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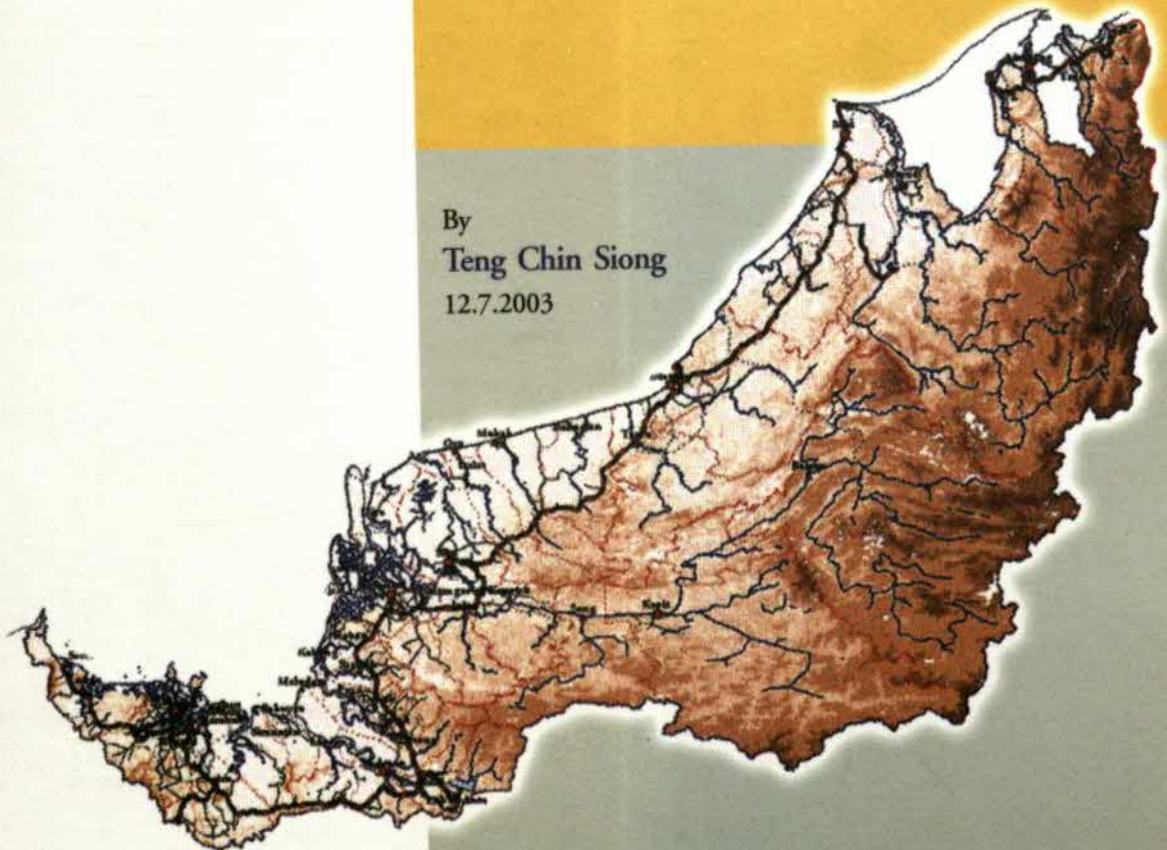


DEPARTMENT OF AGRICULTURE

SOIL MANAGEMENT BRANCH
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CLASSIFICATION AND MANAGEMENT OF THE STEEPLAND FOR AGRICULTURE IN SARAWAK

By
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ABSTRACT

In Sarawak, the "steepland" encompasses dissected hills and mountains with steep and very steep slopes which exceed 25 degrees. The steepland can be considered on basis of the steepness of the slopes, and among others (e.g. soil conditions and erosion hazard) as marginally suitable or conditionally suitable or unsuitable for agriculture.

Traditionally, the steepland is used for small-holder agriculture predominantly for food production by shifting cultivation of hill padi. With the rapid shift towards commercial development of small-holder agriculture, a hill padi-based mixed farming system has developed. It entails other agricultural activities to produce for market. Pepper, rubber and fruit trees are cultivated alongside the hill padi in many parts of the steepland in the State.

The steepland is often being marginalized as non-sustainable for agriculture. It is now common to detect inclusions of large tracts of steepland within the estate and or plantation boundaries. The development trends in the steepland include mono-cropping of pepper, the establishment of oil palm estates and plantations; latex-timber rubber plantations as well as the non-agricultural plantations such as forestry plantations for pulp production. Tentatively, an upper slope limit of 35 degrees is used to delimit the steepland for the cultivation of hill padi by field rotation (indigenous conservation hill padi farming system) whereas a slope limit of 30 degrees is adopted for hill padi-based mixed farming with pepper, rubber on terraced slopes; and fruit trees on platform terrace. A slope safety limit of 30 degrees is adopted for commercial pepper small holdings; 30 degrees for latex-timber rubber plantations; and the establishment of oil palm plantations on terraced slopes; and or non-agricultural forestry projects in the steepland.

Sustained development for agriculture is restricted in the steepland because of severe erosion hazard, infertile soils, high development cost, shortage of available land and work force. The common issues which concern utilization and development of the steepland include the definition and verification of slope safety limit for the various agricultural and non-agricultural crops and their contributory effects on soil erosion. The choice of appropriate crops, soil conservation, soil improvement and environmental protection are pertinent to safeguard long-term productivity of the steepland in the State.

CLASSIFICATION AND MANAGEMENT OF THE "STEEPLAND" FOR AGRICULTURE IN SARAWAK

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INTRODUCTION

The State of Sarawak covers approximately 12.4 million ha. Of which 1.78 million ha (or 14 %) are suitable for agriculture. The remainder 10.7 million ha (or 86 %) are marginally suitable to conditionally suitable for agriculture. Out of the 86 % marginally suitable to conditionally suitable agricultural land, approximately 67 % consist of very hilly, steeply dissected land or commonly known as the *steepland* in the State. The remainder areas are made up of 14 % of basin peat swamps and 5 % of coastal plain respectively.

DEFINITION OF THE "STEEPLAND"

In Sarawak, topography is a dominant factor affecting agricultural land use. Topography, expressed as steepness of slope, is generally used to separate the agricultural land from the non-agricultural land. In the 1960's-1970's, an upper slope limit of 25 degrees was used to differentiate the agricultural land from the land which is considered too steep for sustainable agriculture. With the compilation of the Land Capability Classification and Evaluation of Agricultural Crops in Sarawak, the slope limit for the *steepland* in the State was changed to 33 degrees (Maas, et. al., 1986).

Different slope limits were adopted for the definition of steep land by the Department of Agriculture, Peninsular Malaysia and Sabah respectively. In 1993, a general consensus was reached for the definition of steep land at the Workshop on Preparation of Guidelines for Agricultural Activities in Steep Land at Cameron Highland. An upper slope limit of 25 degrees was adopted to distinguish steep land which, under in its natural state, is generally too steep for agriculture in Malaysia. In Sarawak, steep land is made up of very hilly steeply dissected land. It is categorically described as *steepland* consisting of dissected hills and mountains with common short but steep slopes of more than 25 degrees; and amplitudes of relief which ranges from 30-150m and 150-600 m or in some cases exceeding 600 m above sea level.

SPATIAL DISTRIBUTION OF THE STEEPLAND

The occurrence of steepland is common throughout the State. It is found in the Coastal Lowland as well as the Central Lowland (Midland) and the Interior Upland Regions of the State. Breakdown of the steepland by physiographic region in the State is summarized in Table 1. The spatial distribution of the steepland in the State is shown in Text Map 1.

In the Coastal Lowland Region, the steepland occurs as strongly dissected mountains which rise abruptly to 300 m or more above sea level. In the Central Lowland, low hills and dissected hills of 30-150 m high form a very prominent zone which lies immediately behind the coastal plain and the coastal peat swamps. Farther inland, low hills grade into dissected hills and mountains which are extensive and occupy approximately 64% of the total land area in the Central Lowlands. The main hill summits range from 90-150m above sea level and the strongly dissected hills are interspersed by a few mountain ranges with peaks of up to 600m above sea level. The slopes are steep to extremely steep ranging from 25-33 degrees to more than 33 degrees respectively. In the Interior Uplands, the steepland is largely found at elevations ranging from 600-1500 m above sea level. They are also broken up by a few mountain ranges with peaks of up to 2000 m. The slopes of the steepland in the Interior Uplands are generally extremely steep of more than 33 degrees. The steepland forms approximately 89% of the total land area of the Interior Uplands in the State.

GREAT SOIL GROUPS OF THE STEEPLAND

Red-Yellow Podzolic Soils and Skeletal Soils are the common soils of the steepland in the State (Text Map 2). They are largely classified as Paleudults/Dystropepts and Udorthents under the Soil Taxonomy (USDA, 1999) respectively.

The Red-Yellow Podzolic Soils are differentiated by texture and origin of the parent material. Merit and Bekenu Family soils of the Red-Yellow Podzolic Soils are most extensive in the steepland with slopes ranging between 25-33 degrees; and Kapit Family soils of the Skeletal Soil Group with slopes which exceed 33 degrees. Merit and Bekenu Family soils have developed from non-calcareous sedimentary rocks of predominantly shale. Closely associated with these soil are the Nyalau Family soils which have developed largely from mixed sandstone/shale materials. Merit Family soils have a clayey particle-size; Bekenu family, a fine loamy; and Nyalau family, coarse loamy particle-size class. All these soils have a thin and friable topsoil which becomes firm with weakly developed structure at depth. The soils are well-drained and have variable soil depths ranging from shallow (50-75 cm) to moderately deep (75-100 cm).

Table 1 Major Land Systems and Distribution of Steepland in Sarawak
(Areal extent in hectares; source: Teng, 1994)

Physiographic Region	Coastal Plain	Peat Swamps	Alluvial Plain	Low Hills	Dissected Hills (steep)	Dissected Hills & Mountains (very steep)
Coastal Lowland*1	661,300 (27.1%)	1,767,600 (72.5%)	(sae)	(sae)	(sae)	9,100 (0.4%)
Central Lowland*2	-	(sae)	621,400 (15.0%)	873,600 (21.0%)	1,013,000 (24.5%)	1,636,000 (39.5%)
Interior Upland*3	-	(sae)	75,700 (1.3%)	97,000 (1.7%)	472,300 (8.0%)	5,213,000 (89.0%)
TOTAL	661,300 (5.3%)	1,767,600 (14.2%)	697,100 (5.6%)	970,600 (7.9%)	1,494,400 (12.0%)	6,849,000 (55.0%)

Explanatory Notes :

- *1 Land which lies between the coast and the footslopes of the inland residual hills. The amplitude of the relief is generally less than 15 m (with some localized mountains of >600m) above sea level.
- *2 Land which extends inland from the footslopes of the residual hills up to approximately 150m (with localized mountain ranges of >600m) above sea level.

The average trends for the selected chemical parameters in fine earth of the main soil families of the Red-Yellow Podzolic Soils are shown in Table 2. The soils are generally characterized by a moderately high cation exchange capacity of more than 24 cmol/kg clay. Merit soils have comparatively higher CEC and total nutrient reserve than Bekenu soils which are in turn higher than Nyalau soils. The "available" nutrient level of these soils are generally low and are well expressed by low base saturation of less than 10% and the low levels of exchangeable calcium, magnesium and potassium respectively. Only the surface (A1) horizon is comparatively richer in all nutritional aspects. The level of organic carbon is relatively high ranging from 2.0-3.5 % in the upper 12 cm which decreases abruptly to less than 0.5% in the sub-surface horizons. The C/N ratio is moderately wide ranging between 6-15 in the surface horizons but is generally less than 15 in the subsoils. The soil reaction is acidic. The level of phosphorus is generally low and phosphorus is present only in trace amounts in the sub-surface horizons.

The Skeletal Soils have largely developed from shale parent material. The soils are generally shallow of less than 50 cm overlying weathered rock or a regolith of shale rubble. The soils have a fine loamy to clayey particle-size and are well-drained. The Skeletal soils have also derived from re-worked materials which are low in weatherable minerals. The soils are low in plant nutrients. The soils are also strongly leached under the prevailing high temperature and rainfall conditions. For agriculture, the main constraints of the Kapit soils are the shallow soil depth (<50 cm), low organic carbon content, high acidity, deficiency of exchangeable cations (Ca, Mg, K) and possibly micro-nutrients. In addition, the soils have a very low amount of available phosphorus but a moderately high capacity to fix phosphorus.

Table 1 Average trends for selected chemical parameters in fine earth of main Soil families of Red-Yellow Podzolic Soil Group

Soil Family	Hori	Depth (cm)	% clay	pH	% O.C.	CEC	Ca	Mg	K	V %	Av.P ppm
MERIT	A1	0-10	32.5	4.7	3.73	16.65	1.18	0.72	0.3	17	9
	B1	10-25	41.6	4.9	0.93	14.46	0.36	0.29	0.17	7.69	<1
	B2	25-90	49.9	4.9	0.42	13.72	0.32	0.19	0.13	6.05	<1
	B3	>90	46.8	5	0.22	13.65	0.33	0.25	0.13	7	<1
BEKENU	A1	0-10	27.97	4.7	2.4	15.38	0.32	0.47	0.22	10.6	10
	B1	10-30	29.25	4.8	0.93	9.53	0.16	0.14	0.12	6.73	2
	B2	30-90	31.69	4.9	0.54	11.84	0.16	0.18	0.09	4.72	<1
	B3	>90	38.9	5	0.29	12.5	0.22	0.03	0.12	3.71	<1
NYALAU	A1	0-20	10.87	4.1	2.3	10.9	0.28	0.2	0.19	5.99	5
	B1	20-40	16.6	4.9	0.51	4.5	0.15	0.05	0.02	5.78	<1
	B2	40-60	19.5	4.8	0.21	3.42	0.2	0.02	0.01	7.89	<1
	B3	>60	21.8	4.7	0.2	3.8	0.21	0.02	0.01	7.36	<1

CAPABILITY CLASSIFICATION OF THE STEEPLAND

In Sarawak, the steep land is further differentiated on basis of agricultural potential into three broad categories of land. (Text Map 3). These are described below.

Category I:

Land which is generally of marginal potential and has, for the most part, steep slopes ranging from 25-30 degrees, moderately shallow soils but can, by various methods, be considered suitable for agriculture.

Category II

Land which because of limitations dictated predominantly by very steep slopes exceeding 30 degrees, moderately shallow and infertile soils, but can, by various methods, be considered suitable for a very restricted range of crops.

Category III:

Land which because of limitations dictated by very steep slopes exceeding 30 degrees, shallow and infertile soils, cannot be considered suitable for agriculture.

By the present Land Capability Classification System, the steep land in Category I is rated as Class 4 Land. It encompasses land, having characteristics or limitations (such as soil conditions and erosion hazard) which, in their natural state, are marginally suitable (Actual Suitability) but potentially suitable (Potential Suitability) for sustainable agricultural land use.

The steep land in Category II is rated as Class 5 Land. It encompasses land, having characteristics or limitations (such as soil conditions and erosion hazard) which, in their natural state, are presently unsuitable (Actual Suitability) but by various methods and at some future date after major land improvement with conservation measures, are potentially suitable (Potential Suitability) for some restricted agricultural use. This category of land is commonly known as the *Conditionally Suitable* - Class 5 Land for agriculture in the State.

The steep land in Category III is rated as Class 5 Land. It encompasses land, having characteristics and limitations which are so severe that, in their natural conditions, are presently (Actual Suitability) and potentially unsuitable (Potential Suitability) for sustainable agricultural land use. At the present time, measurable criteria have not yet been developed to distinguish the *Conditionally Suitable*-Class 5 Land (Potential Suitability) from the *Unsuitable*-Class 5 Land. This permits flexibility

in the choice of physical criteria which can be used to elaborate the potential degree of suitability of this category of steep land for agriculture, if any, in future. As a general rule, the conditionally suitable-Class 5 Land which, by various methods and with soil conservation measures, can be considered suitable for sustainable agricultural land use but only of a very restricted scale (e.g. commercial small holdings) and confined to a very few perennial crops only.

AGRICULTURAL LAND USE IN THE STEEPLAND

Shifting Cultivation of Hill Padi

In Sarawak, steep land is used traditionally for small-holder agriculture. Small-holder agriculture refers specifically to the kinds of land utilization in which traditional farming systems are undertaken to produce predominantly food. In the steep land, hill padi farming is, albeit, at subsistence level, a very important land utilization type (Plate 1). The traditional shifting cultivation has evolved from its early origin into an adaptive farming system with inherent conservation features which minimizes soil loss throughout the cultivation cycle (Teng, 1991). The yield of padi is sustained by rotation of field. The production of hill padi provides, on the average, 70% self sufficiency in rice among the rural farming households. It is estimated that approximately 2.67 million ha (or 22%) of the State's land area are used or have been used at least once for the shifting cultivation of hill padi.

Hill Padi-Based Mixed Farming

With the rapid shift towards commercial development of agriculture in the steep land, a hill padi-based mixed farming system has evolved which entails other agricultural activities to produce for market. This farming system is well-adapted to the marginal land resource in the steep land where factors such as operational facilities, infrastructure, access to inputs and market do not provide the opportunity for full commercialization of the farming activities.

By mixed farming, the farmers produce their annual rice requirements but they have to supplement rice production with a modest income by planting of cash generating crops. Several cash generating crops can be found in the steep land. They are associated predominantly with pepper and rubber. Pepper is the most important cash generating crop under the hill padi-based mixed farming system in the steep land (Plate 2). Pepper small holdings in the steep land contribute substantially to the total planted area of approximately 10,000 ha throughout the State. Rubber is the next most important crop. Rubber small holdings in the steep land also contribute very substantially to the total planted area of approximately 118,000 ha in the state. The establishment of rubber small holdings was often considered in strategic land use

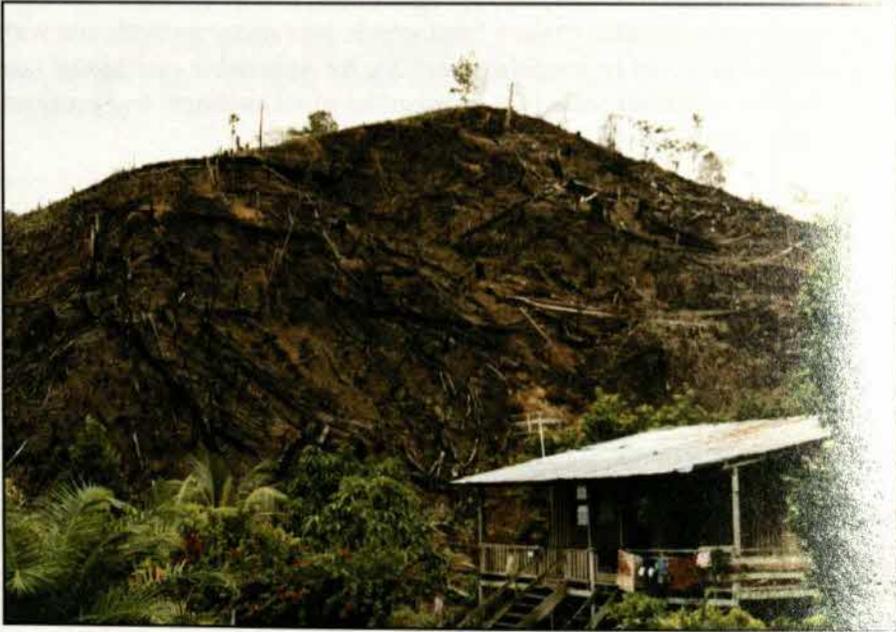


Plate 1 Shifting cultivation of hill padi (Ulu Baram)

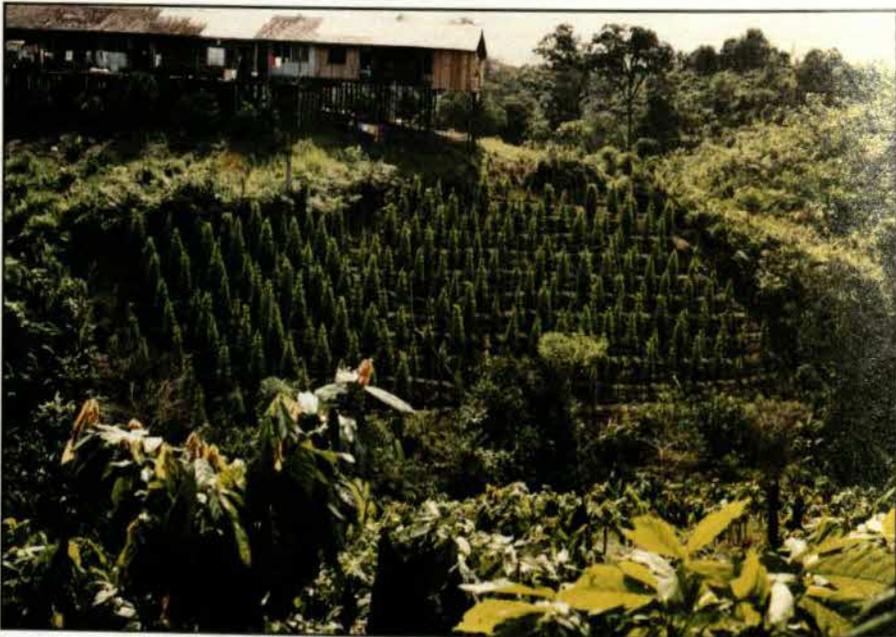


Plate 2 Hill padi-based mixed farming with pepper and cocoa (Ulu Balingian)

planning where steepland is predominant and rubber provided the only forms of sustained agriculture. However, from the present economic standpoint, most of the rubber small holdings are no longer sustainable in the steepland. Under hill-padi based mixed farming system, fruits trees are often planted alongside of rubber and sometimes with some livestock and inland fisheries (Plate 3). These are localized and of little economic importance. The distribution of hill padi-based mixed farming in the steepland of Sarawak is shown in Text Map 4.

LAND USE AND DEVELOPMENT TRENDS IN THE STEEPLAND

The land capability of the steepland is often being marginalized as non-sustainable for agriculture. This, in contrast to the current trends of land utilization whereby the development of estates and plantation takes place rapidly in the steepland throughout the State. It is now common to detect inclusions of large tracts of steepland within the estate/planation boundaries.

Agricultural statistics on the current agricultural land use in the State is outdated and not complete. In this present study, information is obtained from the digital map on spatial distribution of the major economic crops in the State. This information is used to interpret sustained agriculture and the development trends in the steepland of Sarawak which includes commercial pepper farms, rubber estates, oil-palm estates and plantations, integrated latex rubber and rubber wood processing estates, and non-agriculture plantation such as forestry plantation for pulpwood. Only the utilizations of the steepland for oil palm plantation and forest plantation for pulpwood (source: SPU GIS 2000) are indicated in Text Map 5.

Commercial Pepper Farms

Agricultural statistics indicates that commercial pepper farms covered approximately 10,000 ha. (DOA, 1998). They were spread out throughout the State. An additional 1,000 ha of commercial pepper farms has been planned for the next five-year (DOA, 1999). Much of the commercial pepper farming shall be established where the steepland (Categories I and II) is predominant (Plate 4). Pepper has the competitive advantage over the other crops as it requires relatively small areas for commercial operation. Despite the relatively small planted hectareage, pepper contributes very substantially to export earning by the agriculture sector. Commercial pepper farming persists and will continue to be one of the most important land utilization type in the steepland throughout the State.



Plate 3 Hill padi-based mixed farming with rubber on bench terrace (Bintulu, 2000)

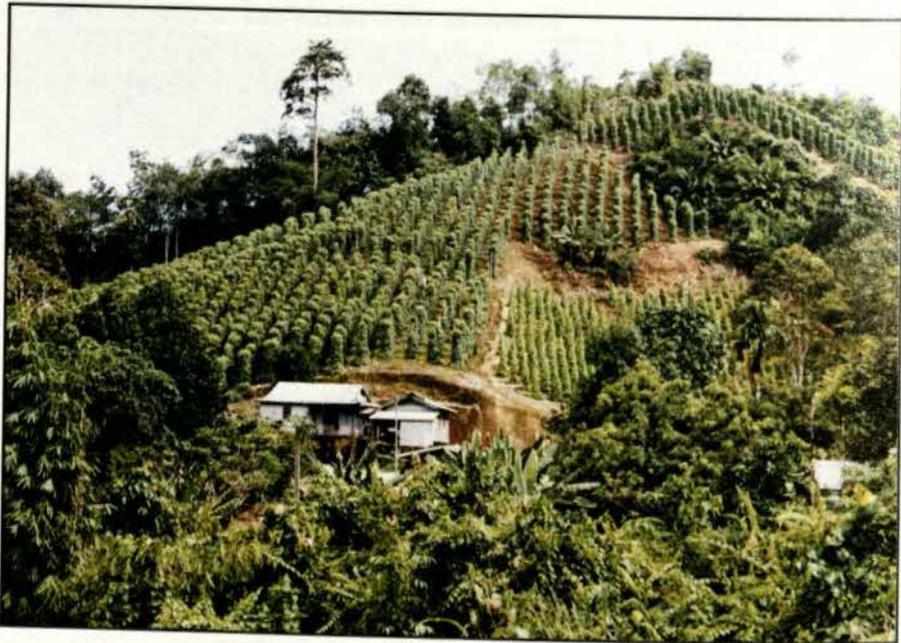


Plate 4 Commercial pepper farm (Balingian, 2000)

Oil Palm Estates/Plantations

Mono-cropping of oil palm in estates and plantations is a promising trend in future utilization of the steepland in the State (Plates 5,6). Out of a total land area of approximately 1,045,800 ha that has been designated for oil palm plantation (Source: Plantation Map, SPU GIS, 2000), approximately 401,500 ha are planted or will be planted on the steepland (most particularly in Miri and Bintulu Divisions). Breakdown of the distribution area by land class, indicates that approximately 160,200 ha (or 15%) of the total oil palm area are found in the steepland with slopes ranging between 25 to 30 degrees; and that approximately 241,300 ha (or 23%) occur in the steepland with slopes of more than 30 degrees. Out of the remainder 644,300 ha (or 62%), approximately 534,700 ha (or 83%) are found in coastal peat swamps and approximately 109,600 ha (or 17%) on low hills in the Central Lowlands. By the year 2010, a larger hectareage of land is needed for the development of commercial oil-palm plantations. With the shortage of limited "flat" land in the State, future utilization of the steepland for the oil palm plantations would probably involve the development of some 1,500,000 ha of oil palm on the steepland comprising both Class 4 and Class 5 (Categories I and II) Land throughout the State.

Integrated Latex Rubber Estates-Rubber Wood Processing

In order to enhance the economic importance of natural rubber as a cash crop, a new approach has been adopted under the natural rubber development programme to replace scattered, non-productive, small rubber holdings with large contiguous plantations. High yielding and fast growing clones will be used particularly latex-timber clones (LTCs) for latex production and rubber wood processing.

Several feasibility studies were undertaken (SPU) over the years to assess and convert selected blocks of the existing rubber plantations and the intervening secondary forests land into large contiguous blocks of high yielding latex-timber plantations. The studies generally underlined that agricultural land not destined for conversion to oil palm (mainly the Classes 3 and 4 Land), be combined with other areas of marginal potential (predominantly Classes 4 and 5 Land) for the establishment of high yielding rubber plantations. For example, the Mid-Rajang IRDP Study indicates specifically that a substantially large areas of steepland in the Central Lowland Region of Sarawak, can be considered suitable for sustainable development of the Latex-Timber Rubber plantations. In order to encourage utilization of the idle land and or steepland, it was proposed that joint venture-between the small holder land owners and or the Native Customary Rights Land claimants and potential investors be given preference in selecting project proponents by the relevant land development authorities. Invariably, the development of commercially viable rubber plantations shall remain the mainstay in future utilization of the steepland in the State (Plates 7, 8).

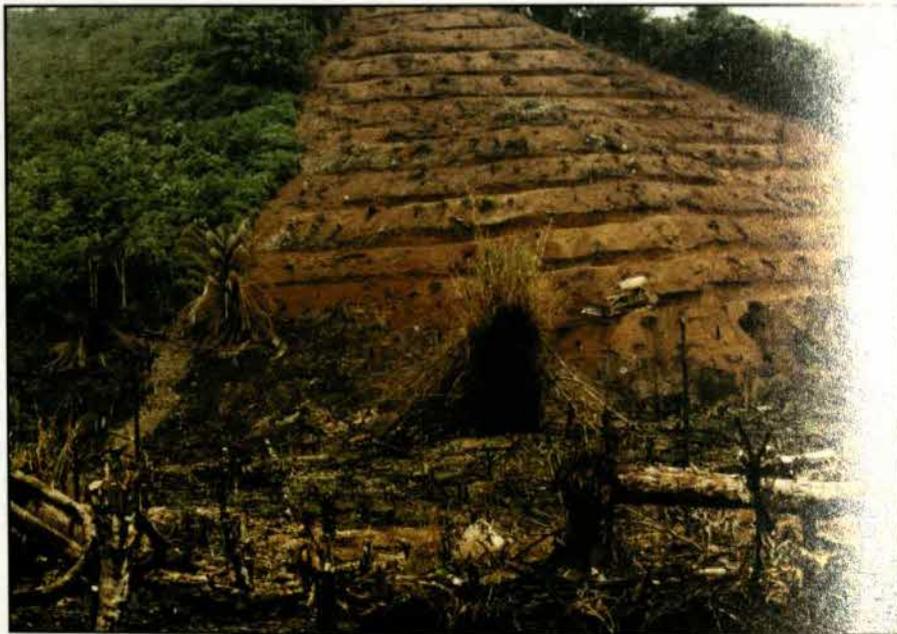


Plate 5 Oil palm in the steepland - Land Preparation (Lubuk Antu, 1995)



Plate 6 Oil palm estate in the steepland (Ulu Tamin Area, 2000)



Plate 7 Rubber on bench terraces in the steepland (Sarikei, 2000)



**Plate 8 Rubber mini estate (Betong, 2000)
(Integrated Latex production and rubber wood processing)**

Forestry Plantation for Pulpwood Production

Forestry plantation is an important non-agricultural but optional land use in the steepland. Generally, substantially large areas of land are required for the development of forest plantation. While it is ideal to develop forest land on slopes not exceeding 25 degrees, potentially available and suitable land for forest plantation development is often a scarce resource in the State. In optimizing the existing resources, suitable techniques and operating systems have been developed by consultants (source: Forest Department, per. Comm.) for safe operation on slopes in the range of 20 to 30 degrees in the State. It appears that forestry plantation for pulpwood production can be a potential non-agricultural alternative land use in the steepland of the State (Plates 9,10).

COMMON ISSUES RELATED TO SUSTAINABLE DEVELOPMENT OF THE STEEPLAND

Technical Issues - Definition and Slope Safety Limit

Definition of steepland; agricultural land as against non-agriculture land and rationale behind the slope safety limits are some of the pertinent issues which pertain to development of the steepland,. Quite often, the definition for these technical terms differ between the various planners and workers. By DOA's definition, the steepland is steep, having characteristics or limitations dictated by steep slopes (25-30 degrees) and very steep slopes (>30 degrees) which, in their natural state, among other things (such as soil conditions and erosion hazard), can be considered marginally suitable (Actual Suitability) or conditionally suitable and/or unsuitable (Potential Suitability) for sustainable agricultural land use.

The steepland in Sarawak are differentiated by the three categories of land, viz., Categories I, II and III. As a general rule, all the steepland are steep land with slopes exceeding 25. The steepland in Category I with slopes ranging between 25-30 degrees is agricultural land. The steepland in Category II with slopes of more than 30 degrees is still considered as agricultural land. It encompasses land, having characteristics or limitations which can somehow be amended and overcome; and can be considered suitable within limit for some kind of sustainable agriculture, for example, indigenous conservation hill padi farming with mixed cropping and/or multiple cropping; commercially viable pepper small holdings and non-agriculture optional land use such as forest plantation for pulpwood production. The steepland in Category III with the same steepness of slopes of more than 30 degrees, but having the other limitations which are so severe that they preclude the use of the land for any kind of agriculture. This category of land is considered as non-agricultural land. Invariably, the steepness of slope at 30 degrees is not used as an absolute limit to differentiate between the agricultural and non-agricultural land but rather the potential

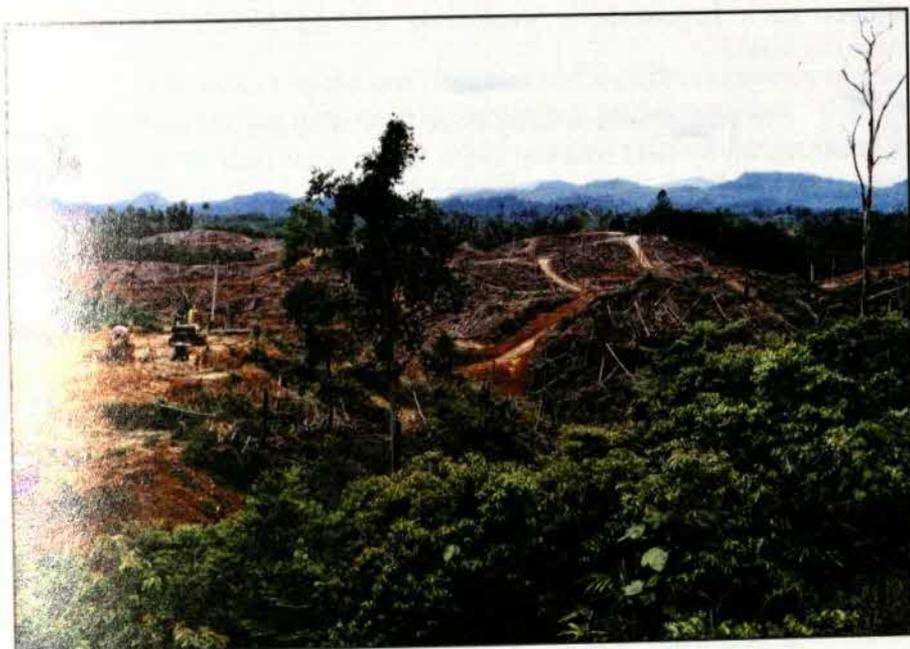


Plate 9 Forestry plantation for pulp production (Bintulu, 2000)



Plate 10 Hill Dipterocarp Forest (Sematan, 1992)

degree of suitability of the land for a specific land utilization type (not general agriculture), be it large-scale or small-scale so long as it is sustainable and/or commercially viable.

In general term, a safety slope limit of 35 degrees has been adopted for hill padi cultivation by field rotation; and a safety slope limit of 30 degrees for hill padi-based mixed farming with pepper, rubber and fruit trees. A safety slope limit of 30 degrees is also adopted for commercial pepper small holdings, 30-35 degrees for rubber latex/timber plantations; and 30 degrees for oil palm plantations. Although oil palm can be planted on terraced slopes up to 30 degrees, a more stringent safety slope limit of 28 degrees has generally be adopted from the crop husbandry and management standpoint as proposed and adopted by Sarawak Land Consolidation and Rehabilitation Authority (SALCRA).

Agricultural Activities and their Contributory Effects on Soil Erosion in the Steepland

Many earlier workers reported that soil erosion under sedentary agriculture was potentially serious in the steepland. Some reported that surface erosion and mass wasting were much in evidence on slopes exceeding 25 degrees. Other workers reported that soil erosion was significantly reduced by planting on bench terraces with cover crops. Many workers have expressed concern, as quite often the steepland is being mismanaged to such low levels that soil erosion and fertility depletion are perceptibly aggravated.

The present available information on agricultural activities and their contributory effects on soil erosion is scarce and incomplete. There is a need to generate updated information to validate the feasibility in adopting some of the previously prescribed slope safety limits for the establishment of oil palm plantation; and of latex-timber rubber plantations in the steepland. Soil research on generation of soil erodibility indices and soil erosion risk is also important to enhance and improved planned operation practices for agriculture in the steepland.

Development of Technological Package

The development of appropriate technological package is pertinent to enhance success and sustainable agriculture in the steepland. Research effort should be continued to improve or complement the existing cropping systems by ways of increasing yield and reducing labour input. The development of specific crop husbandry and management as well as the harvesting techniques is needed to validate, for example, the feasibility for the establishment of oil palm plantation; and of latex-timber rubber plantations on previously prescribed slope limits in the steepland.

Socio-Economic Issues - Operational Facilities and High Development Cost

The lack of operational facilities and high development cost generally constitute severe constraint to sustainable agriculture in the steep land. High cost on developing operational facilities such as road to provide accessibility is often a serious constraint. Construction of road in the steep land is very costly and without which access to inputs and market are both denied. A good road network is essential to ensure economical transportation of the produce from the plantations to the market.

Availability of Work Force

Shortage of work force is also a major constraint in the steep land. Knowledgeable workers at the sub-managerial level are few. A high proportion of the present plantation workers are alien. There is a need to update survey information on the present status, attitudes, perceptions and responses of the local work force towards taking up permanent occupation as remunerative workers in the estates and plantations.

Land Status and Availability of Land

The land status of the steep land in the State comprises Forest Reserve, Protected Forest Land, Native Customary Rights Land, Native Area Land and Interior Area Land as well land which is subjected to Native Customary Rights (NCR) claim. The land status in the steep land can be so diverse that it restricts preferential selection of contiguous blocks of land for the plantation development. The present land cover information indicates that a large proportion of the relatively accessible steep land (outside the Forest Reserves and Protected Forests) has been used at one time or another for small-holder farming by the rural farming households nearby. Inevitably, this land is subjected to some kind of NCR claim. However, such land by inclusion of potential NCR claimants as stakeholders in project proponent is considered a desirable opportunity to facilitate and accelerate the development of some of the steep land into commercial plantations in the State.

GENERAL SOIL CONSERVATION AND MANAGEMENT GUIDELINES FOR AGRICULTURE IN THE STEEP LAND

A national workshop to prepare guidelines for agricultural activities in steep land was held in Cameron Highlands, Pahang Darul Makmur, 5-8 July, 1993. The Workshop has compiled a standard set of guidelines for agricultural activities in steep land of Malaysia. The workshop guidelines provide the basis for the formulation of the general soil conservation and management guidelines in respect of some of the

important land utilization/agricultural crops in steep land of the State. The guidelines consist of three parts which are described below.

A. Land Clearing Measures	Description
	1. by manageable stages 2. clean felling 3. selective felling 4. Method (a) manual (b) mechanical (c) both 5. buffer zone 6. timeliness 7. destumping (a) clean (b) selective 8. zero burning 9. "controlled" burning

Lowland; <300 m (slope in degrees)	0-2	2-6	6-12	12-20	20-25	25-30	30-35
Annual	1,2,4b,6,7,8a	NA	NA	NA	NA	NA	NA
Perennial	1,2,3,4c,5,6,7,8					1,2,3,4a,5,6,7b,8	(1,2,3,4a,5,6,7b,8)
Hill Padi	1,3,4a,5,6,8					1,2,4a,5,6,7,9	
Pepper	1,2,4c,5,6,7,8a					1,2,4a,5,6,7,8	(1,2,4a,5,6,7,8)
Medium Term Crops	1,2,3,4c,5,6,7,8						
Aquaculture	1,2,4c,5,6,7,8						

Explanatory note: Land clearing measures for the perennial crops on very steep slopes ranging between 30-35 degrees are shown in brackets. It indicates that the steepness of slope is a very severe limitation. Given the appropriate land clearing measures, the land with this slope class can only support a very restricted range of crops; marginally suitable and is not encouraged.

Highland; >300 m (slope in degrees)	0-2	2-6	6-12	12-20	20-25	25-30	
Annuals vegetables & flowers	1,2,4c,5,6,7,8		1,4a,5,6				
Perennial	1,2/3,4c,5,6,8					1,2,3,4 a,5,6,8	
Hill Padi	1,3,4a,5,6,8					1,2,4a,5,6,7b,9	
Aquaculture	1,2,4c,5,6,7,8						

B. Conservation Structures/Measures	Description
	1. Reversed-slope Bench terrace 2. Plateau/individual basin 3. Plateau/broad bench 4. Silt pits/traps/contour ditches 5. Orchard terrace 6. Hillside ditches

Lowland <300m (slope in degrees)	0-2	2-6	6-12	12-20	20-25	25-30	30-35
Annual	4	4,6					
Perennial	4	4,6	1,2,3,4,5,6			(1,2,3, 4,5,6)	
Hill Padi	NA	NA	NA	NA	NA	NA	NA
Pepper			1,6				(1,6)
Medium Term Crops	4	4,6	12,3, 4,5				
Aquaculture	4	4,6					

Explanatory note: Soil conservation and management measures for the perennial crops on the very steep slopes (25-30 degrees) and extremely steep slopes (30-35 degrees) are shown in brackets. It indicates that the steepness of slope is a very severe limitation. With soil conservation and management measures, the land with this slope class can only support a very restricted range of crops; marginally suitable and is not encouraged.

Highlands; >300m	0-2	2-6	6-12	12-20	20-25	25-30	30-35
Annual Vegetables & flowers	4	2,3,4,6	1,2,3,4,6	1,2,3,4,5,6			
Perennial	4	4,6	1,2,3,4,6	1,2,3,4,5,6		(1,2,3,4,5,6)	
Hill Padi	NA	NA	NA	NA	NA	NA	NA
Aquaculture	4	4,6					

Explanatory note: Soil conservation and management measures for the perennial crops on very steep slopes (25-30 degrees) are shown in brackets. It indicates that the steepness of slope is a very severe limitation. Given the appropriate soil conservation and management measures, the land with this slope class can only support a very restricted range of crops; marginally suitable and is not encouraged.

C. Agronomic Measures	Description
	<ol style="list-style-type: none"> 1. Ground cover 2. Contour planting 3. Mulching 4. Minimum tillage 5. High density planting 6. Crop rotation 7. Inter-cropping 8. Ally cropping 9. Grass strips/hedge row 10. Wind breakers 11. Fallow period

Lowland; <300 m	0-2	2-6	6-12	12-20	20-25	25-30	30-35
Annual	3,5,6	2 to 10					
Perennial	1,3,4	1,2,3,4,5,7,8				(1,2,3,4,5,7,8)	
Hill Padi			2,3,4,5,8,9			2,3,4,5,11	
Pepper		1,2,3,4				1,2,3,4,9	
Medium Term Crops	1,3,4,5,6,7,8,10						
Aquaculture	1						

Explanatory note: Agronomic measures for the perennial crops on very steep slopes (25-30 degrees) are shown in brackets. It indicates that the steepness of slope is a very severe limitation. Given the appropriate agronomic measures, the land with this slope class can only support a very restricted range of crops; marginally suitable and is not encouraged

Highland;>300 m	0-2	2-6	6-12	12-20	20-25	25-30	30-35
Annual	3,5,6,7			(3,5,6,7)			
Perennial	1,3,4,5,7,8,9,10						
Hill Padi			2,3,4,5,8,9			2,3,4,5,11	
Pepper		1,2,3,4				1,2,3,4,9	(1,2,3,4,9)
Aquaculture	1						

Explanatory note: Agronomic measures for the annual crops on steep slopes (12-20 degrees) and pepper on the extremely steep slopes (30-35 degrees) are shown in brackets. It indicates that the steepness of slope is a severe limitation. Given the appropriate agronomic measures, the land with these slope classes can only support a very restricted range of crops; marginally suitable and is not encouraged.

CONCLUSION

In Sarawak, the "steepland" categorically encompasses dissected hills and mountains with steep and very steep slopes which exceed 25 degrees. The steepland can be considered on basis of the steepness of the slopes, and among others (e.g. soil conditions and erosion hazard) as marginally suitable or conditionally suitable or unsuitable for agriculture.

The Steepland is often being marginalized as non-sustainable for agriculture. It is now common to detect inclusions of large tracts of steepland within the estate and plantation boundaries. The development trends in the steepland include mono-cropping of pepper, the establishment of oil palm estates and plantations (and integration with ruminant livestock); latex-timber rubber plantations as well as the non-agrcultural plantations such as forestry plantations for pulp production. Tentatively, an upper slope limit of 35 degrees is used to delimit the steepland for the cultivation of hill padi by field rotation (indigenous conservation hill padi farming system) whereas a slope limit of 30 degrees is adopted for hill padi-based mixed farming with pepper, rubber on terraced slopes; and fruit trees on platform terrace. A slope safety limit of 30 degrees is adopted for commercial pepper small holdings; 30 degrees for latex-timber rubber plantations; and the establishment of oil palm plantations on terraced slopes; and or non-agricultural forestry projects on terraced slopes in the steepland.

Sustained development for agriculture is restricted in the steepland because of severe erosion hazard, infertile soils, high development cost, shortage of land and work force. The choice of appropriate crops, soil conservation, soil improvement and environmental protection are pertinent to safeguard long-term productivity of the steepland in the State.

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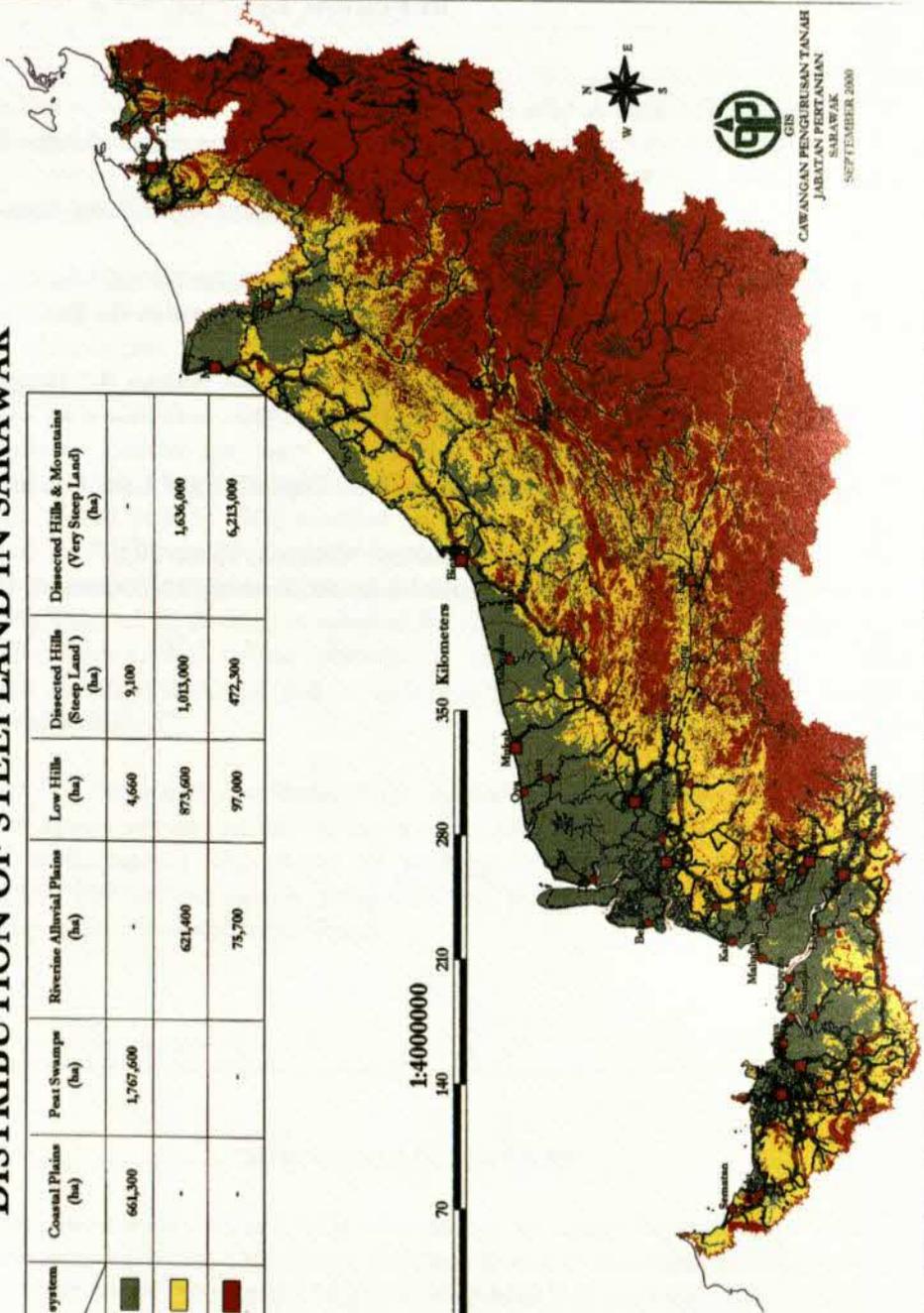
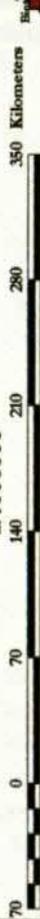
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AGRICULTURAL LAND RESOURCES AND DISTRIBUTION OF STEEPLAND IN SARAWAK

Text Map 1

Physiographical Region	Land system		Coastal Plains (ha)	Peat Swamps (ha)	Riverine Alluvial Plains (ha)	Low Hills (ha)	Dissected Hills (Steep Land) (ha)	Dissected Hills & Mountains (Very Steep Land) (ha)
	Coastal Lowland	Central Lowland						
Coastal Lowland			661,300	1,707,600	-	4,660	9,100	-
Central Lowland			-	-	621,400	875,600	1,013,000	1,636,000
Interior Upland			-	-	75,700	97,000	472,300	6,213,000

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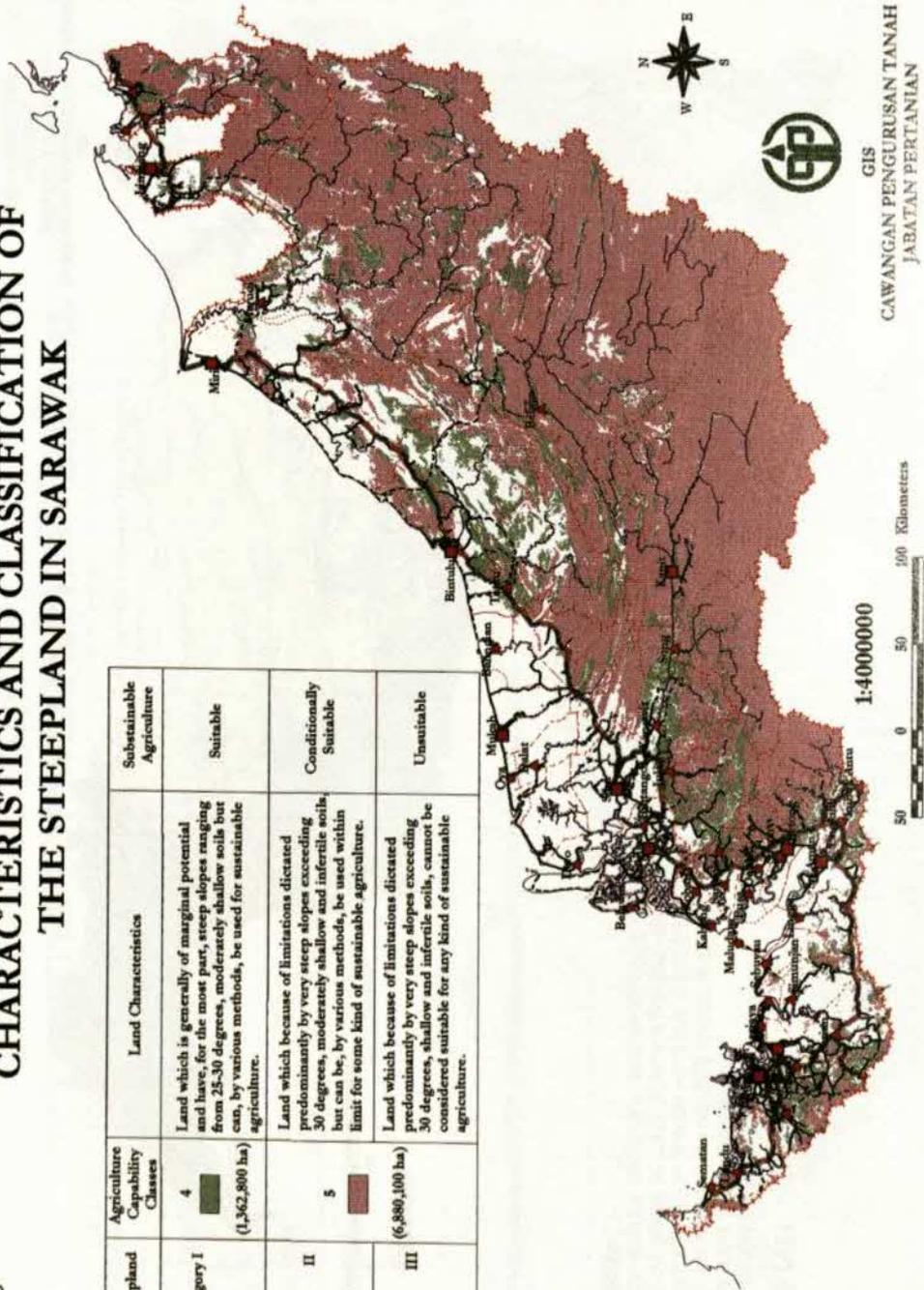


GIS
 CAWANGAN PERKHIDMATAN TANJAH
 JABATAN PERTANIAN
 SARAWAK
 SEPTEMBER 2000

Text Map 3

CHARACTERISTICS AND CLASSIFICATION OF THE STEEPLAND IN SARAWAK

Steepland Category	Agriculture Capability Classes	Land Characteristics	Subsustainable Agriculture
Category I	4 (1,562,800 ha)	Land which is generally of marginal potential and have, for the most part, steep slopes ranging from 25-30 degrees, moderately shallow soils but can, by various methods, be used for sustainable agriculture.	Suitable
II	5 (6,880,100 ha)	Land which because of limitations dictated predominantly by very steep slopes exceeding 30 degrees, moderately shallow and infertile soils, but can be, by various methods, be used within limit for some kind of sustainable agriculture.	Conditionally Suitable
III		Land which because of limitations dictated predominantly by very steep slopes exceeding 30 degrees, shallow and infertile soils, cannot be considered suitable for any kind of sustainable agriculture.	Unsuitable



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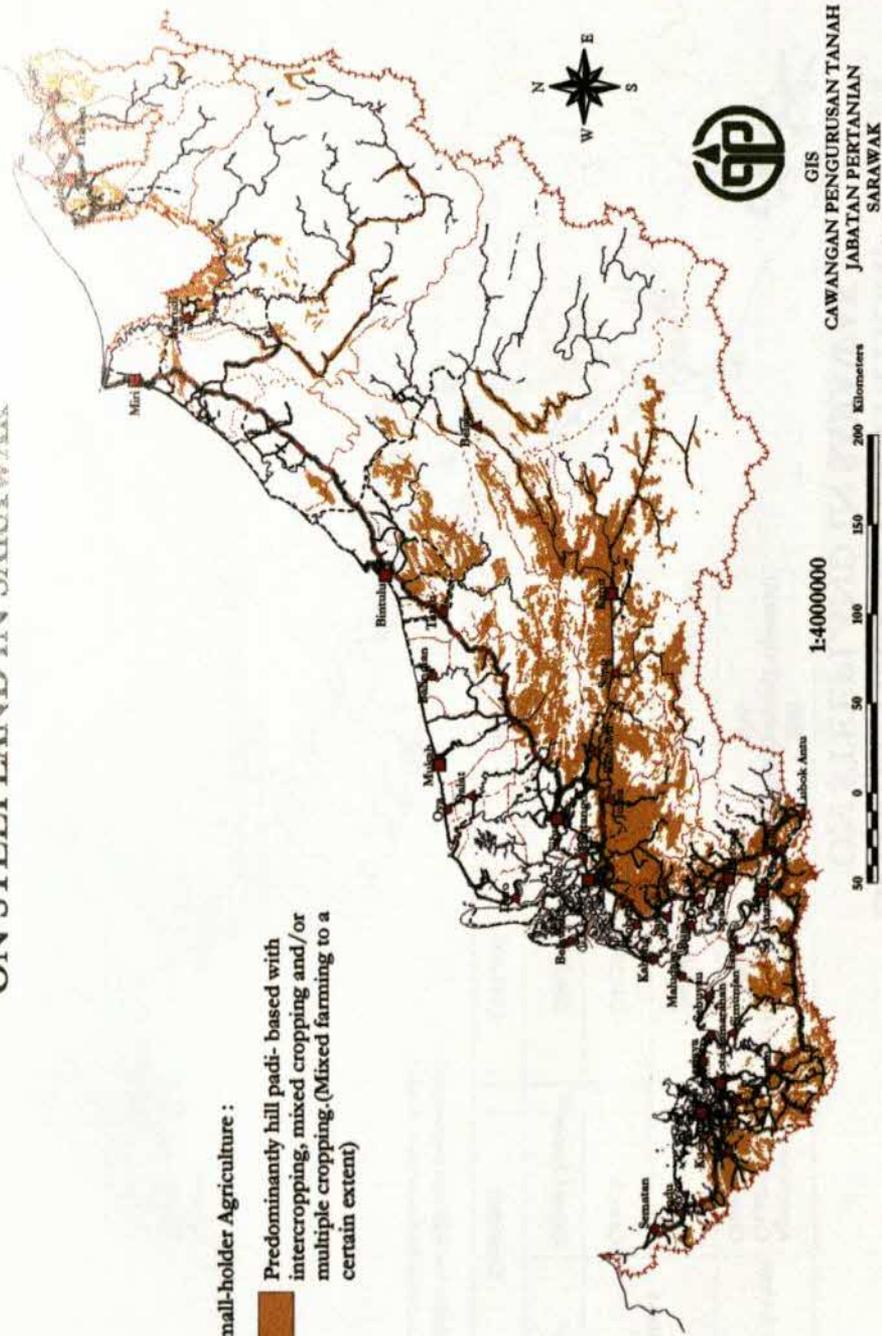


Text Map 4

DISTRIBUTION OF SMALL-HOLDER AGRICULTURE ON STEEPLAND IN SARAWAK

Small-holder Agriculture :

 Predominantly hill padi- based with intercropping, mixed cropping and/or multiple cropping. (Mixed farming to a certain extent)



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