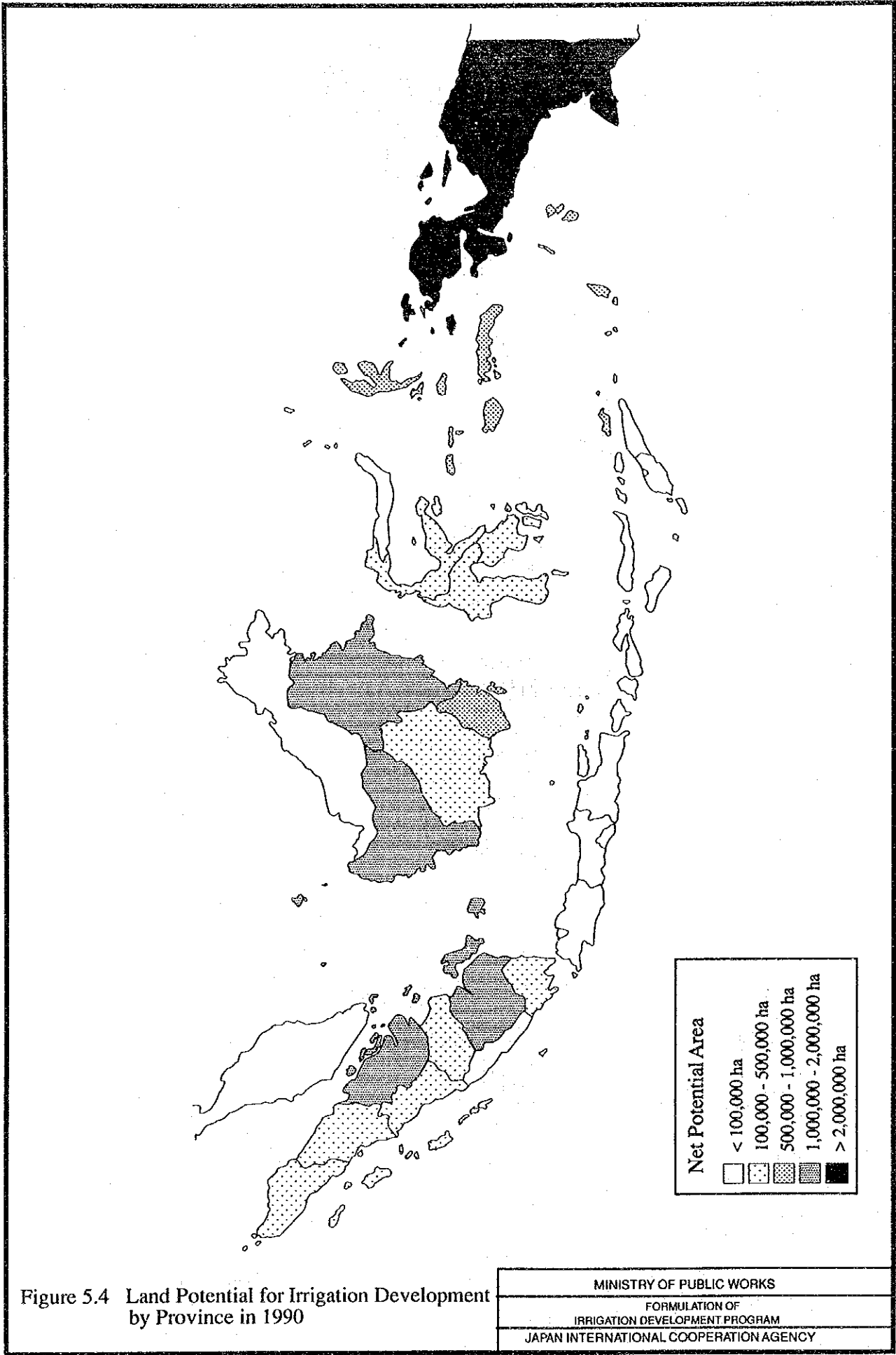


Figure 5.4 Land Potential for Irrigation Development by Province in 1990

*Annex D*

*Water Resources Assessment*





## ANNEX D

### WATER RESOURCES ASSESSMENT

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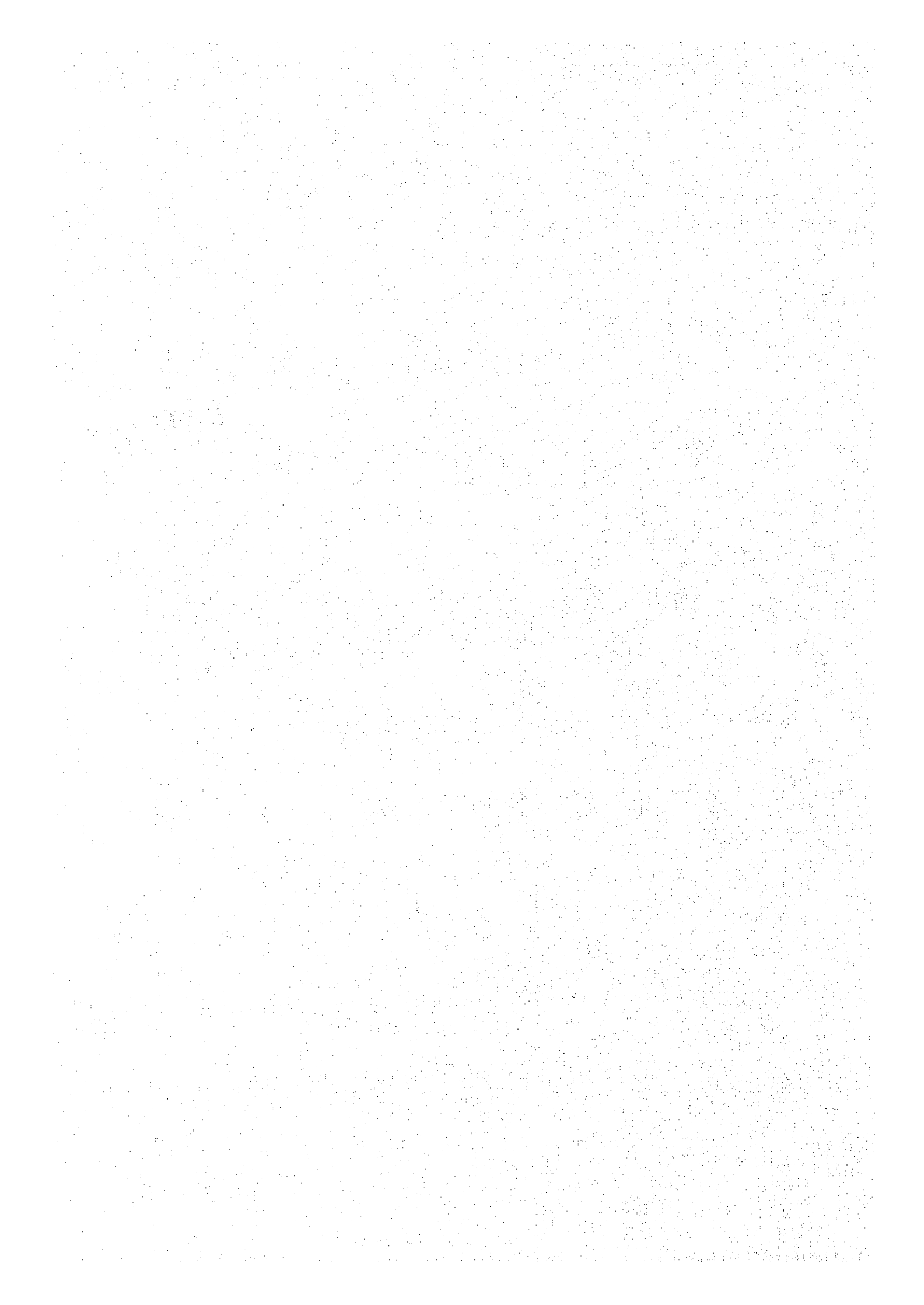
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## Abbreviations

BTA-155	Bantuan Teknik Asin - 155
CBS (BPS)	Central Bureau of Statistics (Biro Pusat Statistik)
DAB	Directorate of Water Supply
DMI	Domestic, Municipal and Industrial
FAO	Food and Agriculture Organization of the United Nations
IWRD	Integrated Water Resources Development
JICA	Japan International Cooperation Agency
NT	Nusa Tenggara
Palawija	Secondary food crops (grown mainly in dry season)
REPELITA	Rencana Pembangunan Lima Tahun (Five-Year Development Plan)
RePPPProt	Regional Physical. Planning Program for Transmigration
SWS	Satuan Wilayah Sungai

*Text*



## **1. Introduction**

The Indonesia is endowed with rich rainfall and fertile land for paddy production. This good circumstance for paddy planting is not cover whole Indonesia uniformly. Fertile land area is not always received enough rainfall and much precipitation zone has not always good soil for planting. To clarify spatial distribution of suitable area for wetland paddy planting (irrigation potential area), this Annex made assessment work in whole Indonesia by using available data and parameter.

Irrigation potential area is derived from balance between land potential area and water potential area. Water potential area is estimated from available water for irrigation and unit irrigation water requirement. For land potential, Annex C give the land availability and suitability in each Province. Then this Annex mainly describe the water availability in whole Indonesia.

Available irrigation water is estimated by subtracting the water demands such as domestic use, industrial water, livestock water etc. from the water resources (river water). Water resources are calculated using the hydrological records of monthly river discharge and monthly rainfall records. Water demands is also calculated on monthly basis.

The procedure of above estimation of irrigation potential area in terms of water resources is shown in Figure 1.1 schematically.

## **2. River Basin**

According to the regulation of the Ministry of Public Works (Ref. 1), Indonesia is divided into 90 river territories or SWS (Satuan Wilayah Sungai). This river territory system is however rather administrative management boundary than hydrological watershed boundary system. For example, SWS No.213 (Kali Brantas) has clear dividing ridge which divide this SWS into two drainage area. For the purpose of water balance calculation and assessment of water availability, this SWS river territory system is divided further into 136 river basins. River territory was subdivided into river basins if it has

- island(s), those island(s) should be one river basin,
- some large scale river systems, SWS divided into those river systems,
- different watershed which estuary is also different ocean and
- large enough drainage area which can be divided into tow parts, i.e. upper river basin and lower river basin.

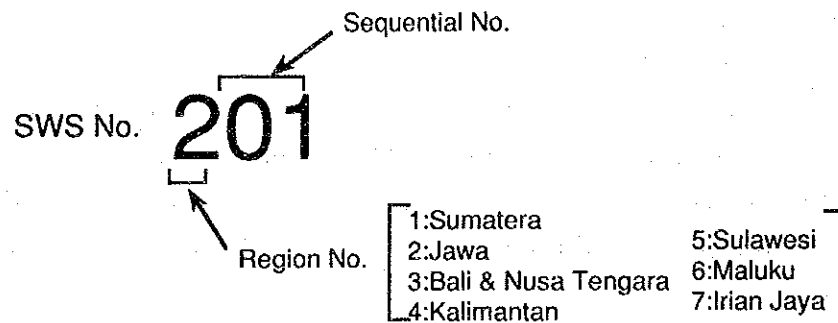
Figure 2.1 ~ 2.7 shows so divided 136 river basins and Figure 2.8 ~ 2.11 shows



fractionized SWS.

## 2.1 River Basin Coding

Each SWS has three digit coding system as illustrated below.



Based on the SWS's coding system, all river basins are coded by four digit coding system as illustrated below and tabulated in Table 2.1.

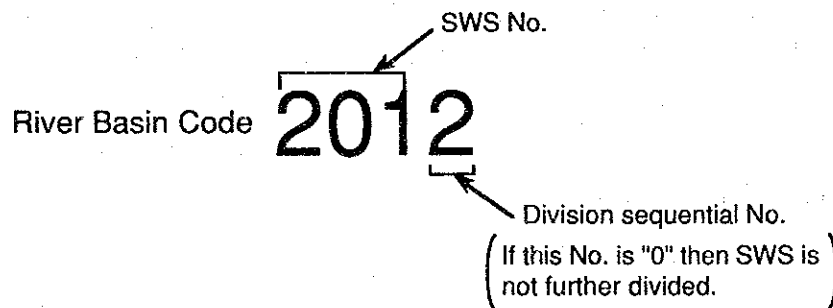
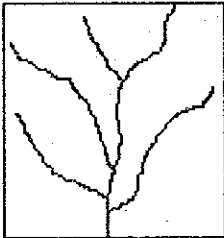

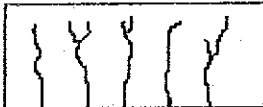



Table 2.1 shows also the name of each river basin which was quoted from its river name or island name.

## 2.2 Basin Geography

Table 2.2 shows the present natural geographic conditions of all river basins except three provinces of Timor Timur, Maluku and Irian Jaya which has incomplete information and some basins which consist of small islands. Information presented in this Table are;

Item	data source
- Basin Area	measured by computer program (ARC/INFO) based on the topographic map of 1:1,000,000 scale
- Kabupaten Area	CBS's province area was allocated to each Kabupaten in proportion to computer measured area.
- Representative Province	If there are two or three provinces, representative province has the largest basin area.
- Basin Rainfall	mean annual rainfall
- Coefficient of Variation	$CV = \frac{\text{standard deviation of monthly rainfall}}{\text{monthly mean rainfall}}$
- Vegetation	applied land use data in CBS's publication, 1990
- Livestock No.	applied livestock numbers data in CBS' publication, 1989
- Population	CBS's data in 1990
- Runoff	estimated from monthly mean rainfall
- Size of Basin	<p>following four types are applied</p> <div style="display: flex; flex-direction: column; align-items: flex-start;"> <div style="margin-bottom: 10px;">  <p><b>Large Scale Type</b> (square shape) Basin area is larger than 10,000 km<sup>2</sup> Long river course Large tributary</p> </div> <div style="margin-bottom: 10px;">  <p><b>Medium Scale Type</b> (tall shape) Basin area is 1,000 km<sup>2</sup>~10,000 km<sup>2</sup> Middle range river course middle size tributary</p> </div> <div style="margin-bottom: 10px;">  <p><b>Small Scale Type</b> (wide shape) Basin area is less than 1,000 km<sup>2</sup> Consist of some short rivers</p> </div> <div>  <p><b>Island Type</b> (circle shape) Small rivers flow from center located mountain to the sea</p> </div> </div>

### 2.3 River Basin Characteristics

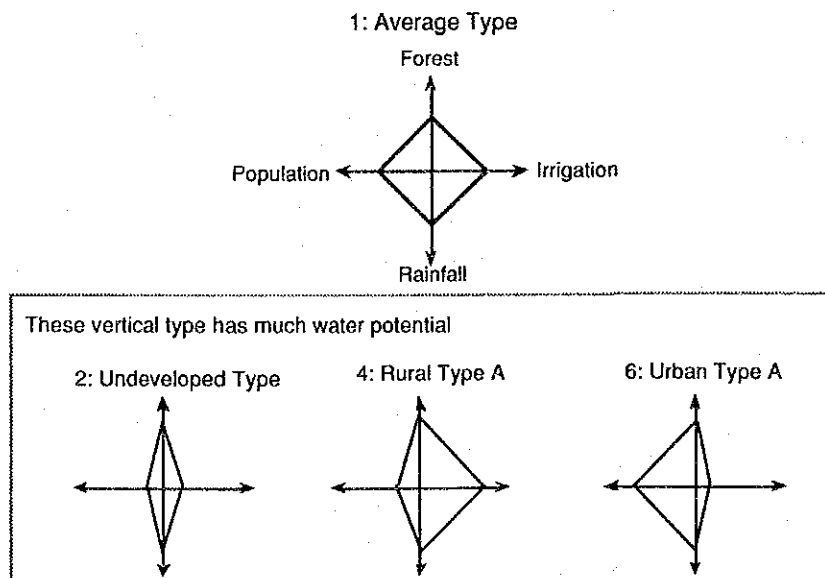
To grasp basin's characteristics in view of water resource development and watershed conservation, four major items, namely forest area, rainfall, irrigation area and population are selected and made radar chart for easy understanding (see Table 2.2).

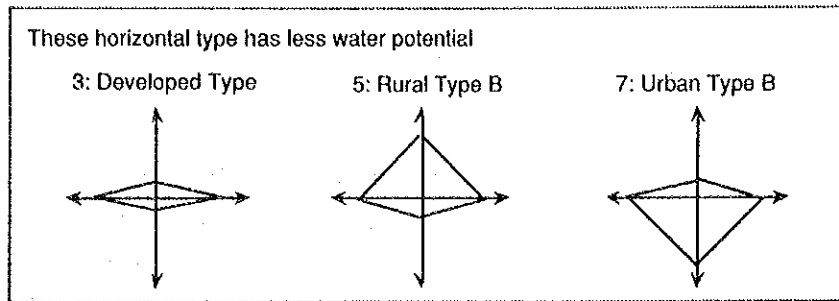
Parameter	Description	Range
1 : Forest	ratio of forest area to basin area	13% ~ 97%
2 : Rainfall	annual rainfall	1,277mm~ 4,224mm
3 : Irrigation	ratio of irrigation area to basin area	0% ~ 35.1%
4 : Population	population density rural population are converted to urban population in proportion of water consumption rate	1 ~ 2,757 person/km <sup>2</sup>

To make radar chart, above four parameters are divided into following five classes.

Class division				
Class	Forest (%)	Irrigation (%)	Population (person / km <sup>2</sup> )	Rainfall (mm)
1	12.5 ~ 30.0	0 ~ 2.5	0 ~ 2.5	< 1,500
2	30.0 ~ 46.0	2.5 ~ 5.0	25 ~ 75	1,500 ~ 2,000
3	46.0 ~ 63.0	5.0 ~ 10.0	75 ~ 150	2,000 ~ 2,500
4	63.0 ~ 80.0	10.0 ~ 15.0	150 ~ 250	2,500 ~ 3,000
5	>80.0	>15.0	>250	>3,000

Figure 2.12 shows the all radar chart for selected river basins. Those radar chart can simply be grouped as following seven types





## 2.4 Basin Development

In view of irrigation development, all selected river basin were evaluated and categorized into following three development type for further development direction taking into account basin's characteristic (radar chart) and some other information (rainfall variation, total population, vegetation).

- 1.: Development Basin has much development potential. Basin development should be pay attention to basin environment and conservation.
- 2.: Conservation Basin can be developed if basin environment and conservation assessment result allow to develop.
- 3.: Management Basin should be developed under the control of overall water resource development management.

Development type of each river basin are so evaluated and shown in Table 2.2 item (11) Type of Development and Figure 2.13. As can be seen in Figure 2.13, almost Jawa island is covered by Managment Type basin and Sulawesi, Nusatenggara and north-eastern part of Sumatera island are covered by Conversion Type. Then Development Type is extended whole Kalimantan island and almost Sumatera island. Maluku and Irian Jaya has not enough data for evaluation.

### 3. Water Resources

#### 3.1 Rainfall

Available rainfall data have been collected in the planning of Integrated Water Resources Development (IWRD) Project<sup>1</sup> (Ref. 2). The data were collected from 1,670 rainfall stations. Most data come from the study of Asian Compendium of Climatic Statistics (1982) (Ref.3).

The average annual rainfall and the average monthly rainfall in each river basin are calculated using the above data. In each river basin, rainfall stations, of which data show similar rainfall pattern, having more than ten year record period, and properly distributed in the basin were selected (refer to Table 3.1). About 1,200 data were selected for the study. Figure 3.1 shows areal distribution of those selected rainfall stations.

The results of average monthly by river basin are shown in Table 3.2. The following table shows the average annual rainfall by region.

Annual Rainfall	
Region	Average Annual Rainfall
Sumatera	2,805
Jawa	2,558
Bali & Nusa tenggara	1,677
Kalimantan	2,723
Sulawesi	2,363
Maluku & Irian Jaya	2,585

Source: JICA-FIDP team estimate based on IWRD.

The rainfall patterns clearly indicate that the dry season will begin in July to September, and the wet season will be in December to February in Sumatera and Jawa. On the other hand, the rainfall patterns in Bali and NT show the same characteristics as in Sumatera and Jawa. However, the rainfall is small in the dry season. In Kalimantan and Irian Jaya, it is difficult to define the wet season and the dry season because even in December to February which are correspond to the rainy season in other regions, the rainfall is small, and is nearly equal to the rainfall in July to September. As for the rainfall patterns in the eastern part of the Sulawesi, the peak of the rainfall distribution will appear in May to June, and the dry season will begin in August to September. In general, the annual rainfall is distributed in the range between 1,500 mm and 4,000 mm, and the average annual rainfalls are shown in Fig. 3.2 by river basin.

<sup>1</sup> BTA - 155

The monthly rainfall 20% probability of non-exceedance is estimated using the following formula which is given by the Asean Compendium of Climatic Statistics (Ref.2):

$$P_{20} = 0.77 \times P_{av} - 51 \text{ (mm/month)}$$

where :

$P_{20}$  = Rainfall at 20% probability of non-exceedance (mm/month)

$P_{av}$  = Average rainfall (mm/month)

The above equation has been formulated on the basis of about 300 rainfall records in Jawa island, and its suitability is high. However, the equation for obtaining the rainfall at 20 % probability of non-exceedance out of Jawa has not been available yet. The rainfall in Jawa tends to show the average rainfall in the whole region. Thus, the above equation is to be applied to the areas outside of Jawa.

The results of probability rainfall by river basin are shown in Table 3.3.

### 3.2 Runoff

The available river discharge data used are derived from IWRD Project data (Ref.4). These data are collected from some 300 observatories stations (see Figure 3.3).

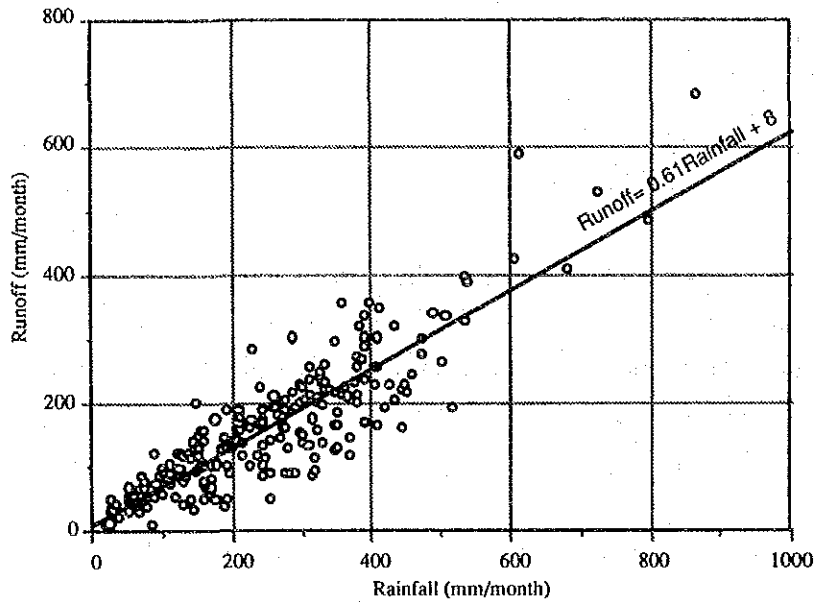
Only the river discharge data with over 5 years have strictly been selected out of 300 runoff stations, and their averages have been obtained on the basis of river basin, which is shown in Table 3.4. However, the discharges in some area which have been supplemented or derived for irrigation can be expected. In this case, the discharges are not actual river discharges. Namely, the discharges tend to show larger or smaller discharges than actual discharges.

The formula for obtaining monthly actual discharge has not been established yet. Therefore, to formulate the equation, the data have been selected on the basis of the following criteria out of the above 300 observation records:

- the area having the river discharge data with more than 5 years observation period.
- no large irrigable area upstream from the area.
- the area with no large lake, and/or reservoir in the catchment area.
- the area having the rainfall data with long period in the catchment area.

Based on the above assumption, the observation data at 47 places have been selected as shown in Table 3.5. Moreover, the data have been selected for which the distribution curve of rainfall is comparatively similar to that of runoff. Consequently, the linear regression

curve has been obtained as shown in the following figure.



The river runoff is estimated from rainfall in the river catchment area, applying the following formula:

$$Q_{rb} = 0.61 \times P_{av} + 8 \text{ (mm/month)}$$

where :  $Q_{rb}$  = river runoff (mm/month)  
 $P_{av}$  = rainfall (mm/month)

Applying above equation and 80% dependable rainfall, 80% dependable river runoff is estimated and tabulated in Table 3.6

The estimated river runoff by volume are calculated by multiplying the river runoff (mm) by river basin area (km<sup>2</sup>). The results of calculation are shown in Table 3.7, and summarized below: This 80% dependable river runoff assumed to be the natural river runoff (without any reductin of water demands) for further calucualtion of water balance.

Estimated Natural River Discharge

Region	MCM/year	Percent
Sumatera	482,173	26%
Jawa	122,699	7%
Bali & Nusa tenggara	45,909	2%
Kalimantan	556,700	30%
Sulawesi	143,343	8%
Maluku & Irian Jaya	496,422	27%
Indonesia	1,847,246	100%

Source: JICA-FIDP team estimate

The total of basin discharge in Indonesia is 1,847 billion m<sup>3</sup> per year. Kalimantan, Irian

Jaya and Sumatera show the high potential of natural river runoff.

#### 4. Water Demands

Water demands for 1) DMI\*1 , 2) river maintenance, 3) fish pond, 4) livestock and 5) irrigation\*2 are estimated based on the various available data and information. To make coincidence with estimated water resources for further water balance calculation, all demands are estimated in monthly bases in each river basin.

##### 4.1 DMI Water Demand

###### (1) Water Consumption

Projection of per capita water consumption is estimated based on the National Water Resources Policy by FAO (Ref. 5) and on a review of considering next water supply target by the Directorate of Water Supply (DAB), Directorate General of Human Settlements (see Table 4.1) :

Projection of Per Capita Water Consumption

City Size Category	Unit = lit/capita/day		
	1990-2000	2000-2015	2015-2020
Urban > 1,000,000	250	270	280
Urban < 1,000,000	150	170	180
Rural	30	38	40

Source: JICA-FIDP calculation based on Ref. 5

###### (2) Population

Population is estimated based on the results of population projection in this study. Details are described in Annex A.

Population projection in FIDP study is by Province. In this study, Population projection by Kabupaten is calculated by multiplying a coefficient with population projection by FIDP study. The coefficient is estimated based on the projection population of Kabupaten and Province by the IWRD (Ref. 6) study (refer to Table 4.2). The calculation of population projection for urban and rural is shown in Table 4.3 to Table 4.4.

###### (3) Water Demand

Total DMI water demand is estimated by multiplying projected population by per capita

\*1 DMI : Domestic, Municipal and Industrial

\*2 Existing irrigatin scheme's water demands in 1990



water consumption rate, as shown in the following formula :

$$Q(\text{DMI}) = 365 \text{ days} \times \left( \frac{q(u)}{1000} \times P(u) + \frac{q(r)}{1000} \times P(r) \right)$$

Where :  $Q(\text{DMI})$  = DMI Water Demand ( $\text{m}^3/\text{year}$ )  
 $q(u)$  = Water Consumption of Urban Area (lit/capita/day)  
 $q(r)$  = Water Consumption of Rural Area (lit/capita/day)  
 $P(u)$  = Urban Population  
 $P(r)$  = Rural Population

The results of DMI water demands by projection year are shown in the following table and in Table 4.5. DMI water demand is estimated at 14.4 billion  $\text{m}^3$  in Indonesia in year of 2020. DMI water demand of Jawa is about 67% in total because of large population of Jawa.

Region	1990	1995	2000	2005	2010	2015	2020
Sumatera	926	1,089	1,465	1,665	1,959	2,316	2,630
Jawa & Bali	3,974	4,705	6,141	6,838	7,637	8,839	9,805
Kalimantan	209	249	346	402	500	675	768
Sulawesi	258	335	441	489	542	623	686
Maluku & NT	161	185	254	286	320	371	406
Irian Jaya	35	43	60	70	81	95	107
Indonesia	5,563	6,606	8,708	9,750	11,038	12,918	14,401

Source: JICA-FIDP team estimate.

## 4.2 River Maintenance Water Demand

### (1) Water Consumption

According to the IWRD (Ref. 4), the present per capita flushing water requirement of urban areas was estimated at 330 lit/day, for 2000 it is expected to rise to 360 lit/day and in 2015 it is expected to reduce to 300 lit/day since by then more people are expected to be connected to a sewerage system. Projection of per capita flushing water requirement is assumed with as follows:

#### Projection of Per Capita Flushing Water Requirement

Projection	Water Requirement
1990 - 2000	330 lit/capita/day
2000 - 2015	360 lit/capita/day
2015 - 2020	300 lit/capita/day

Source: IWRD (Ref. 4)

## (2) Water Demand

River maintenance water demand is estimated by multiplying projected urban population by per capita flushing water requirement, as shown in the following formula :

$$Q_{(RM)} = 365 \text{days} \times \frac{q_{(f)}}{1000} \times P_{(u)}$$

Where :  $Q_{(RM)}$  = River Maintenance Water Demand (m<sup>3</sup>/year)  
 $q_{(f)}$  = Flushing Water Requirement (lit/capita/day)  
 $P_{(u)}$  = Urban Population

The results of river maintenance water demands by projection year are shown in the following table and in Table 4.6. Water demand is estimated at 14.7 billion m<sup>3</sup> in Indonesia in year of 2020 as nearly same as DMI water demand. Water demand of Jawa is about 65% in total.

River Maintenance Flow							Unit : MCM/year
Region	1990	1995	2000	2005	2010	2015	2020
Sumatera	1,119	1,371	1,767	2,071	2,416	2,359	2,733
Jawa & Bali	4,706	5,662	7,203	8,122	9,151	8,653	9,779
Kalimantan	302	373	484	583	697	696	820
Sulawesi	333	399	506	586	680	665	769
Maluku & NT	164	204	266	318	379	379	444
Irian Jaya	48	59	77	92	108	106	124
Indonesia	6,672	8,068	10,303	11,771	13,431	12,857	14,670

Source: JICA-FIDP team estimate

## 4.3 Livestock Water Demand

### (1) Water Consumption

A water consumption rate of livestock unit per day is assumed as follows :

Unit Water Requirement for Livestock	
Livestock	Unit : liters/head/day
Cattle/Buffalo	40
Sheep/Goat	5
Pig	6
Poultry	0.6

Source: Agricultural Compendium (1981),  
Ilacob.V, Netherlands.

## (2) Livestock Population

Livestock population projection is estimated based on the tendency of livestock population from 1984 to 1989 published by CBS (Ref.9). Table 4.7 to Table 4.10 shows the livestock population projection by kind by province.

## (3) Water Demand

Livestock water demand is estimated by multiplying heads of livestock by water consumption rate, as shown in the following formula :

$$Q(L) = \frac{365}{1000} \times (q_{(c/b)} \times P_{(c/b)} + q_{(s/g)} \times P_{(s/g)} + q_{(pi)} \times P_{(pi)} + q_{(po)} \times P_{(po)})$$

Where :

- Q(L) = Livestock Water Demand (m<sup>3</sup>/year)
- q<sub>(c/b)</sub> = Water Requirement for Cattle/Buffalo (lit/head/day)
- q<sub>(s/g)</sub> = Water Requirement for Sheep/Goat (lit/head/day)
- q<sub>(pi)</sub> = Water Requirement for Pig (lit/head/day)
- q<sub>(po)</sub> = Water Requirement for Poultry (lit/head/day)
- P<sub>(c/b)</sub> = Cattle/Buffalo Population
- P<sub>(s/g)</sub> = Sheep/Goat Population
- P<sub>(pi)</sub> = Pig Population
- P<sub>(po)</sub> = Poultry Population

The calculation of livestock water demand is shown in Table 4.11. The following table show the livestock water demand that it is small proportion comparing with other water demand.

<u>Livestock Water Demand</u>							Unit : MCM/year
Region	1990	1995	2000	2005	2010	2015	2020
Sumatera	70.4	84.7	98.6	113.0	127.2	140.8	154.8
Jawa	139.1	155.2	172.1	188.4	204.6	220.9	237.0
Bali&NT	45.0	51.4	57.7	64.2	70.4	76.9	83.4
Kalimantan	13.2	15.9	18.3	21.2	23.9	26.5	29.0
Sulawesi	56.9	65.6	75.0	83.6	92.3	101.1	110.0
Maluku & IJ	4.6	5.2	5.8	6.4	7.1	7.7	8.3
Indonesia	329.2	378.0	427.5	476.8	525.5	573.9	622.5

Source: JICA-FIDP team estimate

## 4.4 Fishpond Water Demand

### (1) Water Consumption

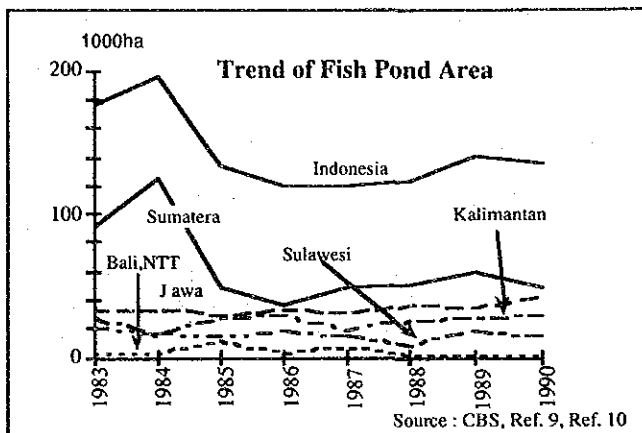
According to the IWRD (Ref. 7), at a pond depth of 70 cm the net water demand for flushing would thus be 35 to 40 mm/day, or about 5 to 6 times as for irrigated paddy.

Water used for flushing however returns entirely into the system, usually at a short distance downstream of the intakes of freshwater ponds. The actual net freshwater consumption of fishpond is therefore of the same order of magnitude as for irrigated paddy

The water consumption rate is assumed to be 7 mm/day with reference to the above figures.

(2) Fishpond Area

Future fish pond area is estimated from past trend. As shown in right Figure, past trend curve of fish pond area is almost flat during recent five years. This flat trend is applied to estimate future fishpond area and assumed 1990's area may keep until 2020. Table 4.11 presents estimated fishpond area in each river basin based on the CBS survey results.



(3) Water Demand

Fishpond water demand is calculated by multiplying projected fishpond area by water consumption rate, as shown in the following formula and results are shown in Table 4.11.

$$Q_{(FP)} = 365 \times \frac{q(f)}{1000} q(f) \times A_{(FP)} \times 1,000$$

Where :  $Q_{(FP)}$  = Fishpond Water Demand (m<sup>3</sup>/year)  
 $q(f)$  = Flushing Water Requirement (mm/day) = 7 mm/day  
 $A_{(FP)}$  = Fishpond Area (ha)

Fishpond Water Demand

Region	Unit: MCM/year
	Water Demand
Sumatera	1,257
Jawa	805
Bali & Nusa Tenggara	44
Kalimantan	753
Sulawesi	354
Maluku & Irian Jaya	0
Indonesia	3,213

Source: JICA-FIDP team estimate based on IWRD.

#### 4.5 Irrigation Water Demand

Since climatic condition is not same in whole Indonesia, irrigation water demand calculation in monthly base is rather complicated than other water demand calculation. First, typical cropping pattern for each Province is made based on the past three or four years cropping pattern. Second, water demand calculation is made for each river basin based on the established 27 cropping patterns. Water demand is estimated by following formula;

$$\text{Irrigation Water Demand} = ( E_{tc} + IR + RW + P - ER ) / IE \times A$$

where	$E_{tc}$	= crop consumptive use = $E_{t0} \times k_c$
	$E_{t0}$	= evapotranspiration
	$k_c$	= crop coefficient
	IR	= land preparation water
	RW	= layer replacement water
	P	= percolation loss
	ER	= effective rainfall
	IE	= irrigation efficiency
	A	= irrigation area

##### (1) Cropping pattern.

Total 27 typical cropping patterns are established for each Province based on the general cropping pattern illustrated in Figure 4.1 and following assumptions and information:

- average monthly planted area for 3- 4 years are calculated by province using statistic data on planted area for paddy and palawija published by CBS (Ref. 10, Ref. 11).
- dry season cultivation and wet season cultivation are defined based on average monthly planted area and average rainfall pattern in the province.
- estimated planted area(per 100 ha) mentioned in Table 4.12 is applied for estimation.
- the upper limit of cropping intensity is to be 2.0.
- During wet season, 100% of paddy is to be planted, while during dry season, paddy and palawija are to be planted.
- crop growing period for wet and dry paddy and palawija is 90 days
- crop growing period for palawija is 90 days

##### (2) Crop consumptive use

The crop consumptive use is calculated as

$$E_{tc} = k_c \times E_{t0}$$

Where :

$E_{tc}$  : crop consumptive use (mm/day)

$E_{to}$  : evapotranspiration (mm/day)  
 $k_c$ : crop coefficient

The crop coefficients for paddy and upland crop given by FAO are used for the calculated (Sources: Table A.2.2 of Irrigation Design Standards, Ref. 12).

Crop Coefficients for Paddy and Palawija

Growth	Crop Coefficient ( $k_c$ )	
	Paddy	Palawija
First month	1.10	0.67
Second month	1.05	1.00
Third month	0.95	0.75

### (3) Evapotranspiration

Monthly evapotranspiration is obtained from the results of Regional Physical Planning Project for Transmigration (RePPProT) study (Ref. 13 ~ Ref. 20) under Ministry of Transmigration (refer to Table 4.13). Monthly evapotranspiration has been calculated using the data in and around the area (refer to Table 4.14).

Evapotranspiration by Island by Penman Method

Island	Mean Monthly $E_{To}$ (mm/month)	Mean Daily $E_{To}$ (mm/day)	Max Monthly $E_{To}$ (mm/month)	Min Monthly $E_{To}$ (mm/month)
Sumatera	113	3.8	143	81
Jawa & Bali	128	4.3	209	70
Kalimantan	122	4.1	157	85
Sulawesi	132	4.4	180	90
Maluku & NT	138	4.6	204	81
Irian Jaya	123	4.1	162	78
Indonesia	127	4.2		

Source: RePPProT

### (4) Land preparation water requirement

The land preparation period is assumed to be 30 days. Water requirements for land preparation of paddy fields are taken at 250 mm, including presaturation of the soil, puddling of soil, and water requirements for nurseries. Above 250 mm figure assumes fine texture soil.

For the calculation of the irrigation requirements during land preparation, van de goor and zijlstra's formula is used (Ref. 12):

$$IR = M \left( \frac{e^k}{e^{k-1}} \right)$$

Where :

IR : irrigation requirement at field level (mm/day)  
M : water requirements to compensate for evaporation and percolation of the fields already saturated (mm/day)

$$M = E_o + p$$

$$E_o = 1.1 E_{to} \text{ (mm/day)}$$

$E_{to}$  = evapotranspiration (mm/day)

$p$  = percolation (mm/day)

$$k = M T / S$$

$T$  : land preparation period (days)

$S$  : presaturation requirements ((mm/day)

The calculation of land preparation water requirement is shown in table 4.18.

#### (5) Percolation

The percolation rate is assumed to be 2 mm/day.

#### (6) Water layer replacement

Twice water layer replacements, each of 50 mm at about 1 month and 2 months after transplanting, are considered according to irrigation design standards (Ref. 12).

#### (7) Effective rainfall

Monthly effective rainfall by river basin is calculated by multiplying proportion by monthly mean rainfall. The Proportion of Monthly Mean Rainfall to Effective Rainfall is considered according to Effective Rainfall (Ref. 22), published by FAO (refer to Table 4.15). Probability (20% non- exceedance) effective rainfall is calculated by probability rainfall as same as monthly effective rainfall (refer to Table 4.16 and Table 4.17).

#### (8) Irrigation diversion requirements

Irrigation diversion requirements are calculated by considering operation loss and conveyance loss. For this study, the following irrigation efficient are adopted :

Irrigation Efficiency	
Canal	Irrigation Efficient
Headreach and main canal	90%
Secondary canal	90%
Tertiary system	70%
Over all	56.7%

Source : Ref.12

Irrigation efficiency of 55% for paddy has been assumed with reference to the above figures. As for irrigation efficiency for palawija, it is assumed to be 50% as the percolation

loss is accounted for in the irrigation efficiency.

Sample calculation of irrigation diversion requirement for wet season paddy, dry season paddy and palawija in Ciujung (Code 2012) river basin are shown in Table 4.19. Applying this procedure for other all river basin, diversion water requirements for wet and dry paddy and palawija was calculated. Calculation results are shown in Table 4.20 for wet season paddy, Table 4.21 for dry season paddy and Table 4.22 for palawija. Total unit monthly irrigation water requirements for each river basin can be estimated by summation of those wet and dry paddy requirements and palawija requirements, namely;

$$\text{Total Unit Irrigation Diversion Requirements} = \text{Table 4.20} + \text{Table 4.21} + \text{Table 4.22}$$

Table 4.23 shows calculation result of total unit irrigation water requirement for all river basin.

#### (9) Water demand

Irrigation water demand is estimated by multiplying irrigation area by irrigation diversion requirement, as shown in the following formula :

$$Q_{(IR)} = \frac{q_{(IR)}}{1000} \times \{A_{(IR)} \times 10000\}$$

Where :  $Q_{(IR)}$  = Irrigation Water Demand (m<sup>3</sup>/month)  
 $q_{(IR)}$  = Unit Irrigation Diversion Requirement (mm/month)  
 $A_{(IR)}$  = Irrigation Area (ha)

The results of irrigation water demand by river basin are shown in the Table 4.24 and summarizes bellow. Total irrigation water demand is about 94 billion m<sup>3</sup> and more than 50 % of total irrigation water is consumed in Jawa Island.

Estimated Irrigation Water Demand

Region	Unit: MCM/year	
	Irrigation Water	
Sumatara	15,992	17.0 %
Jawa	52,541	55.7 %
Bali & Nusa tenggara	7,770	8.2 %
Kalimantan	3,643	3.9 %
Sulawesi	14,243	15.1 %
Maluku & Irian Jaya	182	0.2 %
Indonesia	94,370	100 %

Source: JICA-FIDP team calculation.



## 4.6 Water Demand

Total annual water demand in every river basin in year of 2020 is shown in Table 4.25 and summarized below. Out of 1,847 billion m<sup>3</sup> of available water (see page 8), about 127 billion m<sup>3</sup> of water will be used for DMI, Irrigation, Livestock etc. Balanced water of about 1,720 billion m<sup>3</sup> is available for another new irrigation but not all of them, since wet season surplus water can not be used for dry season irrigation without any large scale water reservoirs. Water availability for irrigation is discussed in next Chapter.

Annual Water Demand in 2020

(Unit MCM m<sup>3</sup>)

Region	DMI	River Maintenance	Irrigation	Fishpond	Livestock	Total
Sumatera	2,630	2,733	15,992	1,257	155	22,766
Jawa & Bali	9,805	9,779	54,918	809	258	75,569
Kalimantan	768	820	3,643	753	29	6,014
Sulawesi	686	769	14,243	354	110	16,162
Maluku & NT	406	444	5,526	40	69	6,485
Irian Jaya	107	124	48	0	2	281
Indonesia	14,401	14,670	94,370	3,213	623	127,277

Source: JICA-FIDP team calculation.

## 5. Water Potential

Water potential for irrigation in each river basin is estimated by subtracting the all water demands from the available water resources. This balance calculation is made assuming that;

- no reservoir or pond for water storage,
- no return flow ,
- no basin transfer water,
- priority order for water demand is DMI first and followed by river maintenance, fish/livestock and irrigation

Monthly water balance by river basin in every five years up to 2020 is calculated based on the result of available water resources and water demands in the previous sections. Monthly water potential in terms of irrigable area is calculated by dividing water balance results by unit monthly irrigation water requirements. And minimum monthly water potential is the potential irrigable area disregarding land availability. Table 5.1 presents sample water balance and potential area calculation at Ciujung river basin (code : 2012). This calculation method is applied to other 135 river basins to obtain the water potential. Table 5.2 shows the calculation results by river basin and summarized below. Table 5.3 shows Provincial base water potential.

### Estimated Water Potential

Region	Unit: 1,000 ha						
	1990	1995	2000	2005	2010	2015	2020
Sumatera	10,398	10,378	10,341	10,315	10,283	10,264	10,228
Jawa	83	80	72	69	67	65	62
Bali & NT	98	97	95	94	93	92	90
Kalimantan	16,506	16,502	16,494	16,488	16,479	16,472	16,464
Sulawesi	1,249	1,247	1,242	1,239	1,235	1,232	1,228
Maluku & IJ	13,813	13,812	13,809	13,807	13,804	13,803	13,800
INDONESIA	42,148	42,115	42,053	42,012	41,960	41,928	41,872

Source: JICA-FIDP team estimate.

As can be seen in Table 5.2 and 5.3, Jawa, Bali, Nusa Tenggara Barat, part of Sulawesi Selatan will suffer the shortage of water in the near future due mainly to population increase.

In the year 2020, river basin in Jawa, Bali, Nusa Tenggara Barat, Sulawesi Selatan, Part of D.I Aceh, part of Sumatera Utara, part of Lampung will not have water potential, but part of Sumatera, Kalimantan, part of Sulawesi and Irian Jaya will have water potential to develop new irrigation area.

In conclusion, Sumatera, Kalimantan, Irian Jaya and part of Sulawesi have quite sufficiency water potential for wetland agriculture development. Jawa and Bali have no more water potential for wetland agriculture development. Potential area in total in Indonesia will be about 41.9 million ha.

## 6. Irrigation Development Potential

For further irrigation development program, maximum extents of irrigation development potential in each river basin is basic and indispensable information. Extent of irrigation development potential can be determined by two limited factors, namely land and water. Land potential assessment therefore, essential for estimation of irrigation development potentials.

### 6.1 Land Potential

Provincial level land potential assessment is discussed in Annex C. The results of land potential assessment is shown in Table 6.1 which is cited from Annex C and summarized bellow.

Land Potential for Irrigation Development by Region

Region	('000 ha)				
	Irrigable rainfed field	Fully suitable	Conditionally suitable	Marginally suitable	Total
Sumatera	388	342	681	2,932	4,343
Jawa	602	27	55	1,086	1,770
Bali & NT	29	70	40	420	559
Kalimantan	258	529	166	2,740	3,693
Sulawesi	220	171	124	375	890
Maluku & IJ	0	1,293	725	565	2,583
Indonesia	1,496	2,432	1,791	8,117	13,836

Source: JICA-FIDP Team.

Based on this assessment results, land potential for wetland paddy in each river basin is estimated. Method of estimation is simply. Provincial land potential area was divided into each river basin in proportion of basin's area within a Province. Table 6.2 present the so divided land potential area of each river basin.

## 6.2 Development Potential Area

Potential area for irrigation development in each river basin is obtained from smaller figure through comparing water potential area (Table 5.2) with land potential area (Table 6.2).

Table 6.3 and Table 6.4 show the estimated irrigation development potential area by river basin and by Province respectively. Following table shows irrigation development potential by region. Figure 6.1 shows river basin wise areal distribution of irrigation potential area.

Irrigation Development Potential by Region

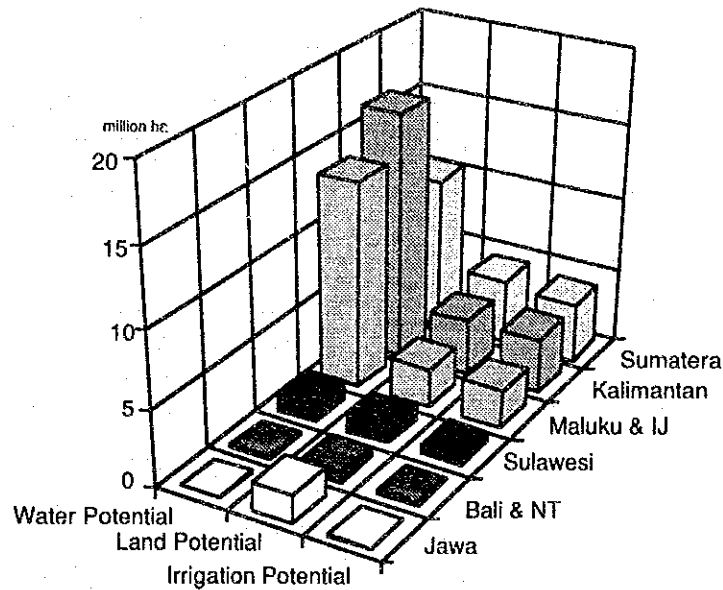
Region	Unit: 1,000 ha						
	1990	1995	2000	2005	2010	2015	2020
Sumatera	4,009	4,006	3,997	3,991	3,983	3,980	3,972
Jawa	83	80	72	69	67	65	62
Bali & NT	98	97	95	94	93	92	90
Kalimantan	3,693	3,693	3,693	3,693	3,693	3,693	3,693
Sulawesi	535	534	532	530	528	526	524
Maluku & IJ	2,525	2,525	2,525	2,525	2,524	2,524	2,524
Indonesia	10,944	10,934	10,913	10,901	10,887	10,879	10,865

Source: JICA-FIDP team estimate.

Comparing above table with previous page of Table "Estimated Water Potential Area", all region except Jawa, Bali and Nusa Tenggara are equal to water potential area. This means that Jawa, Bali and Nusa Tenggara are limited by water and other regions are limited by land. Basin wise limiting factor are tabulated in Table 6.5. Out of 136 river basins, 65 river basins have larger potential area of land than water i.e., limiting factor is "Water" and

remaining have "Land" limiting factor.

Potential Area of Water, Land, and Irrigation Development



Irrigation development potential for whole Indonesia is estimated at about 11 million ha in 1990, and keep this potential area until 2020. About 93% of potential area are scattered in those island of Sumatera (36%), Kalimantan (34%) and Maluku/Irian Jaya (23%). In provincial level, Irian Jaya has most large potential area of 2.1 million ha followed by Sumatera selatan (1,274,000 ha), Kalimantan Timur(1,257,000ha), Kalimantan Barat (1,136,000 ha) and so on (see Table 6.4).

Irrigation development potential so far assessed should be discussion material for the regional level or nation wide irrigation development planning. For other purpose, detailed survey and/or study work will be required.

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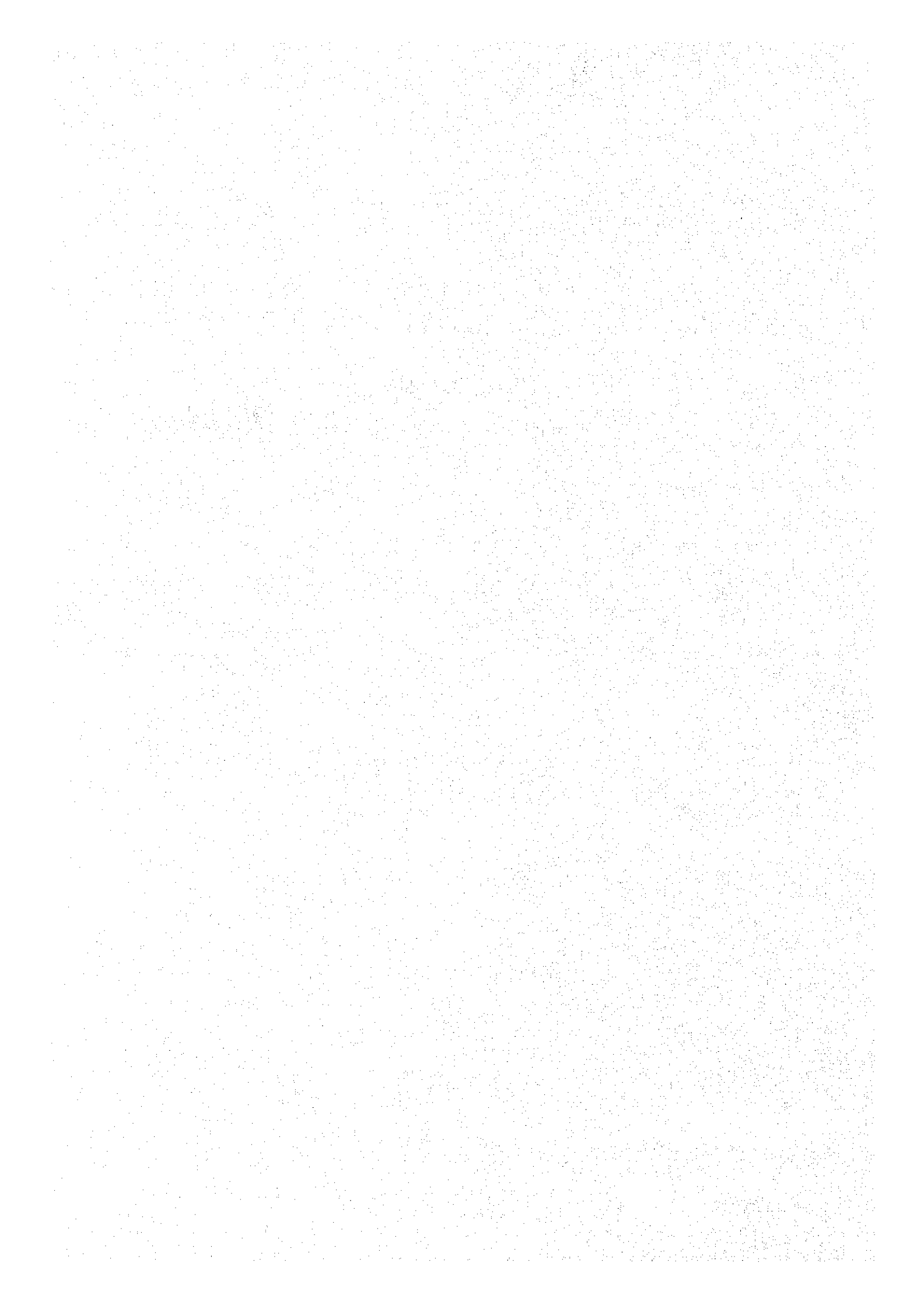
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## ***Tables***





**Table 2.1 SWS and River Basin ( 1/4 )**

No.	Representative Province	SWS Code	Name of SWS	Code of River Basin	Name of River Basin
SUMATERA					
1	D.I.Aceh	101	Krueng Aceh	1010	Krueng Aceh
2	D.I.Aceh	102	Meureudu ureun	1020	Meureudu ureun
3	D.I.Aceh	103	Pase Peusangan	1030	Pase Peusangan
4	D.I.Aceh	104	Jambu Aye	1040	Jambu Aye
5	D.I.Aceh	105	Tamiyang Langsa	1050	Tamiyang Langsa
6	D.I.Aceh	106	Woyla Wambesi	1060	Woyla Wambesi
7	D.I.Aceh	107	Singkulat Tripa	1071	Singkulat Tripa
8				1072	Simeulue
9	Sumatera Utara	108	Singkil	1080	Singkil
10	Sumatera Utara	109	Wampu Besitang	1090	Wampu Besitang
11	Sumatera Utara	110	Belawan Belumai	1100	Belawan Belumai
12	Sumatera Utara	111	S.Pagurawan S.Bahbol	1110	S.Pagurawan S.Bahbolan
13	Sumatera Utara	112	Asahan	1121	Asahan
14				1122	Silau
15	Sumatera Utara	113	Barumon Kualuh	1131	Kualuh
16				1132	Barumon
17	Sumatera Utara	114	Bt.Gadis	1141	Bt.Gadis
18				1142	Nias Tanahmasa
19	Riau	115	Rokan	1150	Rokan
20	Riau	116	Siak	1161	Siak
21				1162	Bengkalis Rupal
22	Riau	117	Kampar	1171	Kampar
23				1172	Batam Bintan
24	Riau	118	Indragiri	1181	Indragiri
25				1182	Singkep Lingga
26	Sumatera Barat	119	Silaut	1191	Silaut
27				1192	Pagai
28	Sumatera Barat	120	Anai Sualang	1201	Anai Sualang
29				1202	Siberut
30	Jambi	121	Bt Hari	1210	Bt Hari
31	Sumatera Selatan	122	Sugihan	1220	Sugihan
32	Sumatera Selatan	123	Baturusa Cerucut	1230	Baturusa Cerucut
33	Sumatera Selatan	124	Musi	1241	Musi
34				1242	Lalang
35	Lampung	125	Mesuji Tl.Bawang	1250	Mesuji Tl.Bawang
36	Lampung	126	Seputih Sekampung	1261	Seputih
37				1262	Sekampung
38	Lampung	127	Semangko	1270	Semangko
39	Bengkulu	128	Kanal-Alas Talo	1280	Kanal-Alas Talo
40	Bengkulu	129	Lais-Bintunan	1290	Lais-Bintunan
41	Bengkulu	130	Ipyu-Temarang	1300	Ipyu-Temarang
Total Unit		30		41	

**Table 2.1 SWS and River Basin ( 2/4 )**

No.	Province	SWS Code	Name of SWS	Code of River Basin	Name of River Basin
<b>JAWA</b>					
42	Jawa Barat	201	Ciujung-Cilimin	2011	Labuhan Merak
43				2012	Ciujung
44	DKI.Jakarta	202	Cisadane-Ciliwung	2020	Cisadane-Ciliwung
45	Jawa Barat	203	Cisadeg-Cikuningan	2030	Cisadeg-Cikuningan
46	Jawa Barat	204	Citarum	2041	Citarum Hulu
47				2042	Citarum Hilir
48	Jawa Barat	205	Cimanuk	2051	Cimanuk
49				2052	Cisanggarung
50	Jawa Barat	206	Ciwulan	2060	Ciwulan
51	Jawa Tengah	207	Citanduy	2070	Citanduy
52	Jawa Tengah	208	Pemali Comal	2080	Pemali Comal
53	Jawa Tengah	209	Serayu	2091	Serayu
54				2092	Lukulo Dulang
55	Jawa Tengah	210	Jratun Seluna	2101	Buyaran
56				2102	Serang Lusi
57				2103	Geris Juana
58	Jawa Tengah	211	Progo-Opak-Oyo	2111	Progo
59				2112	Opak-Oyo
60	Jawa Tengah	212	Bengawan Solo	2121	Bengawan Solo-hulu
61	Jawa Tengah			2122	Bengawan Solo-hilir
62	Jawa Timur			2123	Grindulu Panggul
63	Jawa Timur	213	K.Brantas	2131	K.Brantas-hilir
64	Jawa Timur			2132	K.Brantas-hulu
65	Jawa Timur			2133	Luminu Penguluran
66	Jawa Timur	214	Pekalen Sampean	2141	Pekalen Sampean
67	Jawa Timur			2142	Bedadung
68	Jawa Timur			2143	Bajulputih
69	Jawa Timur	215	Madura	2150	Madura
	Total Unit	15		28	
<b>BALI</b>					
70	Bali	301	Bali	3011	Bali-Singaraja
71	Bali			3012	Bali-denpasar
72	Nusa Tenggara Barat	302	Lombok	3020	Lombok
73	Nusa Tenggara Barat	303	Sumbawa	3030	Sumbawa
74	Nusa Tenggara Timur	304	Sumbawa	3040	Sumbawa
75	Nusa Tenggara Timur	305	Flores	3050	Flores
76	Nusa Tenggara Timur	306	Westt Timor	3060	Westt Timor
77	Timor Timur	307	East Timor	3070	East Timor
	Total Unit	7		8	

Table 2.1 SWS and River Basin ( 3/4 )

No.	Province	SWS Code	Name of SWS	Code of River Basin	Name of River Basin
<b>KALIMATAN</b>					
78	Kalimantan Selatan	401	Cengal-Batulicin	4010	Cengal-Batulicin
79	Kalimantan Tengah	402	Barito	4021	Barito-hulu
80	Kalimantan Selatan			4022	Barito-hilir
81	Kalimantan Tengah	403	Kahayan	4030	Kahayan
82	Kalimantan Tengah	404	Mendawi	4040	Mendawi
83	Kalimantan Tengah	405	Sampit	4050	Sampit
84	Kalimantan Tengah	406	Pembuang	4061	Pembuang
85	Kalimantan Tengah			4062	Lamandau Arut
86	Kalimantan Barat	407	Pawan	4070	Pawan
87	Kalimantan Barat	408	Kapuas	4080	Kapuas
88	Kalimantan Barat	409	Mempawah,Sambas	4090	Mempawah,Sambas
89	Kalimantan Timur	410	Sesayap	4100	Sesayap
90	Kalimantan Timur	411	Kayan	4110	Kayan
91	Kalimantan Timur	412	Berau-Kelai	4120	Berau-Kelai
92	Kalimantan Timur	413	Karangan	4130	Karangan
93	Kalimantan Timur	414	Mahakam	4141	Mahakam
94	Kalimantan Timur			4142	Balikpapan
	Total Unit	14		17	
<b>SULAWESI</b>					
95	Sulawesi Utara	501	Ranowangko Tondano	5011	Manado
96	Sulawesi Utara			5012	Onggak Dumaga
97	Sulawesi Utara	501	Ranowangko Tondano	5013	Sangir
98	Sulawesi Utara	502	Limboto,Bone	5021	Sangkup
99	Sulawesi Utara			5022	Limboto
100	Sulawesi Utara	503	Paguyaman,Randangar	5031	Paleleh
101	Sulawesi Utara			5032	Paguyaman,Randangan
102	Sulawesi Tengah	504	Lambunu Bual	5041	Bual
103	Sulawesi Tengah			5042	Lambunu
104	Sulawesi Tengah	505	Parigi Poso	5050	Parigi Poso
105	Sulawesi Tengah	506	Bongka Malik	5061	Bongka
106	Sulawesi Tengah			5062	Bunta
107	Sulawesi Tengah	507	Lombok,Mantawa	5070	Lombok,Mantawa
108	Sulawesi Tengah	508	Laa-Tambalako	5080	Laa-Tambalako
109	Sulawesi Tengah	509	Palu-Lariang	5091	Palu
110	Sulawesi Tengah			5092	Lariang
111	Sulawesi Tenggara	510	Lasolo-Sumpara	5101	Sumpara
112	Sulawesi Tenggara			5102	Lasolo
113	Sulawesi Tenggara	511	Paleang-Roraya	5111	Roraja
114	Sulawesi Tenggara			5112	Muna Buton
115	Sulawesi Tenggara	512	Tosari-Susua	5120	Tosari-Susua
116	Sulawesi Selatan	513	Kaluku-Karama	5131	Budung-budung
117	Sulawesi Selatan			5132	Karama
118	Sulawesi Selatan			5133	Mamuju
119	Sulawesi Selatan	514	Pompengan-Kalaena L	5141	Rongkong
120	Sulawesi Selatan			5142	Balease
121	Sulawesi Selatan			5143	Kalaena
122	Sulawesi Selatan			5144	Laroma
123	Sulawesi Selatan	515	Sadang	5151	Mapili
124	Sulawesi Selatan			5152	Sadang
125	Sulawesi Selatan			5153	Supa Lipukasi
126	Sulawesi Selatan	516	Walanae-Cenranae	5161	Paremang Gilirang
127	Sulawesi Selatan			5162	Walanae
128	Sulawesi Selatan	517	Jeneberang	5171	Jeneberang
129	Sulawesi Selatan			5172	Selayar
	Total Unit	17		25	

**Table 2.1 SWS and River Basin ( 4/4 )**

No.	Province	SWS Code	Name of SWS	Code of River Basin	Name of River Basin
<b>MALUKU &amp; IRIAN JAYA</b>					
130	Maluku	601	Southeast Maluku	6010	Maluku Tenggara
131	Maluku	602	Central Maluku	6020	Maluku Tengah
132	Maluku	603	North Maluku	6030	Maluku Utara
133	Irian Jaya	701	Wasi-Kias Omba	7010	Wasi-Kias Omba
134	Irian Jaya	702	Mamberamo	7020	Mamberamo
135	Irian Jaya	703	Eilanden Edera	7030	Eilanden Edera
136	Irian Jaya	704	Digul Bikuma	7040	Digul Bikuma
	<b>Total Unit</b>	<b>7</b>		<b>7</b>	

Note : SWS are sub-divided into 136 River basin

Source : Regulation of Minister of Public Works No. 39/1989

**Table 2.2 Condition of River Basin (1/120)**

(1) River Basin Code = 1010 (2) River Basin Name = Krueung Aceh  
 (3) River Basin Area = 4,051 km<sup>2</sup> (4) Representative Province = D.I.Aceh  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1105	Aceh Barat	1,013 km <sup>2</sup>			
1106	Aceh Besar	2,436 km <sup>2</sup>			
1107	Pidie	277 km <sup>2</sup>			
1171	Kotamadya Banda Aceh	85 km <sup>2</sup>			
1172	Kotamadya Sabang	115 km <sup>2</sup>			

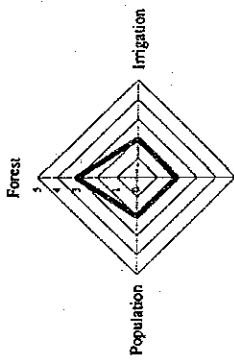
(6) Rainfall

a) Annual Rainfall = 1,624 mm  
 b) Coefficient of Variation = 0.38

(11) Type of Development : Conservation

(7) Vegetation

a) Forested Land 2,081 km<sup>2</sup>  
 b) Wet Paddy Field Irrigation 119 km<sup>2</sup>  
 Rainfed/Tidal/Swamp 258 km<sup>2</sup>  
 Garden/Dryfield 343 km<sup>2</sup>  
 Shifting Cultivation 466 km<sup>2</sup>  
 Glass Land 192 km<sup>2</sup>  
 House Compound 379 km<sup>2</sup>  
 Swamps/Dyke/Pond 82 km<sup>2</sup>  
 Fallow Land 130 km<sup>2</sup>

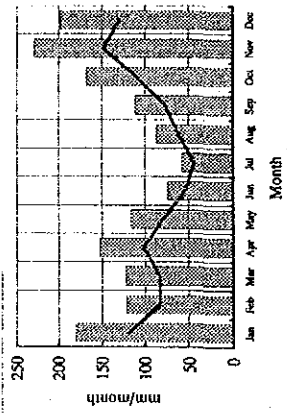


(8) Population  
 Urban 171,681  
 Rural 330,555  
 Total 502,236  
 Density 124

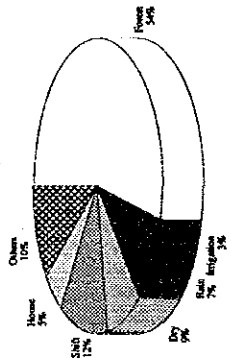
(9) Livestock  
 Cattle/Bufalo 53,200 heads  
 Sheep/Goat 33,100 heads  
 Pig 800 heads  
 Poultry 833,900 heads

(10) Type of Size : Middle

**Rainfall & Runoff**



**Vegetation**



**Table 2.2 Condition of River Basin (2/120)**

(1) River Basin Code = 1020 (2) River Basin Name = Krueung Aceh  
 (3) River Basin Area = 2,789 km<sup>2</sup> (4) Representative Province = D.I.Aceh  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1106	Aceh Besar	88 km <sup>2</sup>			
1107	Pidie	2,236 km <sup>2</sup>			
1108	Aceh Utara	378 km <sup>2</sup>			

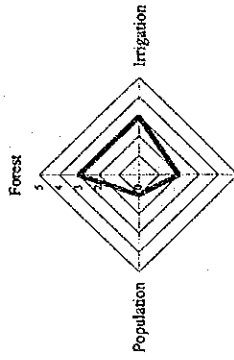
(6) Rainfall

a) Annual Rainfall = 1,757 mm  
 b) Coefficient of Variation = 0.41

(11) Type of Development : Conservation

(7) Vegetation

a) Forested Land 1,509 km<sup>2</sup>  
 b) Wet Paddy Field Irrigation 212 km<sup>2</sup>  
 Rainfed/Tidal/Swamp 55 km<sup>2</sup>  
 Garden/Dryfield 316 km<sup>2</sup>  
 Shifting Cultivation 331 km<sup>2</sup>  
 Glass Land 58 km<sup>2</sup>  
 House Compound 82 km<sup>2</sup>  
 Swamps/Dyke/Pond 55 km<sup>2</sup>  
 Fallow Land 172 km<sup>2</sup>

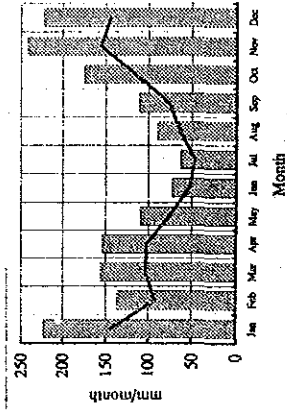


(8) Population  
 Urban 27,692  
 Rural 287,478  
 Total 315,170  
 Density 113

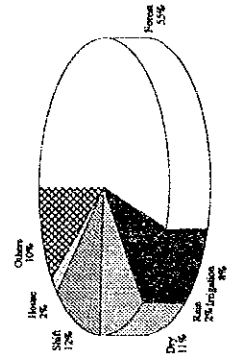
(9) Livestock  
 Cattle/Bufalo 36,600 heads  
 Sheep/Goat 22,800 heads  
 Pig 600 heads  
 Poultry 574,100 heads

(10) Type of Size : Small

**Rainfall & Runoff**



**Vegetation**

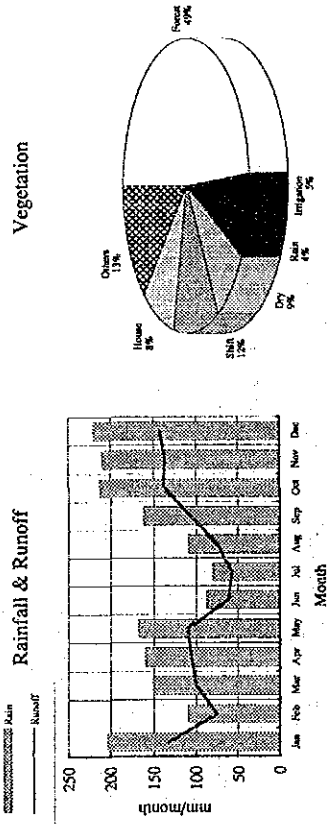
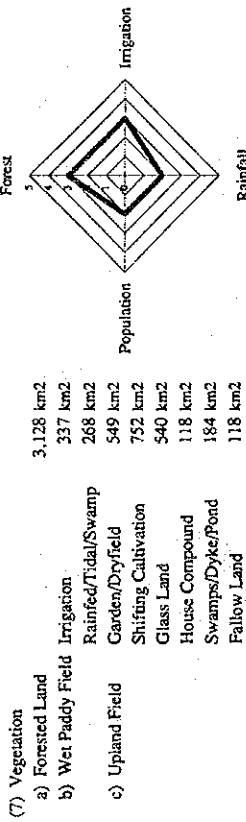


**Table 2.2 Condition of River Basin (3/120)**

(1) River Basin Code = 1030 (2) River Basin Name = Pase Peusangan  
 (3) River Basin Area = 5,993 km<sup>2</sup> (4) Representative Province = D.I.Aceh  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1103	Aceh Timur	141 km <sup>2</sup>			
1104	Aceh Tengah	1,912 km <sup>2</sup>			
1108	Aceh Utara	3,697 km <sup>2</sup>			

(6) Rainfall  
 a) Annual Rainfall = 1,877 mm (11) Type of Development : Conservation  
 b) Coefficient of Variation = 0.32

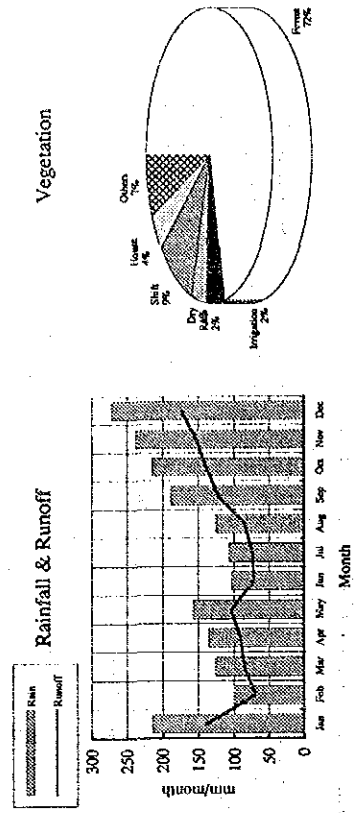
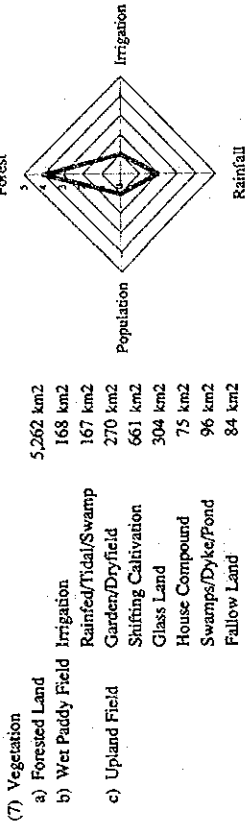


**Table 2.2 Condition of River Basin (4/120)**

(1) River Basin Code = 1040 (2) River Basin Name = Pase Peusangan  
 (3) River Basin Area = 7,086 km<sup>2</sup> (4) Representative Province = D.I.Aceh  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1102	Aceh Tenggara	220 km <sup>2</sup>			
1103	Aceh Timur	3,599 km <sup>2</sup>			
1104	Aceh Tengah	2,998 km <sup>2</sup>			

(6) Rainfall  
 a) Annual Rainfall = 1,989 mm (11) Type of Development : Conservation  
 b) Coefficient of Variation = 0.35



**Table 2.2 Condition of River Basin (5/120)**

(1) River Basin Code = 1050 (2) River Basin Name = Tamiyang Langsa  
 (3) River Basin Area = 6,787 km<sup>2</sup> (4) Representative Province = D.I.Aceh  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1102	Aceh Tenggara	2,158 km <sup>2</sup>			
1103	Aceh Timur	4,096 km <sup>2</sup>			
1211	Langkat	317 km <sup>2</sup>			

(6) Rainfall  
 a) Annual Rainfall = 2,632 mm (11) Type of Development : Conservation  
 b) Coefficient of Variation = 0.34

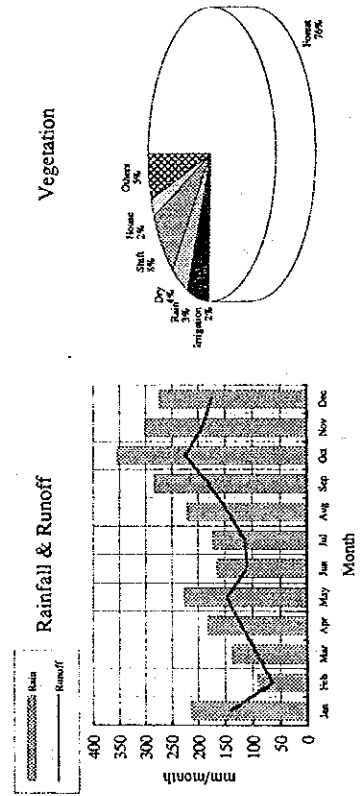
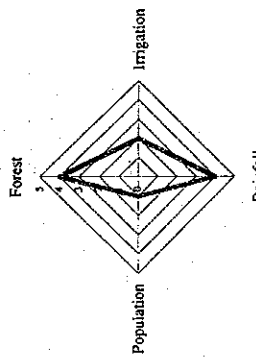
(7) Vegetation

a) Forested Land	Area	5,194 km <sup>2</sup>
b) Wet Paddy Field	Irrigation	171 km <sup>2</sup>
	Rainfed/Tidal/Swamp	212 km <sup>2</sup>
c) Upland Field	Garden/Dryfield	305 km <sup>2</sup>
	Shifting Cultivation	519 km <sup>2</sup>
	Glass Land	133 km <sup>2</sup>
	House Compound	53 km <sup>2</sup>
	Swamps/Dyke/Pond	112 km <sup>2</sup>
	Fallow Land	88 km <sup>2</sup>

(8) Population

Urban	57,415	Cattle/Bufalo	86,700 heads
Rural	334,123	Sheep/Goat	54,800 heads
Total	391,538	Pig	9,900 heads
Density	58	Poultry	1,408,300 heads

(10) Type of Size : Middle



**Table 2.2 Condition of River Basin (6/120)**

(1) River Basin Code = 1060 (2) River Basin Name = Tamiyang Langsa  
 (3) River Basin Area = 7,169 km<sup>2</sup> (4) Representative Province = D.I.Aceh  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1104	Aceh Tengah	481 km <sup>2</sup>			
1105	Aceh Barat	4,896 km <sup>2</sup>			
1107	Pidie	1,569 km <sup>2</sup>			

(6) Rainfall  
 a) Annual Rainfall = 3,652 mm (11) Type of Development : Conservation  
 b) Coefficient of Variation = 0.28

(7) Vegetation

a) Forested Land	Area	5,162 km <sup>2</sup>
b) Wet Paddy Field	Irrigation	188 km <sup>2</sup>
	Rainfed/Tidal/Swamp	220 km <sup>2</sup>
c) Upland Field	Garden/Dryfield	402 km <sup>2</sup>
	Shifting Cultivation	419 km <sup>2</sup>
	Glass Land	81 km <sup>2</sup>
	House Compound	211 km <sup>2</sup>
	Swamps/Dyke/Pond	99 km <sup>2</sup>
	Fallow Land	387 km <sup>2</sup>

(8) Population

Urban	27,596	Cattle/Bufalo	94,100 heads
Rural	309,634	Sheep/Goat	58,600 heads
Total	337,230	Pig	1,500 heads
Density	47	Poultry	1,475,700 heads

(10) Type of Size : Small

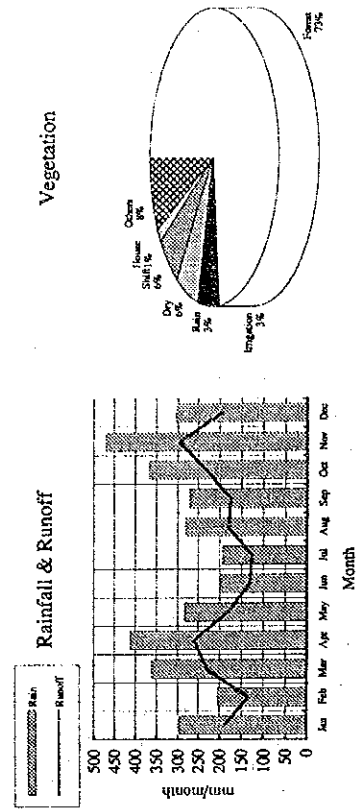
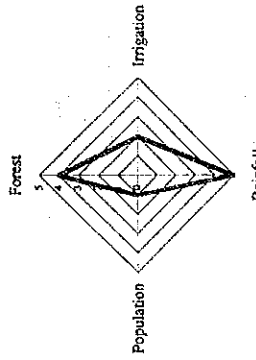




Table 2.2 Condition of River Basin (7/120)

(1) River Basin Code = 1071 (2) River Basin Name = Singkulat Tripa  
 (3) River Basin Area = 11,223 km<sup>2</sup> (4) Representative Province = D.I.Aceh  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1101	Aceh Selatan	265 km <sup>2</sup>			
1105	Aceh Barat	1,708 km <sup>2</sup>			

(6) Rainfall  
 a) Annual Rainfall = 3,101 mm  
 b) Coefficient of Variation = 0.25

(7) Vegetation  
 a) Forested Land 8,263 km<sup>2</sup>  
 b) Wet Paddy Field Irrigation 202 km<sup>2</sup>  
 Rainfed/Tidal/Swamp 265 km<sup>2</sup>  
 Garden/Dryfield 391 km<sup>2</sup>  
 Shifting Cultivation 356 km<sup>2</sup>  
 Glass Land 139 km<sup>2</sup>  
 House Compound 200 km<sup>2</sup>  
 Swamps/Dyke/Pond 425 km<sup>2</sup>  
 Fallow Land 982 km<sup>2</sup>

(8) Population  
 Urban 29,059  
 Rural 317,240  
 Total 346,299  
 Density 31

(9) Livestock  
 Cattle/Bufalo 147,400 heads  
 Sheep/Goat 91,700 heads  
 Pig 2,300 heads  
 Poultry 2,310,200 heads

(10) Type of Size : Middle

(6) Rainfall  
 a) Annual Rainfall = 2,817 mm  
 b) Coefficient of Variation = 0.27

(7) Vegetation  
 a) Forested Land 11,948 km<sup>2</sup>  
 b) Wet Paddy Field Irrigation 504 km<sup>2</sup>  
 Rainfed/Tidal/Swamp 123 km<sup>2</sup>  
 Garden/Dryfield 394 km<sup>2</sup>  
 Shifting Cultivation 601 km<sup>2</sup>  
 Glass Land 477 km<sup>2</sup>  
 House Compound 241 km<sup>2</sup>  
 Swamps/Dyke/Pond 456 km<sup>2</sup>  
 Fallow Land 1,533 km<sup>2</sup>

(8) Population  
 Urban 53,289  
 Rural 719,624  
 Total 772,913  
 Density 48

(9) Livestock  
 Cattle/Bufalo 167,400 heads  
 Sheep/Goat 120,500 heads  
 Pig 156,600 heads  
 Poultry 3,512,100 heads

(10) Type of Size : Middle

Table 2.2 Condition of River Basin (8/120)

(1) River Basin Code = 1060 (2) River Basin Name = Singkulat Tripa  
 (3) River Basin Area = 16,077 km<sup>2</sup> (4) Representative Province = D.I.Aceh  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1101	Aceh Selatan	4,639 km <sup>2</sup>	1209	Karo	623
1102	Aceh Tenggara	5,262 km <sup>2</sup>			
1203	Tapanuli Tengah	448 km <sup>2</sup>			
1204	Tapanuli Utara	2,008 km <sup>2</sup>			
1208	Dairi	2,853 km <sup>2</sup>			

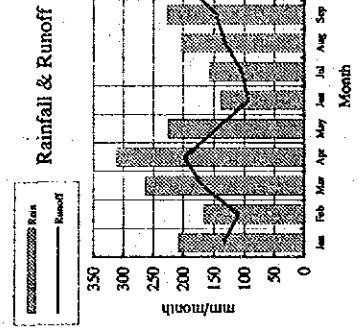
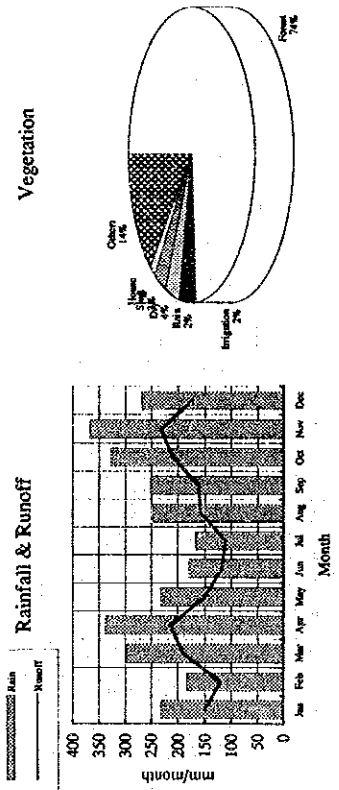
(6) Rainfall  
 a) Annual Rainfall = 2,817 mm  
 b) Coefficient of Variation = 0.27

(7) Vegetation  
 a) Forested Land 11,948 km<sup>2</sup>  
 b) Wet Paddy Field Irrigation 504 km<sup>2</sup>  
 Rainfed/Tidal/Swamp 123 km<sup>2</sup>  
 Garden/Dryfield 394 km<sup>2</sup>  
 Shifting Cultivation 601 km<sup>2</sup>  
 Glass Land 477 km<sup>2</sup>  
 House Compound 241 km<sup>2</sup>  
 Swamps/Dyke/Pond 456 km<sup>2</sup>  
 Fallow Land 1,533 km<sup>2</sup>

(8) Population  
 Urban 53,289  
 Rural 719,624  
 Total 772,913  
 Density 48

(9) Livestock  
 Cattle/Bufalo 167,400 heads  
 Sheep/Goat 120,500 heads  
 Pig 156,600 heads  
 Poultry 3,512,100 heads

(10) Type of Size : Middle



**Table 2.2 Condition of River Basin (9/120)**

(1) River Basin Code = 1090 (2) River Basin Name = Wampu Besitang  
 (3) River Basin Area = 7,712 km<sup>2</sup> (4) Representative Province = Sumatera Utara  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1102	Aceh Tenggara	133 km <sup>2</sup>	1276	Kotamadya Binjai	56
1207	Simalungan	65 km <sup>2</sup>			
1209	Karo	1,426 km <sup>2</sup>			
1210	Deli Serdang	368 km <sup>2</sup>			
1211	Langkat	5,449 km <sup>2</sup>			

(6) Rainfall  
 a) Annual Rainfall = 2,344 mm  
 b) Coefficient of Variation = 0.36  
 (11) Type of Development : Conservation

(7) Vegetation

a) Forested Land	4,854 km <sup>2</sup>
b) Wet Paddy Field	204 km <sup>2</sup>
	538 km <sup>2</sup>
c) Upland Field	385 km <sup>2</sup>
	651 km <sup>2</sup>
	603 km <sup>2</sup>
	114 km <sup>2</sup>
	137 km <sup>2</sup>
	226 km <sup>2</sup>

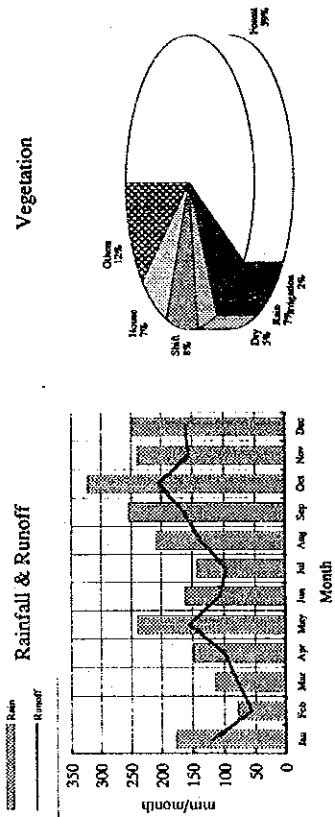
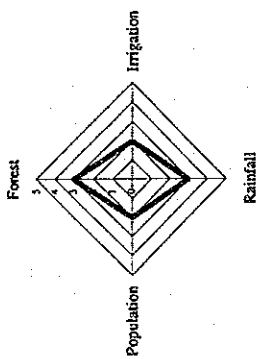
(8) Population

Urban	393,663
Rural	987,241
Total	1,380,904
Density	179

(9) Livestock

Cattle/Bufalo	44,800 heads
Sheep/Goat	49,000 heads
Pig	199,800 heads
Poultry	1,849,700 heads

(10) Type of Size : Middle



**Table 2.2 Condition of River Basin (10/120)**

(1) River Basin Code = 1100 (2) River Basin Name = Wampu Besitang  
 (3) River Basin Area = 6,765 km<sup>2</sup> (4) Representative Province = Sumatera Utara  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1206	Asahan	99 km <sup>2</sup>	1274	Kotamadya Tebing Tinggi	26
1207	Simalungan	1,933 km <sup>2</sup>	1275	Kotamadya Medan	234
1209	Karo	133 km <sup>2</sup>			
1210	Deli Serdang	4,140 km <sup>2</sup>			
1273	Kotamadya Pematang S	32 km <sup>2</sup>			

(6) Rainfall  
 a) Annual Rainfall = 2,381 mm  
 b) Coefficient of Variation = 0.29  
 (11) Type of Development : Conservation

(7) Vegetation

a) Forested Land	4,016 km <sup>2</sup>
b) Wet Paddy Field	709 km <sup>2</sup>
	323 km <sup>2</sup>
c) Upland Field	382 km <sup>2</sup>
	810 km <sup>2</sup>
	218 km <sup>2</sup>
	75 km <sup>2</sup>
	77 km <sup>2</sup>
	155 km <sup>2</sup>

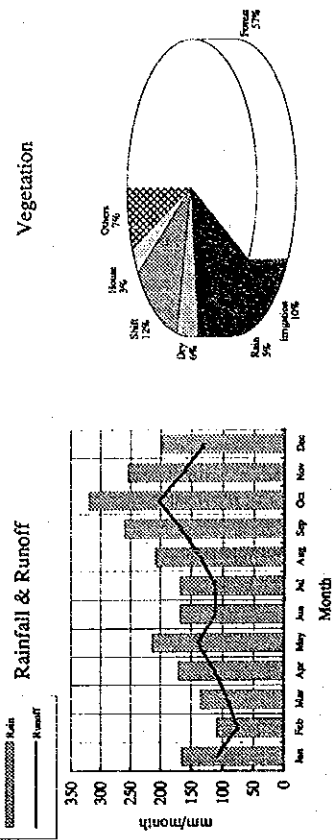
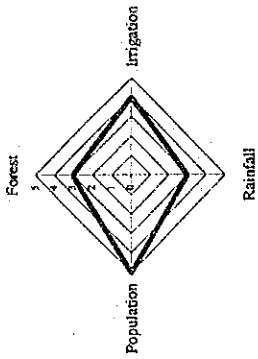
(8) Population

Urban	2,384,842
Rural	1,322,764
Total	3,707,606
Density	548

(9) Livestock

Cattle/Bufalo	38,400 heads
Sheep/Goat	42,800 heads
Pig	178,400 heads
Poultry	1,626,700 heads

(10) Type of Size : Middle



**Table 2.2 Condition of River Basin (11/120)**

(1) River Basin Code = 1110 (2) River Basin Name = S.Pagurawan S.Babbolan  
 (3) River Basin Area = 3,382 km<sup>2</sup> (4) Representative Province = Sumatera Utara  
 (5) Regency

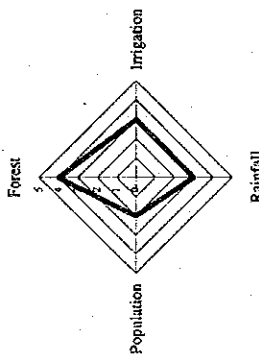
Code	Name of Kabupaten	Area	Name of Kabupaten	Area
1206	Asahan	1,146 km <sup>2</sup>		
1207	Simalungun	2,121 km <sup>2</sup>		
1273	Kotamadya Pematang S	29 km <sup>2</sup>		

(6) Rainfall  
 a) Annual Rainfall = 2,477 mm  
 b) Coefficient of Variation = 0.31

(11) Type of Development : Conservation

(7) Vegetation

Vegetation	Area
a) Forested Land	2,175 km <sup>2</sup>
b) Wet Paddy Field	277 km <sup>2</sup>
c) Upland Field	118 km <sup>2</sup>
Rainfed/Tidal/Swamp	142 km <sup>2</sup>
Garden/Dryfield	279 km <sup>2</sup>
Shifting Cultivation	140 km <sup>2</sup>
Glass Land	70 km <sup>2</sup>
House Compound	71 km <sup>2</sup>
Swamps/Dyke/Pond	112 km <sup>2</sup>
Fallow Land	



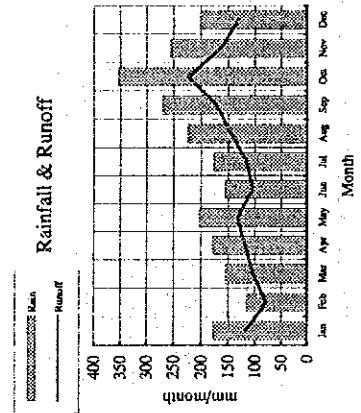
(8) Population

Category	Value
Urban	181,799
Rural	548,374
Total	730,173
Density	216

(9) Livestock

Category	Value
Cattle/Bufalo	19,200 heads
Sheep/Goat	21,400 heads
Pig	89,200 heads
Poultry	813,300 heads

(10) Type of Size : Middle



**Table 2.2 Condition of River Basin (12/120)**

(1) River Basin Code = 1121 (2) River Basin Name = S.Pagurawan S.Babbolan  
 (3) River Basin Area = 1,142 km<sup>2</sup> (4) Representative Province = Sumatera Utara  
 (5) Regency

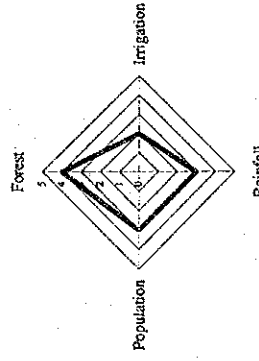
Code	Name of Kabupaten	Area	Name of Kabupaten	Area
1206	Asahan	997 km <sup>2</sup>		
1207	Simalungun	64 km <sup>2</sup>		
1272	Kotamadya Tanjung Ba	35 km <sup>2</sup>		

(6) Rainfall  
 a) Annual Rainfall = 2,141 mm  
 b) Coefficient of Variation = 0.29

(11) Type of Development : Conservation

(7) Vegetation

Vegetation	Area
a) Forested Land	785 km <sup>2</sup>
b) Wet Paddy Field	45 km <sup>2</sup>
c) Upland Field	97 km <sup>2</sup>
Rainfed/Tidal/Swamp	71 km <sup>2</sup>
Garden/Dryfield	57 km <sup>2</sup>
Shifting Cultivation	12 km <sup>2</sup>
Glass Land	3 km <sup>2</sup>
House Compound	59 km <sup>2</sup>
Swamps/Dyke/Pond	13 km <sup>2</sup>
Fallow Land	



(8) Population

Category	Value
Urban	103,538
Rural	179,911
Total	283,449
Density	248

(9) Livestock

Category	Value
Cattle/Bufalo	6,500 heads
Sheep/Goat	7,200 heads
Pig	30,100 heads
Poultry	274,500 heads

(10) Type of Size : Middle

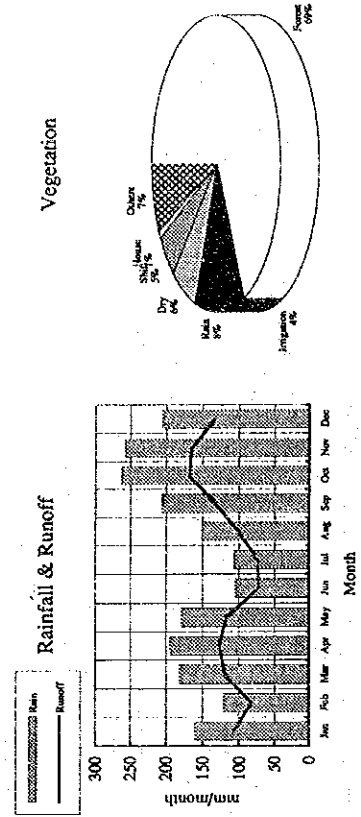


Table 2.2 Condition of River Basin (13/120)

(1) River Basin Code = 1122 (2) River Basin Name = Silau  
 (3) River Basin Area = 6,118 km<sup>2</sup> (4) Representative Province = Sumatera Utara  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1204	Tapanuli Utara	2,916 km <sup>2</sup>			
1206	Asahan	1,789 km <sup>2</sup>			
1207	Simatungan	166 km <sup>2</sup>			
1208	Dairi	223 km <sup>2</sup>			
1272	Kotamadya Tanjung Ba	21 km <sup>2</sup>			

(6) Rainfall  
 a) Annual Rainfall = 2,141 mm  
 b) Coefficient of Variation = 0.29

(7) Vegetation  
 a) Forested Land 4,415 km<sup>2</sup>  
 b) Wet Paddy Field Irrigation 230 km<sup>2</sup>  
 Rainfed/Tidal/Swamp 181 km<sup>2</sup>  
 Garden/Dryfield 229 km<sup>2</sup>  
 Shifting Cultivation 244 km<sup>2</sup>  
 Grass Land 120 km<sup>2</sup>  
 House Compound 184 km<sup>2</sup>  
 Swamps/Dyke/Pond 131 km<sup>2</sup>  
 Fallow Land 383 km<sup>2</sup>  
 Population 1,195,000 heads  
 Irrigation

(8) Population  
 Urban 125,533 Cattle/Bufalo 28,200 heads  
 Rural 522,791 Sheep/Goat 31,400 heads  
 Total 648,344 Pig 131,100 heads  
 Density 106 Poultry 1,195,000 heads

(10) Type of Size : Middle

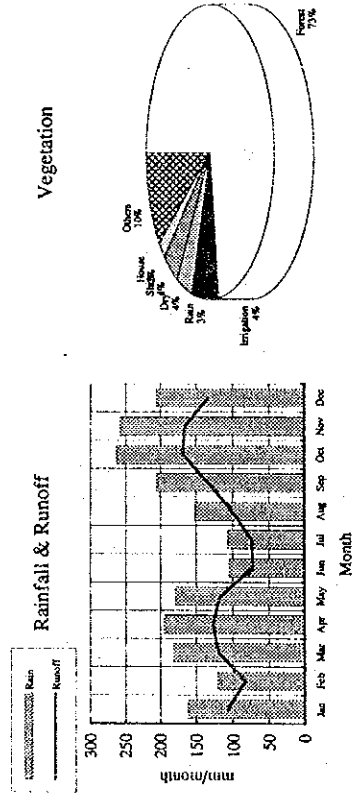


Table 2.2 Condition of River Basin (14/120)

(1) River Basin Code = 1131 (2) River Basin Name = Silau  
 (3) River Basin Area = 8,433 km<sup>2</sup> (4) Representative Province = Sumatera Utara  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1202	Tapanuli Selatan	1,087 km <sup>2</sup>			
1204	Tapanuli Utara	2,028 km <sup>2</sup>			
1205	Labuhan Batu	5,007 km <sup>2</sup>			
1206	Asahan	311 km <sup>2</sup>			

(6) Rainfall  
 a) Annual Rainfall = 2,484 mm  
 b) Coefficient of Variation = 0.32

(7) Vegetation  
 a) Forested Land 6,104 km<sup>2</sup>  
 b) Wet Paddy Field Irrigation 168 km<sup>2</sup>  
 Rainfed/Tidal/Swamp 503 km<sup>2</sup>  
 Garden/Dryfield 267 km<sup>2</sup>  
 Shifting Cultivation 298 km<sup>2</sup>  
 Grass Land 168 km<sup>2</sup>  
 House Compound 169 km<sup>2</sup>  
 Swamps/Dyke/Pond 254 km<sup>2</sup>  
 Fallow Land 501 km<sup>2</sup>  
 Population 222,400 heads  
 Irrigation

(8) Population  
 Urban 121,858 Cattle/Bufalo 47,900 heads  
 Rural 533,379 Sheep/Goat 53,300 heads  
 Total 655,237 Pig 222,400 heads  
 Density 78 Poultry 2,027,600 heads

(10) Type of Size : Middle

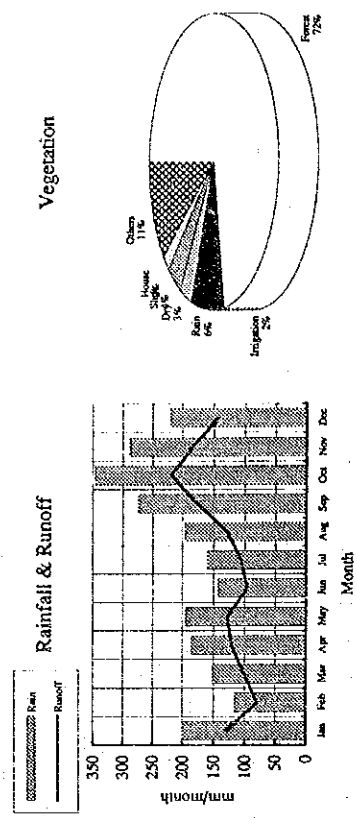


Table 2.2 Condition of River Basin (15/120)

(1) River Basin Code = 1132 (2) River Basin Name = Barumon  
 (3) River Basin Area = 9,091 km<sup>2</sup> (4) Representative Province = Sumatera Utara  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1202	Tapanuli Selatan	5,432 km <sup>2</sup>			
1205	Labuhan Batu	3,070 km <sup>2</sup>			
1405	Bengkalis	369 km <sup>2</sup>			

(6) Rainfall  
 a) Annual Rainfall = 2,512 mm  
 b) Coefficient of Variation = 0.34

(11) Type of Development : Conservation

(7) Vegetation

a) Forested Land	6,742 km <sup>2</sup>
b) Wet Paddy Field	164 km <sup>2</sup>
c) Upland Field	335 km <sup>2</sup>
Irrigation	178 km <sup>2</sup>
Rainfed/Tidal/Swamp	276 km <sup>2</sup>
Garden/Dryfield	133 km <sup>2</sup>
Shifting Cultivation	174 km <sup>2</sup>
Glass Land	348 km <sup>2</sup>
House Compound	741 km <sup>2</sup>
Swamps/Dyke/Pond	
Fallow Land	

(8) Population

Urban	90,064
Rural	445,639
Total	535,703
Density	59

(9) Livestock

Cattle/Bufalo	50,000 heads
Sheep/Goat	55,700 heads
Pig	230,100 heads
Poultry	2,114,000 heads

(10) Type of Size : Middle

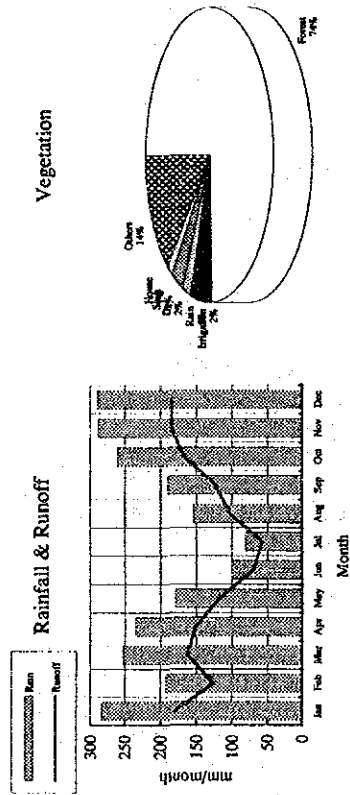
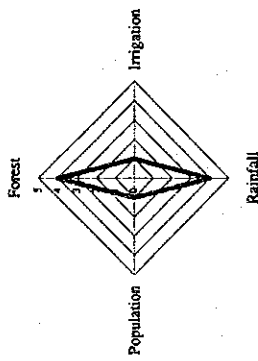


Table 2.2 Condition of River Basin (16/120)

(1) River Basin Code = 1141 (2) River Basin Name = Barumon  
 (3) River Basin Area = 15,055 km<sup>2</sup> (4) Representative Province = Sumatera Utara  
 (5) Regency

Code	Name of Kabupaten	Area	Code	Name of Kabupaten	Area
1202	Tapanuli Selatan	9,036 km <sup>2</sup>			
1203	Tapanuli Tengah	1,891 km <sup>2</sup>			
1204	Tapanuli Utara	3,768 km <sup>2</sup>			
1271	Kotamadya Sibolga	13 km <sup>2</sup>			
1308	Pasaman	446 km <sup>2</sup>			

(6) Rainfall  
 a) Annual Rainfall = 3,224 mm  
 b) Coefficient of Variation = 0.27

(11) Type of Development : Conservation

(7) Vegetation

a) Forested Land	10,478 km <sup>2</sup>
b) Wet Paddy Field	519 km <sup>2</sup>
c) Upland Field	148 km <sup>2</sup>
Irrigation	300 km <sup>2</sup>
Rainfed/Tidal/Swamp	582 km <sup>2</sup>
Garden/Dryfield	279 km <sup>2</sup>
Shifting Cultivation	525 km <sup>2</sup>
Glass Land	558 km <sup>2</sup>
House Compound	1,665 km <sup>2</sup>
Swamps/Dyke/Pond	
Fallow Land	

(8) Population

Urban	145,347
Rural	826,193
Total	971,540
Density	65

(9) Livestock

Cattle/Bufalo	88,300 heads
Sheep/Goat	94,800 heads
Pig	387,300 heads
Poultry	3,627,400 heads

(10) Type of Size : Middle

