

3. LOGGING AND SHIFTING CULTIVATION ACTIVITIES IN FOREST LAND

3.1 Logging Activities

3.1.1 Logging activities in Sabah

During the past 25 years from 1956 to 1980, 5,700 km² in total were logged among the Commercial Forest Reserves of 33,400 km² in Sabah. The historical record on area logged within five years by the respective Forest Reserves is as shown in Table 3.

At present, there exists 27,700 km² of unlogged area in the Commercial Forest Reserves. The Forest Department will request to formulate a land use plan providing directive for optimum land use, taking into consideration the increasing competition for land use between agriculture and forestry sectors. Under the prospective plan, delineation of forest zones is expected for the principal basis for the future forest management. According to a preliminary plan made by the Forest Department, 11 zones are designated as permanent forest reserves; nine for commercial land use forest producing timber for export and local industries: two for multiple land use forest purposing (1) environmental protection reserves for research, education, amenity aesthetic including mangrove forest, (2) national parks and virgin jungle reserves, and (3) the marginal commercial forest reserves, as shown in Tables 4 to 6.

According to the projection of wood supply made by the Sabah Forestry Department, the annual exploited area is projected to be 605 km² in 1981, 549 km² in 1982, 486 km² in 1983, 475 km² in 1984, 471 km² a year from 1985 to 1989, and 316 km² a year from 1990 to 2020. From this projection, around 8,000 km² or 30% of unlogged forest will newly be developed for exploitation purpose during the next two decades up to the year of 2000.

3.1.2 Logging activities in Sarawak

Up to the end of 1979, 3,560 km² or 15% of forests were exploited in the Permanent Forested Area of 23,480 km², and 3,880 km² or 25% of forests in the Licenced Area of 15,270 km² as shown in Table 7. The exploitable forested area in Sarawak totals 31,310 km². Taking into consideration the Government's policy, annual exploited area in Sarawak is assumed to be kept with the latest forest exploitation level of 450 km². Based on this assumption, approximately 9,000 km² or 30% of exploitable forest will be developed during 20 years from 1981 to 2000.

3.2 Shifting Cultivation

3.2.1 Shifting cultivation in Sabah

According to the "Land Resource Study" (Ref. 8), 834 km² or 1.2% of the total State area was recognized as shifting cultivation area as of 1973. The areal distribution of shifting cultivation by District is as shown in Table 8. About 60% of these shifting cultivation area concentrates in the Residencies of Kudat and West Coast.

Usually, hill or dry paddy is grown under shifting cultivation system. The record of hill paddy area in 1973 as shown in Table 8 indicates that approximately 140 km² or 17% of shifting cultivation area is grown with hill paddy every year.

3.2.2 Shifting cultivation in Sarawak

The Land and Survey Department of Sarawak compiled a report of "Planimetric Measurement of Land Use Map, Sarawak" in 1976. In this report, shifting cultivation area totals 28,530 km² and shares 23% of the whole land in Sarawak. Table 9 shows the distribution of shifting cultivation area by Division and District. In the Second and Sixth Divisions, the shifting cultivation area shares about half of its whole area. The Districts where shifting cultivation area occupies more than 50% of the District area are Bau and Serian in the First Division, Lubok Antu, Saribas and Kalaka in the Second Division, Kanowit in the Third Division and Julau in the Sixth Division.

In Sarawak, a practice of hill paddy growing is broadly prevailing in the above shifting cultivation area where at least 40,000 households or 250,000 persons of all ages of the Iban, Land Dayaks and other indigenous races are engaged in shifting culture to a large extent. As shown in Table 9, these local people annually plant an area of approximately 740 km² with hill paddy by shifting cultivation method.

3.2.3 Effect of shifting cultivation

A practice of shifting cultivation is to cut, clear and burn forest land followed by growing of hill paddy for one year or continuously two years as usual. There have been serious problems caused by shifting cultivation in preserving forest resources, but a few problems have been recognized in the field of soil erosion control because the bush/fallow period is sufficiently maintained at effective levels to reduce soil erosion potentials after hill paddy planting period (Refs. 12 & 13).

As shown in Table 9, however, shifting cultivation area has already been over half of the total area in several Districts of Sarawak. Recently, due to less virgin and secondary forest areas in these Districts, the bush/fallow land has repeatedly been grown with hill paddy at short intervals. Thus, hill paddy areas where the bush/fallow period has significantly been shortened have suffered from sheet and gully erosions or from serious landslip and slumping on steeply dissected land.

4. EVALUATION OF SOIL EROSION POTENTIAL

4.1 General

As described in the previous Chapters, logging activities in Sabah and shifting cultivation in Sarawak have formed a contributory cause of surface soil loss in watershed regions. Aiming at quantitative evaluation of the impact of such development activities on watershed regions, various factors concerned are analyzed by using a computer model for evaluation of soil erosion potential. A flow chart of this model is illustrated in Fig. 1. Basic input factors for the above model comprise land use, elevation, slope degree, soil, surface geology, river basin division based on major river systems, river basin sub-division based on tributary system and hydrological observation records. Each input information is assessed and classified into several categories and ranges. Representative input information is schematized on a map with a square or mesh divided by grid system of 2'30" x 2'30".

As a result of application of grid system, the whole area of Sabah is divided into 3,568 meshes for Sabah including the Labuan island and 758 meshes for Banggi and other small islands. The total area is 72,850 km² for the former and 850 km² for the latter.

The entire area of Sarawak is divided into 5,898 meshes. The total area is 124,400 km².

4.2 Outline of Input Data

4.2.1 Land use classification

In Sabah, 16 land use categories are identified as a category with one mesh or more. These land use categories are combined into a more simplified system consisting of 10 categories, i.e. settlements and associated non-agricultural land, horticultural land, rubber land, other tree crop land, paddy land, shifting cultural land, improved permanent pasture and grass land, forest land, swamp and wet forest land, and unused land. Distribution of simplified land use categories by Basin is as shown in Table 10 and illustrated in Fig. 2.

In Sarawak, 16 land use categories are also identified and simplified to the above-mentioned system. The distribution by Basin is as presented in Table 10 and Fig. 2.

4.2.2 Ground elevation and slope degree classifications

Ground elevation is classified into every 100 m intervals and, above El. 801 m, into 801 to 1,000 m, 1,001 to 1,500 m, 1,501 to 2,000 m and over 2,001 m as shown in Table 11 and Fig. 3. Slope degree is divided into five ranges; i.e., 0° to 2°, 3° to 6°, 7° to 12°, 13° to 20° and more than 21° as shown in Table 12 and Fig. 4.

Out of the total area in Sabah, about 40% is classified into a range with the elevation below El. 100 m and 55% is almost flat land with the slope degree of 0° to 2°.

In Sarawak, around 45% of the whole area extends below El. 100 m and 65% has the slope degree of 0° to 2°.

The correlation between the land use category and the ground elevation and that between the land use category and slope degree ranges are as shown in Table 13 to 16.

In Sabah, dry forest land distributes with wide range of elevation. Tree crop development activities are undertaken in areas with the elevation below El. 100 m and the slope degree of less than 2°.

In Sarawak, the existing forests extend over swamp in low-lying area below El. 100 m and mountain with the elevation above El. 300 m. The shifting cultivation areas concentrate into land with the elevation below El. 200 m.

4.2.3 Soil classification

Soils are divided into eight units, i.e. alluvial soils on coastal plains; alluvial soils on coastal plains and/or riverine; alluvial soils on riverine, flood plains and/or low riverine terrace; alluvial soils on intermediate and high terrace; sedentary soils on undulating plains to rolling land; sedentary soils on rolling and low hilly land; sedentary soils on hills and mountains; and urban and mined land as shown in Table 17 and Fig. 5.

In Sabah, a unit of sedentary soils on hills and mountains shares 76% of the total followed by a unit of alluvial soils on coastal plains with a share of 7% and alluvial soils on coastal plains and/or riverine with a share of 6%.

In Sarawak, a unit of sedentary soils on hills and mountains shares 60% of the total followed by a unit of sedentary soils on rolling and low hilly land having a share of 18% and alluvial soils on coastal plains and/or riverine having a share of 13%.

The correlation between the land use category and the soil unit is as shown in Tables 18 and 19.

4.2.4 Surface geology classification

Surface geology was classified into 17 categories. For simplification, these 17 categories were combined into 10 groups. Those distribution by Basin is as shown in Table 20 and Fig. 6.

In Sabah, a category of Tertiary occupies 70% of the whole area. Other prevailing categories are Quaternary with a share of 15% and Intermediate with a share of 6%,

In Sarawak, a category of Tertiary also shares 68% followed by Quaternary and Cretaceous with a share of 18% and 9%, respectively.

4.2.5 Basin division, catchment area and hydrological records

By referring to the Basin division established for water resources engineering studies, schematic Basin division map is reproduced as illustrated in Fig. 7. This Basin indicates a watershed of main stream of each river. The catchment area, Basin rainfall and surface runoff records are given by the hydrological assessment in the Study as shown in Table 21.

Total catchment area covered by a randomized mesh selected on a main river stream and its tributaries is portrayed with some ranges in Fig. 8. Combined with data on Basin rainfall and runoff ratio, stream flow discharge at the randomized mesh mentioned in the above was obtained as schematically pictured in Fig. 9.

4.3 Evaluation

4.3.1 Soil loss under different land use pattern

Some soil loss monitoring works have been undertaken in recent years in Malaysia, but there has been no establishment of systematic monitoring network under the national level coordination. In the "Soil Conservation, A Training Handbook, Volume 1", prepared under the National Extension Project financed by IBRD, experimental data previously made on soil loss under different land use patterns are compiled as shown in Table 22. In these data, however, soil loss born in regenerating forests after exploitation and in rubber areas extending over lands with non-erodible soils are not included. With some modifications and amendments, therefore, the unit soil loss is set up for soil erosion potential study as shown in Table 23.

4.3.2 Soil erosion potential under past and present conditions

Annual volume of soil loss by Basin can be obtained by multiplying the unit soil loss by hectareage of the respective land use patterns.

The result of computation for the present land use pattern is as shown in Table 24. As it means the total annual soil loss in each Basin under the present land use pattern, the average annual soil loss is assumed to indicate a soil erosion potential. In Table 24, this potential is also tabulated by Basin.

For clarifying effect of the past forest exploitation activities on the present soil erosion potential, the average annual soil loss was estimated under the following assumption of land use pattern: (1) urban, (2) mixed horticulture, (3) paddy, (4) forest and (5) swamp. All the present diversified crop field, shifting cultivation area, grassland, scrub forest and newly cleared land are included into natural forest area. Among perennial crop areas, coconut and sago areas are included into swamp, while all the other tree crops are considered as natural forest area. The result of estimate and the increase in soil erosion potential are as shown in Table 24.

4.3.3 Soil erosion potential under future condition

As described in Section 3.1, the existing forest unexploited will be opened up to large extent for the purposes of logging and agricultural land development scheme. Thus, the increase in soil erosion potential caused by the future exploitation of forest is estimated on the basis of the following cases including the case of reforestation which can be greatly expected to reduce the existing soil erosion potential;

- Case 1: Reforestation is carried out in the presently shifting cultivation area and artificial regeneration is conducted in the presently scrub forest.
- Case 2: Forest exploitation for logging purpose is conducted in the presently unexploited forest extending over lands with a slope degree of 0° to 2° .
- Case 3: Forest exploitation for logging purpose is conducted in the presently unexploited forest extending over lands with a slope degree of 3° to 6° .
- Case 4: Agricultural land development scheme for rubber planting purpose is conducted in the presently unexploited forest extending over lands with a slope degree of 0° to 2° .

The results of estimate for the increase in total annual soil loss by Case by Basin are as shown in Table 25. The increase in soil erosion potential by Case by Basin is as shown in Table 26.

To identify problem areas with high soil erosion potential, the following four alternatives are reviewed by estimating the annual average surface soil loss; Alternative 1: same as Case 1, Alternative 2: Case 2 plus Case 3, Alternative 3: same as Case 3, and Alternative 4: same as Case 4 and Alternative 5: Case 3 plus Case 4. The results of estimate are as shown in Table 27.

4.3.4 Suspended solid concentration

The average suspended solid concentration at each estuary of 47 Basins was estimated by dividing the total annual soil loss by the total surface runoff. For this estimate, the following assumptions were made: (1) the whole volume of soil loss occurred in a Basin was delivered into a stream by surface runoff, (2) the soils delivered were thoroughly drifted down to the estuary and (3) specific gravity of soil is 1.00. In another word, both the delivery rations on a slope and in a river were assumed to be 1.0 and also no attention was paid to sediment load and bed load due to lack of useful and accurate hydrological observation data. The results of estimates for the five Alternatives and for the present land use pattern are as shown in Table 28.

The simulation analysis is carried out to visualize the change of suspended solid concentration in the respective river stretches. The results are schematically illustrated in Fig. 10 for the present land use pattern and Fig. 11 for the future land use pattern under the Alternative 5.

4.3.5 Effect of forest exploitation on low flow

It is well known that a part of rainfall is restored to the atmosphere through evaporation and transpiration and the remainder becomes surface runoff and groundwater. In the field of forest hydrology, the correlation between low flow and change in vegetation has not been quantitatively grasped in all over the world.

In Peninsular Malaysia, some experimental works on forest hydrology have been undertaken in two study areas being located in the Gunong Jerai Forest Reserve in Kedah and the Ulu Gombak Forest Reserve in Selangor (Refs. 17 & 18). The main objective of these experimental works is to study the effect of logging on sediment yield. According to the experimental results up to date, the study shows considerably good progress in grasping the difference of sediment yield under logging and undisturbed conditions of forest in both catchments.

The difference of low flows from natural forest and tree crop plantations has, however, not been studied yet under the above experiments. It has been believed that forest clearing results in reduction of low river flow and increase of flood discharge. Experimental records in this respect in other countries are inadequate to draw conclusions applicable to Malaysia. This aspect accordingly has not been analysed, but this does not mean that the importance of forest conservation in water resources conservation can be neglected. In this Study, therefore, discussions are concentrated into the identification of problem areas having high potential of soil erosion.

5. PROBLEM AREAS AND NEEDS

5.1 Identification of Problem Areas

5.1.1 Problem areas in Sabah

Throughout the soil erosion potential evaluation under present land use pattern, the following Basins are recognized as the Basin having the annual average surface soil loss of more than 500 tons/km²/y and the suspended solid concentration of more than 700 mg/lit at estuary; Merutai Besar, Bengkoka, Bongan, Kadamaian, Tuaran and Labuan. In addition to the above, the Basins with the annual average surface soil loss of more than 500 tons/km²/y are Brantian, Umas Umas, Silabukan, Segalid, Labuk, Paitan and Putatan.

Reforestation in the disturbed forest can reduce erosion in a long run. The annual average surface soil loss in Sabah will decrease to 80 tons/km²/y compared with the value of 510 tons/km²/y under the present land use pattern. The suspended solid concentration at estuary will be below 100 mg/lit in all the Basins except for the Bengkoka, Bongan, Kadamaian, Tuaran, Putatan and Labuan of which values range between 100 and 600 mg/lit.

If all natural forest including unexploited and regenerated ones on slope of less than 6° is disturbed, the annual average surface soil loss will increase to 500 to 3,200 tons/km²/y in all the Basins. The suspended solid concentration at estuary will be over 700 mg/lit in all the Basins except for Putatan, Papar, Kimanis and Membakut.

If natural forest exploitation activities are restricted to a land on slope of less than 2°, the annual average surface soil loss in Sabah, will reduce from 2,200 tons/km²/y in the above case to 1,600 tons/km²/y. The Basins of which annual average surface soil loss will be above 1,600 tons/km²/y are Brantian, Umas Umas, Tawau, Kalumpang, Silabukan, Segama, Kinabatangan, Segalid, Paitan, Bengkoka, Bongan, Kadamaian and Tuaran. The suspended solid concentration at estuary will be over 700 mg/lit in 18 Basins in the State. The remaining eight Basins, i.e. Labuk, Sugut, Putatan, Papar, Kimanis, Membakut, Padas and Lakutan, will have the concentration level ranging from 150 to 650 mg/lit.

If all natural forest on slope of less than 2° is cleared and then converted to rubber farm, the annual average surface soil loss will further decrease to 700 tons/km²/y in Sabah. The Brantian, Umas Umas, Merutai Besar, Kalumpang, Silabukan, Segama, Segalid, Paitan, Bengkoka, Bongan, Kadamaian, Tuaran, Putatan and Labuan Basins have still the annual average surface soil loss of higher than 700 tons/km²/y. The suspended solid concentration at estuary will be over 700 mg/lit in the Brantian, Umas Umas, Merutai Besar, Silabukan, Bengkoka, Bongan, Kadamaian, Tuaran and Labuan Basins.

As a result, the following Basins are identified as problem area, because these Basins are presently subject to soil erosion in those catchments; Merutai Basar, Bengkoka, Bongan, Kadamaian, Tuaran and Labuan. In addition, the future forest development will increase soil erosion potential in the Brantian, Umas Umas and Silabukan Basins.

5.1.2 Problem areas in Sarawak

Throughout the soil erosion potential evaluation under present land use pattern, the following Basins are recognized as the Basin having the annual average surface soil loss of more than 500 tons/km²/y and the suspended solid concentration of more than 700 mg/lit at estuary; Miri, Sibuti, Niah, Oya, Kerian, Saribas, Lupar, Sadong and Sarawak. In addition to the above, the Basins with the annual average surface soil loss of more than 500 tons/km²/y are Lawas, Trusan, Limbang, Baram, Kemana, Tatau, Balingian, Mukah, Rajang and Kayan.

Reforestation in the disturbed forest can reduce erosion in a long run. The annual average surface soil loss in Sarawak will decrease to 60 tons/km²/y compared with the value of 1,500 tons/km²/y under the present land use pattern. The suspended solid concentration at estuary will be below 100 mg/lit in all the Basins except for the Kerian Basin of which value is about 150 mg/lit.

If all natural forest including unexploited and regenerated ones on slope of less than 6° is disturbed, the annual average surface soil loss will increase to 1,700 to 4,500 tons/km²/y in all the Basins. The suspended solid concentration at estuary will be over 700 mg/lit in all the Basins.

If natural forest exploitation activities are restricted to a land on slope of less than 2°, the annual average surface soil loss in Sarawak will reduce from 2,900 tons/km²/y in the above case to 2,400 tons/km²/y. The Basins of which annual average surface soil loss will be above 2,400 tons/km²/y are Miri, Sibuti, Niah, Suai, Similajau, Kemana, Tatau, Mukah, Oya, Kerian, Saribas, Lupar, Sadong, Sarawak and Kayan. The suspended solid concentration at estuary will be over 700 mg/lit in 19 Basins in the State. The remaining two Basins, i.e. Lawas and Baram, will have the concentration level of around 650 mg/lit.

If all natural forest on slope of less than 2° is cleared and then converted to rubber farm, the annual average surface soil loss will further decrease to 1,600 tons/km²/y in Sarawak. The Limbang, Miri, Sibuti, Niah, Kemana, Mukah, Oya, Kerian, Saribas, Lupar, Sadong, Sarawak and Kayan Basins have still the annual average surface soil loss of higher than 1,600 tons/km²/y. The suspended solid concentration at estuary will be over 700 mg/lit in the Miri, Sibuti, Niah, Kemana, Mukah, Oya, Rajang, Kerian, Saribas, Lupar, Sadong, Sarawak and Kayan Basins.

As a result, the following Basins are identified as problem area, because these Basins are presently subject to soil erosion in those catchments; Miri, Sibuti, Niah, Oya, Kerian, Saribas, Lupar, Sadong and Sarawak. In addition, the future forest development will increase soil erosion potential in the Limbang, Suai, Kemana, Balingian, Mukah, Rajang and Kayan Basins.

5.2 Needs and Provisional Countermeasures

Based on these considerations, the following conclusions are preliminarily drawn:

- (1) Forest clearing should be limited within the land of 2° in slope.
- (2) After clearing forest, such land use as appropriately protecting soils against erosion should be undertaken.
- (3) As a long-term program for preservation of productive forest and soil conservation, reforestation should be undertaken in the disturbed forest.

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TABLES

Table 1 SUMMARY OF FOREST RESERVE IN SABAH AS OF 1980

Unit: km²

Class & Category	Forest Reserve			Proportion to (%)	
	Gazetted	Preliminary Notified	Proposed Notified	Forest Reserve	State Land
Inland Forest Reserves					
Class I Protection forest	1,885	360	-	5.8	3.1
Class II Commercial forest	19,699	9,642	4,080	86.2	45.2
Class III Domestic forest	92	-	-	0.2	0.1
Class IV Amenity forest	150	-	-	0.4	0.2
Sub-total	21,826	10,002	4,080	92.6	48.6
Mangrove Forest Reserves					
Class V Commercial/Domestic	727	-	-	1.9	1.0
Virgin Jungle Reserves					
Inland forest	362	-	244	1.6	0.8
Mangrove forest	11	-	1	0.0	0.0
Sub-total	373	-	245	1.6	0.8
National Parks					
Inland forest	1,115	-	-	2.9	1.5
Mangrove forest	361	-	-	0.9	0.5
Sub-total	1,476	-	-	3.8	2.0
Water Catchment					
Water Catchment	26	-	-	0.1	0.0
Total Forest Reserve	24,428	10,002	4,325	100.0	52.4

Source; Ref. 1

Table 2 AREAL DISTRIBUTION OF GAZETTED FOREST
BY DIVISION IN SARAWAK

Unit: km²

Division	Forest Type	Forest Reserve	Protected Forest	Sub-total	Communal Forest	Total
First	Hill	723	245	968	-	-
	Swamp	457	36	493	-	-
	Mangrove	140	0	140	-	-
	Sub-total	1,320	281	1,601	13	1,614
Second	Hill	0	492	492	-	-
	Swamp	300	492	792	-	-
	Mangrove	0	0	-	-	-
	Sub-total	300	984	1,284	10	1,294
Third	Hill	13	1,221	1,234	-	-
	Swamp	923	1,843	2,766	-	-
	Mangrove	0	0	0	-	-
	Sub-total	936	3,064	4,000	7	4,007
Fourth	Hill	2,009	5,900	7,909	-	-
	Swamp	1,387	886	2,273	-	-
	Mangrove	12	0	12	-	-
	Sub-total	3,408	6,786	10,194	3	10,197
Fifth	Hill	541	165	706	-	-
	Swamp	125	0	125	-	-
	Mangrove	27	0	27	-	-
	Sub-total	693	165	858	4	862
Sixth	Hill	0	289	289	-	-
	Swamp	196	761	957	-	-
	Mangrove	94	130	224	-	-
	Sub-total	290	1,180	1,470	9	1,479
Seventh	Hill	533	11,071	11,604	-	-
	Swamp	0	390	390	-	-
	Mangrove	0	0	0	-	-
	Sub-total	533	11,461	11,994	259	12,253
State	Hill	3,819	19,383	23,202	-	-
	Swamp	3,388	4,408	7,796	-	-
	Mangrove	273	130	403	-	-
	Total	7,480	23,921	31,401	305	31,706

Source; Ref. 7

Table 3 HISTORICAL RECORD ON LOGGED AREA
WITHIN COMMERCIAL FOREST RESERVE
FROM 1956 TO 1980 IN SABAH

Unit: km²

Period	Gazetted Reserve	Preliminary Notified Reserve	Proposed Reserve	Total	Accumulated Total
<u>(1) Logged Area</u>					
1956/60	49	-	-	49	49
1961/65	236	-	-	236	285
1966/70	709	113	15	837	1,112
1971/75	1,986	101	117	2,207	3,326
1976/80	1,930	270	159	2,359	5,685
<u>(2) Exploitable Area</u>					
Total Area	19,699	9,642	4,080	33,421	
Logged Area	4,910	483	292	5,685	
Unlogged Area	14,789	9,159	3,788	27,736	

Source; Ref. 1

Table 4 LIST OF FOREST RESERVES WITH EXPLOITABLE
FOREST AREA IN SABAH (1/3)

Unit: km²

Zone	Forest Reserve	Status	Total		
			Total	Logged	Unlogged
1	1. Deramakot	G	512.6	478.5	34.1
	2. Tangkulap	G	259.0	93.0	166.0
	3. Malua	G	344.5	111.5	233.0
	4. Kuamut	G	1,096.2	147.7	948.5
	5. Segaliud-Lokan	G	634.3	384.8	249.5
	6. Segaliud-Lokan Ext. III	PN	22.7	-	22.7
	7. Lamag	G	168.4	101.6	66.8
	Sub-total		3,037.7	1,317.1	1,720.6
2	1. Ulu Segama	G	2,562.3	695.8	1,866.5
	2. Ulu Segama Ext. I to III	G	102.1	-	102.1
	3. Binuang Tinkayu	G	102.0	90.9	11.1
	4. Ulu Kalumpang	G	484.6	484.6	-
	5. Madai Baturong	G	19.4	-	19.4
	6. Madai Baturong Ext. I	PN	112.5	109.3	3.2
	7. Ulu Tengkeyu-Sabahan	P	170.0	155.1	14.9
	8. Mt. Wullersdorf	G	91.3	5.8	85.5
	9. Mt. Andrassy	G	29.9	-	29.9
	10. Mt. Andrassy Ext. I to III	G	4.6	-	4.6
	Sub-total		3,678.7	1,541.5	2,137.2
3	1. Silabukan	G	1,119.0	960.5	158.5
	2. Bonggaya	G	621.6	159.5	462.1
	3. Sugut	G	379.9	48.0	331.9
	4. Paitan	G	703.2	188.5	514.7
	5. Bengkoka	G	64.8	43.1	21.7
	6. Lumerau	G	377.4	94.1	283.3
	7. Banggi	G	119.4	-	119.4
	Sub-total		3,385.3	1,493.7	1,891.6
4	1. Ulu Tungud	PN	1,313.1	84.5	1,228.6
	2. Trus Madi	G	740.3	-	740.3
	3. Trus Madi Ext. I to III	PN	1,082.6	68.1	1,014.5
	4. Sg. Tongod	PN	168.4	43.6	124.8
	5. Sg. Mangkuwagu	P	82.9	13.4	69.5
	6. Pinangah (North)	G	479.2	51.7	427.5
	7. Bangkulat	PN	6.5	-	6.5
	Sub-total		3,873.0	261.3	3,611.7

Remarks; G: Gazetted, PN: Preliminary notified, and
P: Proposed

Source; Ref. 1

Table 5 LIST OF FOREST RESERVES WITH EXPLOITABLE FOREST AREA IN SABAH (2/3)

Unit: km²

Zone	Forest Reserve	Status	Total		
			Total	Logged	Unlogged
5	1. Gunong Rara	G	2,697.5	274.6	2,422.9
	2. Kalabakan	G	829.8	337.6	492.2
	3. Kalabakan Ext. I to IV	G	2,067.3	-	2,067.3
	Sub-total		5,594.6	612.2	4,982.4
6	1. Gunong Lumak	G	834.8	158.3	676.5
	2. Gunong Lumak Ext. I & II	PN	258.0	-	258.0
	3. Ulu Sg. Padas	PN	1,605.8	-	1,605.8
	4. Klias	PN	36.3	-	36.3
Sub-total		2,734.9	158.3	2,576.6	
7	1. Ulu Sg. Milian	PN	972.4	161.1	811.3
	2. Mt. Mandalom	G	186.3	-	186.3
	3. Mt. Mandalom Ext. I	PN	165.8	6.3	159.5
	4. Pensiangan	PN	1,126.6	10.6	1,116.0
Sub-total		2,451.1	178.0	2,273.1	
8	1. Sapulut	PN	2,411.3	-	2,411.3
	2. Sapulut Ext. I & II	PN	38.9	-	38.9
	3. Temalacak	PN	102.3	-	102.3
	4. Kabu	PN	141.4	-	141.4
	5. Salibir	PN	77.7	-	77.7
	6. Pinangah (South)	G	2,067.0	-	2,067.0
Sub-total		4,838.6	-	4,838.6	
9	1. Timimbang	P	366.4	85.9	280.5
	2. Ulu Tomani	P	354.1	-	354.1
	3. Kuala Tomani	P	246.9	-	246.9
	4. Labau	P	216.7	-	216.7
	5. Sg. Tagul	P	1,066.8	-	1,066.8
	6. Sg. Mengalong & Sg. Muaya	P	76.3	-	76.3
	7. Telekosang	P	366.2	-	366.2
	8. Lingkabau	P	977.7	37.4	940.3
	9. Binsuluk	P	156.2	-	156.2
Sub-total		3,827.3	123.3	3,704.0	

Remarks; G: Gazetted, PN: Preliminary notified, and
P: Proposed

Source; Ref. 1

Table 6 LIST OF FOREST RESERVES WITH EXPLOITABLE FOREST AREA IN SABAH (3/3)

Unit: km²

Zone	Forest Reserve	Status	Total		
			Total	Logged	Unlogged
10	1. Protection Forest Reserve	G	1,885.0	-	1,885.0
		N	359.6	-	359.6
	2. Virgin Jungle Reserve	G	361.7	-	361.7
		Proposed G	208.3	-	208.3
		Proposed PN	26.8	-	26.8
		Proposed P	9.3	-	9.3
	3. National Park		1,115.1	-	1,115.1
	4. Domestic Forest Reserve		91.6	-	91.6
	5. Amenity Forest Reserve		150.0	-	150.0
	6. Water Catchment		25.9	-	25.9
	Sub-total		4,233.3	-	4,233.3
11	1. National Park (Mangrove)		360.6	-	360.0
			737.3	-	727.3
			12.4	-	12.4
	3. Virgin Jungle Reserve (Mangrove)		1,100.3	-	1,100.3
	Sub-total		1,100.3	-	1,100.3
Summary					
	Commercial Forest Reserves		33,421.2	5,685.4	27,735.8
	Protection Forest Reserves		2,244.6	-	2,244.6
	Virgin Jungle Reserves		606.1	-	606.1
	National Parks		1,115.1	-	1,115.1
	Domestic Forest Reserves		91.6	-	91.6
	Amenity Forest Reserves		150.0	-	150.0
	Water Catchment		25.9	-	25.9
	Sub-total		37,654.5	5,685.4	31,969.1
	National Parks (Mangrove)		360.6	-	360.6
	Virgin Jungle Reserves (Mangrove)		727.3	-	727.3
	Mangrove Reserves		12.4	-	12.4
	Sub-total		1,100.3	-	1,100.3
	Total		38,754.8	5,685.4	33,069.4

Remarks; G: Gazetted, PN: Preliminary notified, and
P: Proposed

Source; Ref. 1

Table 7 EXPLOITED AND EXPLOITABLE
FOREST AREA IN SARAWAK

Unit: km²

Section/Plan	No. of Plan	Permanent Forested Area	Licensed Area	Exploited Area	Exploitable Area
Kuching Section					
Working plan	14	2,373	-	753	1,620
Felling plan	8	-	737	380	357
Sub-total	22	2,373	737	1,133	1,977
Sibu Section					
Working plan	17	8,677	-	1,170	7,507
Felling plan	10	-	2,962	430	2,532
Sub-total	27	8,677	2,962	1,600	10,039
Bintulu Section					
Working plan	16	7,392	-	729	6,663
Felling plan	20	-	3,569	618	2,951
Sub-total	36	7,392	3,569	1,347	9,614
Miri Section					
Working plan	16	5,039	-	907	4,132
Felling plan	37	-	8,006	2,454	5,552
Sub-total	53	5,039	8,006	3,361	9,684
State					
Working plan	63	23,481	-	3,559	19,922
Felling plan	75	-	15,274	3,882	11,392
Total	138	23,481	15,274	7,441	31,314

Source; Ref. 7

Table 8 SHIFTING CULTIVATION AND HILL PADDY GROWING AREAS BY DISTRICT IN SABAH AS OF 1973

Unit: km²

Residency/District	Total Area	Shifting Cultivation		Hill Paddy Growth Area
		Area	Proportion (%)	
Tawau Residency				
Tawau	5,675	1	0.02	0.2
Semporna	1,043	2	0.19	0.5
Lahad Datu	7,247	5	0.07	0.2
Total	13,965	8	0.06	0.9
Sandakan Residency				
Sandakan	2,183	4	0.18	0.8
Kinabatangan	17,472	24	0.14	13.3
Labuk/Sugut	8,367	50	0.60	20.2
Total	28,022	78	0.28	34.3
Kudat Residency				
Kudat & others	2,841	126	4.43	21.8
Total	2,841	126	4.43	21.8
West Coast Residency				
Ranau	2,945	90	3.06	12.1
Kota Belud	1,395	93	6.67	5.8
Tuaran	1,154	76	6.59	6.1
Kota Kinabalu	812	45	5.54	1.0
Penampang	1,755	43	2.45	2.9
Papar	1,238	51	4.12	0.3
Total	9,299	398	4.28	50.2
Interior Residency				
Beaufort & Kuala Penyu	2,131	44	2.06	4.1
Sipitang	2,757	22	0.80	6.4
Tenom	2,368	27	1.14	2.4
Pensiangan	6,033	31	0.51	7.3
Keningau	3,321	53	1.60	6.9
Tambunan	1,380	41	2.97	6.3
Total	17,990	218	1.21	33.4
Labuan	97	6	6.19	0.2
Sabah State Total	72,214	834	1.15	140.8

Source; Refs. 8 & 9

Table 9 SHIFTING CULTIVATION AND HILL PADDY GROWING AREAS BY DISTRICT IN SARAWAK

Unit: km²

Division	District	Total Area	Shifting Cultivation		Hill Paddy Growth Area
			Area	Proportion (%)	
First	Kuching	2,323	822	35.4	23.4
	Bau	881	535	60.7	15.5
	Serian	2,043	1,115	54.6	12.8
	Lundu	1,783	531	29.8	8.1
	Simunjan	1,602	353	22.0	1.7
	Total	8,632	3,357	38.9	62.0
Second	Batang Lupar	4,203	1,736	41.3	48.1
	Lubok Antu	2,372	1,555	65.6	39.0
	Saribas	1,803	994	55.1	38.0
	Kalaka	1,598	988	61.8	25.2
	Total	9,976	5,273	52.9	150.3
Third	Sibu	3,400	1,190	35.0	29.5
	Mukah	5,017	1,337	26.6	9.7
	Dalat	2,200	908	41.3	4.5
	Kanowit	2,231	1,367	61.3	28.3
	Total	12,848	4,802	37.4	72.0
Fourth	Miri	5,025	1,011	20.1	32.4
	Baram	21,628	2,921	13.5	60.7
	Bintulu	11,839	2,134	18.0	55.3
	Total	38,492	6,066	15.8	148.4
Fifth	Limbang	3,934	736	18.7	18.8
	Lawas	3,799	450	11.8	26.7
	Total	7,733	1,186	15.3	45.5
Sixth	Sarikei	1,690	776	45.9	28.3
	Binatang	1,067	444	41.6	6.1
	Daro	1,261	300	23.8	-
	Julau	2,625	1,762	67.1	32.7
	Total	6,643	3,282	49.4	67.1
Seventh	Kapit	15,594	2,236	14.3	104.9
	Belaga	19,401	1,092	5.6	32.4
	Song	3,934	1,235	31.4	59.5
	Total	38,929	4,563	11.7	196.8
Sarawak State Total		123,253	28,529	23.1	742.1

Source; Refs. 10 & 11

Table 10 DISTRIBUTION OF LAND USE CATEGORY BY BASIN IN SABAH AND SARAWAK

Unit: No. of mesh

Basin No.	Name of Basin	Land Use Category										Total
		SA	HL	RC	TC	PL	SC	GL	FL	SW	UL	
(1) Sabah												
201	Pensiangan	-	-	-	-	-	-	-	292	-	-	292
202	Serudong	-	-	-	-	-	-	-	56	17	-	73
203	Kalabakan	-	-	-	-	-	-	-	65	4	-	69
204	Brantian	-	-	-	-	-	-	-	38	2	-	40
205	Umas Umas	-	-	-	-	-	-	-	25	3	-	28
206	Merutai Besar	-	-	-	1	-	-	-	16	1	-	18
207	Tawau	-	-	6	7	-	-	-	34	2	-	49
208	Kalumpang	-	-	-	12	-	-	-	122	21	-	155
209	Silabukan	1	-	-	4	-	-	-	101	22	-	128
210	Segama	-	-	1	1	-	-	-	227	41	-	270
211	Kinabatangan	-	-	-	-	-	-	-	686	82	-	768
212	Segalid	2	-	5	2	-	-	-	74	37	-	120
213	Labuk	-	-	-	6	1	4	1	243	62	1	318
214	Sugut	-	-	-	-	2	-	-	134	10	-	146
215	Paitan	-	-	-	-	-	-	-	58	22	-	80
216	Bengkoka	-	-	-	-	-	-	2	62	26	-	90
217	Bongan	1	1	-	10	-	-	5	87	11	1	116
218	Kadamaian	-	2	1	-	4	-	9	48	3	-	67
219	Tuaran	-	-	13	-	-	-	4	39	5	-	61
220	Putatan	2	1	12	-	-	-	1	10	4	-	30
221	Papar	-	2	3	-	2	-	-	29	1	-	37
222	Kimanis	-	-	7	-	-	-	-	13	7	-	27
223	Membakut	-	-	6	-	-	-	-	9	12	-	27
224	Padas	-	-	21	2	4	-	5	389	30	-	451
225	Labuan	-	2	2	-	-	-	-	1	-	-	5
226	Lakutan	-	-	5	-	-	-	1	53	8	-	67
State Total		6	8	82	45	13	4	28	2,911	433	2	3,532
(2) Sarawak												
227	Lawas	-	-	-	-	-	10	-	33	5	-	48
228	Trusan	-	-	-	-	-	15	-	104	9	-	128
229	Limbang	-	-	-	-	-	46	-	136	2	-	184
230	Baram	-	-	-	-	-	113	3	848	88	-	1,052
231	Miri	-	-	-	-	-	12	-	9	18	-	39
232	Sibuti	-	-	-	4	-	22	-	6	2	-	34
233	Niah	-	-	-	7	-	17	-	32	7	-	63
234	Suai	-	-	-	-	-	6	-	52	11	-	69
235	Similajau	-	-	-	-	-	1	-	60	8	-	69
236	Kemana	-	-	2	-	-	65	-	191	24	-	282
237	Tatau	-	-	-	-	-	33	-	180	25	-	238
238	Balingian	-	-	-	-	-	28	-	35	68	-	131
239	Mukah	-	-	-	3	-	37	-	35	38	-	113
240	Oya	-	-	-	-	-	50	-	23	32	-	105
241	Rajang	-	-	27	-	-	476	1	1,704	206	-	2,414
242	Kerian	-	-	-	-	1	46	4	-	29	-	80
243	Saribas	-	-	2	-	1	42	-	-	44	-	89
244	Lupar	-	-	1	-	2	169	3	42	103	-	320
245	Sadong	-	-	-	4	-	78	1	32	56	-	171
246	Sarawak	-	-	2	10	-	101	2	21	26	-	162
247	Kayan	-	-	-	-	-	23	-	66	16	-	105
State Total		-	-	34	28	4	1,390	14	3,609	817	-	5,896
Sabah Islands		-	-	-	-	-	-	1	23	12	-	36
Total		6	8	116	73	17	1,394	43	6,543	1,262	2	9,464

Remarks: SA: Settlements and associated non-agricultural land, HL: Horticultural land, RC: Rubber land, TC: Other tree crop land, PL: Paddy land, SC: Shifting cultural land, GL: Improved permanent pasture and grass land, FL: Forest land, SW: Swamp and wet forest land, and UL: Unused land

Source: Ref. 10

Table 11 DISTRIBUTION OF ELEVATION RANGE BY BASIN
IN SABAH AND SARAWAK

Unit: No. of mesh

Basin No.	Name of Basin	Range of Elevation									Total
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
(1) Sabah											
201	Pensiangan	-	-	5	29	82	147	26	3	-	292
202	Serudong	33	11	2	5	5	14	3	-	-	73
203	Kalabakan	13	17	5	20	7	6	1	-	-	69
204	Brantian	6	9	4	6	7	8	-	-	-	40
205	Umas Umas	7	7	2	10	1	1	-	-	-	28
206	Merutai Besar	7	5	2	2	1	1	-	-	-	18
207	Tawau	30	3	3	6	3	3	1	-	-	49
208	Kalumpang	82	30	11	18	12	2	-	-	-	155
209	Silabukan	92	19	6	6	3	2	-	-	-	128
210	Segama	128	52	12	29	29	20	-	-	-	270
211	Kinabatangan	340	114	21	73	101	106	10	3	-	768
212	Segalid	120	-	-	-	-	-	-	-	-	120
213	Labuk	128	32	17	21	29	52	28	9	2	318
214	Sugut	37	26	8	28	17	17	7	3	3	146
215	Paitan	61	12	1	5	-	1	-	-	-	80
216	Bengkoka	53	15	1	9	3	9	-	-	-	90
217	Bongan	58	10	3	11	12	19	2	1	-	116
218	Kadamalan	31	7	-	9	4	9	3	3	1	67
219	Tuaran	21	7	3	2	7	15	5	1	-	61
220	Putatan	19	6	-	1	1	3	-	-	-	30
221	Papar	9	1	1	5	7	8	6	-	-	37
222	Kimanis	17	1	1	2	1	2	3	-	-	27
223	Membakut	20	2	2	-	-	3	-	-	-	27
224	Padas	47	5	16	59	53	131	101	37	2	451
225	Labuan	5	-	-	-	-	-	-	-	-	5
226	Lakutan	24	6	7	11	8	6	4	1	-	67
State Total		1,388	397	133	367	393	585	200	61	8	3,532
(2) Sarawak											
227	Lawas	15	1	4	3	9	6	8	2	-	48
228	Trusan	17	8	7	5	4	39	34	13	1	128
229	Limbang	52	21	11	9	15	33	30	11	2	184
230	Baram	267	103	48	145	101	252	92	44	-	1,052
231	Miri	37	-	2	-	-	-	-	-	-	39
232	Sibuti	33	-	-	-	1	-	-	-	-	34
233	Niah	61	2	-	-	-	-	-	-	-	63
234	Sual	65	3	1	-	-	-	-	-	-	69
235	Similajau	69	-	-	-	-	-	-	-	-	69
236	Kemana	241	26	5	3	4	3	-	-	-	282
237	Tatau	157	46	10	19	4	2	-	-	-	238
238	Balingian	106	19	2	3	1	-	-	-	-	131
239	Mukah	80	27	-	4	1	1	-	-	-	113
240	Oya	77	19	3	5	-	1	-	-	-	105
241	Rajang	700	421	172	257	194	528	124	18	-	2,414
242	Kerian	73	7	-	-	-	-	-	-	-	80
243	Saribas	67	16	3	3	-	-	-	-	-	89
244	Lupar	204	34	21	35	20	6	-	-	-	320
245	Sadong	158	6	2	2	3	-	-	-	-	171
246	Sarawak	139	14	2	4	1	2	-	-	-	162
247	Kayan	93	9	-	-	-	3	-	-	-	105
State Total		2,711	782	293	497	358	876	288	88	3	5,896
Sabah Islands		30	5	1	-	-	-	-	-	-	36
Total		4,129	1,184	427	864	751	1,461	488	149	-	9,464

Remarks: (1): 1 to 100 m, (2): 101 to 200 m, (3): 201 to 300 m, (4): 301 to 400 m,
(5): 401 to 500 m, (6): 501 to 1,000 m, (7): 1,001 to 1,500 m,
(8): 1,501 to 2,000 m, and (9): above 2,001 m above sea level

Table 12 DISTRIBUTION OF SLOPE DEGREE RANGE BY BASIN IN SABAH AND SARAWAK

Unit: No. of mesh

Basin No.	Name of Basin	(1)	(2)	(3)	(4)	(5)	Total
(1) Sabah							
201	Pensiangan	100	73	81	25	13	292
202	Serudong	43	12	7	7	4	73
203	Kalabakan	28	28	9	3	1	69
204	Brantian	18	9	12	1	-	40
205	Umas Umas	16	9	3	-	-	28
206	Merutai Besar	10	6	1	-	1	18
207	Tawau	31	6	10	2	-	49
208	Kalumpang	106	25	20	4	-	155
209	Silabukan	102	18	5	2	1	128
210	Segama	172	63	29	5	1	270
211	Kinabatangan	480	128	95	45	20	768
212	Segalid	120	-	-	-	-	120
213	Labuk	167	65	42	31	13	318
214	Sugut	70	27	25	13	11	146
215	Paltan	66	11	2	1	-	80
216	Bengkoka	63	11	14	2	-	90
217	Bongan	65	9	25	9	8	116
218	Kadamaian	34	7	14	3	9	67
219	Tuaran	24	11	14	9	3	61
220	Putatan	21	5	-	3	1	30
221	Papar	11	9	7	7	3	37
222	Kimanis	17	2	2	2	4	27
223	Membakut	21	2	1	3	-	27
224	Padas	169	91	96	52	43	451
225	Labuan	5	-	-	-	-	5
226	Lakutan	29	13	14	7	4	67
State Total		1,988	640	528	236	140	3,532
(2) Sarawak							
227	Lawas	21	3	8	5	11	48
228	Trusan	46	16	24	12	30	128
229	Limbang	85	26	23	19	31	184
230	Baram	487	131	189	84	91	1,052
231	Miri	37	1	1	-	-	39
232	Sibuti	33	-	-	1	-	34
233	Niah	62	1	-	-	-	63
234	Suai	65	4	-	-	-	69
235	Similajau	69	-	-	-	-	69
236	Kemana	246	27	3	6	-	282
237	Tatau	190	25	19	4	-	238
238	Balingian	118	9	4	-	-	131
239	Mukah	99	11	3	-	-	113
240	Oya	89	14	1	1	-	105
241	Rajang	1,261	472	381	203	97	2,414
242	Kerian	77	3	-	-	-	80
243	Saribas	83	5	1	-	-	89
244	Lupar	253	49	15	2	1	320
245	Sadong	161	4	3	3	-	171
246	Sarawak	143	16	2	1	-	162
247	Kayan	92	10	-	-	3	105
State Total		3,717	887	677	351	264	5,896
Sabah Islands		30	5	1	-	-	36
Total		5,735	1,532	1,206	590	404	9,464

Remarks; (1): 0° to 2°, (2): 3° to 6°, (3): 7° to 12°, (4): 13° to 20°, and (5): over 21°

Table 13 CORRELATION BETWEEN LAND USE CATEGORY AND GROUND ELEVATION IN SABAH

Unit: No. of mesh

Range of Elevation	Land Use Category										Total
	SA	HL	RC	TC	PL	SC	GL	FL	SW	UL	
1 - 100 m	6	8	57	41	7	-	17	824	428	-	1,388
101 - 200 m	-	-	8	4	3	-	-	378	4	-	397
201 - 300 m	-	-	8	-	-	1	-	124	-	-	133
301 - 400 m	-	-	7	-	3	3	4	350	-	-	367
401 - 500 m	-	-	2	-	-	-	4	387	-	-	393
501 - 600 m	-	-	-	-	-	-	-	58	-	-	58
601 - 700 m	-	-	-	-	-	-	1	245	-	-	246
701 - 800 m	-	-	-	-	-	-	1	164	1	-	166
801 - 900 m	-	-	-	-	-	-	-	-	-	-	-
901 - 1,000 m	-	-	-	-	-	-	1	114	-	-	115
1,001 - 1,500 m	-	-	-	-	-	-	-	200	-	-	200
1,501 - 2,000 m	-	-	-	-	-	-	-	60	-	1	61
Above 2,000 m	-	-	-	-	-	-	-	7	-	1	8
Total	6	8	82	45	13	4	28	2,911	433	2	3,532

Remarks; SA, HL, RC, TC, PL, SC, GL, FL, SW & CL:
See remarks in Table 11.

Table 14 CORRELATION BETWEEN LAND USE CATEGORY AND SLOPE DEGREE IN SABAH

Unit: No. of mesh

Range of Slope Degree	Land Use Category										Total
	SA	HL	RC	TC	PL	SC	GL	FL	SW	UL	
0° - 2°	6	8	76	40	12	1	21	1,396	428	-	1,988
3° - 6°	-	-	5	5	1	1	2	622	4	-	640
7° - 12°	-	-	-	-	-	1	5	522	-	-	528
13° - 20°	-	-	1	-	-	1	-	234	-	-	236
21° -	-	-	-	-	-	-	-	137	1	2	140
Total	6	8	82	45	13	4	28	2,911	433	2	3,532

Remarks; SA, HL, RC, TC, PL, SC, GL, FL, SW & UL:
See remarks in Table 11.

Table 15 CORRELATION BETWEEN LAND USE CATEGORY AND GROUND ELEVATION IN SARAWAK

Unit: No. of mesh

Range of Elevation	Land Use Category										Total
	SA	HL	RC	TC	PL	SC	GL	FL	SW	UL	
1 - 100 m	-	-	34	28	4	1,046	14	768	817	-	2,711
101 - 200 m	-	-	-	-	-	211	-	571	-	-	782
201 - 300 m	-	-	-	-	-	36	-	257	-	-	293
301 - 400 m	-	-	-	-	-	48	-	449	-	-	497
401 - 500 m	-	-	-	-	-	10	-	348	-	-	358
501 - 600 m	-	-	-	-	-	4	-	96	-	-	100
601 - 700 m	-	-	-	-	-	9	-	323	-	-	332
701 - 800 m	-	-	-	-	-	1	-	137	-	-	138
801 - 900 m	-	-	-	-	-	-	-	55	-	-	55
901 - 1,000 m	-	-	-	-	-	9	-	242	-	-	251
1,001 - 1,500 m	-	-	-	-	-	14	-	274	-	-	288
1,501 - 2,000 m	-	-	-	-	-	2	-	86	-	-	88
Above 2,000 m	-	-	-	-	-	-	-	3	-	-	3
Total	-	-	34	28	4	1,390	14	3,609	817	-	5,896

Remarks; SA, HL, RC, TC, PL, SC, GL, FL, SW & CL:
See remarks in Table 11.

Table 16 CORRELATION BETWEEN LAND USE CATEGORY AND SLOPE DEGREE IN SARAWAK

Unit: No. of mesh

Range of Slope Degree	Land Use Category										Total
	SA	HL	RC	TC	PL	SC	GL	FL	SW	UL	
0° - 2°	-	-	34	28	4	1,216	14	1,604	817	-	3,717
3° - 6°	-	-	-	-	-	131	-	756	-	-	887
7° - 12°	-	-	-	-	-	25	-	652	-	-	677
13° - 20°	-	-	-	-	-	11	-	340	-	-	351
21° -	-	-	-	-	-	7	-	257	-	-	264
Total	-	-	34	28	4	1,390	14	3,609	817	-	5,896

Remarks; SA, HL, RC, TC, PL, SC, GL, FL, SW & UL:
See remarks in Table 11.

Table 17 DISTRIBUTION OF SOIL UNIT BY BASIN
IN SABAH AND SARAWAK

Unit: No. of mesh

Basin No.	Name of Basin	Soil Unit								Total
		AC	AR	AF	AT	SR	SH	SM	UM	
(1) Sabah										
201	Pensiangan	-	-	2	3	-	-	287	-	292
202	Serudong	17	-	5	-	-	-	51	-	73
203	Kalabakan	4	-	1	-	-	-	64	-	69
204	Brantian	2	-	5	-	-	-	33	-	40
205	Umas Umas	3	-	5	-	-	-	20	-	28
206	Merutai Besar	2	-	3	-	2	-	11	-	18
207	Tawau	6	1	16	-	4	-	22	-	49
208	Kalumpang	11	6	17	-	5	31	85	-	155
209	Silabukan	10	11	3	5	13	1	85	-	128
210	Segama	19	26	1	-	10	9	205	-	270
211	Kinabatangan	35	56	8	14	14	40	601	-	768
212	Segalid	28	2	2	-	16	36	36	-	120
213	Labuk	36	14	14	-	9	14	231	-	318
214	Sugut	2	9	6	-	-	-	129	-	146
215	Paitan	16	-	20	-	-	-	44	-	80
216	Bengkoka	19	2	15	-	-	-	54	-	90
217	Bongan	6	7	4	-	-	2	97	-	116
218	Kadamaian	5	7	1	-	-	-	54	-	67
219	Tuaran	5	1	-	-	-	-	55	-	61
220	Putatan	-	4	-	-	-	-	26	-	30
221	Papar	1	5	-	-	-	-	31	-	37
222	Kimanis	2	5	-	-	-	-	20	-	27
223	Membakut	3	11	2	-	-	-	11	-	27
224	Padas	13	30	28	10	-	-	370	-	451
225	Labuan	-	-	-	-	-	-	5	-	5
226	Lakutan	3	6	2	-	-	-	56	-	67
State Total		248	203	160	32	73	133	2,683	-	3,532
(2) Sarawak										
227	Lawas	3	3	3	-	-	9	30	-	48
228	Trusan	3	6	5	-	-	25	89	-	128
229	Limbang	4	6	10	-	-	21	143	-	184
230	Baram	1	90	68	1	-	111	781	-	1,052
231	Miri	2	18	4	4	-	9	2	-	39
232	Sibuti	3	5	6	-	-	19	1	-	34
233	Niah	1	7	5	-	-	37	13	-	63
234	Sual	1	9	6	1	-	40	12	-	69
235	Simlajau	2	6	1	5	-	45	10	-	69
236	Kemana	-	42	21	4	-	133	82	-	282
237	Tatau	-	21	12	-	-	93	112	-	238
238	Balingian	-	61	5	-	-	23	42	-	131
239	Mukah	1	38	5	7	2	25	35	-	113
240	Oya	1	39	5	1	1	26	32	-	105
241	Rajang	74	203	35	1	-	174	1,927	-	2,414
242	Kerian	8	15	13	-	-	30	14	-	80
243	Saribas	2	31	15	-	-	12	29	-	89
244	Lupar	3	99	13	4	7	71	123	-	320
245	Sadong	6	65	14	1	2	57	26	-	171
246	Sarawak	30	17	11	6	-	70	28	-	162
247	Kayan	25	2	5	7	24	26	16	-	105
State Total		170	783	262	42	36	1,056	3,547	-	5,896
Sabah Islands		4	1	4	-	-	12	15	-	36
Total		422	987	426	74	109	1,201	6,245	-	9,464

Remarks: AC: Alluvial soils on coastal plains, AR: Alluvial soils on coastal plains and/or riverine, AF: Alluvial soils on riverine, flood plains and/or low riverine terrace, AT: Alluvial soils on intermediate and high terraces, SR: Sedentary soils on undulating plains to rolling land, SH: Sedentary soils on rolling and low hilly land, SM: Sedentary soils on hills and mountains, and UM: Urban and mined land

Source: Refs. 14 & 15

Table 18

CORRELATION BETWEEN LAND USE CATEGORY AND SOIL UNIT IN SABAH

Unit: No. of Mesh

Soil Unit	Land Use Category										Total
	SA	HL	RC	TC	PL	SC	GL	FL	SW	UL	
Alluvial Soils on Coastal Plains	1	-	2	3	1	-	3	14	228	-	252
Alluvial Soils on Coastal Plains and/or Riverine	-	1	11	3	3	-	1	6	88	-	113
Alluvial Soils on Riverine, Flood Plains and/or Low Riverine Terrace	2	4	4	5	6	-	-	45	39	-	105
Alluvial Soils on Intermediate and High Terrace	-	-	8	5	-	-	8	109	25	-	155
Sedentary Soils on Undulating Plains to Rolling Land	-	-	10	1	-	-	1	162	23	-	197
Sedentary Soils on Rolling and Low Hilly Land	-	2	15	16	-	-	6	347	15	-	401
Sedentary Soils on Hills and Mountains	3	1	32	12	3	4	10	2251	27	2	2345
Urban and Mined Land	-	-	-	-	-	-	-	-	-	-	-
Total Brunei Grand Total	6	8	82	45	13	4	29	2934	445	2	3568

Remarks; SA, HL, RC, TC, PL, SC, GL, FL, SW & UL: See remarks in Table 20.

Table 19 CORRELATION BETWEEN LAND USE CATEGORY
AND SOIL UNIT IN SARAWAK

Unit: No. of Mesh

Soil Unit	Land Use Category										Total
	AL	HL	RC	TC	PL	SC	GL	FL	SW	UL	
Alluvial Soils on Coastal Plains	-	-	-	8	-	36	1	7	103	-	155
Alluvial Soils on Coastal Plains and/or Riverine	-	-	16	5	2	109	2	39	609	-	783
Alluvial Soils on Riverine, Flood Plains and/or Low Riverine Terrace	-	-	7	4	2	135	7	41	66	-	262
Alluvial Soils on Intermediate and High Terrace	-	-	-	1	-	10	-	23	8	-	42
Sedentary Soils on Undulating Plains to Rolling Land	-	-	1	-	-	24	-	35	10	-	70
Sedentary Soils on Rolling and Low Hilly Land	-	-	9	10	-	520	3	497	17	-	1056
Sedentary Soils on Hills and Mountains	-	-	-	-	-	556	1	2967	4	-	3528
Urban and Mined Land	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	34	28	4	1390	14	3609	717	-	5896
Brunei											
Grand Total											

Remarks: SA, HL, RC, TC, PL, SC, GL, FL, SW & UL: See remarks in Table .

Table 20

DISTRIBUTION OF SURFACE GEOLOGICAL CATEGORY
BY BASIN IN SABAH AND SARAWAK

Unit: No. of mesh

Basin No.	Name of Basin	Surface Geological Category									Total	
		QT	TT	CR	CJ	TR	PC	AC	IN	BA		UT
(1) Sabah												
201	Pensiangan	12	280	-	-	-	-	-	-	-	-	292
202	Serudong	20	53	-	-	-	-	-	-	-	-	73
203	Kalabakan	5	62	2	-	-	-	-	-	-	-	69
204	Brantian	5	15	20	-	-	-	-	-	-	-	40
205	Umas Umas	6	12	8	-	-	-	-	-	2	-	28
206	Merutai Besar	6	8	-	-	-	-	1	1	2	-	18
207	Tawau	22	-	-	-	-	-	1	19	7	-	49
208	Kalumpang	22	33	34	-	-	-	5	43	17	1	155
209	Silabukan	42	37	5	-	-	-	-	43	-	1	128
210	Segama	47	91	47	-	-	-	-	73	2	10	270
211	Kinabatangan	49	622	32	-	-	-	-	21	17	27	768
212	Segalid	36	83	1	-	-	-	-	-	-	-	120
213	Labuk	57	199	3	-	-	-	2	-	26	31	318
214	Sugut	7	132	-	-	-	-	5	-	-	2	146
215	Paitan	25	55	-	-	-	-	-	-	-	-	80
216	Bengkoka	16	74	-	-	-	-	-	-	-	-	90
217	Bongan	14	95	2	-	-	-	-	-	-	5	116
218	Kadamaian	11	50	3	-	-	-	2	-	-	1	67
219	Tuaran	10	51	-	-	-	-	-	-	-	-	61
220	Putatan	13	17	-	-	-	-	-	-	-	-	30
221	Papar	5	32	-	-	-	-	-	-	-	-	37
222	Kimanis	9	18	-	-	-	-	-	-	-	-	27
223	Membakut	13	14	-	-	-	-	-	-	-	-	27
224	Padas	81	370	-	-	-	-	-	-	-	-	451
225	Labuan	-	5	-	-	-	-	-	-	-	-	5
226	Lakutan	11	56	-	-	-	-	-	-	-	-	67
State Total		544	2,464	157	-	-	-	16	200	73	78	3,532
(2) Sarawak												
227	Lawas	9	39	-	-	-	-	-	-	-	-	48
228	Trusan	16	112	-	-	-	-	-	-	-	-	128
229	Limbang	18	166	-	-	-	-	-	-	-	-	184
230	Baram	107	910	1	-	-	-	33	-	1	-	1,052
231	Miri	18	21	-	-	-	-	-	-	-	-	39
232	Sibuti	3	31	-	-	-	-	-	-	-	-	34
233	Niah	7	56	-	-	-	-	-	-	-	-	63
234	Suai	10	59	-	-	-	-	-	-	-	-	69
235	Similajau	7	62	-	-	-	-	-	-	-	-	69
236	Kemana	21	261	-	-	-	-	-	-	-	-	282
237	Tatau	21	214	-	-	-	-	-	-	3	-	238
238	Balingian	66	65	-	-	-	-	-	-	-	-	131
239	Mukah	51	62	-	-	-	-	-	-	-	-	113
240	Oya	47	58	-	-	-	-	-	-	-	-	105
241	Rajang	287	1,756	285	-	-	-	41	21	24	-	2,414
242	Kerian	34	2	44	-	-	-	-	-	-	-	80
243	Saribas	45	-	44	-	-	-	-	-	-	-	89
244	Lupar	111	60	137	-	4	-	8	-	-	-	320
245	Sadong	76	19	-	13	44	2	4	13	-	-	171
246	Sarawak	53	24	-	58	10	3	5	9	-	-	162
247	Kayan	39	37	-	-	-	20	9	-	-	-	105
State Total		1,046	4,014	511	71	58	25	100	43	28	-	5,896
Sabah Islands		9	6	17	-	-	-	-	-	-	4	36
Total		1,599	6,484	685	71	58	25	116	243	101	82	9,464

Remarks; QT: Quaternary, TT: Tertiary, CR: Cretaceous, CJ: Cretaceous & Upper Jurassic,
TR: Treassic, PC: Permian Carboniferous, AC: Acid, IN: Intermediate,
BA: Basic and UT: Ultrabasic

Table 21 SURFACE RUNOFF IN SABAH AND SARAWAK

Basin No.	Name of Basin	Catchment Area (km ²)	Rainfall (10 ⁹ m ³ /y)	Total Surface Runoff (10 ⁹ m ³ /y)	Unit Surface Runoff (10 ⁶ m ³ /y/km ²)
(1)	Sabah				
201	Pensiangan	5,971	14.87	8.91	1.49
202	Serudong	1,308	2.74	1.38	1.06
203	Kalaban	1,371	2.97	1.56	1.14
204	Brantian	741	1.53	0.76	1.03
205	Umas Umas	553	1.11	0.53	0.96
206	Merutai Besar	558	1.16	0.58	1.04
207	Tawau	888	2.01	1.10	1.24
208	Kalumpang	2,792	6.23	3.37	1.21
209	Silibukan	2,714	7.16	4.49	1.65
210	Segama	5,558	14.17	8.65	1.56
211	Kinabatangan	16,755	44.57	22.32	1.33
212	Segaliud	2,335	7.38	5.31	2.27
213	Labuk	6,829	22.34	16.31	2.39
214	Sugut	3,094	10.07	7.34	2.37
215	Paitan	1,474	5.17	3.87	2.63
216	Bengkoka	1,866	5.04	2.37	1.27
217	Bongan	2,126	5.49	2.45	1.15
218	Kadamajan	1,336	4.18	2.27	1.70
219	Tuaran	1,247	3.77	2.43	1.95
220	Putatan	629	1.97	1.15	1.83
221	Papar	805	2.57	1.53	1.90
222	Kimanis	607	1.89	1.10	1.81
223	Membakut	736	2.26	1.30	1.77
224	Padas	9,180	19.37	9.43	1.03
225	Labuan	86	0.29	0.18	2.09
226	Lakutan	1,291	3.74	2.07	1.60
	State Total	72,850	194.05	112.76	1.55
(2)	Sarawak				
227	Lawas	1,080	4.06	2.68	2.48
228	Trusan	2,768	8.30	4.71	1.70
229	Limbang	3,920	15.23	10.58	2.70
230	Baram	22,325	84.70	58.21	2.61
231	Miri	788	2.35	1.30	1.65
232	Sibuti	935	2.57	1.31	1.40
233	Niah	1,345	3.61	1.79	1.33
234	Buai	1,440	4.31	2.39	1.66
235	Similajau	1,268	4.28	2.62	2.07
236	Kemena	6,000	23.51	15.83	2.64
237	Tatau	5,150	20.15	13.56	2.63
238	Balingian	2,518	9.64	6.41	2.55
239	Mukah	2,625	10.27	6.92	2.64
240	Oya	2,005	6.75	4.13	2.06
241	Rajang	51,053	203.75	127.20	2.49
242	Kerian	1,675	6.09	3.80	2.27
243	Saribas	1,900	6.74	4.14	2.18
244	Lupar	6,813	24.61	15.27	2.24
245	Sadong	3,645	13.54	8.55	2.35
246	Sarawak	3,358	14.08	9.17	2.73
247	Kayan	1,838	8.81	6.13	3.34
	State Total	124,449	477.35	306.70	2.46

Table 22 ANNUAL SOIL LOSS UNDER DIFFERENT
LAND USE IN MALAYSIA

Unit: ton/ha/y

Land Use	Annual Soil Loss	Remarks
1. Natural Forest	0.33	P.G.D. Shallow, Tech. Comm. 3 Central Elec. Board (1956) Cameron Highlands
2. Tea	6.73	- do -
3. Vegetables	10.09	- do -
4. Rubber		
(a) Mature rubber under soil series Rengam on slopes of 7 to 9% and rainfall of 2,920 mm		Rubber Research Institute: Soil Erosion & Conservation in Peninsular Malaysia (1980)
Bare	103	
Grass	44	
Nephrolepis	Negligible	
(b) The same conditions as above but under soil series Serdang on slopes of 5 to 7% and rainfall of 3,250 mm		RRIM
Bare	132	
Grass	117	
Neophrolepis	59	
5. Oil Palm		
Harvesting Path	14.9	L.M. Maene, K.C. Thong, T.S. Ong and A.M. Mokhtaruddin-
Tree Row	7.5	Surface Wash Under Natural
FronD Row	1.1	Oil Palm -
Mixed Row	4.2	Dept. of Agriculture, Kuala Lumpur (1979)
Average for the whole area	7.7	
6. Pepper		
Up and down cultivation	64	Dept. of Agri. Sarawak (1980)
Bench Terraced	0.9	- do -
7. Grass with spray of Natural Rubber formulation on the soil	35 to 62	RRIM Experiments Handbook of Soil Erosion and Conservation in Peninsular Malaysia (1980)

Source; Refs. 17 & 18

Table 23

ASSUMED SOIL LOSS FOR EROSION POTENTIAL
EVALUATION IN MALAYSIA

Land Use Pattern	Slope	Soil Erodability		
		None	Light	Heavy
Unit: ton/ha/y				
Forest				
- Natural hill	0°-	0.33	0.33	0.33
- Natural wet	0°-	0	0	0
- Scrub	0°-	35	35	35
- Newly cleared	0°-	62	62	62
Tree Crops				
- Rubber	0°-2°	2	6	36
	3°-6°	2	12	72
	7°-12°	6	18	108
	13°-20°	12	24	144
- Oil palm & others	0°-2°	2	2	6
	3°-6°	2	6	12
	7°-12°	2	12	18
	13°-20°	6	18	24
- Coconut & Sago	0°-20°	0	0	0
Annual Crops				
- Paddy	0°-	0	0	0
- Upland crops	0°-	10.09	10.09	10.09
- Shifting area	0°-	62	62	62
Grass Land				
- Improved	0°-	35	35	35
- Wild	0°-	62	62	62

Table 24 ANNUAL SURFACE SOIL LOSS BY BASIN UNDER PRESENT AND PAST LAND USE PATTERNS

Basin No.	Name of Basin	CA (km ²)	Present Land Use Pattern		Past Land Use Pattern	
			TASSL (10 ³ ton/y)	AASSL (ton/km ² /y)	TASSL (10 ³ ton/y)	AASSL (ton/km ² /y)
(1)	Sabah					
201	Pensiangan	5,971	550	92	185	31
202	Serudong	1,308	35	27	35	27
203	Kalabakan	1,371	553	403	41	30
204	Brantian	741	389	525	24	32
205	Umas Umas	553	308	557	16	29
206	Merutai Besar	558	526	943	11	20
207	Tawau	888	442	498	28	32
208	Kalumpang	2,792	1,203	431	82	29
209	Silabukan	2,714	2,329	858	64	24
210	Segama	5,558	1,840	331	145	26
211	Kinabatangan	16,755	6,718	401	433	26
212	Segalid	2,335	1,425	610	51	22
213	Labuk	6,829	3,525	516	158	23
214	Sugut	3,094	1,254	405	85	27
215	Paitan	1,474	1,279	868	37	25
216	Bengkoka	1,866	1,981	1,062	40	21
217	Bongan	2,126	3,777	1,777	58	27
218	Kadamaian	1,336	3,183	2,382	37	28
219	Tuaran	1,247	2,742	2,199	35	28
220	Putatan	629	553	879	15	24
221	Papar	805	31	39	20	25
222	Kimanis	607	38	63	13	21
223	Membakut	736	31	42	10	14
224	Padas	9,180	2,010	219	262	29
225	Labuan	86	82	953	2	23
226	Lakutan	1,291	331	256	37	29
	State Total	72,850	37,135	510	1,924	26
(2)	Sarawak					
227	Lawas	1,080	1,327	1,229	27	25
228	Trusan	2,768	2,024	731	75	27
229	Limbang	3,920	6,092	1,554	115	29
230	Baram	22,325	15,681	702	609	27
231	Miri	788	1,573	1,996	13	16
232	Sibuti	935	2,893	3,094	20	21
233	Niah	1,345	2,269	1,687	35	26
234	Suai	1,440	816	567	37	26
235	Similajau	1,268	169	133	39	31
236	Kemana	6,000	8,633	1,439	163	27
237	Tatau	5,150	4,423	859	135	26
238	Balingian	2,518	3,678	1,461	40	16
239	Mukah	2,625	4,853	1,849	46	18
240	Oya	2,005	6,543	3,263	46	23
241	Rajang	51,053	63,516	1,244	1,395	27
242	Kerlan	1,675	6,529	3,898	32	19
243	Saribas	1,900	5,501	2,895	28	15
244	Lupar	6,813	22,489	3,301	136	20
245	Sadong	3,645	10,335	2,835	70	19
246	Sarawak	3,358	13,542	4,033	80	24
247	Kayan	1,838	3,045	1,657	56	30
	State Total	124,449	185,931	1,494	3,197	26

Remarks; CA : Total catchment area
TASSL : Total annual surface soil loss
AASSL : Average annual surface soil loss

Table 25 INCREASE IN TOTAL SURFACE SOIL LOSS BY BASIN UNDER FUTURE LAND USE PATTERN

Basin No.	Name of Basin	Present Land Use	Future Land Use Pattern			
			Case 1	Case 2	Case 3	Case 4
(1)	Sabah					
201	Pensiangan	550	-365	7,162	5,252	368
202	Serudong	35	-	1,900	877	102
203	Kalabakan	553	-512	1,608	1,681	87
204	Brantian	389	-365	804	658	397
205	Umas Umas	308	-292	950	512	405
206	Merutai Besar	526	-512	292	219	158
207	Tawau	442	-365	1,169	146	99
208	Kalumpang	1,203	-1,096	4,531	1,535	1,048
209	Silabukan	2,329	-2,265	4,092	658	1,304
210	Segama	1,840	-1,608	8,258	4,238	3,787
211	Kinabatangan	6,718	-6,284	24,261	8,477	3,202
212	Segalid	1,425	-1,315	4,092	-	580
213	Labuk	3,525	-3,215	6,139	3,727	1,257
214	Sugut	1,254	-1,169	3,362	1,900	165
215	Paitan	1,279	-1,242	2,119	658	104
216	Bengkoka	1,981	-1,681	1,242	512	61
217	Bongan	3,777	-3,069	585	365	29
218	Kadamaian	3,183	-1,973	292	73	14
219	Tuaran	2,742	-2,119	219	-	11
220	Putatan	553	-365	-	73	-
221	Papar	31	-	219	658	11
222	Kimanis	38	-	219	146	11
223	Membakut	31	-	219	146	11
224	Padas	2,010	-1,023	7,235	6,358	354
225	Labuan	82	-73	-	-	-
226	Lakutan	331	-146	1,023	877	50
	State Total	37,135	-31,054	81,992	39,746	13,615
(2)	Sarawak					
227	Lawas	1,327	-1,271	438	219	21
228	Trusan	2,024	-1,928	1,754	1,096	136
229	Limbang	6,092	-5,863	3,142	1,681	213
230	Baram	15,681	-14,471	22,798	12,642	1,563
231	Miri	1,573	-1,523	462	73	76
232	Sibuti	2,893	-2,816	365	-	60
233	Niah	2,269	-2,191	2,265	73	271
234	Suai	816	-769	3,508	292	484
235	Similajau	169	-146	4,385	-	585
236	Kemana	8,633	-8,339	11,400	1,900	1,308
237	Tatau	4,423	-4,220	9,719	1,754	1,041
238	Balingian	3,678	-3,592	1,681	585	124
239	Mukah	4,853	-4,750	1,608	731	112
240	Oya	6,543	-6,418	658	877	32
241	Rajang	63,516	-60,753	45,232	30,253	2,571
242	Kerian	6,529	-5,927	-	-	-
243	Saribas	5,501	-5,368	-	-	-
244	Lupar	22,489	-21,705	1,169	1,462	74
245	Sadong	10,335	-10,035	1,973	73	358
246	Sarawak	13,542	-13,031	731	731	44
247	Kayan	3,045	-2,964	3,873	731	1,803
	State Total	185,931	-178,080	117,161	55,173	10,876

Remarks; Case 1 : Reforestation of all existing forests disturbed.
Case 2 : All natural forests on slope of less than 2° are disturbed.
Case 3 : All natural forests on slope of 3°-6° are disturbed.
Case 4 : All natural forests on slope of less than 2° are disturbed and then converted to rubber firm.

Table 26 INCREASE IN ANNUAL AVERAGE SURFACE SOIL LOSS
BY BASIN UNDER FUTURE LAND USE PATTERN

Unit: ton/km²/y

Basin No.	Name of Basin	Present Land Use	Future Land Use Pattern			
			Case 1	Case 2	Case 3	Case 4
(1) Sabah						
201	Pensiangan	92	-61	1,199	880	62
202	Serudong	27	-	1,453	670	78
203	Kalabakan	403	-373	1,173	1,226	63
204	Brantian	525	-493	1,085	888	536
205	Umas Umas	557	-528	1,718	926	732
206	Merutai Besar	943	-918	523	392	283
207	Tawau	498	-411	1,316	164	111
208	Kalumpang	431	-393	1,623	550	375
209	Silabukan	858	-835	1,508	242	480
210	Segama	331	-289	1,486	763	681
211	Kinabatangan	401	-375	1,448	506	191
212	Segalid	610	-563	1,752	-	248
213	Labuk	516	-471	899	546	184
214	Sugut	405	-378	1,087	614	53
215	Paitan	868	-842	1,438	446	71
216	Bengkoka	1,062	-901	666	274	33
217	Bongan	1,777	-1,444	275	172	14
218	Kadamaian	2,382	-1,477	219	55	10
219	Tuaran	2,199	-1,699	176	-	9
220	Putatan	879	-580	-	116	-
221	Papar	39	-	272	817	14
222	Kimanis	63	-	361	241	18
223	Membakut	42	-	298	198	15
224	Padas	219	-111	788	693	39
225	Labuan	953	-849	-	-	-
226	Lakutan	256	-113	792	679	39
State		510	-426	1,125	546	187
(2) Sarawak						
227	Lawas	1,229	-1,177	406	202	19
228	Trusan	731	-697	634	396	49
229	Limbang	1,554	-1,496	802	429	54
230	Baram	702	-648	1,021	566	70
231	Miri	1,996	-1,933	586	93	96
232	Sibuti	3,094	-3,012	390	-	64
233	Niah	1,687	-1,629	1,684	54	201
234	Suai	567	-534	2,436	203	336
235	Similajau	133	-115	3,458	-	461
236	Kemana	1,439	-1,390	1,900	317	218
237	Tatau	859	-819	1,887	341	202
238	Balingian	1,461	-1,427	668	232	49
239	Mukah	1,849	-1,810	613	278	43
240	Oya	3,263	-3,201	328	437	16
241	Rajang	1,244	-1,190	886	593	50
242	Kerian	3,898	-3,538	-	-	-
243	Saribas	2,895	-2,825	-	-	-
244	Lupar	3,301	-3,186	172	215	11
245	Sadong	2,835	-2,753	541	20	98
246	Sarawak	4,033	-3,880	218	218	13
247	Kayan	1,657	-1,613	2,107	398	981
State		1,494	-1,431	941	443	87

Remarks; Case 1 : Reforestation of all existing forest disturbed.
Case 2 : All natural forests on slope of less than 6° are disturbed.
Case 3 : All natural forests on slope of 2° are disturbed.
Case 4 : All natural forests on slope of less than 2° are disturbed and then converted to rubber firm.

Table 27 ANNUAL AVERAGE SURFACE SOIL LOSS BY BASIN
UNDER ALTERNATIVES OF FUTURE LAND USE PATTERN

Unit: ton/km²/y

Basin No.	Name of Basin	Catchment Area	Alternatives				
			1	2	3	4	5
(1) Sabah							
201	PenSIangan	5,971	31	2,171	1,291	154	1,034
202	Serudong	1,308	27	2,150	1,480	105	775
203	Kalabakan	1,371	30	2,802	1,576	466	1,692
204	Brantian	741	32	2,498	1,610	1,061	1,949
205	Umas Umas	553	29	3,201	2,275	1,289	2,215
206	Merutai Besar	558	25	1,858	1,466	1,226	1,618
207	Tawau	888	87	1,978	1,814	609	773
208	Kalumpang	2,792	38	2,604	2,054	806	1,356
209	Silabukan	2,714	23	2,608	2,366	1,338	1,580
210	Segama	5,558	42	2,580	1,817	1,012	1,775
211	Kinabatangan	16,755	26	2,355	1,849	592	1,098
212	Segalid	2,335	47	2,362	2,362	858	858
213	Labuk	6,829	45	1,961	1,415	700	1,246
214	Sugut	3,094	27	2,106	1,492	458	1,072
215	Paitan	1,474	26	2,752	2,306	939	1,385
216	Bengkoka	1,866	161	2,002	1,728	1,095	1,369
217	Bongan	2,126	333	2,224	2,052	1,791	1,963
218	Kadamaian	1,336	905	2,656	2,601	2,392	2,447
219	Tuaran	1,247	500	2,375	2,375	2,208	2,208
220	Putatan	629	299	995	879	879	995
221	Papar	805	39	1,128	311	53	870
222	Kimanis	607	63	665	424	81	322
223	Membakut	736	42	538	340	57	255
224	Padas	9,180	108	1,700	1,007	258	951
225	Labuan	86	104	953	953	953	953
226	Lakutan	1,291	143	1,727	1,048	295	974
State Total		72,850	84	2,181	1,635	697	1,243
(2) Sarawak							
227	Lawas	1,080	52	1,837	1,635	1,248	1,450
228	Trusan	2,768	34	1,761	1,365	780	1,176
229	Limbang	3,920	58	2,785	2,356	1,608	2,037
230	Baram	22,325	54	2,289	1,723	772	1,338
231	Miri	788	63	2,675	2,582	2,092	2,185
232	Sibuti	935	82	3,484	3,484	3,158	3,158
233	Niah	1,345	58	3,425	3,371	1,888	1,942
234	Suai	1,440	33	3,206	3,003	903	1,106
235	Similajau	1,268	18	3,591	3,591	594	594
236	Kemana	6,000	49	3,656	3,339	1,657	1,974
237	Tatau	5,150	40	3,087	2,746	1,061	1,402
238	Balingian	2,518	34	2,361	2,129	1,510	1,742
239	Mukah	2,625	39	2,740	2,462	1,892	2,170
240	Oya	2,005	62	4,028	3,591	3,279	3,716
241	Rajang	51,053	54	2,723	2,130	1,294	1,887
242	Kerian	1,675	360	3,898	3,898	3,898	3,898
243	Saribas	1,900	70	2,895	2,895	2,895	2,895
244	Lupar	6,813	115	3,688	3,473	3,312	3,527
245	Sadong	3,645	82	3,396	3,376	2,933	2,953
246	Sarawak	3,358	153	4,469	4,251	4,046	4,264
247	Kayan	1,838	44	4,162	3,764	2,638	3,036
State Total		124,449	63	2,878	2,435	1,581	2,024

Remarks; Alternative 1: Reforestation of all existing forest disturbed.
Alternative 2: All natural forests on slope of less than 6° are disturbed.
Alternative 3: All natural forests on slope of less than 2° are disturbed.
Alternative 4: All natural forests on slope of less than 2° are disturbed and then converted to rubber firm.
Alternative 5: All natural forest on slope of less than 6° are disturbed and then converted to rubber farm on slope of less than 2°.

Table 28 ESTIMATE OF SUSPENDED SOLID CONCENTRATION
AT ESTUARY BY BASIN

Unit: mg/lit

Basin No.	Name of Basin	Present Land Use Pattern	Alternative				
			1	2	3	4	5
(1) Sabah							
201	Pensiangan	62	21	1,457	866	103	694
202	Serudong	25	25	2,028	1,396	99	731
203	Kalabakan	354	26	2,458	1,382	409	1,484
204	Brantian	510	31	2,425	1,563	1,030	1,892
205	Umas Umas	580	30	3,334	2,370	1,343	2,307
206	Merutai Besar	907	24	1,787	1,410	1,179	1,556
207	Tawau	402	70	1,595	1,463	491	623
208	Kalumpang	356	31	2,152	1,698	666	1,121
209	Silabukan	520	14	1,581	1,434	811	958
210	Segama	212	27	1,654	1,165	649	1,138
211	Kinabatangan	302	20	1,771	1,390	445	826
212	Segalid	269	21	1,041	1,041	378	378
213	Labuk	216	19	820	592	293	521
214	Sugut	171	11	889	630	193	452
215	Paitan	330	10	1,046	877	357	527
216	Bengkoka	836	127	1,576	1,361	862	1,078
217	Bongan	1,545	290	1,934	1,784	1,557	1,707
218	Kadamaian	1,401	532	1,562	1,530	1,407	1,439
219	Tuaran	1,128	256	1,218	1,218	1,132	1,132
220	Putatan	480	163	544	480	480	544
221	Papar	21	21	594	164	28	456
222	Kimanis	33	33	350	223	43	169
223	Membakut	23	23	297	188	31	141
224	Padas	124	61	960	569	146	537
225	Labuan	925	101	925	925	925	925
226	Lakutan	122	68	826	501	141	466
	State	329	54	1,407	1,055	450	802
(2) Sarawak							
227	Lawas	496	21	741	659	503	585
228	Trusan	430	20	1,036	803	459	692
229	Limbang	576	21	1,031	873	596	754
230	Baram	269	21	877	660	296	513
231	Miri	1,210	38	1,621	1,565	1,268	1,324
232	Sibuti	2,210	59	2,489	2,489	2,256	2,256
233	Niah	1,268	44	2,575	2,535	1,420	1,460
234	Suai	342	20	1,931	1,809	544	666
235	Similajau	64	9	1,735	1,735	287	287
236	Kemana	545	19	1,385	1,265	628	748
237	Tatau	327	15	1,174	1,044	403	533
238	Balingian	573	13	926	835	592	683
239	Mukah	700	15	1,038	933	717	822
240	Oya	1,584	30	1,955	1,743	1,592	1,804
241	Rajang	500	22	1,094	855	520	758
242	Kerian	1,717	159	1,717	1,717	1,717	1,717
243	Saribas	1,328	32	1,328	1,328	1,328	1,328
244	Lupar	1,474	51	1,646	1,550	1,479	1,575
245	Sadong	1,206	35	1,445	1,437	1,248	1,257
246	Sarawak	1,477	56	1,637	1,557	1,482	1,562
247	Kayan	496	13	1,246	1,127	790	909
	State	607	26	1,170	990	643	823

Remarks; Alternative 1 : Reforestation of all existing forest disturbed.
Alternative 2 : All natural forests on slope of less than 6° are disturbed.
Alternative 3 : All natural forests on slope of less than 2° are disturbed.
Alternative 4 : All natural forests on slope of less than 2° are disturbed and then converted to rubber farm.
Alternative 5 : All natural forest on slope of less than 6° are disturbed and then converted to rubber farm on slope of less than 2°.

FIGURES

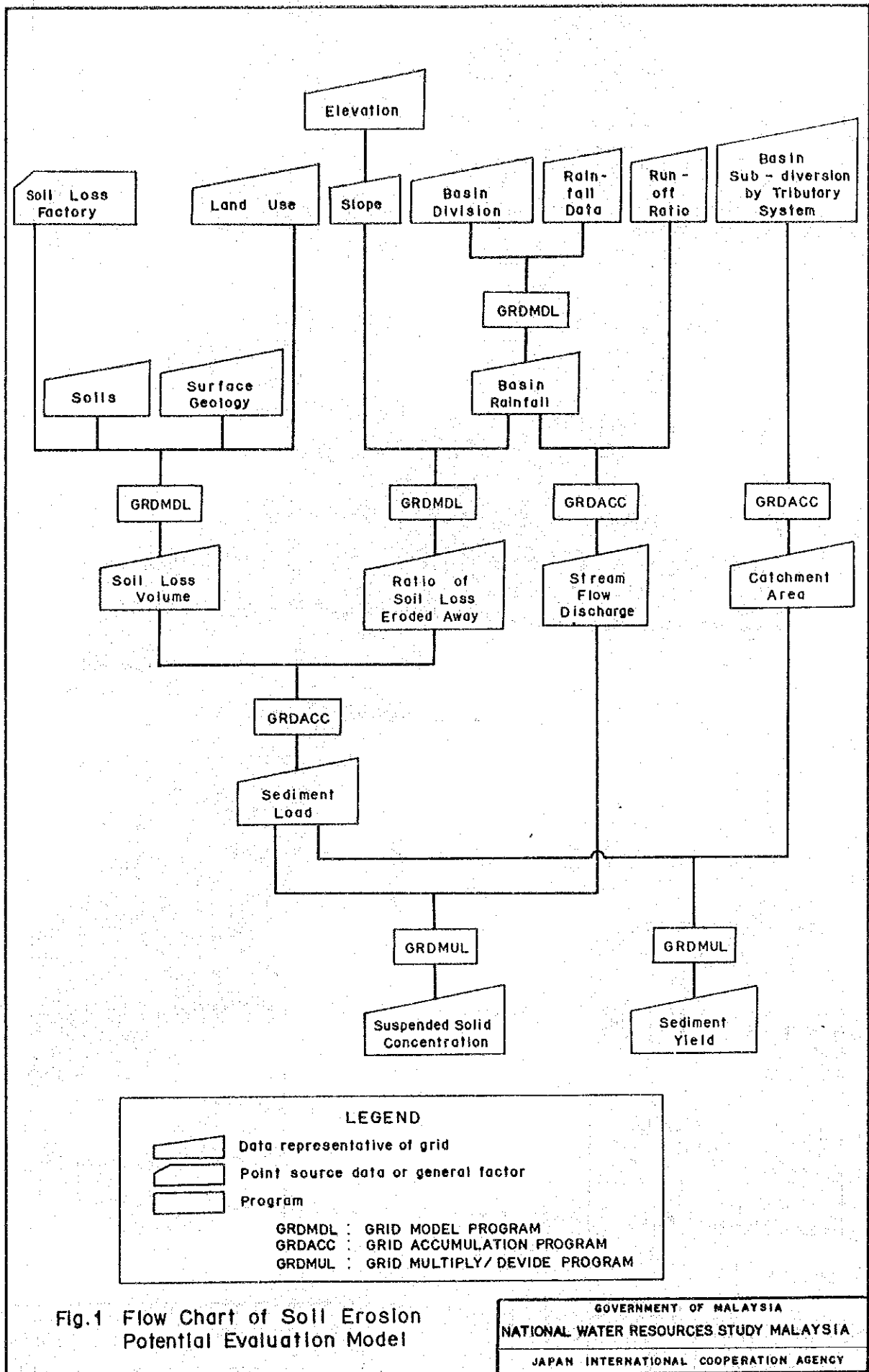
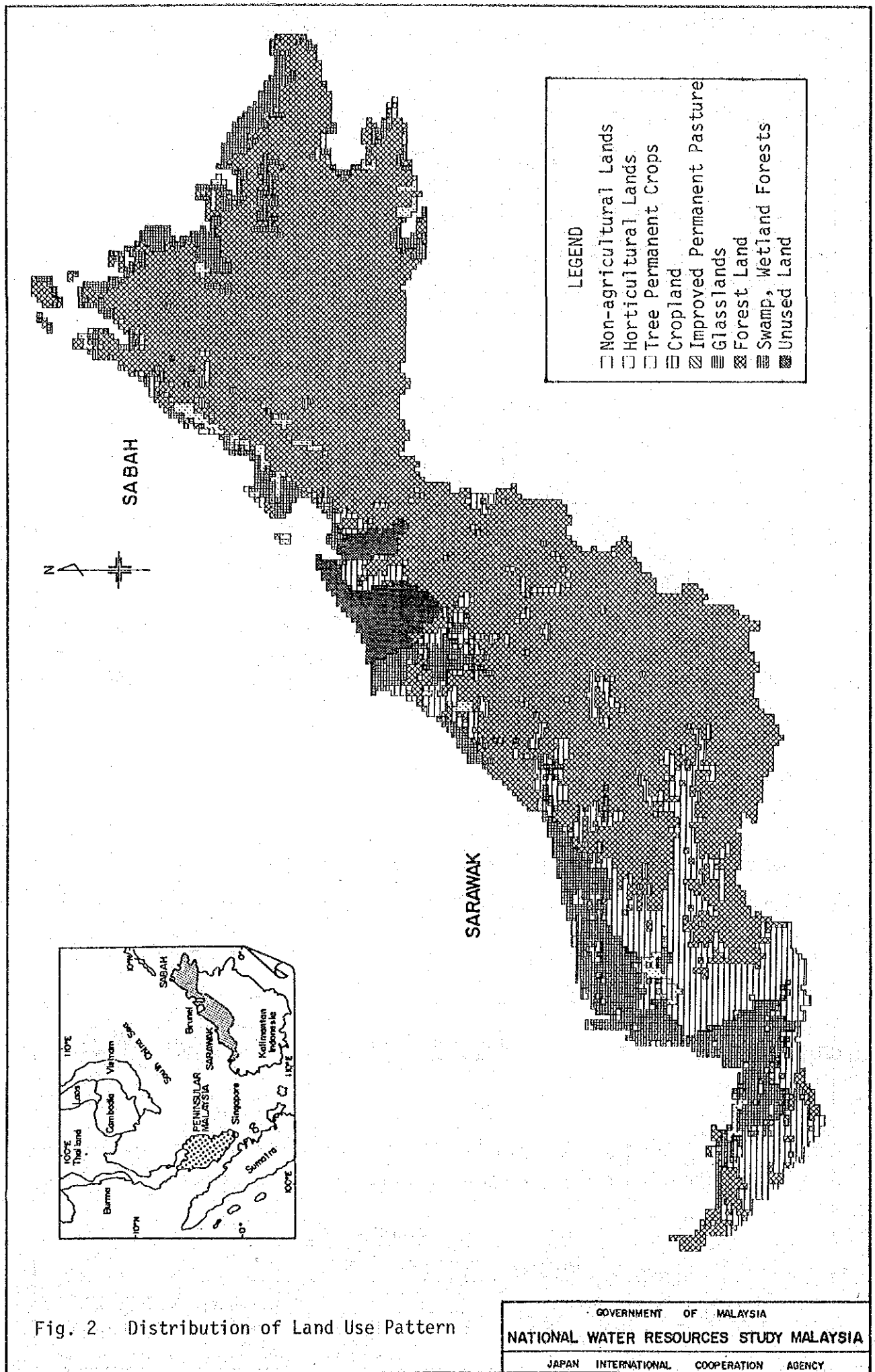
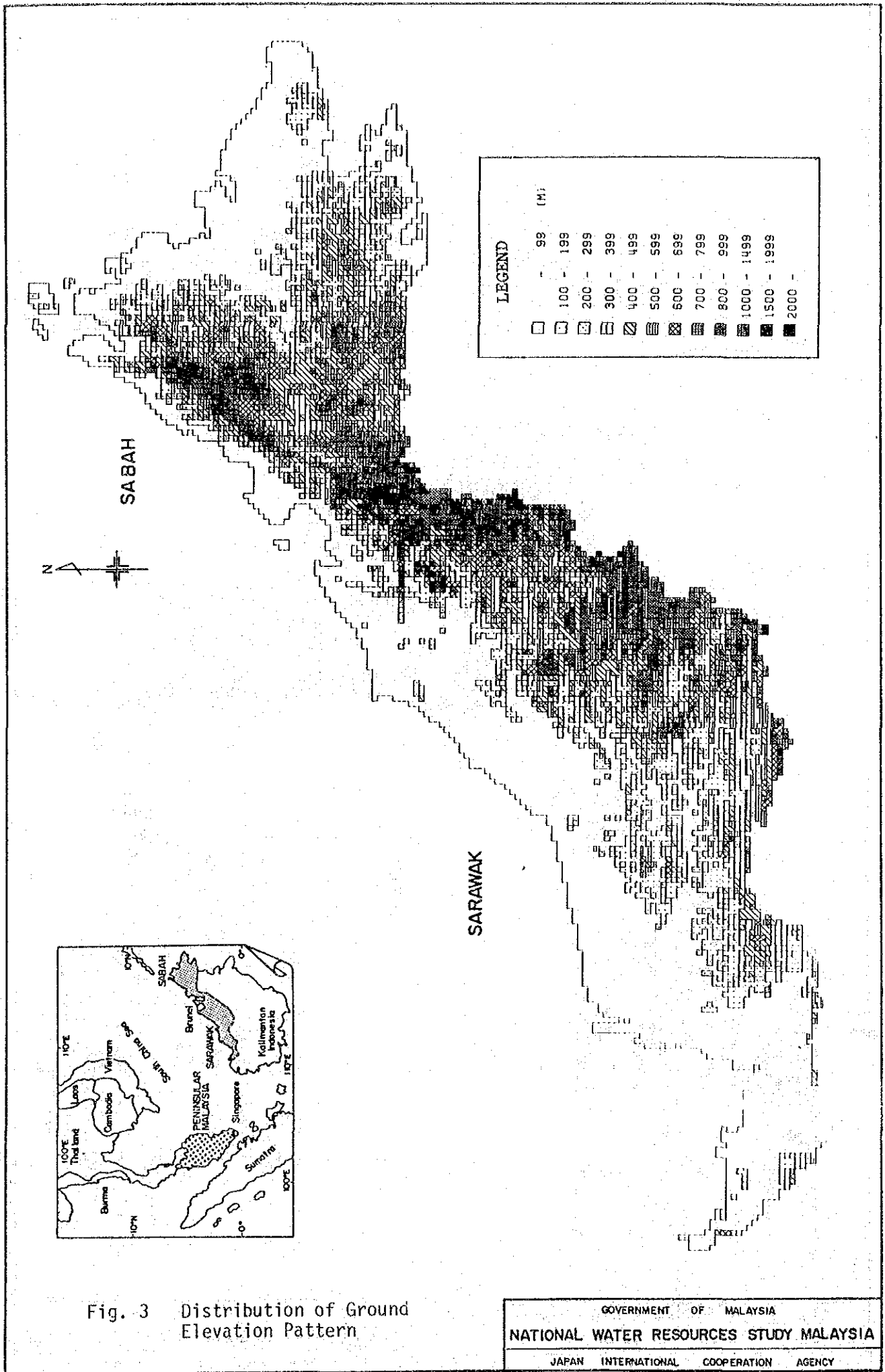


Fig.1 Flow Chart of Soil Erosion Potential Evaluation Model





LEGEND

(M)

[White box]	0 - 99
[Diagonal lines /]	100 - 199
[Diagonal lines \]	200 - 299
[Horizontal lines]	300 - 399
[Vertical lines]	400 - 499
[Cross-hatch]	500 - 599
[Dense cross-hatch]	600 - 699
[Dotted pattern]	700 - 799
[Stippled pattern]	800 - 999
[Dense stippled pattern]	1000 - 1499
[Very dense stippled pattern]	1500 - 1999
[Solid black box]	2000 -

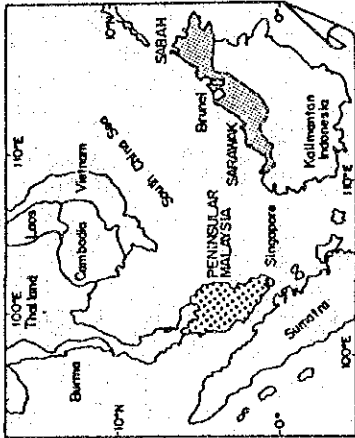
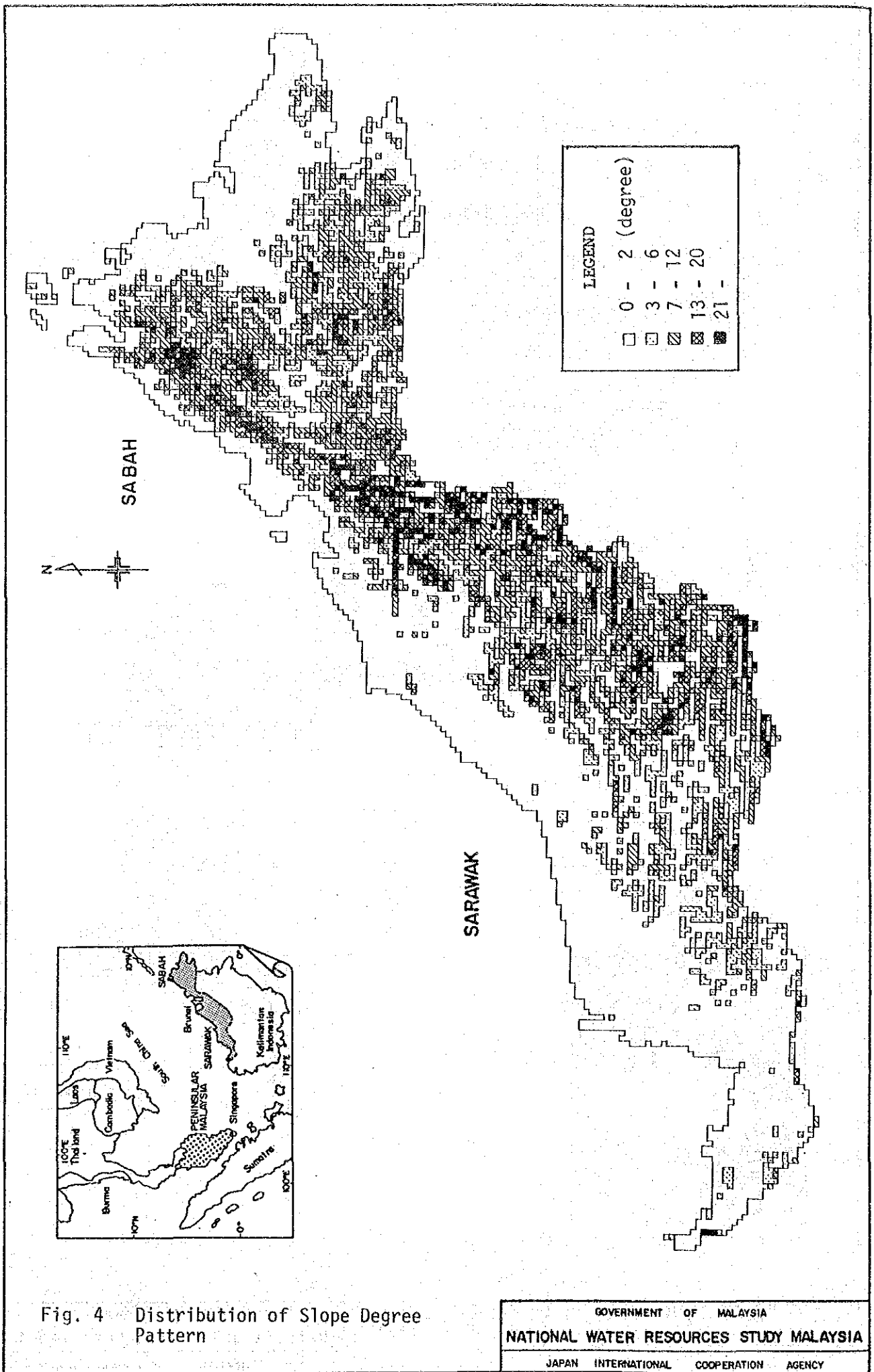


Fig. 3 Distribution of Ground Elevation Pattern



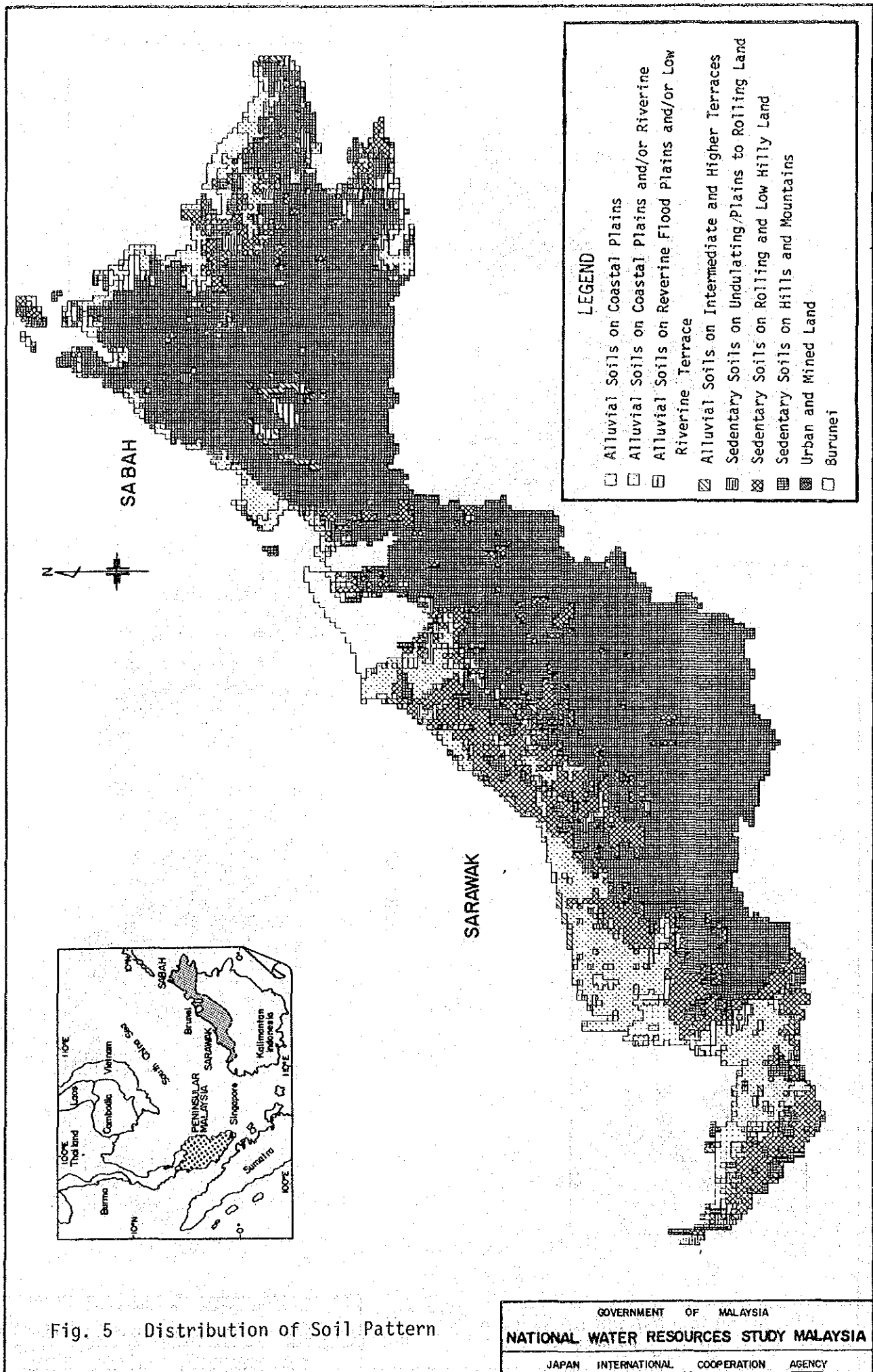
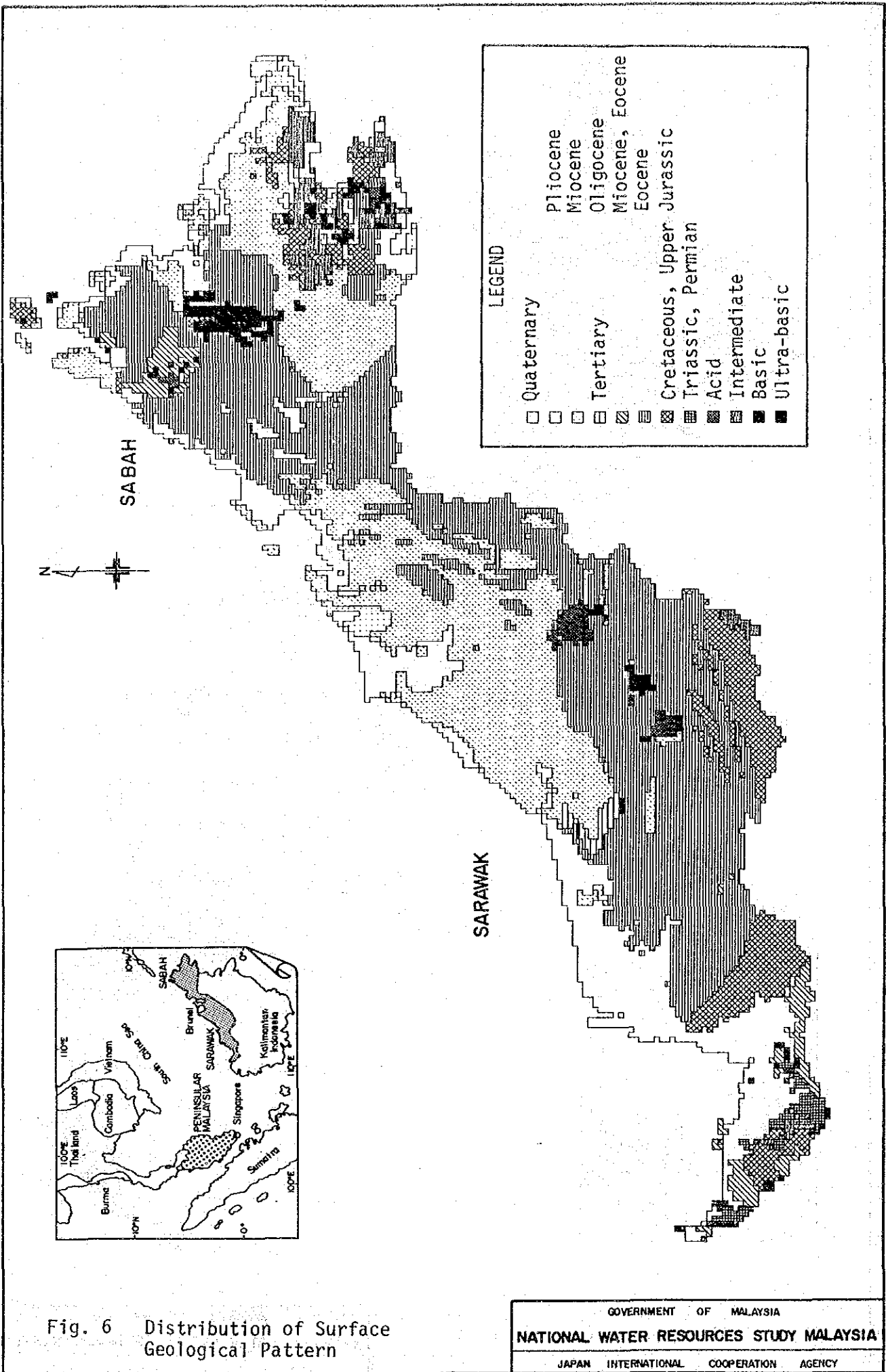


Fig. 5 Distribution of Soil Pattern



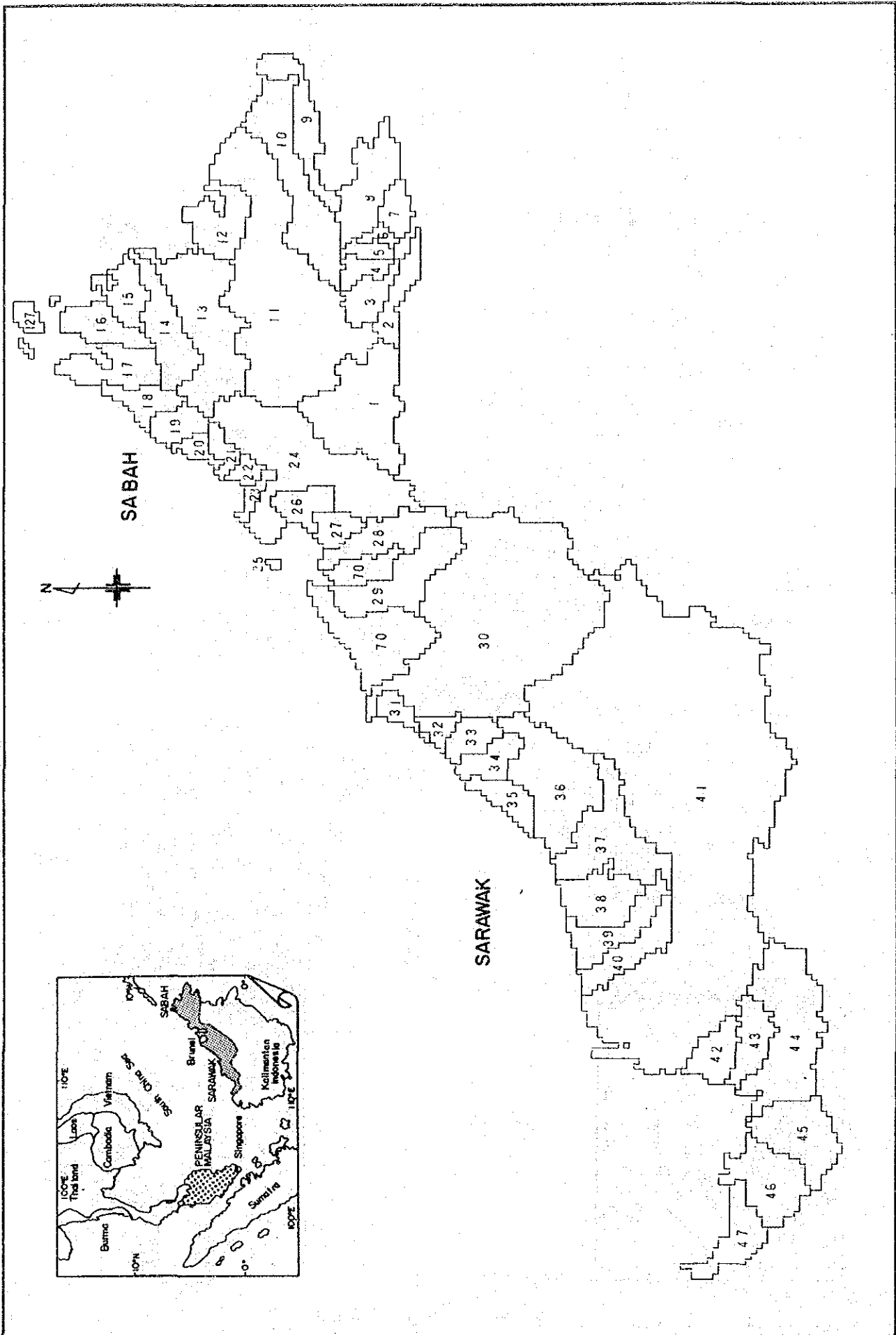


Fig. 7 Schematic Basin Division

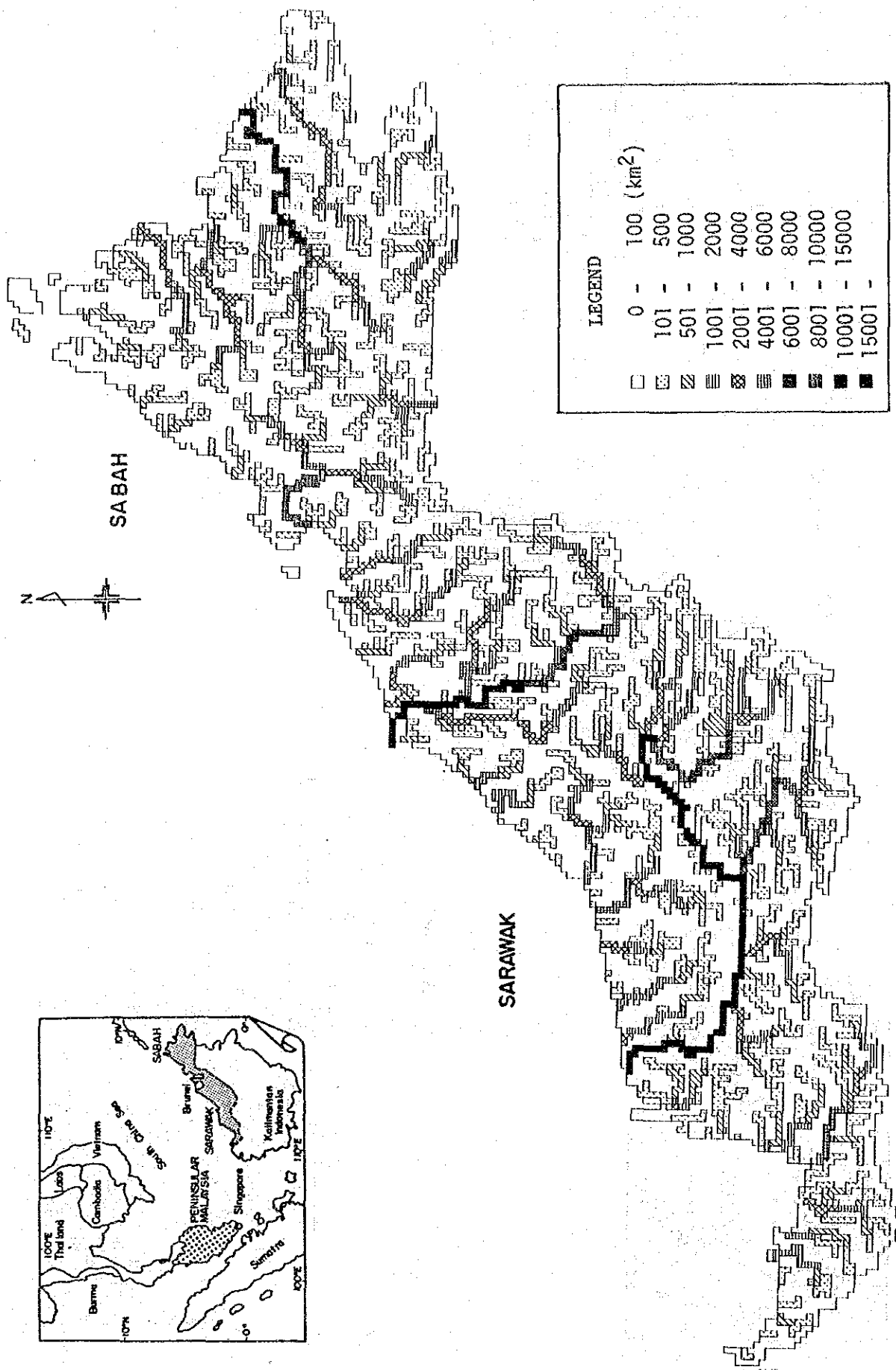


Fig. 8 Change of Catchment Area

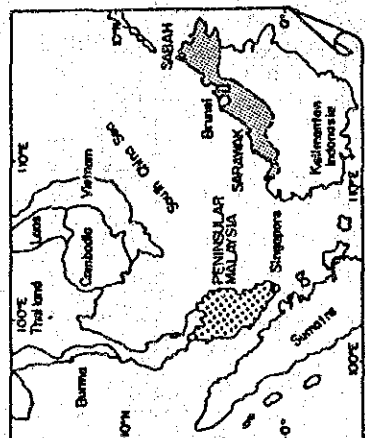
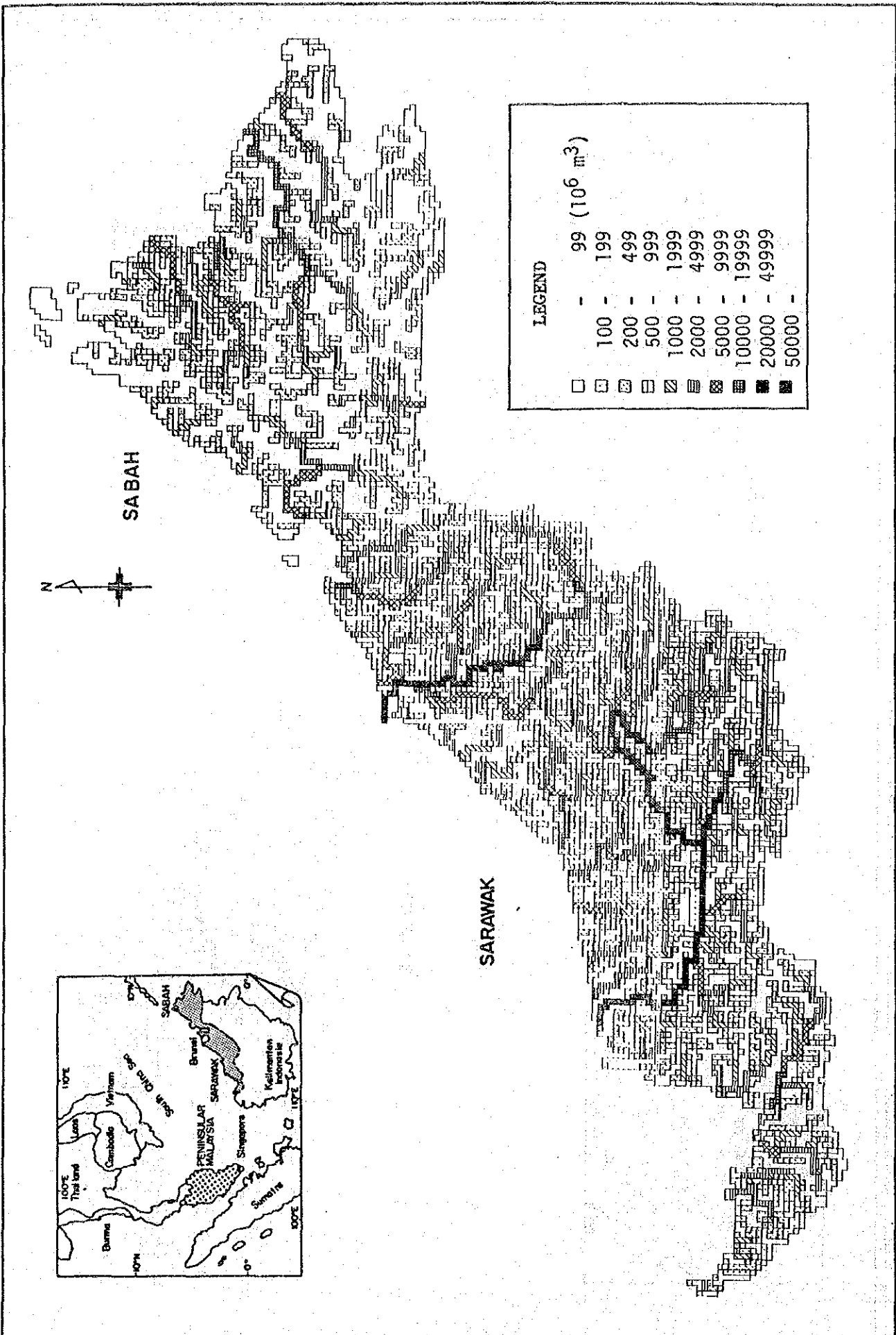


Fig. 9 Change of Stream Flow Discharge

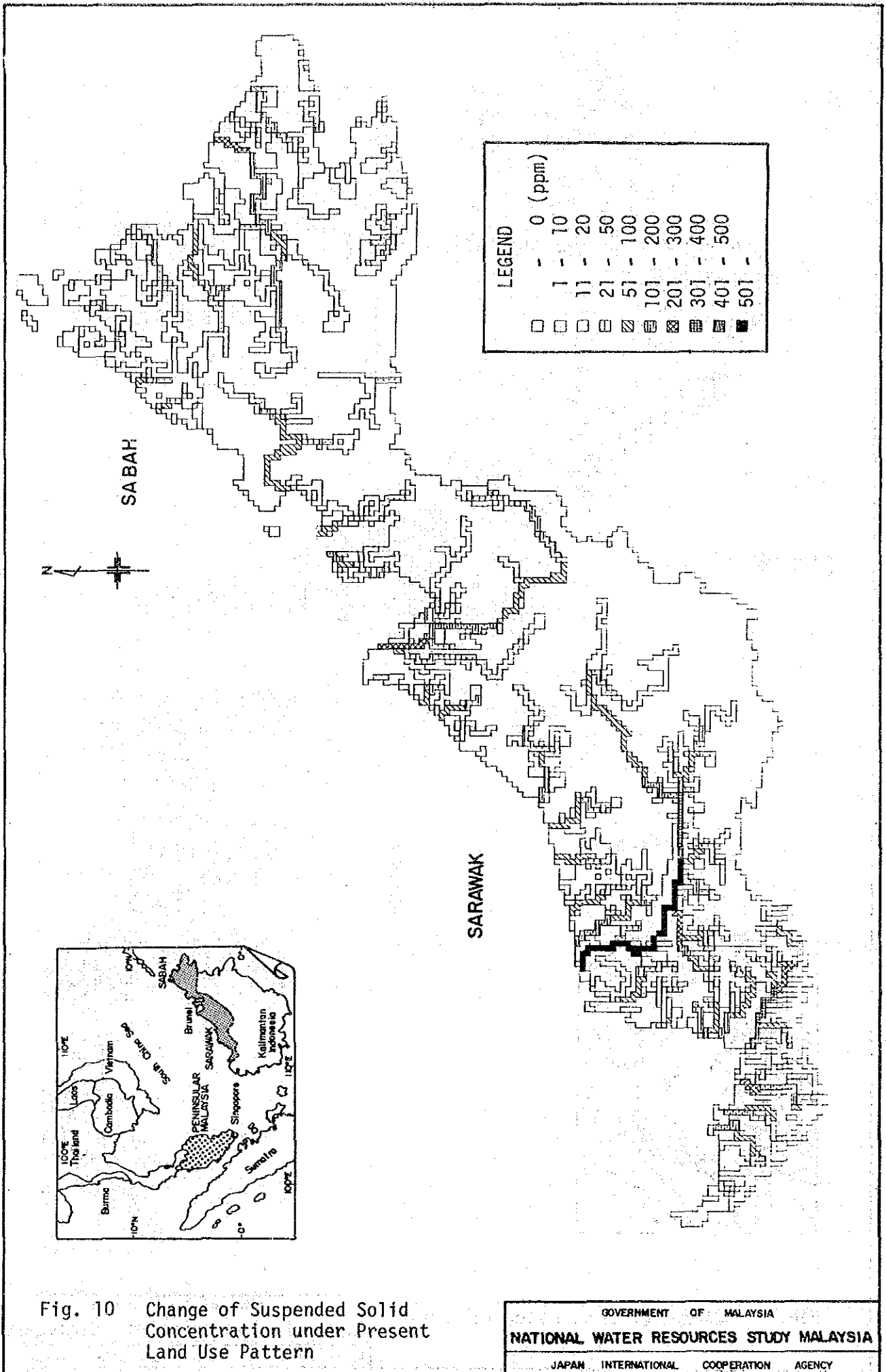


Fig. 10 Change of Suspended Solid Concentration under Present Land Use Pattern

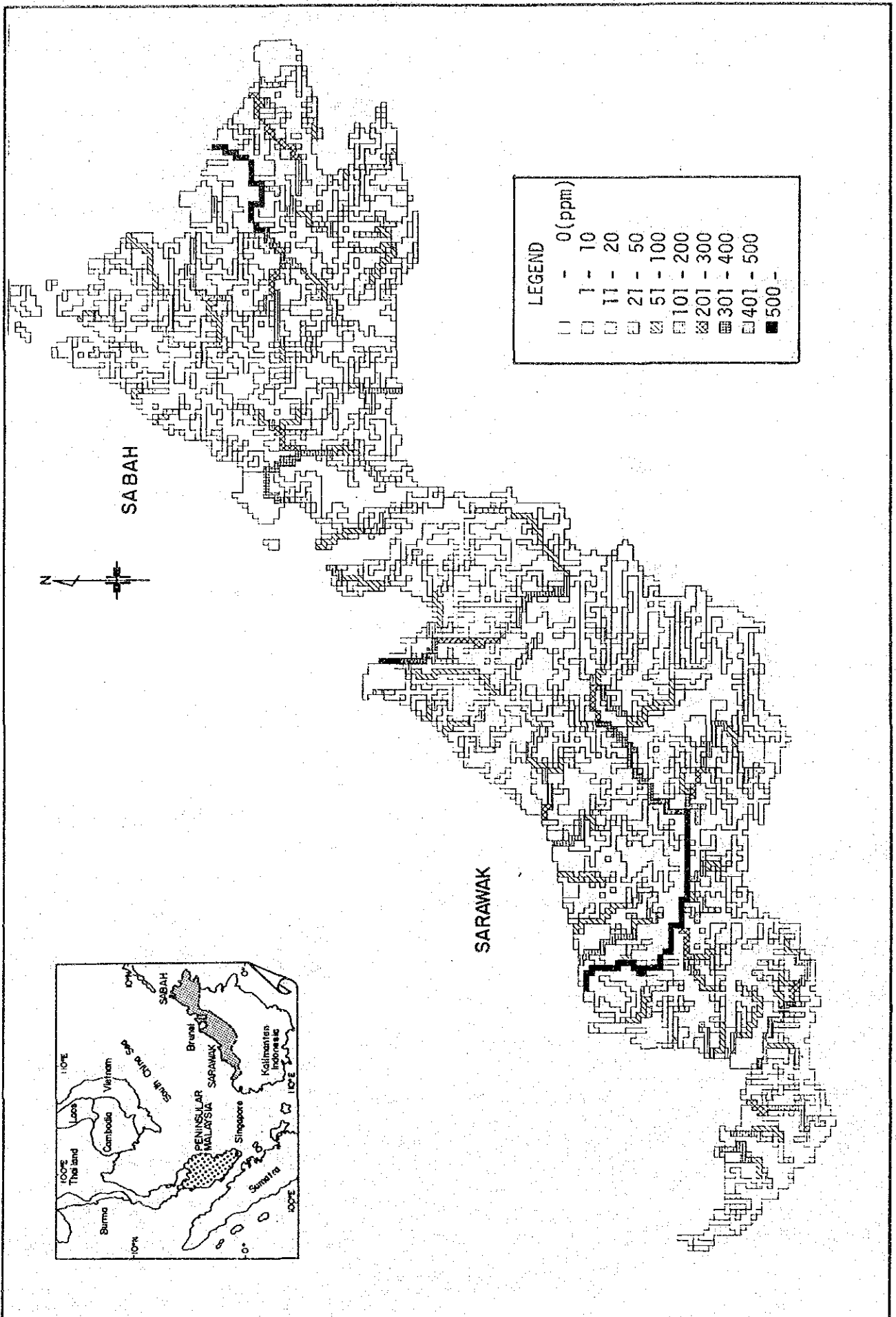


Fig. 11 Change of Suspended Solid Concentration under Future Land Use Pattern



