VIII. PREPARATION OF THE MAP FOR THE BASIC WATERSHED MANAGEMENT PLAN

On the basis of the basic approach for the land use program and the forest deployment program, a map (whole map) of the basic watershed management plan is prepared.

Of the watersheds, several watersheds which have many project factors are selected, and an attempt is made to prepare a blueprint of a model area which will serve as a guideline for forest management.

On the whole map, the area for each land classification is computed, and the outline of the findings of the watershed management plan is studied.

1. Preparation of the Whole Map

(1) Recorded Matters

This whole map records the following matters which are considered necessary at least for the formulation of a basic land use program and a forest deployment program.

(i) Forest Region

a. Forest region for the time being

b. Forest region in the future

(ii) Classification of farm areas -- Areas outside forest region in the future

a. Mountainous farmland

b. Farmland for export crop

c. Irrigated paddy field

(iii) Forest Deployment Program

a. Protection forests (immediate afforestation areas will be shown elsewhere.)

b. Temporary protected areas (emergency plantation areas will be shown elesewhere.)

c. Production forests

d. Reserved forests for production

(2) Preparation Method

A base map was prepared with 1 cm meshes placed on a contour map, 1:50,000 in scale, and the aforementioned matters were illustrated on the base map in the following manner.

(i) By the Contour Map

a. A line of 1,000 m in height above sea level was drawn. Meshes were marked according to the rate of occupancy, and protection forest areas were sampled.

b. A 2-mm-wide belt was drawn along the main ridgeline which formed a unit watershed boundary in the mountainous areas, and this belt was designated as a shelter belt along the main ridge belt. Using a land use map, shifting cultivated lands, grasslands and second growths were located and formed immediate afforestation areas.

c. A 2-mm-wide belt was drawn along each bank of the main river and set aside for a bank erosion prevention forest. On the basis of a land use map, the places which have been used as shifting cultivated lands, grasslands and second growths formed immediate afforestation areas. The rubber plantations, settled farm areas and communities formed areas to which consideration for reasonable management should be paid.

(ii) By the Forest Type Map

a. The circumferences of the existing natural forests were illustrated on the aforementioned base map. Meshes were marked and the circumferences formed boundaries of the forest region for the time being.

b. Stands with an average growing stock of more than 150 m^3/ha were sampled according to the forest types and expressed in meshes. They were proposed production forests. Stands of less than 150 m^3/ha were proposed reserved forests for production.

(iii) By the Slope Inclination Map (expressed in meshes)

a. The meshes which belong to the ranks of more than 21° in slope were sampled and made protection forests against erosion. Using a land use map, shifting cultivated lands, grasslands and second growths were extracted and made immediate afforestation areas.

b. The meshes which belong to the ranks of 11-20° in slope were sampled and made production forests.

c. The external peripheries of the areas with slopes of 11-20° were made forest region boundaries.

d. The meshes which belong to the ranks of 6-10° in slope were sampled and made mountainous farmlands.

e. The meshes with ranks of 2-5° in slope were made farmland for export crops.

f. The meshes with ranks of 0-1° in slope were made irrigated paddy fields.

(iv) By the Land Use Map

a. The areas which are currently used as shifting cultivated lands, grasslands and second growths have been extracted, and the areas which belong to the protection forests and the temporary protected forests have been designated as immediate afforestation areas.

With a combination of the aforementioned meshes in (i) through (iv), this whole map was prepared. In the combination, the weight of each classification was considered in the following manner and it was decided that a low weight would be canceled if it came under a high weight. Protection forests → production forests and reserved forests → farmland

This map is given in an attached paper. As an example, partial maps, 1:100,000 in scale, have been prepared from this map, and are attached to the last page of this report.

2. Preparation of the Model Area Map

(1) Selection of Model Area

The following two unit watersheds (with a total watershed area of 16,589 ha) were selected as watersheds which included various plan factors and the area of which was substantial to some extent in the subject area.

(Large watershed)	(Medium watershed)	(Small watershed)	(Unit watershed/No.)	(Area)
A. Rawas	A. Rupit	A.B.Pu	A.B.Pu(U) No. 17	10,965 ha
			A.B.Pu(L) No. 18	5,624 ha

These watersheds are located in the northern part of the subject area. They are watersheds of the main stream of the B. Pu River which originates in the Barisan mountains and its tributary, the Latang River. The community of Tanjungagung is situated along the lower reaches. These rivers join the Rupit River between Sukamenang situated along a national road and the hamlet of Sukaraja.

The land use of this model area is shown in Table 20.

Table 20. Land use ratio of model area

(Unit: %)

Name of unit watershed	Area(ha)	Natural forest	Second growth	Rubber plantations	Grass-land	Bare-land	Farm-land	Shifting cultivated land	Urban site
A.B.Pu(U)	10,965	84	1	13			1	1	
A.B.Pu(L)	5,624	40	1	55		1	2	1	

Note: (U) represents the upper stream and (L) the lower stream.

(2) Descriptions

In addition to the matters which are written on the whole map (IX-1-(1)i ∿ iv), it was decided to draw in the proposed forest roads (main forest roads).

(3) Process of Preparation

(i) Using a contour map, 1:20,000 in scale, the following detailed classification maps (1:20,000) were prepared.

a. Slope classification map -- Iso-inclination map by contour intervals.

b. Forest type map ---------- Enlarged copying of a forest type map, 1:50,000 in scale.

c. Land use map ---------- Enlarged copying of a land use map, 1:50,000 in scale.

(ii) As elucidated in the process to prepare a whole map, the necessary matters were extracted from the aforementioned classification maps, and on the basis of a combination of these maps, a land use program and a forest deployment program were schematized for the model area. In the whole map, they are expressed in 25 ha meshes. In case of the model area, however, they are

expressed in a detailed classification which is fitted to the topography.

(iii) The routes of forest roads in the model area were decided as follows on the basis of the basic approach of the forest road program which will be referred to in the next chapter.

a. The main forest road runs from the community of Muara Tiku along the trans-Sumatra road and goes up about 20 km along the Tiku River and into the Tupa stream basin. The road is divided into two routes at the head water of the Tupa stream -- one which goes across the Leko River toward the upper stream of the B. Pu River and the other which goes across the B. Pu River to reach the mountain area. The length of the main forest road which runs from the trans-Sumatra road to the model area is about 38 km.

b. Arrangements are so made, as the public interest of local residents has been taken into account, that the main forest road connects communities along the river as well as possible along the way until it reach the production forests. In the production forests, the main forest road is so arranged as to pass practically through the center of the production forests or a place which is of advantage to the carrying out of timber.

c. The route of the forest road should be on topography with a moderate slope, the banking and cutting should be minimum, the drainage good and little construction of such things as earth dams and bridges. In the hills, therefore, the road will run on the ridgeline, whereas in the relatively sharp mountainous area, the road will run on the moderate slopes of the river side (river terraces) for the sake of soil conservation.

d. The working road will be made roughly 1 km for every 1 km of the main forest road in the production forests. The actual length and location of the working road should be decided after

the area and growing stoch of commercial trees in the production forests are grasped and a felling plan is worked out. For this reason, no attempts have been made to schematize the working roads in the report.

The outline of the program for the main forest road in the model area is shown in Table 21 and Fig. 5.

Table 21 Projected forest roads in model area

Name of route	Length	Remarks
(H)	38,000m	Distance to the Unit Watershed No. 17
(A)	18,600	Forest roads in production forests, totaling 49,200m
(B)	19,400	
(C)	11,200	
Total	87,200m	

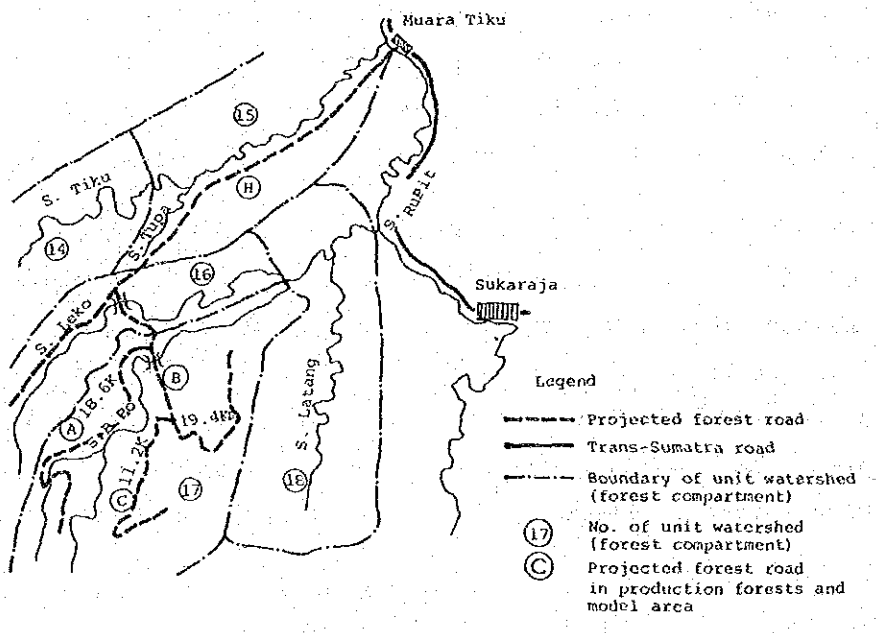


Fig. 5 Location of projected forest roads in model area

An example of the model area plan worked out according to the aforementioned process is attached to the last page of this report. (Partial map of 1:40,000 scaled down to 1:20,000.)

3. Table of Areas for Each Section under the Basic Watershed Management Plan

The area by section is computed as shown in Table 22 on the basis of the existing forest region, using the whole map of the basic watershed management plan.

According to Table 22, the forest region including the immediate afforestation areas is about 146,000 ha for the time being, about 36% of the subject area. The areas outside the forest region is about 64%.

The ratio of area by section is shown below.

(Areas within forest region)	(Area) ha	(Within entire subject area) %	(Areas within forest region) %
Protection forests	490	0.1	0.3
Temporary protected forests	29,126	7.2	20.0
Production forests	71,077	17.5 (a)	48.7 (a')
Reserved forest for production	45,246	11.2 (b)	31.0 (b')
Immediate afforestation areas	156	0.04	0.11

If areas outside the forest region are developed and redeveloped under a future program, the forest region of the subject area will total about 89,300 ha, decreasing to about 22.0% (-14.0%) of the entire area. The areas outside the forest region will increase as much as the decreasing area of the forest region. The ratio of area by section will change as shown below.

(Areas within forest region)	(Area)ha	(Within entire subject area)%	(Areas within forest region)%
Protection forests	490	0.1(± 0)	0.6(+0.3)
Temporary protected forests	29,126	7.2(± 0)	32.6(+12.6)
Production forests	59,680	14.7(-14.0 obtained from a+b)	66.8(-12.9 obtained from a'+b')

(Outside forest region)	(Area)ha	(Within entire subject area)%	(Outside forest region)%
Temporary protected forests (Conservation areas)	15,036	3.7	4.8
Irrigated paddy field	44,806	11.1	14.2
Farmland for export crop	186,085	45.9	58.8
Mountainous farmland	53,800	13.3	17.0
Others	16,378	4.0	5.2

Table 22. Table of areas for basic watershed management plan (1/3)

Name and No. of unit watershed		Area of watershed (ha)	Inside forest region (ha)																Outside forest region (ha)								
			Protection forests			Temporary protected forests			Production forests					Reserved forests for production					Total	Conservation areas			Others					Total
			Natural forests	Immediate afforestation areas	Total	Natural forests	Immediate afforestation areas	Total	Slope classification				Total	Slope classification				Total		Farmlands, rubber plantations, etc.	Immediate afforestation areas	Total	Slopes				Total	
									0°-1°	2°-5°	6°-10°	11°-20°		0°-1°	2°-5°	6°-10°	11°-20°						0°-1°	2°-5°	6°-10°	11°-20°		
Keruh	1	6,828	73		73	1,198	4	1,202	0	98	758	2,447	3,303	0	24	367	685	1,076	5,654	49	73	122	0	269	416	367	1,052	1,174
Rawas (U)	2	5,849	0		0	539	26	565	0	154	410	462	1,026	0	138	1,051	1,540	2,719	4,310	257	51	308	0	205	462	564	1,231	1,539
Rawas (M)	3	7,766	0		0	849	75	924	0	0	200	1,997	2,197	0	0	25	574	599	3,720	749	25	774	0	375	1,024	1,873	3,272	4,046
Rawas (L)	4	9,352	0		0	781	0	781	0	126	806	2,774	3,706	0	25	202	1,160	1,387	5,874	176	0	176	50	706	1,008	1,538	3,302	3,478
Kulus	5	4,802	0		0	755	27	782	0	27	135	837	999	0	0	27	755	782	2,563	513	0	513	54	297	701	674	1,726	2,239
Senawar	6	4,342	0		0	719	0	719	0	72	240	695	1,007	0	0	48	624	672	2,398	384	24	408	24	408	528	576	1,536	1,944
Mung-Kulam	7	6,404	0		0	1,474	0	1,474	203	25	153	1,170	1,551	25	0	201	1,397	1,625	4,650	280	25	305	127	127	407	788	1,449	1,754
Kuwis	8	4,688	0		0	1,203	0	1,203	150	0	201	1,179	1,530	25	0	100	777	902	3,635	25	0	25	0	25	251	752	1,028	1,053
Kutu	9	8,099	0		0	2,748	0	2,748	0	98	687	3,069	3,854	0	0	74	1,153	1,227	7,829	0	0	0	0	49	147	74	270	270
Ulas	10	72	0		0	0	0	0	0	0	72	0	72	0	0	0	0	0	72	0	0	0	0	0	0	0	0	0
Minak (U)	11	5,620	0		0	685	0	685	0	49	1,002	2,785	3,836	0	147	464	464	1,075	5,596	24	0	24	0	0	0	0	0	24
Minak (M)	12	12,363	0		0	541	0	541	26	1,004	2,421	2,215	5,666	0	1,133	1,932	2,009	5,074	11,781	103	77	180	77	541	232	52	902	1,082
Minak (L)	13	3,837	0		0	0	0	0	0	1,191	609	26	1,826	0	132	185	0	317	2,143	53	0	53	26	1,218	344	53	1,641	1,694
Tiku (U)	14	9,366	0		0	1,868	0	1,868	0	205	1,331	4,862	6,398	26	26	281	767	1,100	9,366	0	0	0	0	0	0	0	0	0
Tiku (L)	15	10,823	0		0	120	24	144	24	818	1,107	673	2,622	0	192	770	529	1,491	4,257	457	0	457	457	3,151	1,852	649	6,109	6,566
Leko	16	6,052	0		0	1,702	0	1,702	0	27	314	1,284	1,625	0	27	210	1,389	1,626	4,953	183	0	183	0	314	419	183	916	1,099
B.Pu (U)	17	10,965	103		103	2,465	0	2,465	0	0	437	3,723	4,160	0	0	308	1,926	2,234	8,962	411	0	411	26	205	693	668	1,592	2,003
B.Pu (L)	18	5,624	0		0	415	0	415	26	26	233	855	1,140	0	103	52	415	570	2,125	441	0	441	26	1,088	1,503	441	3,058	3,499
Rupit (U)	19	7,493	289		289	3,077	0	3,077	0	79	184	1,919	2,182	0	131	158	1,630	1,919	7,467	26	0	26	0	0	0	0	0	26
Rupit (L)	20	7,193	0		0	131	0	131	0	26	0	185	211	0	53	0	78	131	473	840	0	840	368	3,806	1,575	131	5,880	6,720

Table 22. Table of areas for basic watershed management plan (2/3)

Name and No. of unit watershed		Area of watershed (ha)	Inside forest region (ha)																Outside forest region (ha)								
			Protection forests			Temporary protected forests			Production forests					Reserved forests for production					Total	Conservation areas			Others					Total
			Natural forests	Immediate afforestation areas	Total	Natural forests	Immediate afforestation areas	Total	Slope classification				Total	Slope classification				Total		Farmlands, rubber plantations, etc.	Immediate afforestation areas	Total	Slopes				Total	
									0°-1°	2°-5°	6°-10°	11°-20°		0°-1°	2°-5°	6°-10°	11°-20°						0°-1°	2°-5°	6°-10°	11°-20°		
Mala-mingan	21	5,762	0		0	0	0	0	76	230	25	0	331	0	153	51	188	332	663	178	25	203	561	3,341	612	332	4,896	5,099
Petai	22	1,803	0		0	0	0	0	82	301	109	27	519	55	191	95	27	328	847	0	0	0	82	355	328	191	956	956
Liam-kecil	23	2,051	0		0	259	0	259	493	675	260	52	1,480	0	0	26	182	208	1,947	0	0	0	26	78	0	0	104	104
Dulu (U-A)	24 a	12,022	0		0	1,699	0	1,699	1,294	1,598	329	1,370	4,591	558	710	152	1,040	2,460	8,750	101	152	254	761	1,091	857	710	3,018	3,272
Dulu (U-B)	24 b	4,715	0		0	113	0	113	791	675	141	28	1,635	85	988	85	28	1,186	3,134	197	0	197	310	903	85	85	1,383	1,581
Dulu (L)	25	9,035	0		0	151	0	151	1,082	1,385	503	151	3,121	1,032	855	252	76	2,214	5,486	277	0	277	1,989	1,082	151	50	3,272	3,549
Plikai	26	6,945	0		0	2,222	0	2,222	23	23	94	1,777	1,917	0	0	70	678	748	4,887	164	0	164	842	818	117	117	1,894	2,058
Bal	27	9,248	25		25	2,349	0	2,349	24	147	147	1,370	1,688	147	440	122	561	1,272	5,334	587	0	587	1,321	1,223	147	636	3,327	3,914
Lakitan (U)	28	14,053	0		0	0	0	0	25	25	25	127	202	51	279	152	304	786	988	582	0	582	1,848	6,457	2,279	1,899	12,483	13,065
Lakitan (L)	29	6,311	0		0	101	0	101	102	280	76	0	458	102	255	25	51	433	992	382	0	382	1,654	2,902	254	127	4,937	5,319
Malus (U)	30	14,567	0		0	252	0	252	0	25	0	25	50	0	277	0	126	403	705	528	25	553	956	6,918	4,076	1,359	13,309	13,862
Malus (L)	31	8,831	0		0	201	0	201	0	25	0	0	25	25	0	0	100	125	351	326	0	326	3,211	4,642	201	100	8,154	8,480
Tikip-Delago	32	3,072	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	26	1,471	1,549	0	26	3,046	3,072
Megang (U)	33	8,307	0		0	73	0	73	0	0	0	73	73	0	0	0	171	171	317	391	0	391	1,833	3,445	1,393	928	7,599	7,990
Megang (L)	34	8,893	0		0	152	0	152	0	25	0	0	25	0	0	0	76	76	253	280	0	280	1,608	4,116	279	357	8,360	8,640
Ketuan	35	10,387	0		0	51	0	51	431	279	25	0	735	1,342	456	0	0	1,798	2,584	152	76	228	1,596	5,852	127	0	7,575	7,803
Klingi (U)	36	7,973	0		0	0	0	0	0	0	0	0	0	0	0	0	26	26	26	258	0	258	2,116	4,541	1,006	26	7,689	7,947
Klingi (L)	37	11,709	0		0	25	0	25	407	229	0	0	636	229	356	25	0	610	1,271	25	0	25	942	9,318	153	0	10,413	10,438
Teman	38	6,138	0		0	0	0	0	0	177	0	0	177	0	0	0	0	0	177	177	25	202	581	4,951	227	0	5,759	5,961
Belili	39	12,518	0		0	0	0	0	0	337	0	0	337	0	26	0	0	26	363	830	0	830	467	10,184	674	0	11,325	12,155
Kari	40	4,369	0		0	26	0	26	26	465	0	0	491	0	233	26	0	259	776	103	0	103	181	3,128	129	52	3,490	3,593

Table 22. Table of areas for basic watershed management plan (3/3)

Name and No. of unit watershed		Area of watershed (ha)	Inside forest region (ha)																Outside forest region (ha)								Total
			Protection forests			Temporary protected forests			Production forests					Reserved forests for production						Conservation areas			Others					
			Natural forests	Immediate afforestation areas	Total	Natural forests	Immediate afforestation areas	Total	Slope classification				Total	Slope classification				Total	Total	Farmlands, rubber plantations, etc.	Immediate afforestation area	Total	Slopes				Total	
									0°-1°	2°-5°	6°-10°	11°-20°		0°-1°	2°-5°	6°-10°	11°-20°						0°-1°	2°-5°	6°-10°	11°-20°		
Sinie	41	6,279	0		0	0	0	0	0	408	0	0	408	0	0	0	0	0	408	459	0	459	102	5,004	306	0	5,412	5,871
Saling	42	1,411	0		0	0	0	0	0	26	0	0	26	0	0	0	0	0	26	157	0	157	0	941	287	0	1,228	1,385
Pigi	43	3,871	0		0	0	0	0	0	0	0	0	0	25	0	0	0	25	25	76	0	76	1,044	2,701	25	0	3,770	3,846
Gegas	44	8,195	0		0	0	0	0	0	26	0	0	26	0	0	0	0	0	26	410	230	640	1,511	5,992	26	0	7,529	8,169
Temelat (U)	45	8,237	0		0	0	0	0	0	353	50	0	403	0	428	0	0	428	831	529	25	554	101	5,794	957	0	6,852	6,406
Temelat (L)	46	7,542	0		0	0	0	0	0	126	0	75	201	0	126	0	0	126	327	402	151	553	503	5,958	201	0	6,662	7,215
Bungin (U)	47	2,625	0		0	0	0	0	0	51	25	0	76	0	76	51	0	127	203	76	0	76	76	1,607	661	0	2,346	2,422
Bungin (L)	48	4,517	0		0	0	0	0	26	52	0	0	78	26	105	0	0	131	209	236	26	262	341	3,626	79	0	4,046	4,308
Kungku (U)	49	3,297	0		0	0	0	0	0	0	0	0	0	0	357	110	0	467	467	55	0	55	0	1,978	797	0	2,775	2,830
Kungku (L)	50	15,366	0		0	0	0	0	76	914	25	0	1,015	0	305	25	0	330	1,345	254	229	483	1,016	11,709	813	0	13,538	14,021
Tambangan	51	5,763	0		0	0	0	0	0	0	0	0	0	51	615	51	0	717	717	26	0	26	103	4,379	538	0	5,020	5,046
Musi (U)	52	9,107	0		0	0	0	0	0	0	0	0	0	0	442	147	0	589	589	172	0	172	1,645	5,498	1,203	0	8,346	8,518
Musi (L)	53 a	3,533	0		0	0	0	0	25	454	0	0	479	0	76	0	0	76	555	25	0	25	252	2,524	177	0	2,953	2,978
Musi (L)	53 b	3,430	0		0	0	0	0	0	0	0	0	0	0	25	25	0	50	50	76	0	76	127	2,925	252	0	3,304	3,380
Banyu	54	5,467	0		0	0	0	0	0	130	26	0	156	26	596	181	0	803	959	110	52	182	233	3,471	622	0	4,326	4,508
Kikim	55	1,847	0		0	0	0	0	23	205	0	0	228	23	205	137	0	365	593	23	0	23	46	820	365	0	1,231	1,254
Aur	56	4,306	0		0	0	0	0	0	278	101	0	379	51	456	76	0	583	962	0	0	0	127	3,014	203	0	3,344	3,344
Pangi	57	4,361	0		0	26	0	26	0	0	0	0	0	78	337	26	0	441	467	52	52	104	571	2,778	441	0	3,790	3,894
Total		405,601	490	0	490	28,970	156	29,126	5,435	14,149	13,261	38,232	71,077	3,982	11,489	8,327	21,448	45,246	145,939	13,693	1,343	15,036	35,309	160,447	32,212	16,378	244,426	259,462

Note: In future programs, it is assumed that the slopes will be set at 0°-1° for irrigated paddy fields, 2°-5° for farmland for export crops, 6°-10° for mountainous farmlands and 11°-20° inside of the forest region for the afforestation area of production forests. The slopes of 11°-20° outside the forest region will be maintained.
Conservation areas are the areas where the management should be done in the same manner as temporary protected forests. The areas with slopes at 11°-20° outside the forest region which should be afforested as future production forests are involved in the area of reserved forests.

IX. FOREST MANAGEMENT PLAN

1. Production Plan

(1) Production Forests

The production forests as referred to under this plan have already been elucidated. For the time being, they are:

a. Natural forests except protection forests and temporary protected forests; and

b. Forests which have a growing stock of more than 150 m^3/ha and are designed primarily for the production of timber.

The area of the forests which have been calculated according to this classification on the basis of the forest deployment program is estimated at 71,000 ha.

If the priorities in timber production are oriented to the mountainous area in the northern part of Lubuklinggau (Fig. 6) and the establishment of a production forest is hypothesized, the total area will be 44,225 ha, the total growing stock 10,972 m^3 and the prospective timber output 3,291,000 m^3.

The prospective timber output is estimated at 30% of the total growing stock.

Table 23. Outline of production forest in the whole production forest (Northern mountainous area)

No.	Watershed classification	Area (ha)	Total growing stock (1,000 m^3)	Prospective timber output (1,000 m^3)	Growing stock per ha (m^3)
①	1 ∿ 2	4,325	1,081	324	250
②	4	2,300	575	172	250
③	11	6,775	1,693	508	250
④	9, 4	4,500	1,350	405	300
⑤	3	1,900	513	154	270
⑥	14	6,500	1,653	496	250
⑦	12	3,600	720	216	216
⑧	13, 15	4,350	914	274	210
⑨	16 ∿ 17	5,400	1,512	454	280
⑩	24, A, B	4,575	961	288	210
Total		44,225	10,972	3,291	

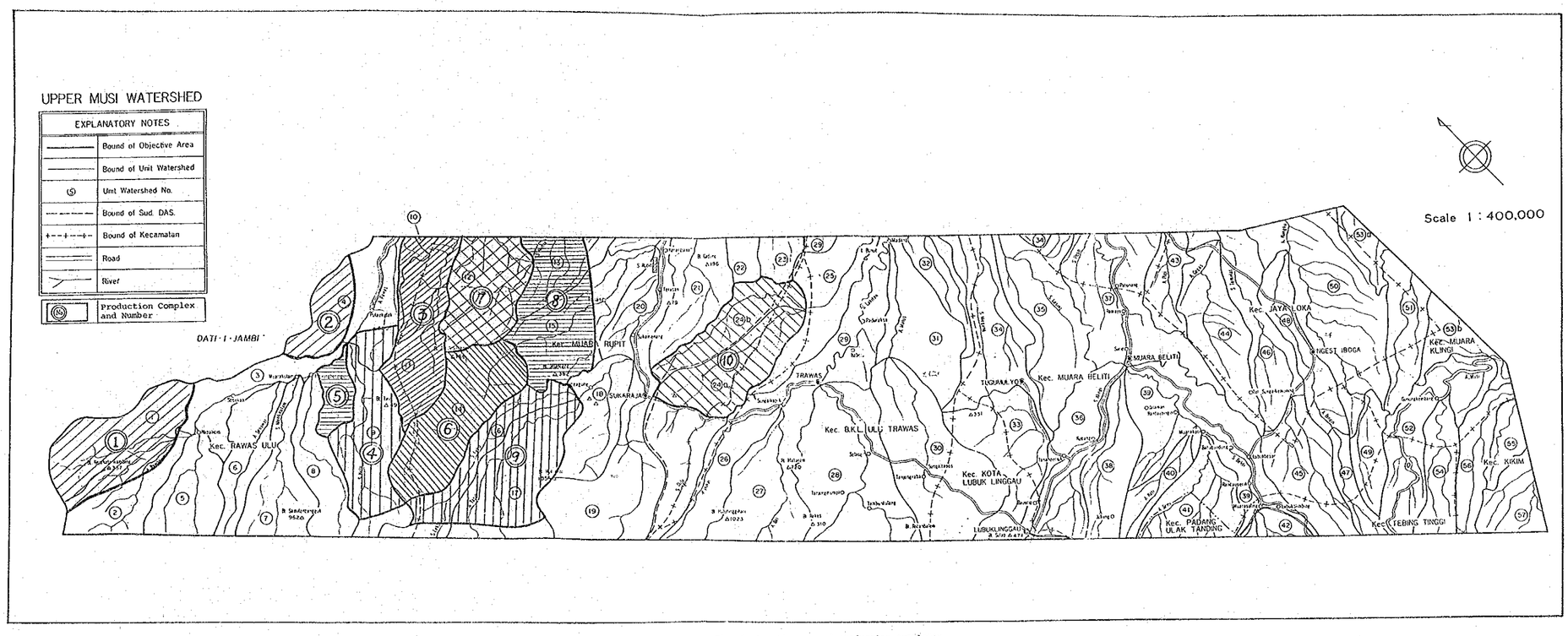


Fig. 6 Location map of production complexes

(2) Production Scale

Giving priority to the export of oil, timber and rubber, Indonesia intends to check increases in the export of logs and to boost the export of processed wood and wooden products in a positive manner under the Five-Year Development Program, as their added values have been raised in the nation. There are signs that Indonesia will concentrate on stepping up the demand for wood and the processing of wood in the nation.

As for forests in the survey area, some of the forests in the flatland have been logged over and converted into farmlands. In the mountainous area, however, the trees have been cut for use in daily living by the local inhabitants and no systematic felling has been carried out. Those forests are undeveloped stands.

In case of the systematic timber production with these undeveloped stands, the unsystematic operation as in the past should be improved.

The following points must be taken into account for systematic timber production.

a. In response to the supply of timber, this area as a part of whole country, should be replenished.

b. There is a need to respond to locally unique demand.

c. The timber production in a production forest, even if private enterprises carry it out, is essentially a project of Indonesia, and attempts must be made to harmonize it with the lives of local residents.

d. The conditions must be so arranged as to make it possible to step up the reforestation of logged over areas -- particularly, man-made reforestation -- and to cope with land utilization after logging.

e. The speed of developing in the undeveloped stands must be in proportion to the socio-economic development of the region.

f. Timber production must be enough to assure a profit.

The points enumerated in a through f, above, are incorporated in the following estimates.

a. The amount of Timber Supply from This Area as Estimated from Overall Aspects of Indonesia

Various statistical data have not been sufficiently collected and there are many points of incompatibility between statistical data, but the following estimates may be hypothetically made.

i. The annual lumber output of Indonesia in 1977 is hypothesized at 24,500,000 to 25,000,000 m^3.

ii. Estimate on the basis of the ratio of area of the forests

$25,000,000\ m^3 \times 0.001 = 25,000\ m^3$ ..... (ii)

The area of forests in the survey area is 1,440,000 m^2 (0.1% of the entire area) and the area of forests in the entire land of Indonesia is 1,222,000,000 m^2.

Estimate from the ratio of forest area excluding protection forests (at present)

$25,000,000\ m^3 \times 0.0018 = 45,000\ m^3$ ..... (ii)'

The area of forests excluding protection forests in the survey area is 1,440,000 m^2. The area of forests in the entire land of Indonesia excluding whole protection forests in Indonesia is 802,000,000 m^2.

$$\frac{1,440}{802,000} \times 100 = 0.15\%$$

iii. Estimate from the timber output

The timber output of the Province of South Sumatra in 1975 is used.

$25,000 \times 0.035 \times 0.035 = 31,000\ m^3$ ..... (iii)

The output of the Province of South Sumatra is 563,000 m^3 (3.5% of the entire area), and the output of the entire land of Indonesia is 16,296,000 m^3. The area of forests in the Province of South Sumatra is 40,668,000 m^2 (excluding 11,162 km^2 of protection forests), and the area of forests in this area is 1,440,000 m^2 (3.5% of the Province of South Sumatra).

iv. Estimate from the Amount of Timber Collection and Shipment in Palembang's Vicinity

The amount of timber collected and shipped in the vicinity of Palembang is estimated at 1,200,000 m^3 according to local interviews. When this volume is checked against the output of the Province of South Sumatra,

$1,200,000\ m^3 \times 0.035 = 42,000\ m^3$ ..... (iv)

"0.035" represents 3.5%, the ratio of area of forests in this area against the area of forests in the Province of South Sumatra.

From the foregoing various estimates, an output of 25,000-45,000 m^3 (volume of supply) may be considered the volume of supply from this area as viewed from the entire land of Indonesia.

If forestry development has been carried out in any area, the values estimated from the ratio of lumber production and the rate of area of forests would be generally reasonable, but the values contained in the statistical data have nothing to do with the degree of development and the estimates made on these values may be considered insufficient. However, they may well serve as yardsticks.

b. Estimate from Locally Special Lumber Demand

The number of wood processing existing farms in the area (Palembang) is 18, 26 are under construction and 45 under appli-

cation. A plywood plant with a monthly log consumption of 20,000 m^3 is under plan. The timber demand is on the rise, but the supply is short in this area.

Judging from this tendency, there will be a rise of at least more than 50% from the present amount of timber collection and shipment totalling 1,200,000 m^3 in the vicinity of Palembang.

Should this tendency be applied to the survey area, the output would be 37,500 to 67,500 m^3 as against the 25,000-45,000 m^3 enumerated in a, above. If the forests were productive enough, there would be a need to maintain nearly 70,000 m^3 of production.

c. Harmony with Lives of Local Residents

As described in respect to land use, there are many rubber plantations, shifted fields and farms at moderate slopes of the existing forest areas, and similar signs are also observed on sharp slopes to some extent. Under this program, therefore, it has been made a rule to determine a forest region for the future, while the forests which may be offered for the lives of local residents are managed in consideration of local needs and are stepped up in a reasonable manner. There is a need for the greatest degree of cooperation from local residents for the establishment, protection and control of a forest region, and things must be stepped up according to this pre-condition. Here, this basic concept is upheld.

Should things be stepped up according to this concept, the following points will have to be taken into account, so that there is a need to carry out the timber production at several areas, not in a concentrated area.

(i) Timber production will be started at places with fully prepared systems and conditions for redevelopment of farmland and plantations of rubber, coffee or other export crops, and farms.

In other words, it is a prerequisite to prepare residents to respond to a new system of land use.

(ii) Timber production will be started at places where manpower is fully available for timber production, afforestation, protection and preservation of forest in the future.

For this purpose, it is a prerequisite to establish local sources of manpower.

(iii) As not enough roads are available in this area, there is a need to develop logging roads so that they may also serve as roads for traffic in collaboration with local residents, and this is closely tied in with an upgrading of the preparedness of local residents.

(iv) There is a need to step up land use in the whole survey area and to reserve forest regions for the future as soon as possible.

The above factors are common to the points of study in d and e.

d. and e. Points of Study

The points of study have been omitted here, as they have been elucidated in c, above.

f. Economically Feasible Scale

The actual records of timber production in the survey area are insignificant.

Therefore, no statistical data are available to make possible the computation of the degree where the timber production is economically payable. Therefore, an estimate has to be made on the way in which timber production is done in other areas. The conditions of timber production in the survey area have the following features.

i) In this area there is only one road. It runs from Lubuklinggau to Surulangun as a trans-Sumatra road, and no other roads, if any, are developed enough.

ii) The rivers in the survey area are generally shallow. The upper stream from Muara Rupit is not navigable.

iii) Therefore, it is indispensable to construct forest roads for logging. The construction of forest roads would be quite expensive, as there are a number of disadvantages, such as that they would have to pass across rivers, that they would have to run across sharp slopes, that their development would pose issues in relation to the ownership of farmlands and other areas along the lower stream, and that the approach to forests is long.

iv) Depending on the place, there would be a need for a combination of cableways, skidders and yarders.

v) Even if logging areas were grouped, they would ramin relative dispersed.

vi) The production will have to be dispersed and small in scale for a harmony with the lives of local residents.

The cost of timber production varies, depending on annual production scale, output per lot, years of timber production and other factors. When the factors in i through vi, above, are taken into account, the cost will rise by a

considerable extent. A production program is prepared as indicated in Table 24 on the basis of the conditions set forth in its note.

(a) Production Program

Table 24. Production Program (Draft)

Phase	Program for the phase	Area of logging in the phase	Prospective timber output	Reforestation
I	300 ha at 3 lots (100 ha per lot). 10% increase a year	1,831 ha Annual average (367)	136,226 m^2 Annual average (27245)	1,831 ha Annual average (367)
II	600 ha at 3 lots (200 ha per lot). 20% increase a year.	4,463 (892)	332,047 (66,409)	4,463 (892)
III	1,500 ha at 3 lots (500 ha per lot). 10% increase a year.	9,156 (1,831)	681,206 (136,241)	9,156 (1,831)
IV	2,100 ha at 3 lots (700 ha per lot). 5% increase a year.	11,592 (2,318)	862,444 (172,488)	11,592 (2,318)
V	2,100 ha at 3 lots (700 ha per 1 lot). 5% increase a year.	11,592 ha Annual average (2,318)	862,444 m^3 Annual average (172,488)	11,592 ha Annual average (2,318)
VI	The remaining area to be logged over in 50 years.	5,581 (1,116)	415,226 (83,045)	5,581 (1,116)
Total		44,225 (1,474)	3,291 (109)	44,225 (1,474)

Note:

- Production forests in the northern mountainous area will be logged over in 30 years.

- As for the timber production program, it will be made a policy approach to increase the amount step by step, depending on the preparedness of collaboration by local residents.
- Five years will be counted as one phase.
- In Phase VI, timber production will be started in the stands of less than 150 m^3/ha at present.

(b) Trial computation of costs

- To be conducted at 30 places on the assumption that the total annual production will be 109,000 m^3.
- Minimum quantity of machinery to be deployed.

Machine	Number per lot	Number	Number required for 30 years
Tractor (for logging and construction)	3	9	54 (5 years of durability)
Skidder	2	6	36 (")
Logging truck	2	6	36 (")
Graders	1	3	18 (")
Wheeled loader	1	3	18 (5 years of durability)
Jeep	1	3	30 (3 years of durability)
Dump truck	1	3	30 (")
Chain saw	4	12	180 (2 years of durability)
Office		1	3 (10 years of durability)
Field office	1	3	9
Warehouse	2	6	18
Repair shop	1	3	9
Billet	2	6	18

When the costs required for the above facilities, those for spare facilities and those for repair work are included, the investment will be $4 million for the initial phase and $25 million for 30 years.

$25,000,000÷3,291,000 m^3 = $7.6 ..... depreciation per m^3
..... (1)

* Costs for Logging ..... $1/$m^3$ ..... (2)
  20 m^3 of felling per person a day and 30 m^3 of yardage per person a day

* Costs for Transportation ..... $2/$m^3$ ..... (3)
  Transportation by truck and raft (from Muararupit to Palembang)

* Costs for Forest Roads
  Main forest road 615 km × (construction cost $15/m + maintenance cost $5/m) = $12,300,000
  Branch forest roads 510 km × (construction cost $8/m + maintenance cost $2.5/m) = $5,360,000

Total	$17,660,000

Per cubic meter of production forests --
$17,660,000÷3,291,000 m^3 = $5.36 ≒ $5 ..... (4)

* Fuel Cost ..... $0.5/$m^3$ .....(5)
  8,000 l/day×25 days×12 months×$0.1÷100,000 m^3 = $0.5

* Local miscellaneous costs
  30% of (1) to (5)
  $16.1 × 0.3 = $5 ..... (6)

* Felling Tax, Money Interest, Taxes, Management Costs, Etc.

Felling tax	$8	..... $23	(7)
Export costs	15		

Processing plants			
Reserves	4		
Taxes	30		
Interest on loans			
Long term	5	$46	(8)
Short term	2		
Management costs	5		
Total: (1) - (8)		$90.0	

There are many uncertainties about this process and others. A trial computation using the data available from actual logging areas indicates that they would be marketable if products were sold at $100 per cubic meter.

However, this represents cases where 109,000 m^3 is realized in one year and it is averaged by the total output of 3,291,000 m^3. Production Phases I and II envisions an annual output of 2,700 to 6,600 m^3 and is in the term of the initial investment period, so that it seems to be impossible to put production on profitable basis or to set up the management on a solid footing in this 10-year period.

For this reason, it would be necessary to advance long-term loans for fixed investments, such as forest roads (which could be turned into public roads for living in the area after logging) or to have the State take charge of the fixed investments. It would also be required to reduce, exempt or deter taxes, etc., during Phases I and II.

In such a manner, the production should be carried out at a gradual pace. It should be done so in parallel to the progress of the area's socio-economic development. It has been conceived that the scale of 109,000 m^3 on the average a year is a generally favorable borderline in terms of management.

(3) Production System

The production system is based on the following factors.

(i) Operations will be taken for the areas which are closely tied in with the lives of local inhabitants.

The production will be stepped up first in particularly closely related areas in order to determine the intention of inhabitants in respect to the rubber plantations, shifting cultivated land and farms which are competitive with the forests, and to reach agreement on, and get prepared for, the conversion of forests into other land use and vice versa.

(ii) It will be made a basic rule to make use of the labor of residents in the neighborhood for the project as far as possible, and the timber production will be stepped up while bringing up skilful workers for each district.

(iii) Strict care will be taken over the disruption of forest areas and the outflow of soil due to the operation, such as the use of machinery and the construction of forest roads, and the redevelopment of felling blanks and afforestation will be completed at least in two years.

(iv) With respect to windy places, river basins, sharp slopes and other areas where felling should be temporarily prohibited for the sake of land conservation, they will be designated before production is initiated and strict control will be enforced.

(v) As regards the body of undertaking of the timber production, attempts will be made to select such a body as will pay particular attention to conservation. At the same time the State will take corresponding measures, such as assistance and loans.

(vi) The timber production will be stepped up in line with the progress in reforestation on logged over areas. If felling alone makes progress and reforestation is delayed, some kind of system should be worked out to control the felling.

2. Reforestation Plan

(1) Policy for Reforestation Program

The purpose of a reforestation program is to reproduce forest resources and at the same time to conserve the soil and maintain the environment.

It is desirable to perform these roles, but as a matter of fact, the roles are not easy to coordinate.

If forest conditions are induced to suit timber production and at the same time to facilitate soil conservation and preservation of the environment, forest management may be stepped up in an ideal manner.

There is a need to step up reforestation projects to meet this purpose. At this juncture, the immediate task will be to carry out reforestation in conjunction with the exploitation of undeveloped forests and the immediate afforestation of bare lands and second growths which are required for soil conservation.

(2) Matters for Basic Study

It has been recorded in history that forests in this area have been felled and turned into farmlands and rubber plantations at times, but practically no attempts have ever been made to

reproduce subsequent lumber resources after felling. When a reforestation project is to be stepped up in this area, there is a need to take serious note of the following matters.

i) Changes in forest type after felling
(Selective felling in particular)

-- Changes in logged over area without silvicultural operations e.g.,

a. Will vegetation cover a site where selective cutting has been done? If so, in what manner?

b. Is it possible to regenerate any commercial tree species?

c. Will the forest be eroded before vegetation covers a site where selective cutting has been done?

d. Will the logged over area turn into a grassland without regenerating?

e. If a logged over area is left as it is, will the commercial trees survive?

After checking all these questions, the basic way in which reforestation project should be launched will be studied.

ii) Possibilities of Artificial reforestation on a logged over area

a. Planting method

b. Prospects for survival, growth and forest formation of planted trees.

c. Tending method for the above purpose.

d. Selection of tree species for man-made forests (including relations with soil conditions and topographical conditions).

After all these factors are tested, it is necessary to finalize a method by which reforestation is put on a business basis.

iii) Tending of seedlings for man-made forests

a. Nursing methods, acquisition of seeds, acquisition of nurseries and survival percent of seedlings.

b. Out-planting time and transportation method.

After studying the result of an experiment on these two problems and judging the prospects for the production of seedlings, it is necessary to finalize a nursing method of seedling on a business basis.

It is basically necessary to study the above-mentioned matters for the execution of a project. After they are studied, a project should be worked out. However, this procedure requires quite a long time, and on some problems it may be hard to reach a conclusion.

Under this program, therefore, it is indispensable to study the aforementioned matters first and, while a reforestation project is stepped up, to continue studying the matters.

(3) Stepping up of the Reforestation

Stepping up the reforestation in the survey area is classified as follows, depending on forest classification.

i) As regards protection forests and temporary protected forests, reforestation should be made from the viewpoint of soil conservation and the preservation of environment. Measures should be taken so that forests may be maintained, by planting trees or intensive natural regeneration on existing critical bare land or on a poor stand. Thus, the measures enable the maintenance of well balanced stand types overall.

ii) In regard to production forests, reforestation will be positively conducted on a logged over area primarily to retain forest resources for the future. As reforestation methods, artificial reforestation and, if possible, natural regeneration will be used.

As species for reforestation, both those of short and long cutting age will be used to assure the perpetuality of timber production. In other words, the production cycle will be set at 30-40 years for those of short cutting age (30-40 years). While the several cycles are repeated, attempts will be made to grow trees of long cutting age (100-200 years).

With such a combination, attempts will be made to induce a rich stand with valuable trees one after another.

iii) As for reserved forests for production, reforestation will be made in bare lands and poor stands for the time being according to the method described in ii), and once production is started, the forests will be treated as production forests.

iv) In areas which may be turned into a forest region according to the new classification of land use, afforestation will be carried out according to their forest classification.

(4) Afforestation Outside Forest Region

The foregoing is a concept for afforestation in a forest region. The Greening Movement has been unfolded for Alang Alang and other areas as an important policy of Indonesia, and it is expected that this movement will be stepped up in a positive manner in the future.

According to the new classification of land use, afforestation projects will be worked out in proposed areas.

(5) Reforestation Programs

i) Reforestation program for northern mountainous area in forest region

a. Protection forests and temporary protected forests

To strengthen the functions of protection forests and temporary protected forests, plans are afoot for 156 ha of afforestation as indicated in Table 22.

As for the projected areas and the degree of urgency, there is a need to make a further comparison and a further study on the spot, so that estimated figures are enumerated.

For the sake of the project, it would be convenient to carry out the plans practically simultaneously with the planting incorporated in logging due partly to the conditions of the roads and manpower for the operations, but priority will be given to planting operation if there are no road problems and other obstacles.

b. Production forests

A program for reforestation at the logged over areas of production forests will be stepped up according to the areas along with the production volume.
The volume are once again enumerated below.

Phase	Concept on phase program	Annual average reforestation areas	Reforestation areas for the phase
		ha	ha
I (5 years)	Reforestation to be carried out at 3 lots with a 10% rise a year at a rate of 100 ha per lot a year	367	1,831
II (5 years)	Reforestation to be carried out at 3 lots with a 20% rise a year at a rate of 200 ha per lot a year	892	4,463
III (5 years)	Reforestation to be carried out at 3 lots with a 10% rise a year at a rate of 500 ha per lot a year	1,831	9,156
IV (5 years)	Reforestation to be carried out at 3 lots with a 5% a year at a rate of 700 ha per lot a year	2,318	11,592
V (5 years)	Ditto	2,318	11,592
VI (5 years)	Reforestation to be completed in the remaining area in 5 years	1,116	5,581
Total (30 years)		1,474	44,225

After Phase VI, reforestation will be made for reserved forests for production.

c. Reserved forests for production

Plans will be worked out for reforestation in poor stands or bare lands in the reserved forests for production. The projected areas are indicated in Table 22.

Reforestation in the reserved forests for production will be made at the same time as that in the production forests.

ii) Afforestation program in areas outside forest region

Afforestation in areas outside the forest region occurs mainly on bare lands, grasslands and second growths, and 1,343 ha is projected as indicated in Table 22 according to the existing Greening Movement program. The promotion of this afforestation will be made in the same manner as in the Bunacat area.

(6) Tree Species for Reforestation

No actual records are available for afforestation in this area, but on the basis of literature and the approach which is being implemented by Indonesia, tree species which are suitable for the meteorological and soil conditions should be selected.

As described in respect to the way in which reforestation should be stepped up, there is a need to take into account a combination of short- and long-cutting age species, a combination of artificial afforestation and natural regeneration and a combination of tree species for commercial use and those to prevent disasters for early greening.

On the basis of these considerations, the tree species may be selected as indicated below, but there is a need for a further study in this respect.

Tree species	Growth conditions, use and best suited place
Agathis loranthifolia	Grows fast and reaches 2m in diameter. For resin, furniture, match sticks, pulp. A-type climate.
Albizzia falcata	Briskly growing trunks. Grows fast. For veneer, pulp, packing materials, match sticks, furniture
Anthocephalus cadsmba	Fast growth. Reaches 40-60cm in diameter. For low-quality matches; tea chests, sandals, pulp
(Araucaria cunninghamii)	No actual records available on afforestation. Grows in the same way as pine trees.
Ochroma lagopus (Balsa)	Grows fast. Reaches 50-120cm in diameter. For aircraft materials, insulation materials, rescue equipment. Suitable for somewhat high lands. A-type climate.
Pinus caribaes (vas houndurensis)	Grows fast. Reaches 1.3m in diameter. For architecture, civil engineering, furniture, pulp. B-type climate.
Pinus merkusii	Grows favorably. Reaches 2m in diameter. For architecture, resin, pulp. B-type climate.
Personema canescens (Sungkai)	For architecture
Acacia arabica	For early greening

(7) Reforestation Methods

A reforestation project is made up of five processes -- nursing, land preparation, planting, maintenance and control. Each process requires much manpower and full care must be exercised in each process at all times. Even if a new type of

land use was adopted and forests, farmlands and rubber plantations were classified, the risk would be extremely great to the remaining poor stand or to go back to shifting cultivated land without full management after felling.

The management of the forests is difficult to carry out by limited government agencies.

For the management of the forests which are closely associated with local society, there is a need for the understanding and collaboration of local residents.

Therefore, it would be ideal to give local people what should be given to them and have them maintain the forests as an obligation.

i) Tumpang sari method

Of all the Indonesian reforestation methods, the Tumpang sari is worthy of special mention. This method has yielded great results in the reforestation of teak and other species in Java. In other words, intermediate culture is done by farmers in planting areas before and after reforestation. For this, the farmers are asked to take charge of land preparation and nursing. When the teak trees reach a certain height, the reforestation areas are turned over to the owners from the farmers. This reforestation method is profitable in terms of afforestation costs, job opportunities for farmers and their income.

Such a method also might be used for reforestation in this area.

ii) Reforestation by private enterprises

Reforestation is closely tied in with timber production, so that reforestation may be entrusted to the private enterprises instead of the Government.

In this case, it will be desirable to contract with farmers in the aforementioned Tumpang sari method. The direct supervision of the reforestation rests with the enterprise, and the Government will have them calculate the costs and disburse an appropriate amount of money to them. After a certain period, the Government will receive the reforested area.

In this method, the Government carries out planning and overall supervision, and no manpower is necessary for reforestation.

If the enterprises carry out a reforestation project simultaneously with their own production project they can manage the forests over several years on a contract base. Local farmers may also yield a profit.

iii) Implementation by the government

If the staff is available for actual reforestation and management, it is desirable that the Government carry out a reforestation project directly.

In this situation, it would be ideal to conduct various surveys and researches at the same time, but problems would be posed as to increases in manpower and cost as well as reorganizing of the staff.

A variety of reforestation methods are elucidated in the foregoing, but it is desirable that other methods which are used at various places in Indonesia be examined at the start of a new project.

3. Forest Road Plan

In view of the geographical and topographical conditions and the productivity of this area, the following basic matters should be taken into account for a forest road program in this area.

a. For the transportation of produced timber to Palembang, the lower stream down from Muara Rupit is generally usable, but the upper reaches which run through this area are so shallow that rafting is not available except for the transportation of small logs in pieces.

b. For the transportation of materials and logs, there is a need to construct considerably long forest roads. Planning of forest roads will face many difficulties such as the crossing of rivers and streams, passing through sharply-sloped terrain and farmlands. The costs should be quite high.

c. The results of a trial computation indicates that 615.3 km of main forest roads and 509.7 km of branch roads would be required to produce about 3,300,000 m^3 (in terms of logs), or 1.86 km of main roads and 1.54 km of branch roads per 1 ha. (In this case, 1 km of branch road requires about 1 km of main road. Table 25)

d. For the construction of forest roads, it is necessary to give full thought to their relations with the lives of local people and take on the character of publci roads in the future.

e. For transportation between forest roads to the main timber yards (Muara Rupit or Lubuk Linggau), the trans-Sumatra road (national road) may be used, but its improvement and extension are strongly desirable. The forest roads should be developed, depending on the improvement and extension of this highway.

f. The burden of costs from the forest roads on the production cost depends on the amount of timber production, but if maintenance and other costs are included, it may be estimated at 10-20% of the production cost. The forest roads play an important role as livelihood-associated roads, so that from this point of view, a legal system which reduces the costs of forest roads for loggers is desirable.

Table 25. Growing stock and forest roads by production forests

Production forests No.	Unit watershed No.	Area estimated (ha)	Growing stock estimated (m^3/ha)	Total growing stock estimated (1,000 m^3)	Prospective commercial wood in total growing stock (1,000 m^3)	Main forest roads (km)	Branch roads (km)
1	1.2	4,325	250	1,081	324	83.3	42.8
2	4	2,300	250	575	172	37.5	20.5
3	11	6,775	250	1,693	508	81.8	75.8
4	4.9	4,500	300[1)]	1,350	405	75.8	73.5
5	3	1,900	270[2)]	513	154	35.3	18.0
6	14	6,500	250[3)]	1,653	496	73.5	73.5
7	12	3,600	200	720	216	47.3	47.3
8	13.15	4,350	210	914	274	68.3	51.0
9	16.17	5,400	280[4)]	1,512	454	66.0	66.0
10	24a,b	4,575	210	961	288	46.5	41.3
Total		44,225		10,972	3,291	615.3	509.7

Note: The production forests are roughly designated on the whole map for the basic Watershed Management Plan (1:50,000 in scale).

The estimated growing stocks are based on the Land Use Map (1:50,000 in scale) and the Forestry Inventory Book. 1) 350 m^3/ha × 0.6, 230 m^3/ha × 0.4, 2) 350 m^3/ha × 0.2, 230 m^3/ha × 0.8, 3) 350 m^3/ha × 0.2, 230 m^3/ha × 0.8, 4) 350 m^3/ha × 0.4, 230 m^3/ha × 0.6
The branch roads are computed at a rate of 1 km per 1 km of main route which excludes the approach road run to the production forests.

4. Disaster Prevention Plan

(1) Conditions of Watersheds

The flow of river water in the watersheds and the volument of sediment in the running water are extremely small as elucidated in Chapter III. No significant relations are observed between the conditions of forests in the watersheds and other types of land use.

In the field survey, practically no landslips, wild streams and land creeps were observed.

(2) Volume of Sediment

As for the volume of sediment at the Measurement No. 12 at A. Rawas, 0.04 ml in a 15 ml test tube. It is 0.27% of that of water. From the water flow measured at that time, the total sediment run-off of 14,350,000 m^3 a year is computed.

(Run-off 168.48 m^3/s × 60' × 60' × 24 hours × 365 days × 0.0027 = 14,348,000 m^3.)

The sediment mixture rate at A. Rawas and Muararupit in the down stream area is 0.6%. Computed from this rate, the annual run-off will be 45,000,000 m^3. It follows, therefore, that the volume of sediment is 30,000,000 m^3 greater in the lower stream than in the upper stream.

The following factors are conceivable for this increase:

(i) Erosion on the river bank

(ii) Increases of open land, such as farmlands.

Eroded river banks by streams and fall-offs from the slopes at river sides were observed at several places in A. Rawas. The width of river bank erosion reached 3 m a year at some places.

The erosion is due to increases in water level and flow speed, suggesting the importance of control of water resources in the upper stream. It was found in the latest survey that when the areas of watershed is rather large and the forest rate is rather high, flow conditions are normal, attesting to the necessity of improvement of forest conditions in the upper stream area.

(3) Disaster Prevention with Forests

In the development of forests, the following points must be taken into account, as elucidated in the system.

(i) Forests at sharp slopes and along river sides must be kept as temporarily protected forests without felling.

(ii) Particular care must be taken for forests at the heads of rivers.

(iii) Care must be taken in treating water and soil during the construction of forests roads. A concentration of water flow should be avoided, thus forest roads will be preserved and the flow of sediment into lower streams will be prevented.

(iv) Bare lands caused from forest operations must be minimized as far as possible. The logged over areas should be quickly prepared for reforestation.

(v) For land use other than forests, attempts must be made to adapt forests for this as far as possible.

(4) Soil Conservation

In the latest survey, we could not find any places for which a soil conservation project would have to be carried out, but there is a need to take note of the following points.

(i) The fluctuations of sediment run-off due to changes in land use such as forest, shifting cultivated lands and farms, must be measured to secure basic data for management in the future.

(ii) To ascertain the functions of forest areas such as the nursing of water resources and the prevention of floods, the precipitation and run-off of water and sediment must be measured.

(iii) Similar surveys must be conducted both on logged over areas and non-logged areas.

(iv) With these surveys, attempts must be made to collect basic data.

Changes in water level, run-off of sediment and erosion on the river bank pose in great issues, but in case of the exploitation of undeveloped forest areas and the stepping up of changes in land use in the upper stream area, it is necessary to assign experts and to make organization in the Regional, District and other Forest Offices, in order to take countermeasures against the changes in conditions in the watershed, checking the phenomena at an early stage.

X. RECOMMENDATIONS ON THE IMPLEMENTATION OF THE PLAN

In carrying out the watershed management plan in this survey, we would like to suggest the following as some especially important considerations:

1. Long-term observation of mountainous weather conditions, flow rate, and sediment discharge.

2. Development of techniques for timber production in the mountainous areas.

3. Reforestation tests (both afforestation on grasslands and on mountainous areas with useful tress.

4. Establishment of methods to prevent shifting cultivation ——— installation of settled farmlands and management methods thereof.

5. Study on development of the secondary industry.
   (timber industry, rubber industry, etc.)

6. Establishment of organizations for forest management.

7. Securing of budget funds to carry out the plan.

XI. TANGIBLE SURVEY RESULTS

The following materials have been prepared as a consequence of this Watershed Management Plan.

1. The Map for the Basic Watershed Management Plan

   (1) Whole Map

   (Scale 1 : 50,000 Polyester base), original ..... 1 set

   Reprint of above

   (Scale 1 : 50,000 Polyester base) ..... 1 set

   (2) Model Area Map

   (Scale 1 : 20,000 Polyester base) ..... 1 set

   Reprint of above

   (Scale 1 : 20,000 Polyester base) ..... 1 set

2. Report (in Japanese) ..... 10 copies

3. Report (in English) ..... 10 copies

Attached Table 1. The drainage system and unit watershed

Large Watershed	Middle Watershed	Small Watershed		Unit Watershed	No.
the 1st	the 2nd	the 3rd	the 4th	the 5th		
A. Musi	A. Rawas	A. Rawas	A. Rawas		S. Keruh	1
					A. Rawas (U)	2
					A. Rawas (M)	3
					A. Rawas (L)	4
			S. Kukus		S. Kukus	5
			S. Senawar		S. Senawar	6
			S. Mungkulam		S. Mungkulam	7
			S. Kuwis		S. Kuwis	8
			S. Kutu		S. Kutu	9
		A. Rupit	A. Ulas		A. Ulas	10
			A. Minak		A. Minak (U)	11
					A. Minak (M)	12
					A. Minak (L)	13
			A. Tiku		A. Tiku (U)	14
					A. Tiku (L)	15
			A.B. Pu	A. Leko	A. Leko	16
				A.B. Pu	A.B. Pu (U)	17
					A.B. Pu (L)	18
			A. Rupit		A. Rupit (U)	19
					A. Rupit (L)	20
		S. Liam	S. Liangedang	S. Malamingan	S. Malamingan	21
				S. Petal	S. Petal	22
			S. Liamkecil		S. Liamkecil	23
	A. Musi	A. Lakitan	A. Dulu		A. Dulu (U-A)	24a
					A. Dulu (U-B)	24b
					A. Dulu (L)	25
			A. Bal	A. Plikai	A. Plikai	26
				A. Bal	A. Bal	27
			A. Lakitan		A. Lakitan (U)	28
					A. Lakitan (L)	29
			A. Malus		A. Malus (U)	30
					A. Malus (L)	31
			S. Megang	S. Tikipbelago	S. Tikipbelago	32
				S. Megang	S. Megang (U)	33
					S. Megang (L)	34
				S. Ketuan	S. Ketuan	35
		A. Klingi	A. Klingi		A. Klingi (U)	36
					A. Kling (L)	37
			S. Teman		S. Teman	38
			A. Beliti	A. Beliti	A. Beliti	39
				A. Koti	A. Koti	40
				A. Sinie	A. Sinie	41
				S. Saling	S. Saling	42
		A. Musi	A. Temelat	A. Pigi	A. Pigi	43
				A. Gegas	A. Gegas	44
				A. Temelat	A. Temelat (U)	45
					A. Temelat (L)	46
				A. Kungku	S. Bungin (U)	47
					S. Bungin (L)	48
					A. Kungku (U)	49
					A. Kungku (L)	50
			A. Tambangan		A. Tambangan	51
			A. Musi		A. Musi (U)	52
					A. Musi (L)	53a
					A. Musi (L)	53b
			S. Banyu		S. Banyu	54
			A. Kikim	A. Kikim	A. Kikim	55
				A. Aur	A. Aur	56
				A. Pangi	A. Pangi	57
(1)	(2)	(6)	(26)	(38)	(59)	

(Remarks)
(U): the upper reach of river
(M): the middle reach of river
(L): the lower reach of river

Attached Table 2. Cross table of land use and natural environment

1/4 (Upper left)

	Item		Land use								Topography							Slope inclination						
	Category	No.	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Land use	Natural forest	1	1415	0	0	0	0	0	0	0	390	115	209	315	263	120	3	84	290	223	227	347	207	37
	Second growth	2	0	58	0	0	0	0	0	0	4	2	3	12	33	4	0	7	28	8	6	8	1	0
	Rubber forest	3	0	0	1865	0	0	0	0	0	52	18	28	172	1387	166	42	202	1205	280	91	68	18	1
	Grassland	4	0	0	0	249	0	0	0	0	1	0	0	0	229	19	0	36	197	15	0	1	0	0
	Bareland	5	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
	Farmland	6	0	0	0	0	0	283	0	0	3	0	0	7	148	114	11	112	152	13	1	1	4	0
	Shifting cultivation	7	0	0	0	0	0	0	60	0	4	0	3	15	33	2	3	4	28	14	6	7	1	0
	Urban site	8	0	0	0	0	0	0	0	18	0	0	0	0	9	9	0	7	10	1	0	0	0	0
Topography																								
	Ridge	1	390	4	52	1	1	3	4	0	455	0	0	0	0	0	0	6	3	30	96	190	111	19
	Mountain-side	2	115	2	18	0	0	0	0	0	0	135	0	0	0	0	0	0	0	8	17	50	52	8
	Mountain dale (valley)	3	209	3	28	0	0	0	3	0	0	0	243	0	0	0	0	1	5	25	50	98	53	11
	Large-wave hill	4	315	12	172	0	0	7	15	0	0	0	0	521	0	0	0	1	55	212	149	90	14	0
	Small-wave hill	5	263	33	1387	229	0	148	33	9	0	0	0	0	2102	0	0	136	1665	276	20	4	1	0
	Low flat plateau	6	120	4	166	19	0	114	2	9	0	0	0	0	0	434	0	283	150	1	0	0	0	0
	Flood plain	7	3	0	42	0	0	11	3	0	0	0	0	0	0	0	59	25	32	2	0	0	0	0
Slope inclination	0° - 1°	1	84	7	202	36	0	112	4	7	6	0	1	1	136	283	25	452	0	0	0	0	0	0
	2° - 5°	2	290	28	1205	197	0	152	28	10	3	0	5	55	1665	150	32	0	1910	0	0	0	0	0
	6° - 10°	3	223	8	280	15	0	13	14	1	30	8	25	212	276	1	2	0	0	554	0	0	0	0
	11° - 15°	4	227	6	91	0	1	1	6	0	96	17	50	149	20	0	0	0	0	0	332	0	0	0
	16° - 20°	5	347	8	68	1	0	1	7	0	190	50	98	90	4	0	0	0	0	0	0	432	0	0
	21° - 30°	6	207	1	18	0	0	4	1	0	111	52	53	14	1	0	0	0	0	0	0	0	231	0
	31° or over	7	37	0	1	0	0	0	0	0	19	8	11	0	0	0	0	0	0	0	0	0	0	38

(Note): No. of samples : 3949

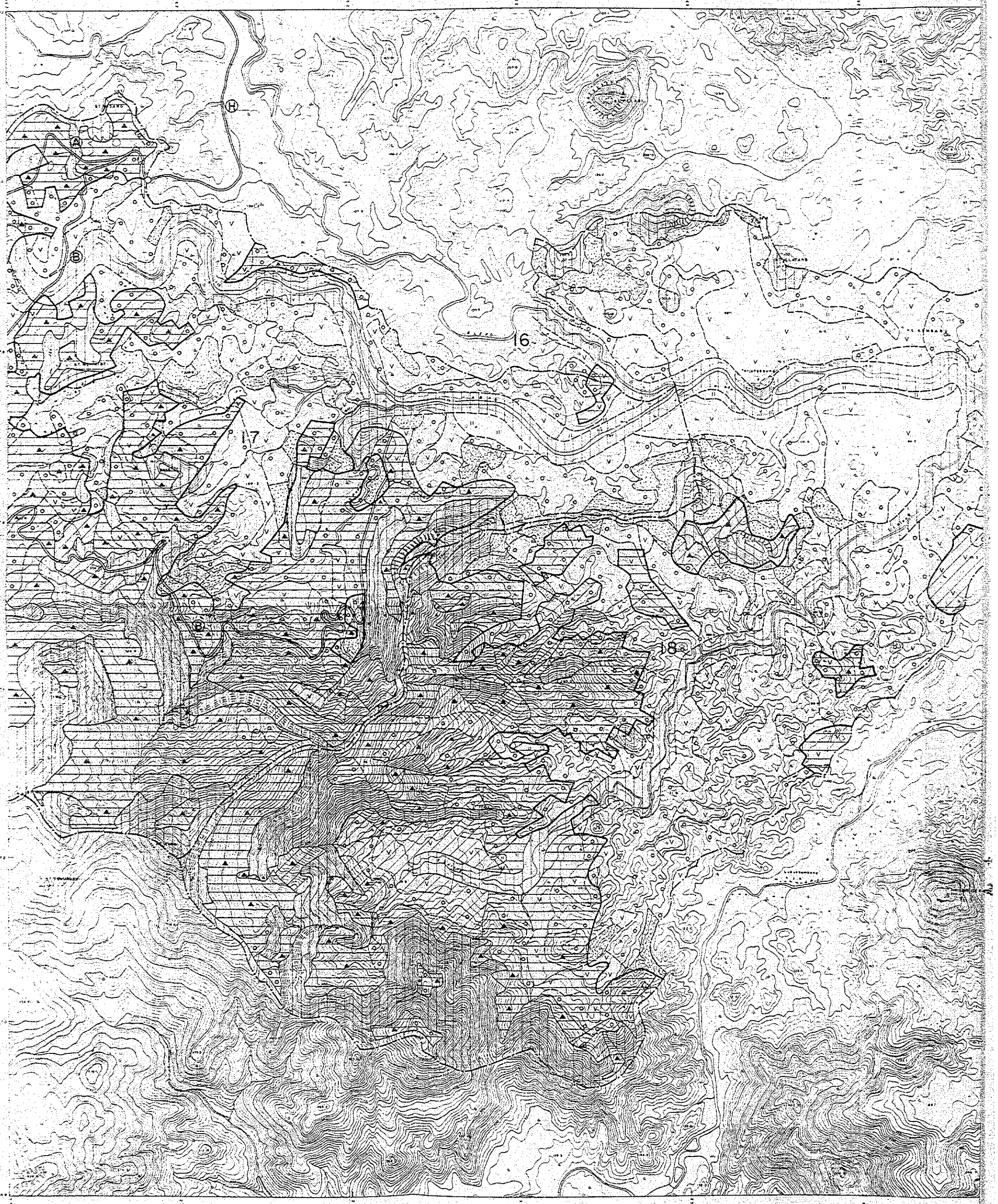
Item			Valley density					Geology											
	Category	No.	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10	11	12
Land use	Natural forest	1	276	363	398	235	143	12	303	40	72	23	137	41	244	4	30	369	140
	Second growth	2	16	15	15	9	3	1	29	0	7	1	0	0	2	0	3	15	0
	Rubber forest	3	394	526	522	292	131	104	1196	109	214	16	18	0	25	0	19	157	7
	Grassland	4	51	39	67	46	46	5	215	20	7	0	0	0	1	0	0	1	0
	Bareland	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	Farmland	6	133	85	43	14	8	13	249	4	9	2	0	0	3	0	0	3	0
	Shifting cultivation	7	9	20	11	12	8	3	20	4	11	0	4	0	1	0	2	15	0
	Urban site	8	12	2	3	1	0	2	16	0	0	0	0	0	0	0	0	0	0
Topography	Ridge	1	58	116	148	74	59	1	24	15	1	9	34	19	116	4	24	132	76
	Mountain-side	2	36	48	33	14	4	1	12	11	0	3	11	5	36	0	5	38	13
	Mountain dale (valley)	3	4	42	84	61	52	0	4	7	3	4	19	16	71	0	11	63	45
	Large-wave hill	4	74	155	154	96	42	0	71	11	34	23	70	0	32	0	12	255	13
	Small-wave hill	5	415	550	602	355	180	125	1519	117	232	2	23	1	15	0	2	66	0
	Low flat plateau	6	292	109	29	3	1	7	380	7	32	1	0	0	2	0	0	5	0
	Flood plain	7	12	31	9	6	1	6	18	9	18	0	2	0	4	0	0	2	0
Slope inclination	0° - 1°	1	245	114	62	22	9	9	375	20	34	0	1	0	5	0	0	3	5
	2° - 5°	2	420	513	502	316	159	101	1403	101	199	9	21	0	13	0	4	56	3
	6° - 10°	3	97	162	169	80	46	25	173	24	68	14	65	3	25	0	2	140	15
	11° - 15°	4	35	77	116	64	40	4	30	11	10	11	33	4	50	3	19	127	30
	16° - 20°	5	50	118	132	80	52	1	32	11	7	6	26	12	93	1	21	159	63
	21° - 30°	6	35	56	72	40	28	0	14	8	2	2	11	17	75	0	8	69	25
	31° or over	7	9	11	6	7	5	0	1	2	0	0	2	5	15	0	0	7	6

	Item		Land use								Topography							Slope inclination						
	Category	No.	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Valley density	No. of valleys in mesh 0	1	276	16	394	51	0	133	9	12	58	36	4	74	415	292	12	245	420	97	35	50	35	9
	" 1	2	363	15	526	39	1	85	20	2	116	48	42	155	550	109	31	114	513	162	77	118	56	11
	" 2	3	398	15	522	67	0	43	11	3	148	33	84	154	602	29	9	62	502	169	116	132	72	6
	" 3	4	235	9	292	46	0	14	12	1	74	14	61	96	355	3	6	22	316	80	64	80	40	7
	" more than 4	5	143	3	131	46	0	8	8	0	59	4	52	42	180	1	1	9	159	46	40	52	28	5
Geology	Qhv	1	12	1	104	5	0	13	3	2	1	1	0	0	125	7	6	9	101	25	4	1	0	0
	QTpv	2	303	29	1196	215	0	249	20	16	24	12	4	71	1519	380	18	375	1403	173	30	32	14	1
	Tppp	3	40	0	109	20	0	4	4	0	15	11	7	11	117	7	9	20	101	24	11	11	8	2
	Tmpl	4	72	7	214	7	0	9	11	0	1	0	3	34	232	32	18	34	199	68	10	7	2	0
	Tmts	5	23	1	16	0	0	2	0	0	9	3	4	23	2	1	0	0	9	14	11	6	2	0
	Tomlp	6	137	0	18	0	0	0	4	0	34	11	19	70	23	0	2	1	21	60	33	26	11	2
	Tmv	7	41	0	0	0	0	0	0	0	19	5	16	0	1	0	0	0	0	3	4	12	17	5
	Tov	8	244	2	25	1	0	3	1	0	116	36	71	32	15	2	4	5	13	25	50	93	75	15
	Ta	9	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	3	1	0	0
	Kgr	10	30	3	19	0	0	0	2	0	24	5	11	12	2	0	0	0	4	2	19	21	8	0
	Jrs	11	369	15	157	1	1	3	15	0	132	38	63	255	66	5	2	3	56	140	127	159	69	7
	pTsb	12	140	0	7	0	0	0	0	0	76	13	45	13	0	0	0	5	3	15	30	63	25	6

Item			Valley density					Geology											
	Category	No.	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10	11	12
Valley density	No. of valleys in mesh 0	1	891	0	0	0	0	30	549	32	147	5	8	9	29	0	1	71	10
	" 1	2	0	1051	0	0	0	27	519	61	105	17	45	4	56	2	15	156	44
	" 2	3	0	0	1059	0	0	38	506	40	52	12	56	15	75	2	25	191	47
	" 3	4	0	0	0	609	0	31	296	27	14	7	38	5	58	0	10	95	28
	" more than 4	5	0	0	0	0	339	14	158	17	2	1	12	8	58	0	3	48	18
Geology	Qhv	1	30	27	38	31	14	140	0	0	0	0	0	0	0	0	0	0	0
	Qtpv	2	549	519	506	296	158	0	2028	0	0	0	0	0	0	0	0	0	0
	Tppp	3	32	61	40	27	17	0	0	177	0	0	0	0	0	0	0	0	0
	Tmpl	4	147	105	52	14	2	0	0	0	320	0	0	0	0	0	0	0	0
	Tmts	5	5	17	12	7	1	0	0	0	0	42	0	0	0	0	0	0	0
	Tomlp	6	8	45	56	38	12	0	0	0	0	0	159	0	0	0	0	0	0
	Tmv	7	9	4	15	5	8	0	0	0	0	0	0	41	0	0	0	0	0
	Tov	8	29	56	75	58	58	0	0	0	0	0	0	0	276	0	0	0	0
	Ta	9	0	2	2	0	0	0	0	0	0	0	0	0	0	4	0	0	0
	Kgr	10	1	15	25	10	3	0	0	0	0	0	0	0	0	0	54	0	0
	Jurs	11	71	156	191	95	48	0	0	0	0	0	0	0	0	0	0	561	0
	pTsb	12	10	44	47	28	18	0	0	0	0	0	0	0	0	0	0	0	147

AFFORESTATION PROYECT IN UPPER MUSI SOUTH SUMATRA

MODEL AREA MAP FOR BA



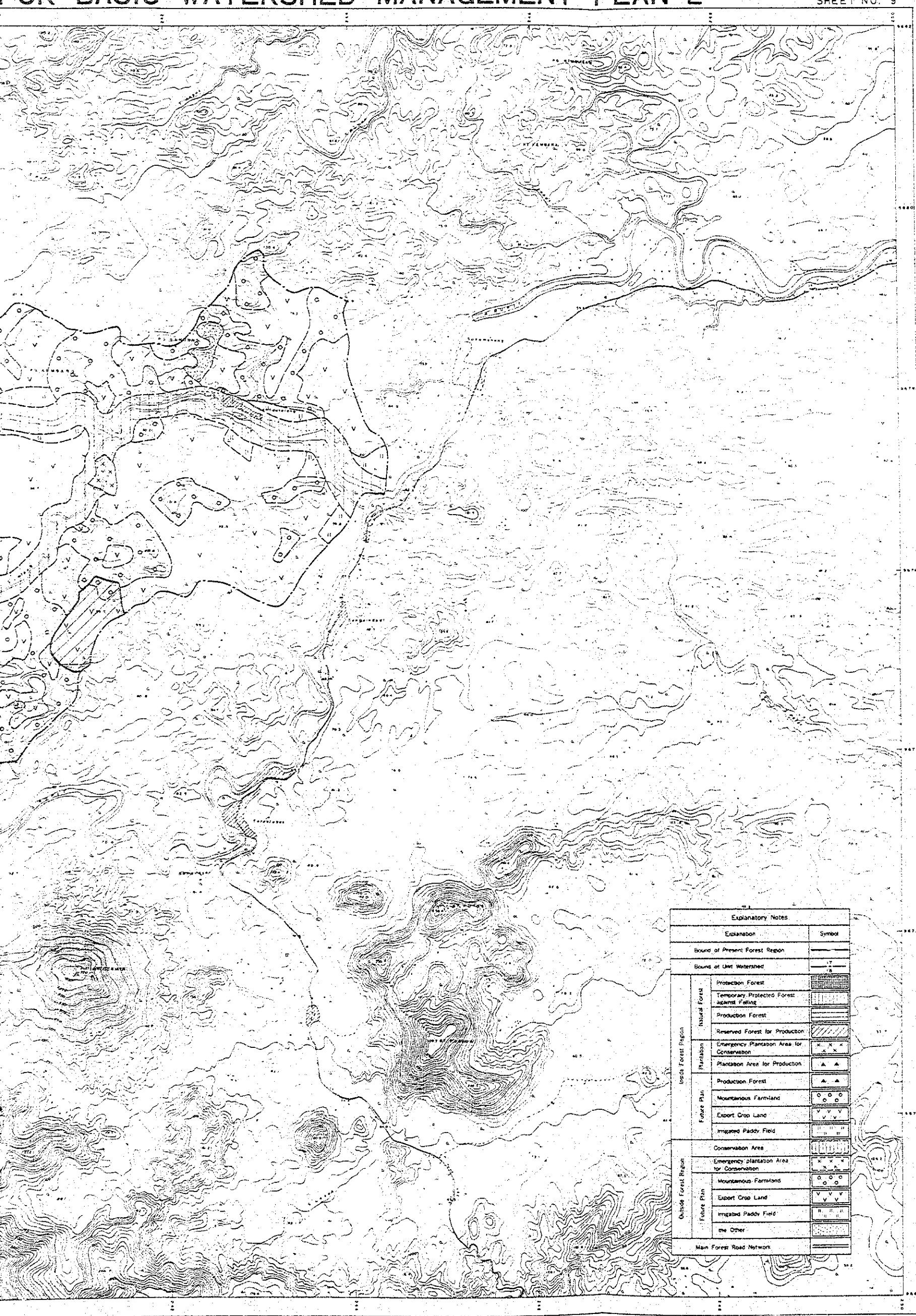
PREPARED BY THE JAPAN INTERNATIONAL COOPERATION AGENCY
AND THE DIRECTORATE GENERAL OF FORESTRY THE REPUBLIC OF INDONESIA
UNDER THE SPONSORSHIP OF THE GOVERNMENT OF JAPAN

SCALE 1:40,000
0 200 1000 3000 m

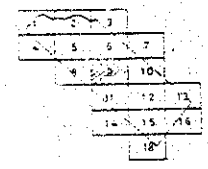
CONTOUR INTERVAL 10 M
COORDINATE : U.T.M

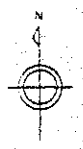
FOR BASIC WATERSHED MANAGEMENT PLAN 2

SHEET NO. 9



Explanatory Notes		
Explanation		Symbol
Bound. of Present Forest Region		
Bound. of Unit Watershed		
Inside Forest Region	Natural Forest	Protection Forest
		Temporary Protected Forest against Felling
		Production Forest
		Reserved Forest for Production
	Plantation	Emergency Plantation Area for Conservation
		Plantation Area for Production
	Future Plan	Production Forest
		Mountainous Farmland
		Export Crop Land
		Irrigated Paddy Field
Outside Forest Region		Conservation Area
		Emergency plantation Area for Conservation
	Future Plan	Mountainous Farmland
		Export Crop Land
		Irrigated Paddy Field
		the Other
Main Forest Road Network		





KETERANGAN

- TITIK TRIANGULASI
- TIANG PENYIPAT
- TITIK ASTRONOMI
- TELAH DIPERIKSA DILAPANGAN
- BELUM DIPERIKSA DILAPANGAN DENGAN SPOT HEIGHT
- P.P. PHOTO
- RUMAH
- RUMAH HAMPIR ROBOH
- BANGUNAN RUMAH BATU
- BANGUNAN SEKOLAH
- RUMAH TERPENCAR
- LEBARNYA JALAN
- JALAN KUDA
- JALAN SETAPAK
- JALAN SEDANG DIBUAT
- TEROWONGAN
- MENCANTARA
- JALAN DAN POHON
- BAGIAN JALAN GALIAN
- BAGIAN JALAN TIMBUNAN
- JALAN KERETA API
- MENCANTARA
- JALAN KERETA API BERGERIGI
- STASIUN
- KERETA API
- BATAS NEGARA
- BATAS PROPINSI
- BATAS KABUPATEN
- BATAS KECAMATAN
- PAGAR (BATU)
- PAGAR (KAYU)
- PAGAR (BESI)
- PAGAR HIDUP
- KANTARAN LISTRIK TEGANGAN TINGGI
- KANTOR PEMERINTAHAN
- SEKOLAHAN
- KANTOR POLISI
- KANTOR POS
- KANTOR KEJAKSAAN
- KANTOR PENGADILAN
- KANTOR PAJAK
- KANTOR TELEGRAM TELPON
- STASION PEMADAM KEBAKARAN
- GARDU INDUK LISTRIK
- PUSAT LISTRIK TENAGA AIR
- BANK
- RUMAH SAKIT
- MESJID
- GEREJA
- KLENTENG
- PABERIK
- PENGINAPAN
- LOS PASAR
- GUDANG
- TEMPAT POMPA
- MENARA
- TANDA PERINGATAN
- POHON
- CEROBONG ASAP
- ISLAM
- KRISTEN
- PEKUBURAN T. TIONGHOA
- BALI
- TONGGAK KM
- TANGKI AIR
- TANGKI MINYAK GAS
- STASIUN RADIO
- BATAS TUMBUHAN
- BATAS SAWAH
- SAWAH
- LADANG KEBUN
- BUAH BUAHAN
- KELAPA
- KAPET
- KINA
- LADA
- HUTAN BELANTARA
- HUTAN BELUKAR
- HUTAN BUATAN
- ALANG ALANG
- BAMBU RUMPUT
- SABANA
- DAMAR
- BAKAU BAKAU
- PALEM RAWA
- KELAPA SAWIT
- RAWA
- GOSONG
- ANAK SUNGAI
- GOSONG PASIR
- SALURAN AIR
- TALUUD BETON
- SUNGAI BENBATU
- PIPA AIR
- MINYAK GAS
- BENDUNG
- PINTU AIR
- AIR TERJUN
- TAMBANGAN
- ARAH ARUS
- BENDUNGAN
- TUMPUAN PELABUHAN
- CEROKAN KEPIL BATU BESI / KAYU
- GARIS SAMA TINGGI
- INDEKS GARIS SAMA TINGGI
- GARIS SAMA TINGGI BANTUAN
- KARANG CURAM
- SUSUR CURAM
- TEBING BATU
- TEBING BERBATU
- LERENG TEREROSI
- DANAU TANAH BENCAH
- GARIS PANTA
- BATU KARANG

:40 000

2000 m

NTERVAL 10 M

E : U.T.M

ABBREVIATION

PG. MOUNTAIN
Tai VILLAGE
S. RIVER
k STREAM

AIR FOTOGRAPHY IN 1978
PHOTOGRAMMETRIC MAPPING IN 1979