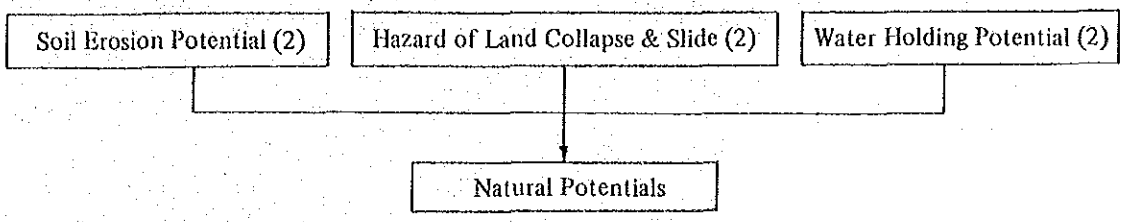
(7) **Analysis of Natural Environment**

By combining the respective results of the Soil Erosion Potential analysis, the Land Collapse & Slide Potential analysis, and the Water Holding Potential analysis, as discussed in the preceding sections, the overall natural environment was studied. The study procedure is schematically shown below.



The above analysis of the natural environment addresses the existing forest land and grassland as defined in the following classifications.

1) Existing forest land:
   1. Areas high in soil erosion and land collapse & slide potentials, and low in water holding potential, where total felling should basically be banned.
   2. Areas sensitive to either soil erosion or land collapses & slides, where some restrictions of felling are desirable.
   3. Areas least sensitive to both soil erosion and land collpases/slides, and high in water holding potential, where felling is least likely to cause hazards.
2) Existing grassland:
   1. Areas high in land collapse & slide potential and low in water holding potential where afforestation is desired.
   2. Areas low in land collapse & slide potential and water holding potential as well, where other land uses than afforestation are feasible.
3) Existing agriculture land:
   1. Existing farmland and areas with rivers, major urban centers, settlements, etc.

Figure 3-40 shows the above analysis results. The figure serves as the basis for the Forest Management Plan for Wide Area to be discussed in the following chapter.

Fig. 3-40. Natural Potentials

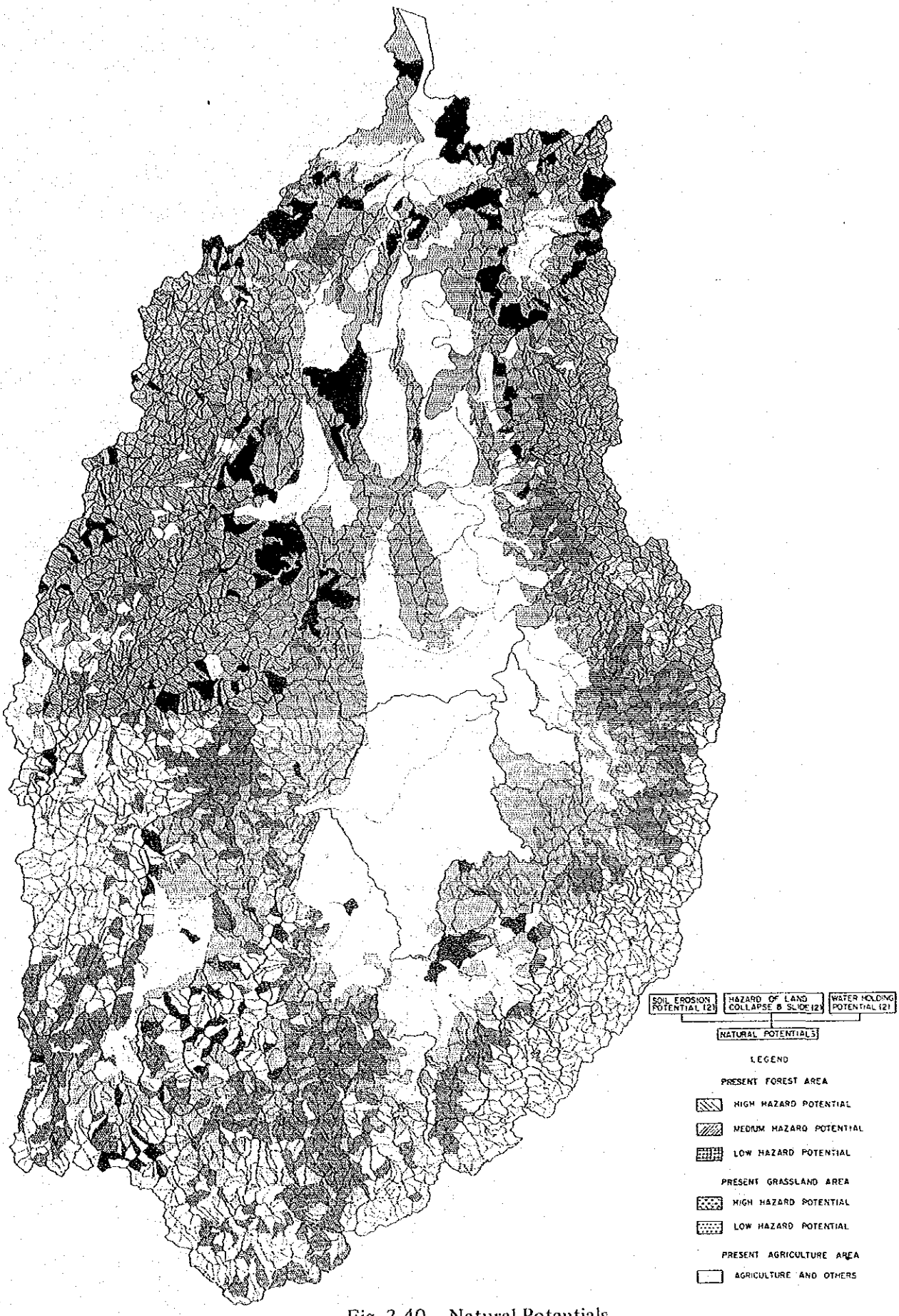


Fig. 3-40. Natural Potentials

CHAPTER 4. FOREST MANAGEMENT PLAN FOR WIDE AREA

4–1 Basic Policy of Forest Management

In the study area, located in the northeast of Luzon Island covering the Cagayan River Valley, the land use is characterized by agriculture, mainly rice production, livestock, fruit growing, and timber production, which are major industries in the area.

With respect to forests, the area originally is abundant in forest resources but due to excessive felling of Philippine mahogany and other species for export and for domestic construction purposes, augmented by the ever growing need for firewood, as well as the unabated increase of kaingin further inland for agricultural expansion, all these have shrunk the forest area substantially including a deterioration of the quality of resources therein resulting in reduced production capacity not to mention the bigger environmental problems they caused from frequent outflows of sand and gravel and increasing occurrence of flood which damaged farmland, infrastructure, and other built-up areas downstream.

In the face of this situation, the need is being strongly felt by regional communities to let the forests function fully in the public interests to control water, prevent hazards, and conserve the environment as a whole, and to promote forestry in such a manner as to help develop the region by providing increased employment while ensuring planned production of timber and firewood.

The basic policy for formulation of the Forest Management Plan for Wide Area, therefore, is to help maintain and nurture the forest resources while enhancing the multi-lateral functions of forests to benefit the regional communities in accordance with the basic forestry policy of the Philippine Government.

4–2. Setting of Forest Management Bicok

The Cagayan River Basin has the Cagayan River running in the middle from south to north, and the Cordillera Central Range and the Siera Madre Range closing in on the west and the east respectively.

For evaluations of the natural potentials, the study area was divided into some 3,000 'study units' according to the drainage patterns and ridges, to form the smallest unit for analysis. Those units were aggregated into 306 management unit unit and further into 12 Watershes.

The Watersheds involve the river basins of six rivers: Chico, Magat, Cagayan, Dummon, Pinacanauan de Tuguegarao, and Ilagan. Figure 4-1 shows Watersheds as well as the Watersheds which have been made the basic units for the Forest Management Planning for Wide Area.

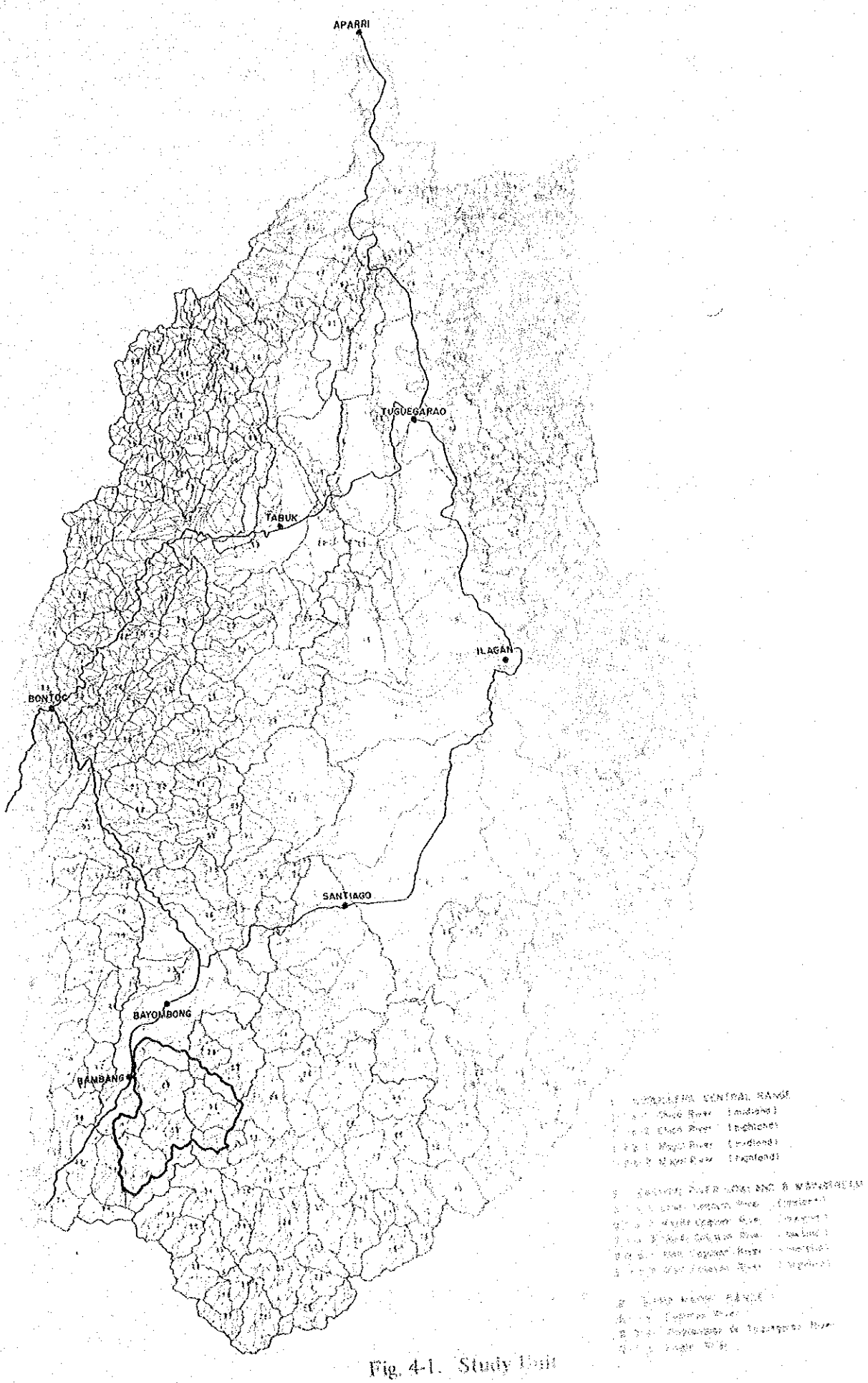


Fig. 4-1. Study Unit

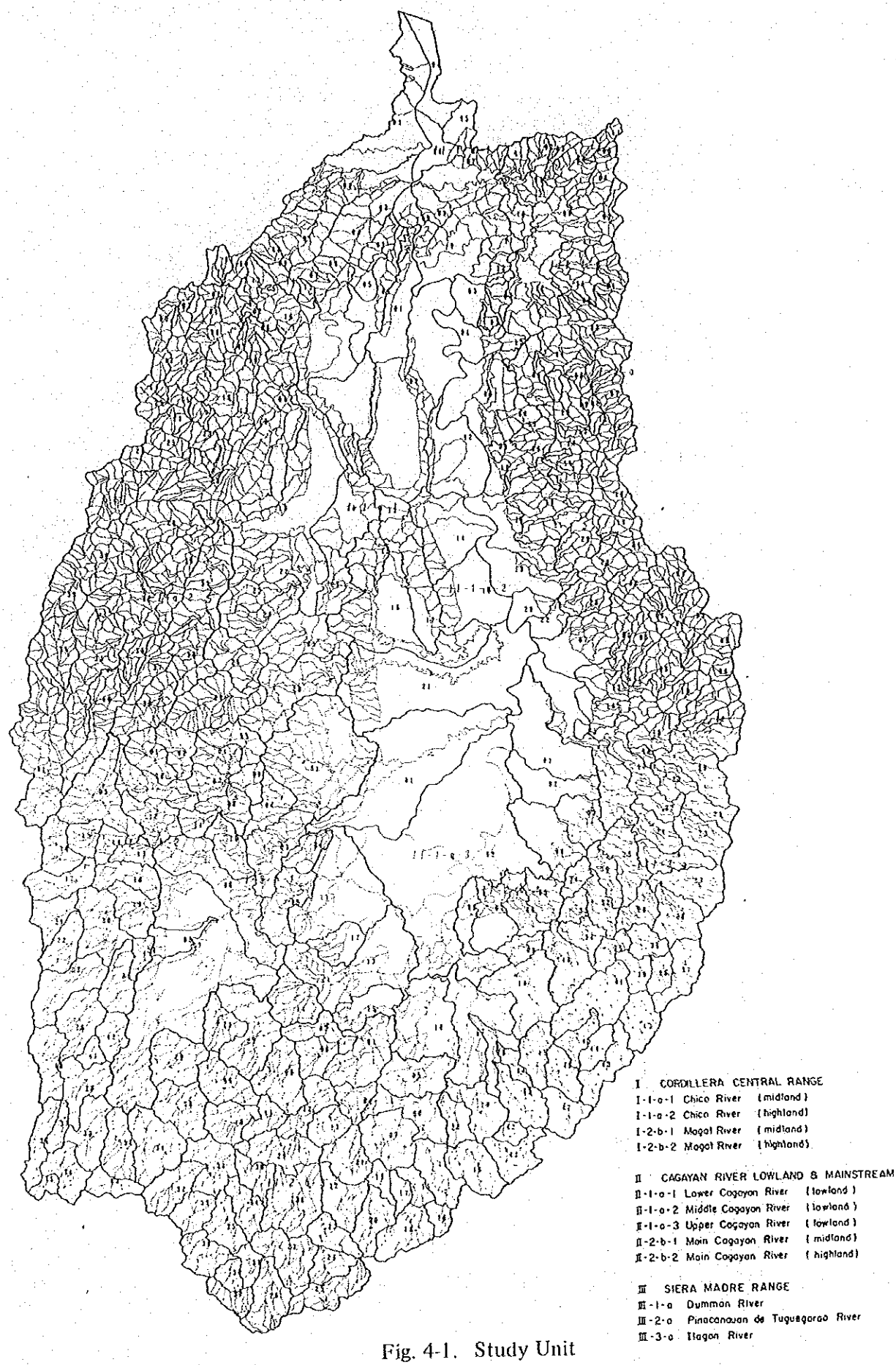


Fig. 4-1. Study Unit

4–3. Zoning for Forest Management

As previously discussed, 306 Management Units have been set as the basic areal units for forest management. Furthermore, the forestland was classified into Existing Forestland and Existing Grassland, for which classifications were set as follows for the purpose of forest management.

1) Existing Forestland
   - (A) Areas with high potential for natural hazards requiring prohibition of felling for forest protection.
   - (B) Areas with fairly high potential for natural hazards allowing selective felling subject to soil conservation.
   - (C) Areas with low potential for natural hazards permitting clear cutting and afforestation subject to planned management.

2) Existing Grassland
   - (D) Areas with the continuing presence of soil erosion and land hazards (outflow of sands and gravel) requiring active reforestation to prevent hazards.
   - (E) Areas with the continuing relative absence of soil erosion and land hazard (outflow sands and gravel) requiring reforestation stressing soil enrichment.

4–4 Preparation of Forest Information Table

The findings of studies made to understand the existing natural and social conditions and analyse the forest land use for the purpose of forest management planning for wide area with respect to each management unit have been tabulated into "The Forest Information Table" as shown in the Annex. In the table, the following are represented.

(1) Watershed:
Watersheds formed by dividing the study area into 12 major river basins. (See Figure 4-1.)

(2) Watershed:
The Management Units are further sub-divided into 306 smaller units according to the basins of smaller rivers. (Basic units for forest management)

(3) Elevations:
The highest and lowest elevations(m) in each management unit

(4) Slopes:
Areas with slopes of 18% or more and their sizes (ha.) in each management unit.

(5) Vegetation and Land Use:
Existing vegetation and land use is classified into Forestland, Kaingin, Grassland, Agriculture Land, and others with their respective areal sizes (ha.)

represented.

(6) A&D (Alienable and Disposable):

A&D in each management unit in hectares

(7) Legal and Regulatory Restrictions:

Restricted areas and their sizes (ha.) in each management unit

Types of restrictions – Forest Reserve, Watershed Forest Reserve, Civil Reservation, Resettlement Project, National Park

(8) Soil Erosion Potential (2):

Areas rated by soil Erosion Potential in H, M, and L, and their sizes (ha.) in each management unit.

H: Areas with steeply sloped terrains, sandy soils, and much rainfall.

M: Areas with moderately sloped terrains, silty soils, and fairly much rainfall.

L: Areas with mildly sloped terrains, clayish soils, and little rainfall.

(9) Land Collapse/Slide Potential (2):

Areas rated by Land Collapse/Slide Potential in H, M, and L, and their sizes (ha.) in each management unit.

H: Areas with steeply sloped terrains, heavily weathered, and much rainfall.

M: Areas with sloped terrains, slightly weathered, and little rainfall. fairly much rainfall.

L: Areas with sloped terrains, slightly weathered, and little rainfall.

(10) Water Holding Potential (2):

Areas rated by Water Holding Potential in H, M, and L and their sizes (ha.) in each management unit.

H: Areas with mildly sloped terrains, soils with loose grains, and much rainfall.

M: Areas with moderately sloped terrains, soils with fairly compact grains, and fairly much rainfall.

L: Areas with steeply sloped terrains, soils with compact grains, and fairly much rainfall.

(11) Flooding Potential:

Areas rated by Flooding Potential in H, M, and L and their sizes (ha.) in each management unit.

H: Areas 800m or less in elevation back-up wetland, flood plains, valley bottom lowland, fans, river beds.

M: Areas 800m or less in elevation, other than those falling in H above.

L: Areas 800m or more in elevation.

(12) Vegetation Impact on Soil Erosion Potential:

Areas rated in H, M, L and their sizes (ha.) in each management unit.

H: Areas with a strong vegetation impact to prevent soil erosion.

M: Areas with a fairly strong vegetation impact to prevent soil erosion.

L: Areas with a least vegetation impact to prevent soil erosion.

(13) Vegetation Impact on Land Collapse/Slide Potential:

Areas rated in H, M, and L and their sizes (ha.) in each management unit.

H: Areas with a strong vegetation impact to prevent soil erosion.

M: Areas with a fairly strong vegetation impact to prevent soil erosion.

L: Areas with a least vegetation impact to prevent soil erosion.

(14) Vegetation Impact on Water Holding Potential:

Areas rated in H, M, and L and their sizes (ha.) in each management unit.

H: Areas with a strong vegetation impact to prevent soil erosion.

M: Areas with a fairly strong vegetation impact to prevent soil erosion.

L: Areas with a least vegetation impact to prevent soil erosion.

(15) Tree Growth Potential:

Grassland rated in H, M, and L and their sizes (ha.) in each watershed.

H: Areas with mildly sloped terrains, and soft and deep soils.

M: Areas with moderately sloped terrains, and fairly hard and fairly shallow soils.

L: Areas with steeply sloped terrains, and hard and shallow soils.

(16) Natural Potentials:

Areas rated in H, M, and L and their sizes (ha.) in each management unit.

H: Areas prone to both soil erosion and land collapses/slides, with high water holding potential.

M: Areas prone to either soil erosion or land collapses/slides.

L: Areas least prone to soil erosion and land collapses/slides with low water holding potential.

4–5 Compilation of Basic Forest Management Map

The Forest management Plan for Wide Area sets forth the goals and criteria for each Management Unit based on the Forest Information Table and provides for the management classifications in tables.

According to the management goals, the Existing Forestland is classified into three groups and the Existing Grassland into two, and criteria are set for each management unit in accordance with areas as defined by these classifications.

The management goals and criteria are as follows.

Existing Forestland

(A) Areas with high potential for natural hazards requiring prohibition of felling for forest protection.

(B) Areas with fairly high potential for natural hazards allowing selective cutting subject to soil conservation.

(C) Areas with low potential for natural hazards permitting clear cutting and afforestation subject to planned management.

Existing Grassland

(D) Areas with the continuing presence of soil erosion and land hazards requiring active reforestation to prevent hazards.

(E) Areas with the continuing relative absence of soil erosion and land hazards requiring reforestation stressing soil enrichment.

The standard combinations of above classifications are shown in Figure 4-2.

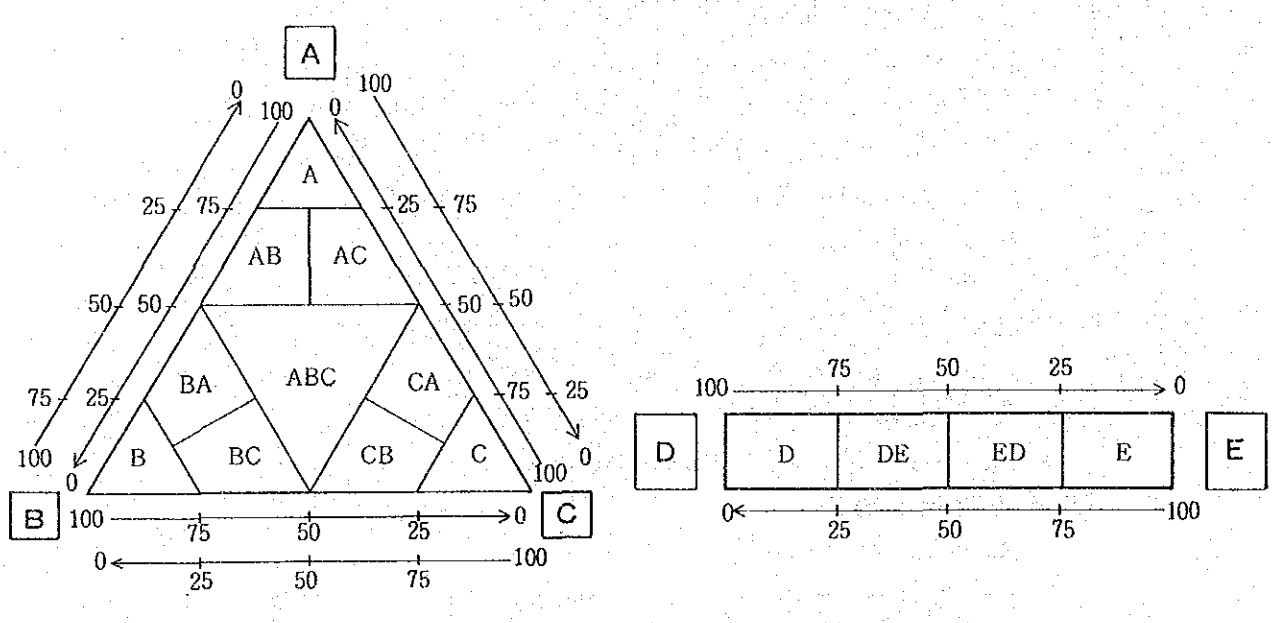


Fig. 4-2. Combinations of Management Classifications

(Note): The above figures show the combinations of the management classifications with the ratios of respective areas developed from the Forest Information Table.

Based on the combinations of management classifications as shown in Figure 4-2, the Forest Management Map (1/200,000) (Figure 4-3) and the Forest Management Classification Table (Table 4-1) have been compiled.

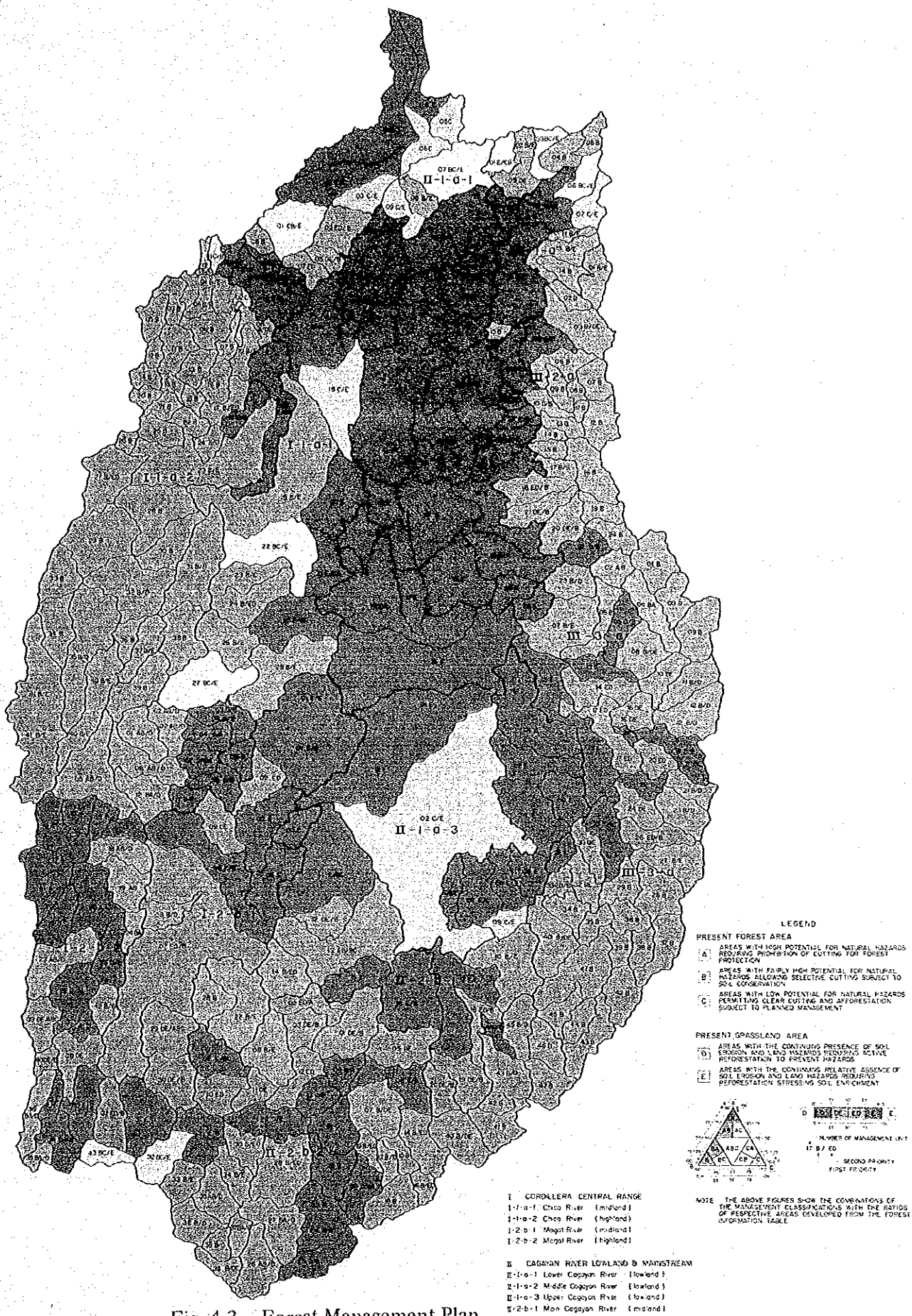


Fig. 4-3. Forest Management Plan

Table 4-1. Forest Management Classification

management unit No.	area (ha) fores + grass land	management objective first priority	management objective second priority
I. CORDILLERA CENTRAL RANGE			
I-1-a-1 Chico R. (midland)			
01	11,943	CB	E
02	8,354	ED	B
03	3,154	E	B
04	10,059	E	C
05	858	E	–
06	3,040	DE	B
07	3,744	ED	–
08	2,798	B	–
09	1,829	E	–
10	2,645	E	–
11	1,782	C	B
12	1,799	DE	C
13	3,427	E	–
14	1,181	E	–
15	1,691	E	–
16	7,747	E	B
17	5,192	E	–
18	17,591	C	E
19	20,629	B	E
20	7,843	E	–
21	7,658	E	CB
22	17,946	BC	E
23	7,153	B	C
24	10,446	B	ED
25	14,643	E	BC
26	10,115	B	E
27	14,286	BC	E
28	19,284	B	E
total	218,837		

I-1-a-2 Chico R. (highland)			
01	5,705	B	E
02	406	C	–
03	4,397	B	–
04	2,576	B	E
05	4,380	B	–
06	6,301	B	–
07	2,799	B	–
08	3,690	B	DE
09	15,796	E	BC
10	4,201	B	E
11	5,933	B	–
12	2,111	B	–
13	4,846	B	–
14	2,772	B	–
15	1,924	B	–
16	4,284	B	–
17	5,184	B	ED
18	4,829	E	B
19	2,124	B	–
20	2,271	B	–
21	2,999	B	–
22	3,467	B	–
23	26,815	B	E
24	2,748	B	D
25	4,943	B	–
26	1,704	B	–
27	11,830	B	ED
28	13,291	B	–
29	15,955	B	–
30	7,891	B	–
31	16,510	B	D
32	14,892	B	D
33	7,197	B	–
34	4,925	B	–
35	15,579	B	D
36	2,359	B	–
37	6,319	B	E
38	10,319	B	–
39	10,364	B	E
40	11,808	B	E

manage-ment unit No.	area (ha) forest+grass land	management objective first priority	management objective second priority
41	18,634	B	E
total	297,078		

I-2-b-1 Magat R. (midland)			
01	38,492	E	B
02	7,331	ED	–
03	12,995	E	–
04	5,293	E	–
05	10,723	E	–
06	23,002	ED	B
08	1,812	B	D
09	7,784	DE	–
total	145,425		

I-2-b-2 Magat R. (highland)			
01	7,313	AB	D
02	6,304	AB	D
03	6,522	D	B
04	4,489	D	A
05	13,513	AB	D
06	7,873	AB	D
07	4,975	D	BA
08	4,175	D	–
09	5,957	D	B
10		none	
11	3,737	D	A
12	7,324	BA	D
13	3,579	A	–
14	3,310	A	–
15	4,320	A	–
16	7,313	A	–
17	7,727	A	–
18	7,187	AB	D
19	7,727	AB	–
20	11,634	A	–
21	6,266	A	–

manage-ment unit No.	area (ha) forest+grass land	management objective first priority	management objective second priority
22	6,814	A	–
23	12,178	AB	D
24	2,958	BA	–
25	7,590	D	B
26	9,788	D	AB
27	16,379	B	E
28	6,545	B	–
29	9,331	DE	ABC
30	9,251	DE	B
31	12,929	E	B
32	7,220	ED	B
33	8,403	E	B
34	7,075	D	AB
35	2,036	BA	D
36	6,802	BA	D
37	3,013	A	D
38	8,782	DE	
39	6,434	DE	ABC
40	1,957	ED	B
41	2,358	D	–
42	4,834	B	D
43	4,395	BC	E
total	288,723		

II. CAGAYAN RIVER LOWLAND & MAINSTREAM			
II-1-a-1 Lower Cagayan R. (lowland)			
01	18,173	E	C
02	9,426	E	C
03	7,240	C	E
04	0	agriculture land	
05	5,081	C	–
06	670	C	–
07	6,709	BC	E
08	1,772	B	E
09	2,890	C	E
10	18,715	E	C
11	3,082	E	–

manage-ment unit No.	area (ha) forest+grass land	management objective first priority	management objective second priority
12	2,930	E	–
total	76,688		

II-1-a-2 Middle Cagayan R. (lowland)			
01	3,663	E	C
02	14,010	E	–
03	6,113	E	–
04	2,283	E	–
05	15,574	E	C
06	2,596	E	C
07	3,037	E	BC
08	999	E	–
09	3,992	E	C
10	2,907	E	–
11	7,741	E	–
12	1,757	E	C
13	6,440	E	–
14	7,229	E	–
15	9,615	E	–
16	14,213	E	C
17	6,910	E	–
18	4,558	E	–
19	2,862	E	A
20	1,086	E	–
21	11,325	E	–
22	4,143	E	–
total	133,053		

II-1-a-3 Upper Cagayan R. (lowland)			
01	3,751	E	–
02	7,058	C	E
total	10,809		

II-2-b-1 Main Cagayan R. (midland)			
01	118	E	–

manage-ment unit No.	area (ha) forest+grass land	management objective first priority	management objective second priority
02	10,833	E	–
03	8,056	E	–
04	13,962	E	–
05	6,424	E	–
06	5,876	E	–
07	10,299	E	C
08	5,366	E	–
09	2,395	C	E
10	8,908	B	E
11	5,725	E	BC
12	2,691	DE	B
13	10,401	ED	BC
14	9,689	B	ED
15	3,669	E	–
16	2,492	E	B
17	8,968	E	C
18	4,287	ED	B
19	8,349	DE	B
20	5,371	DE	B
total	133,879		

II-2-b-2 Main Cagayan R. (highland)			
01	13,773	DE	B
02	5,912	ED	A
03	5,582	DE	B
04	4,790	D	A
05	5,713	DE	–
06	7,745	E	B
07	10,868	B	DE
08	11,538	B	E
09	7,740	E	BC
10	7,416	ED	–
11	3,547	DE	–
12	7,253	ED	–
13	5,427	D	B
14	8,771	B	ED
15	3,310	B	–

manage-ment unit No.	area (ha) forest+grass land	management objective first priority	management objective second priority
16	2,798	B	ED
17	2,729	B	D
18	8,619	B	–
19	2,797	B	ED
20	7,647	D	BA
21	8,222	D	–
22	8,331	D	–
23	5,615	D	–
24	5,139	D	B
25	8,242	D	B
26	9,893	AB	D
27	11,175	B	E
28	14,823	B	–
29	10,156	DE	ABC
30	5,415	DE	B
31	9,383	E	B
32	8,325	BC	E
33	5,964	B	E
34	6,282	B	E
35	6,622	AB	D
36	6,865	B	D
37	3,310	BA	D
38	3,039	B	D
39	4,231	B	DE
40	9,781	B	DE
41	7,624	B	–
42	2,393	B	–
43	8,796	B	D
44	2,892	D	E
45	6,903	B	D
46	5,887	B	–
47	6,608	B	–
total	326,773		

III. SIERA MADRE RANGE			
III-1-a Dummon R.			
01	3,568	E	CB
02	2,867	B	E
03	4,024	BC	E
04	5,132	B	–
05	1,538	B	–
06	5,540	BC	E
07	5,343	C	E
08	5,269	E	B
09	4,368	DE	–
10	3,769	E	C
11	3,822	B	E
12	11,330	E	C
13	5,396	B	E
14	3,811	B	–
15	2,534	B	–
total	67,311		
III-2-a Pinacanauan de Tuguegarao R.			
01	6,260	B	E
02	2,886	B	–
03	11,290	B	DE
04	6,467	E	B
05	6,029	E	–
06	5,439	B	–
07	4,990	B	–
08	1,460	B	–
09	3,588	B	–
10	3,330	D	B
11	1,198	B	–
12	6,707	B	–
13	2,917	B	–
14	1,772	B	–
15	2,625	B	–
16	9,050	B	–
17	2,996	B	E
18	6,377	ED	B
19	4,310	B	–
20	7,599	DE	B

manage-ment unit No.	area (ha) forest+grass land	management objective first priority	management objective second priority
21	6,472	DE	B
22	5,829	D	B
23	6,586	B	D
24	4,788	B	–
total	120,965		

III-3-a Hagan R.			
01	8,304	B	–
02	5,163	AB	–
03	5,679	B	–
04	6,800	BA	–
05	6,397	D	B
06	10,001	B	–
07	8,218	B	E
08	8,806	B	DE
09	6,456	B	–
10	5,981	DE	–
11	6,876	B	D
12	10,801	B	D
13	3,353	D	–
14	6,529	ED	–
15	5,285	E	–
16	5,242	DE	–
17	5,788	E	D
18	1,233	E	–
19	8,671	D	B
20	4,939	ED	–
21	4,636	B	D
22	2,303	D	–
23	7,675	B	D
24	6,175	DE	–
25	9,240	E	B
26	6,856	ED	B
27	10,347	B	E
28	8,997	B	–
29	5,497	B	–
30	4,805	DE	–

manage-ment unit No.	area (ha) forest+grass land	management objective first priority	management objective second priority
31	3,182	E	–
32	5,597	DE	–
33	3,155	ED	B
34	4,475	B	–
35	3,761	B	–
36	4,541	B	–
37	7,306	B	–
38	3,624	B	–
39	4,437	B	–
40	8,555	B	DE
41	13,916	B	–
42	7,286	B	–
43	7,932	B	–
44	4,207	B	–
45	4,481	B	–
total	283,508		

4–6. Forest Management Objective in Watershed

In the Cagayan River Basin under current study, the diminishing of forestland and deteriorating quality of forest resources have resulted in the sharp decline of such original functions of forests as production of timber, conservation of water resources, and prevention of outflow of sand and soil materials.

As can be seen from the Forest Management Map compiled in the preceding section, potential for natural hazards varies from one area to another, and, therefore, the Forest Management should be studied carefully before implementation in relation to the individual conditions of respective areas.

This section discusses the natural and social environments of each management unit as they are now, regional characteristics, and management objective for Forest Management Plan, based on Table 4-2 and Figure 4-4 both developed from the Forest Information Table and the Forest Management Map.

I. Cordillera Central Range

(1) I-1-a-1. Chico River (midland)

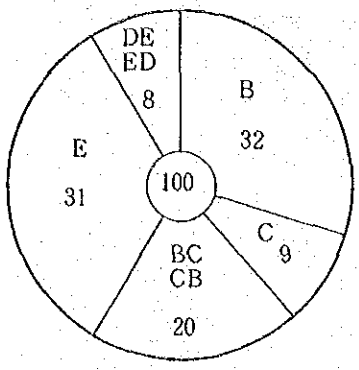
This basin is located in the midland down-stream section of Chico River on the left bank of down-stream Cagayan River. The entire basin encompasses an area of 2,660 km^2, averaging about 400 meters in elevation with the terrains becoming sharper in slope as they go up higher. Forestland is 1,340 km^2 in area and grassland 848 km^2.

With respect to Existing Forestland, there are many areas with high potential for land collapses/slides among other natural hazards, requiring proper management based on the practice of selective cutting. On the other hand many areas of Existing Grassland are least prone to natural hazards. In addition, these areas have good access roads running along Chico River with sizeable populations in such municipalities as Tabuk and Tuao which can be counted upon for labor force. It follows then that this basin should be defined as requiring restoration of forests by, for one thing, introducing I. S. F. program in some parts.

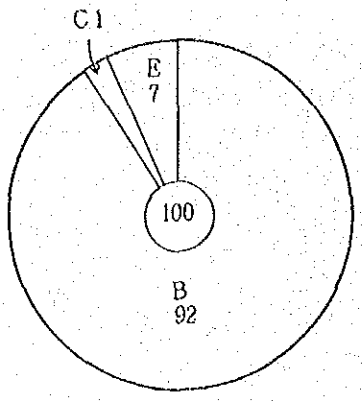
Table 4-2. Summary Table of Forest Management by Watersheds

Watershed	Management target of first priority	A	B	C	AB BA	AC CA	BC CB	ABC	D	D	DE ED	total
I-1-a-1	number	–	6	2	–	–	3	–	–	13	4	28
	area	–	704	194	–	–	442	–	–	679	169	2,188
	area ratio	–	32	9	–	–	20	–	–	31	8	100
I-1-a-2	number	–	38	1	–	–	–	–	–	2	–	41
	area	–	2,761	4	–	–	–	–	–	206	–	2,971
	area ratio	–	92	1	–	–	–	–	–	7	–	100
I-2-b-1	number	–	1	–	–	–	–	–	–	5	3	9
	area	–	18	–	–	–	–	–	–	905	531	1,454
	area ratio	–	1	–	–	–	–	–	–	62	37	100
I-2-b-2	number	9	3	–	11	–	1	–	10	2	6	42
	area	540	278	–	816	–	44	–	567	213	430	2,888
	area ratio	19	10	–	28	–	1	–	20	7	15	100
II-1-a-1	number	–	1	4	–	–	1	–	–	5	–	11
	area	–	18	159	–	–	67	–	–	523	–	767
	area ratio	–	2	21	–	–	9	–	–	68	–	100
II-1-a-2	number	–	–	–	–	–	–	–	–	22	–	22
	area	–	–	–	–	–	–	–	–	1,331	–	1,331
	area ratio	–	–	–	–	–	–	–	–	100	–	100
II-1-a-3	number	–	–	1	–	–	–	–	–	1	–	2
	area	–	–	71	–	–	–	–	–	37	–	108
	area ratio	–	–	66	–	–	–	–	–	34	–	100
II-2-b-1	number	–	2	1	–	–	–	–	–	12	5	20
	area	–	186	24	–	–	–	–	–	818	311	1,339
	area ratio	–	14	2	–	–	–	–	–	61	23	100
II-2-b-2	number	–	22	–	3	–	1	–	9	3	9	47
	area	–	1,528	–	198	–	83	–	562	249	648	3,268
	area ratio	–	47	–	5	–	3	–	17	8	20	100
III-1-a	number	–	7	1	–	–	2	–	–	4	1	15
	area	–	241	53	–	–	96	–	–	239	44	673
	area ratio	–	36	8	–	–	14	–	–	35	7	100
III-2-a	number	–	17	–	–	–	–	–	2	2	3	24
	area	–	789	–	–	–	–	–	92	125	204	1,210
	area ratio	–	65	–	–	–	–	–	8	10	17	100
III-3-a	number	–	25	–	2	–	–	–	4	5	9	45
	area	–	1,768	–	120	–	–	–	207	247	493	2,835
	area ratio	–	63	–	4	–	–	–	7	9	17	100

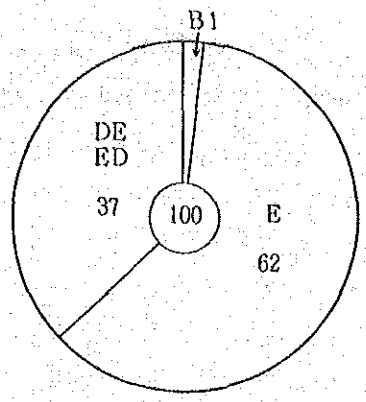
*1. Numbers indicate these of Forest Management units.
*2. Area is a total of the units for each management objective, in the unit of km^2.



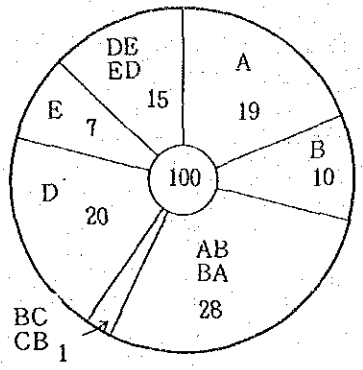
I−1−a−1
Chico R. (midland)



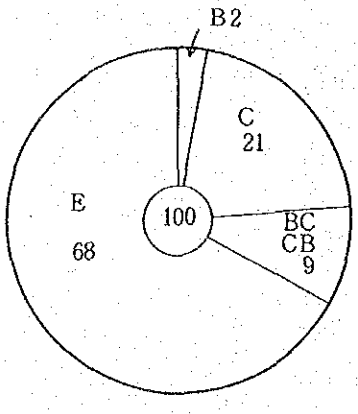
I−1−a−2
Chico R. (highland)



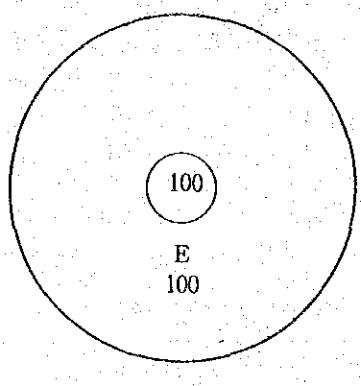
I−2−b−1
Magat R. (midland)



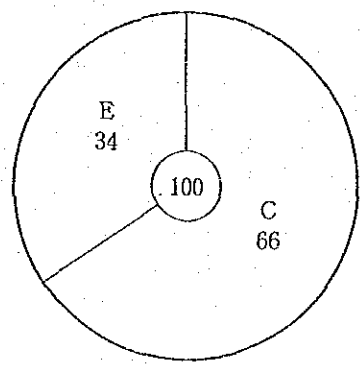
I−2−b−2
Magat R. (highland)



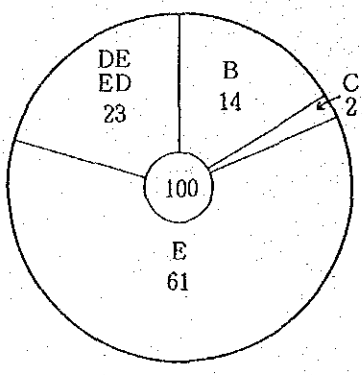
II−1−a−1
Lower Cagayan R. (lowland)



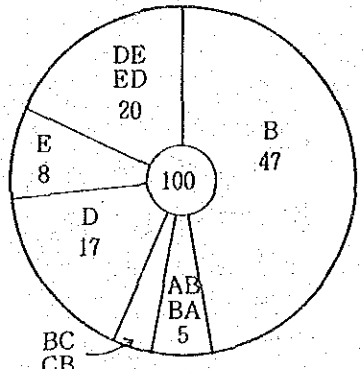
II−1−a−2
Middle Cagayan R. (lowland)



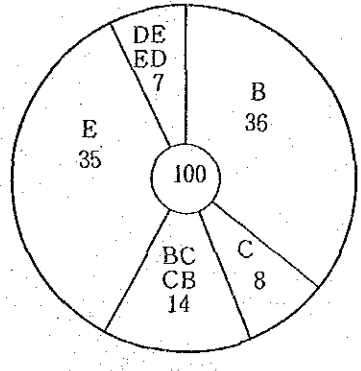
II−1−a−3
Upper Cagayan R. (low land)



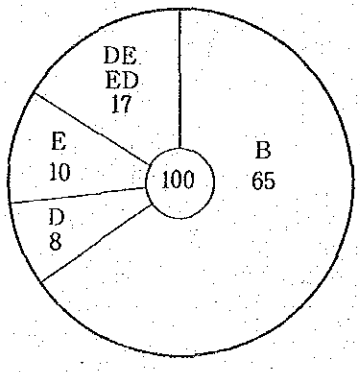
II−2−b−1
Main Cagayan R. (midland)



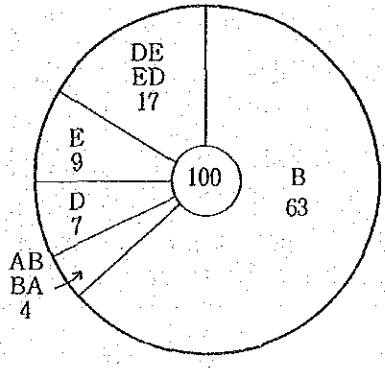
II−2−b−2
Main Cagayan R. (highland)



III−1−a
Dummon R.



III−2−a
Pinacanauan de Tuguegarao R.



III−3−a
Ilagan R.

Fig. 4-4. Ratios of Management Classifications

(2) I-1-a-2. Chico River (highland)

This basin is located upstream of Chico River with an area of 3,275 km², averaging approximately 1,400 m in elevation and sharply sloping in many parts. Specifically, there are some 3,000 km² with slopes of more than 18% and about 300 km² of less than 18%. The basin is mostly forestland with 2,765 km² forests and 206 km² of grassland. As shown in Figure 4-4, 92% of this area comes under Management Classification "B", thus requiring management based on selective cutting in principle for this basin. Incidentally, in the Bontoc area, uniform forest stands of Benguet Pines are distributed extensively.

(3) I-2-b-1. Magat River (midland)

Located at the mid- and down-stream sections of the Magat River, the basin has 1,720 km² in area, averaging about 900 m in elevation and mildly sloped in many parts. The area breaks down to 18 km² of forestland, 1,436 km² grassland and 344 km² agricultural land. There are 8 cities like Solano, Bayombong, Bambong, located in the basin and these cities are surrounded by paddy fields.

The Existing Grassland in this area has mildly sloped terrains and there are many parts with low potential for natural hazards. In addition, the area is of easy access and reasonably populated. These naturally and socially favorable conditions make the basin suitable for restoration of forests based mainly on I.S.F. program.

(4) I-2-b-2. Magat River (highland)

This basin is located upstream of the Magat River with an area 3,173 km², averaging about 1,500 m and sharply sloped in many parts. The area has 1,678 km² of forests and 1,210 km² of grassland with the forestland accounting for 60% of this basin.

In terms of the forest management classifications areas with high potential for natural hazards account for 19% (540 km²) and when combined areas with fairly high potential (AB, BA), they add up to 47% (818 km²), which means tree cutting could have a great impact on the downstream region causing flooding and land hazards. Therefore, basically tree cutting should be banned to protect forests in this area.

With respect to Existing Grassland, to the west of Bambang are extensive distributions of grassland. Areas with high potential for natural hazards and those with low potential (in combinations of DE or ED by management classifications) are mixed. Since this basin falls in the Model Area, further considerations will be discussed in the later sections.

(5) II-1-a-1. Lower Cagayan River (lowland)

The basin refers to the lowland downstream of the Cagayan River covering 1,191 km², averaging about 100 m in elevation. The terrains are flat or mildly sloped in many parts. There are 244 km² of forests and 523 km² of grassland.

With respect to the Forestland areas with low potential for natural hazards are extensively distributed and the anticipated impact downstream, if any, is least, so that clear cutting and reforestation can be undertaken subject to planned management in this area.

As for Existing Grassland, the terrains are mildly sloped in many parts and the potential for natural hazards is estimated low, so that this basin is defined as an area where efforts should be directed to restoration of forests with emphasis on soil enrichment.

(6) II-1-a-2. Middle Cagayan River (lowland)

This basin covers the lowland and hills at the mid-section of the Cagayan River, having 3,311 km² in total area. The average elevation is about 200 m and the terrains are flat or mildly sloped in many parts.

In terms of land use types and areal sizes, there are 1,921 km² of farmland and 1,331 km² of grassland. Forestland is almost non-existent. The area as a whole has low potential for natural hazards. Besides, the land already has been developed into rice paddies. Therefore, such land use as rice paddies and grazing land is recommended for this area.

(7) II-1-a-3. Upper Cagayan River (lowland)

This basin falls in the southern parts of II-1-a-2 with 1,456 km² in total area. The average elevation is 200 m and in many parts, land is flat.

In terms of land use types and areal sizes, there are 1,348 km² of farmland, 66 km² of forestland and 37 km² of grassland. The area is occupied mostly by farmland. Characteristics of this basin are similar to natural and social environments of II-1-a-2. Therefore, such land use as rice paddies and grazing land is recommended for this area.

(8) II-2-b-1. Main Cagayan River (midland)

This basin falls in the hills on the Main Cagayan River with 2,420 km² in total area. The average elevation is about 300 m and the many parts, slopes are more than 18%.

Areas occupied by forests and grassland are 210 km² and 1,129 km² respectively, the grassland accounting for much larger portions. In terms of the Forest Management Classifications, these forests and grassland are least vulnerable to soil erosion and land hazards while having high ratings for water retaining capacity. In addition, the area is highly accessible and has a sizable population. These naturally as well as socially favorable conditions make this area appropriate for active utilization of forests and reforestation based mainly on I.S.F.

(9) II-2-b-2. Main Cagayan River (highland)

This area is the highland section of the main Cagayan River basin, covering an area of 3,280 km² in total. The average elevation is about 800 m and in many

parts, the terrains are sharply sloped.

Areas of forests and grassland are 1,809 km² and 1,459 km² respectively. The forestland has fairly high potential for natural hazards and there are many parts highly vulnerable to soil erosion in particular, so that total banning of clear cutting while promoting soil conservation is recommended for forest management in this area.

As for grassland, potential for soil erosion and land hazards is high in many parts. Therefore, to reduce a possible unfavorable impact downstream, active effects should be made for restoration of forests in this area.

(10) III-1-a. Dummon River

This river basin represents the northernmost portions of the right bank of the Cagayan River covering an area of 819 km² in total. The average elevation is about 400 m and the terrains are relatively mildly sloped in many parts.

Areas of forests and grassland are 390 km² and 283 km² respectively. The forestland includes many parts with low potential for soil erosion. Considering also the relatively small size of the basin, thus having little impact downstream, forest management for this area should be based on planned cutting and reforestation. The grassland in this basin has low potential for soil erosion and land collapses, so that efforts should be directed to restoration of forests with emphasis on soil enrichment.

(11) II-2-a. Pinacanauan de Tuguegarao River

This river basin represents the hills and highland of the right bank of the Cagayan River, covering 1,244 km². The average elevation is about 800 m and the terrains are sharply sloped in many parts. Areas of forests and grassland are 789 m² and 421 km² respectively, thus forests exceeding grassland in area.

The forestland includes many areas with high potential for natural hazards and, moreover, those high-risk areas are high in elevation (Management Unit Nos. 07, 12, 16, 19, 24, for example), making them difficult to reach. Therefore, forest management for this area should focus on protection of forests based on total banning of cutting.

With respect to grassland, there are relatively many areas with high potential for natural hazards, so that efforts should be directed to restoration of forests in this area.

(12) III-3-a. Ilagan River

This river basin represents the hills and mountains in the south of the river basin discussed in the preceding III-2-9. It covers a total area of 3,186 km² and the average elevation is about 600 m. The terrains are sharply sloped in many parts. Areas of forests and grassland are 1,888 km² and 947 km² respectively.

With respect to forestland, those highly elevated areas falling in the manage-

ment classification of B are difficult to access as in the case of Pinacanauan de Tuguegarao River basin, so that efforts should be directed to forest protection based mainly on total banning of cutting. Grassland is most vulnerable to natural hazards in relatively many parts, and, therefore, efforts should focus on restoration of forests.

CHAPTER 5. FOREST INFORMATION MANAGEMENT SYSTEM BY PERSONAL COMPUTER

A personal computer system has been designed to effectively utilize, maintain and update the data generated by this study.

5–1. Data Base Contents

Figure 5-1 and Table 5-1 show the index of topographic map of the Cagayan River Basin and the list of map sheets, respectively.

Compiled in terms of grid cells (approximately 1 km by 1 km each, and 500 cells per map sheet) made by dividing the map sheet equally by 20 vertically and 25 horizontally, the data base stores the data under the following items.

A) Thematic
   (1) elevation
   (2) slope
   (3) aspect
   (4) sun intensity
   (5) exposure
   (6) naturality
   (7) average annual rainfall
   (8) monthly tropical cyclone route
   (9) vegetation and land use
   (10) soil texture
   (11) geology

B) Forest Land Classification
   (1) soil erosion potential (1)
   (2) soil erosion potential (2)
   (3) integrated soil erosion potential
   (4) vegetation impact on soil erosion potential
   (5) hazard of land collapse and slide (1)
   (6) hazard of land collapse and slide (2)
   (7) integrated hazard of land collapse and slide
   (8) vegetation impact on hazard of land collapse and slide
   (9) water holding potential (1)
   (10) water holding potential (2)
   (12) vegetation impact on water holding potential
   (13) flooding potential
   (14) tree growth potential
   (15) natural potentials

5–2. Software

The following softwares have been created.

1. Data and edit:
   For input and modification of grid cell data
2. Calculation:
   For commutation of slopes and slope aspects; land classification analysis by scoring method.
3. Output screen & color printer:
   For output of grid cell data on display screen or color printer. (7 colors on CRT, 7 colors on color printer)
4. Output screen & color printer 4 maps:
   For output of grid cell data on screen or color printer, allowing one screen to show four different map sheets. (7 colors on CRT, 7 colors on color printer)
5. Output X-Y Plotter:
   For output of grid cell data on X-Y plotter. (4 colors on plotter, each color with corresponding hatching)
6. Name input, edit, & Color Change:
   For input of item names and internal codes and color setting

5–3. Hardware

This sytem is comprised by the following hardwares.

1. Personal Computer (PC9801VM4)
2. Display (N-5913)
3. Color Printer (PC-PR201V)
4. X-Y Plotter (DPX-2000)
5. Floppy Disk
6. Power Source

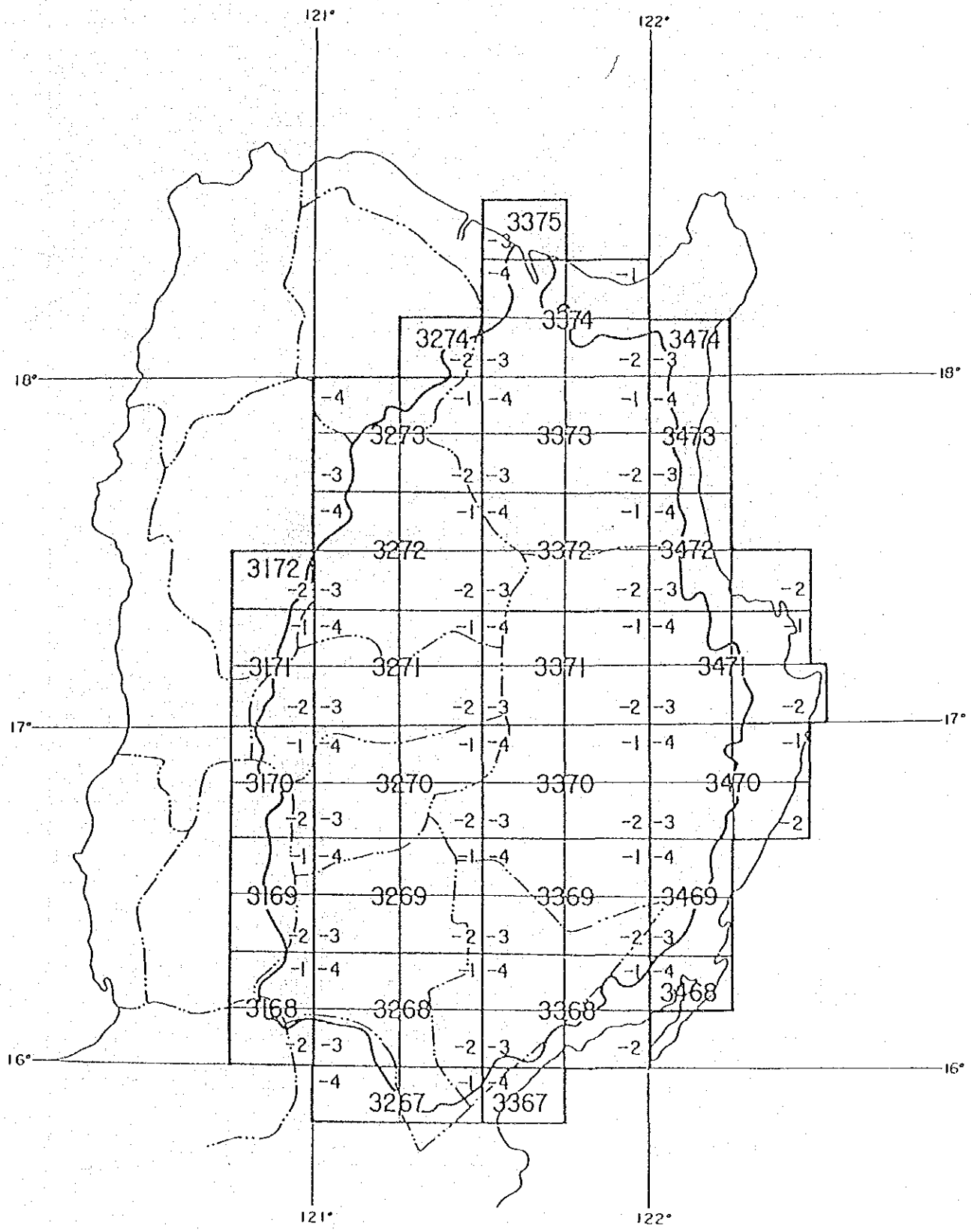


Fig. 5-1. Index of Topographical Maps

Table 5-1. Map Index

Philippines

Map number	Map Name	Map number	Map Name
3168-1	PINGKIAN	3369-1	DIBULUAN
-2	SAN NICOLAS	-2	MAPALAD
3169-1	KABAYAN	-3	MADDELA
-2	BOKOO	-4	JONES
3170-1	MANKAYAN	3370-1	CAUAYAN
-2	ABATAN	-2	PISAY
3171-1	QUILI	-3	SANTIAGO
-2	BONTOC	-4	CABATUAN
3172-2	DANAC	3371-1	TUMAUINI
3167-1	ALUPIPEY	-2	ILAGAN
-4	CARRANGLAN	-3	ROXAS
3268-1	TANAP	-4	MALLIG
-2	DAKGAN	3372-1	PENABLANCA
-3	BUNGA	-2	CABAGAN
-4	ARITAO	-3	MINABBAG
3269-1	BAGABAG	-4	TUGUEGARAO
-2	CALIAT	3373-1	BAGGAO
-3	BAYONBONG	-2	CALLAO
-4	SOLANO	-3	IGUIG
3270-1	DALLOG	-4	FAIRE
-2	CORRON	3374-1	BUGUEY
-3	KIANGAN	-2	CAPISAYAN
-4	BANAUE	-3	GATTARAN
3271-1	PASAKING	-4	CAMALANIUGAN
-2	NATONIN	3375-3	APARRI
-3	KADAKLAN	3468-4	CASIGURAN
-4	SADANGA	3469-3	DIKABASAN
3272-1	PINUKPUK	-4	MOUNT DOS HERMANOS
-2	TABUK	3470-1	PINACANAUAN RIVER
-3	LUBUAGAN	-2	LUKBAN POINT
-4	SALEGSEG	03	BUYASAN
3273-1	RIZAL	-4	SAN MARIANO
-2	TUAO	3471-1	DIVILACAN PEAK
-3	KATABLANGAN	-2	PALANAN
-4	KARAGAWAN	-3	LUPIGUE
3274-2	TAWIT	-4	MOUNT CRESTA
3367-4	DIPACULAO	3472-3	DIKATAYAN RIVER
3368-1	MOUNT ANACHUAO	-3	LOBOO POINT
-2	DILALONGAN	3473-3	BAGUIO POINT
-3	PUGO	-4	TWIN PEAKS
-4	SANTO NINO	2374-3	CABUTUNAN POINT

CHAPTER 6. FOREST MANAGEMENT PLANNING FOR MODEL AREA

6–1 Selection of Model Area

To select the most appropriate Model Area for the Forest Management Planning, the whole study area encompassing some 2.8 million hectares was studied in terms of the following as criteria.

(1) Conditions of vegetation and land use:
- Presence of tree stands,
- Presence of burned-down or deserted kaingin sites,
- Feasibility of forestry serving the local interests,
- Possibility of the area becoming designated for forest development district,
- Problems involved in land use (ownership) in connection with a forestry project,
- Access to timber market place,
- Possibility of incorporating "Integrated Social Forestry" in the Forestry Project,
- Feasibility of forestry helping to prevent downstream sedimentary outflow, preserve watershed, and serve other public needs,
- Conflicts with other projects,
- Others.

(2) Social factors:
- Security for field work,
- Availability of cooperation from agencies concerned,
- Availability of cooperation from local citizens,
- Availability of access roads,
- Conflicts with other projects,
- Others.

At the time of Reconnaissance Map compilation, Bayombong, Lagawe, Bontoc, and Tabuk were tentatively selected as candidate sites on the basis of preliminary interpretations of forests and land use. And they were further investigated on site in consultation with the Philippine side. The table below summarizes the study results.

The result is as follows.

Field Survey Result of Candidate Model Sites

Criteria \ Candidate Sites	Bayom-bong	Lagawe	Bontoc	Tabuk
(1) Conditions of vegetation and land use				
1. Presence of tree stands	O	O	x	O
2. Presence of burned-down or deserted kaingin sites	O	O	O	O
3. Possibility of forestry serving the local interests	O	x	x	x
4. Possibility of the area becoming designated for forest development	O	O	O	O
5. Problems involved in land use in connection with a forestry project	x	x	x	O
6. Access to timber market place	O	x	x	O
7. Possibility of incorporating I.S.F. in the Forestry Project	O	O	O	O
8. Conflicts with other projects	O	O	x	x
Decision	O	O	x	O
(2) Social conditions				
1. Problems of sequrity for field work	O	x	x	x
2. Availability of cooperation from agencies concerend	O	x	O	O
3. Availability of cooperation from local citizens	O	x	x	x
4. Availability of access roads	O	O	O	x
5. Conflicts with other projects	O	O	x	x
6. Others	O	O	O	O
Decision	O	x	x	x

O : Suitable
x : Not suitable

Namely:

- Bayombong area meets all the requirements.
- Lagawa area meets many requirements but land is being occupied and utilized by local residents.
- Bontoc area has highland coniferous forests in the main which are not suitable as a model for our purposes. And access is difficult.
- Tabuk area is mostly inaccessible for field survey due to the lack of roads and other social constraints.

For the above reasons, the Philippine side, the counterparts, the Survey Team, and the Supervising Commission, agreed after consultations to select an area about 50 km southeast of Bayombong as the most appropriate site for the Model Area.

To expand further, the area,located in the north of Luzon and with forests and presence of kaingin and grazing land as they are, represents almost all of the problems involved in the forest management for the Cagayan River Valley. In addition, the potentials for forest development, marketing of forest products, and expanded I.S.F. make the area most appropriate to represent the study area.

The major rivers in Norther Luzon, Cagayan and Magat, originate here making the selected area important in its role to help water and land resources conservation and other public functions of forests. Access roads are also developed. These combine to make the area appropriate as the Model Area for forest management planning for the Cagayan River Valley. This selection of the area as such has been approved by the Ministry of Natural Resources, the Philippine Government.

6–2. Methodology of Forest Management Planning for Model Area

The Forest Management Plan for Model Area sets forth the technical procedures and guidelines for implementation of forest management with respect to the Model Area in line with the management goals established for each management block and unit as defined in the Forest Management Plan for Wide Area while paying due attention to environmental conservation.

In the forest management planning for wide Area, data and information were acquired, organized and analysed in terms of the smallest land, units for study ranging 500–1,000 ha. in area based on the watersheds and drainage areas, while the plan is designed from an overall viewpoint. To translate the plan into detailed criteria for implementation to suit the respective local conditions requires further supplementary work.

The Model Area involves Watersheds I-2-b-2 and II-2-b-2, and relates to 5 Management Units, as defined in the Wide Area. Based on the management objectives and forest information set for these Management Units, the Forest Management Plan was formulated in the procedure shown as the Work Flow.

Note: New Aerial Photographs

Aerial Photography : 3, 10, 17/Jan./1987

Courses : 10 courses, Flight Line: North to South

Sheets : 153 sheets

Scale : 1/20,000

Photo Interpretation

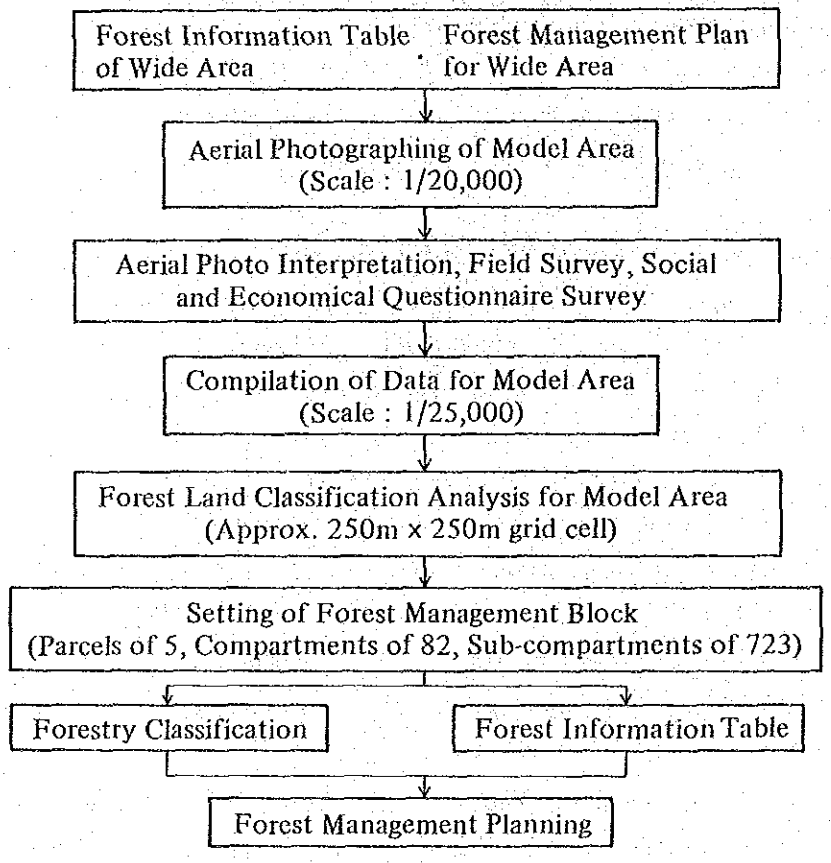
Contact prints and twice enlarged prints

Minimum Interpretable size of objects

Approximately 1 ha

The two Forest Management Plans prepared in this project, one for the Wide Area and the other for the Model Area, are compared for differences and summarized in the Table 6-1.

Table 6-1 (1) Flow of Forest Management Planning for Model Area



Further, main information on these five management units compiled in "Forest Information Table for Wide Area" is as follows;

watershed	management unit	area (ha)	forestland /A&D (ha)	natural potentials (forestarea)			natural potentials (grassland)		management objective main / sub	parcel in model area
				hazard (H)	hazard (M)	hazard (L) (ha)	hazard (H)	hazard (L) (ha)		
II-2-B-2	09	9,069	7,138/1,929	152	2,168	1,371	1,065	2,984	reforestation / elective cutting · ISF	I
"	10	7,601	3,556/4,043	00	0	0	2,108	5,308	reforestation	II
I-2-B-2	29	10,763	8,682/2,085	2,052	1,154	1,143	2,637	2,345	reforestation / protection · elective cutting	III
"	30	10,358	7,992/2,367	330	4,140	2,496	4,140	2,496	reforestation / elective cutting	IV
"	31	13,151	10,254/2,893	1,609	0	5,031	0	5,031	reforestation / elective cutting	V

Table 6-1 (2) Differences of the Wide Area and the Model Area for Forest Management Plan

Items	Forest Management Plan for Wide Area	Forest Management Plan for Model Area	Remarks (Supplement work, etc.)
Area	Approx. 2.8 million ha.	Approx. 50,000 ha.	
Base scale	1/100,000	1/25,000	Aerial photographic representation of photo interpretation field surveying, questionnaire survey
.Geographic information unit	Approx. 1 km x 1 km grid cell	Approx. 250m x 250m grid cell	Mapping of elevations, slope, exposure, etc.
Management blocks	Watersheds (12), Management units (306), Study units (approx. 3,000 each ranging 500–1,000ha.) *Note:* The Model Area covers 5 management units of watersheds I-2-b-2 and II-2-b-2.	Parcels (5, each 5,000–10,000 Compartments (82, each 500–1,000ha.) Sub-compartments (723, each 50–100ha.)	Parcels are formed by division or integration of Watersheds; Compartments by division or integration of Management Unit or Study Unit, Sub-compartments by division of compartment.
Management classifications	Classification of three for forest and two for grassland.	Forestry classifications (6): Timber production, fuelwood production, protection, parks and outdoor recreation, I.S.F.	

6–3. Outline of Model Area

6–3–1. Natural Environment

(1) Location and Area

The area under study is located in the northeast of Luzon Island of the Republic of the Philippines along the entire length of the Cagayan River encompassing an area of approximately 2.8 million hectares. The area chosen as the Model Area is about 50 kilometers south-east of Bayombong City in Nueva Vizcaya Province in the southern part of the Cagayan River Basin. It is a mountanous area of 48,980 hectares ranging 300 – 1,600 meters in elevation and involving the two river basis of Cagayan and Manga. The location of the Model Area is shown in Figure 6-1.

(2) Geomorphology

Geomorphology was compiled according to the classifications as shown in Table 6-3. The Model Area consists of two parts, Dupax and Kasibu, with the central ridges as the divide. The Dupax Area extends east of the two cities, Bambang and Dupax, consisting mainly of hills, lowland, and middle relief piedmont, ranging 300–800 m. in elevation.

The Caraballo mountains at the southern end of the area reaches nearly 1,600 meters at the highest peak. Geologically, the northern portions are volcanic and the western and southern portions granite (where land collapses are concentrated), making distinct differences in drainage patterns and relief energy. They are both heavily weathered in parts, as reflected in expanding grassland and extensive soil erosion and outflow of sands and earth.

The Kasibu area consists of large relief mountains (ranging 800 – 1,300 m, in elevation, conposed of young intrusive rocks) in the middle, small to middle relief mountains (extensive, well-developed, mildly-sloped mountain foots) on the upperside, and enclosed lowland (represented by Kongkong Valley). The small to middle relief mountains are composed mainly of moderately or heavily weathered volcanic rocks and those portions of relatively young rocks remain as ridges. In the piedmont, dissected upland, fans, and colluvial slopes are developed, forming grassland or kaingin in many parts. Small and medium sized revers in the lowlands in the area at large are marked by frequent meandering particularly in those with large sedimentary outflows which apparently change courses in every flooding. (There are many old river courses observed in the downstream basin).

The Geomorphology Map is as shown in Figure 6-2.

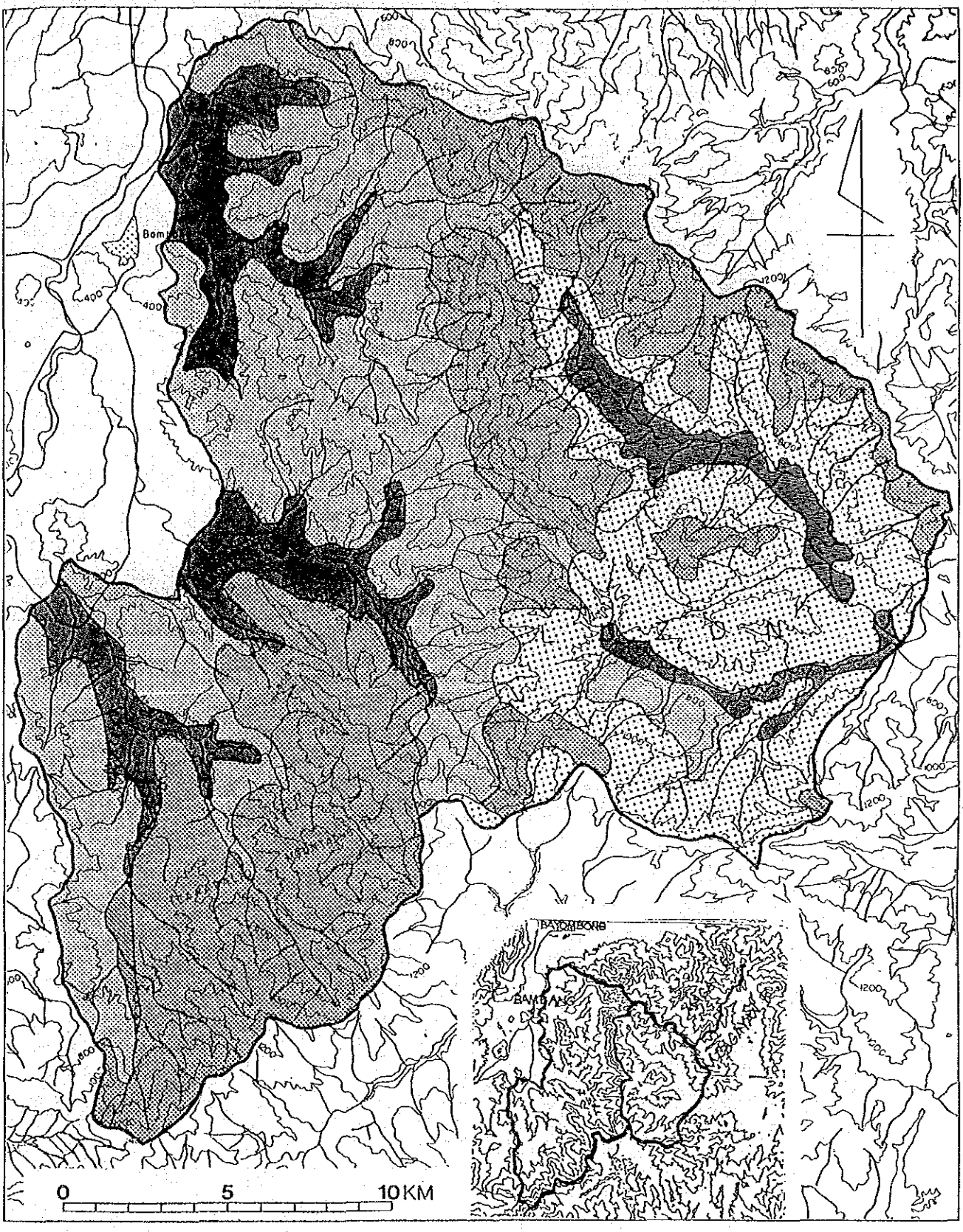


Fig. 6-1. Model Area Location Map

Table 6-2. Legend of Geomorphology

Lowland

- B – Back Marsh
- N – Nature Levee
- Fp – Flood Plain
- V – Valley Bottom Lowland
- F – Fan
- O – Old River
- R – Riverbed (River)

Midland

- T – Terrace
- C – Colluvial Slope & Talus
- D – Dissected Upland
- G – Hill
- Pr – Piedmont (Rolling)
- Pd – Piedmont (Dissected)

Highland

- E – Escarpment
- L – Low Relief Surface on Mountain
- Sd – Dissected Slope on Mountain
- Sg – Gentle Slope on Mountain
- Ss – Steeply Dissected Slope

Miscellaneous

- W – Water Body (Reservoir)
- – Cliff
- – Landslide
- – Collapse
- X – Collapse (Small size)
- △ – Boulder Flow (Rock Stream)

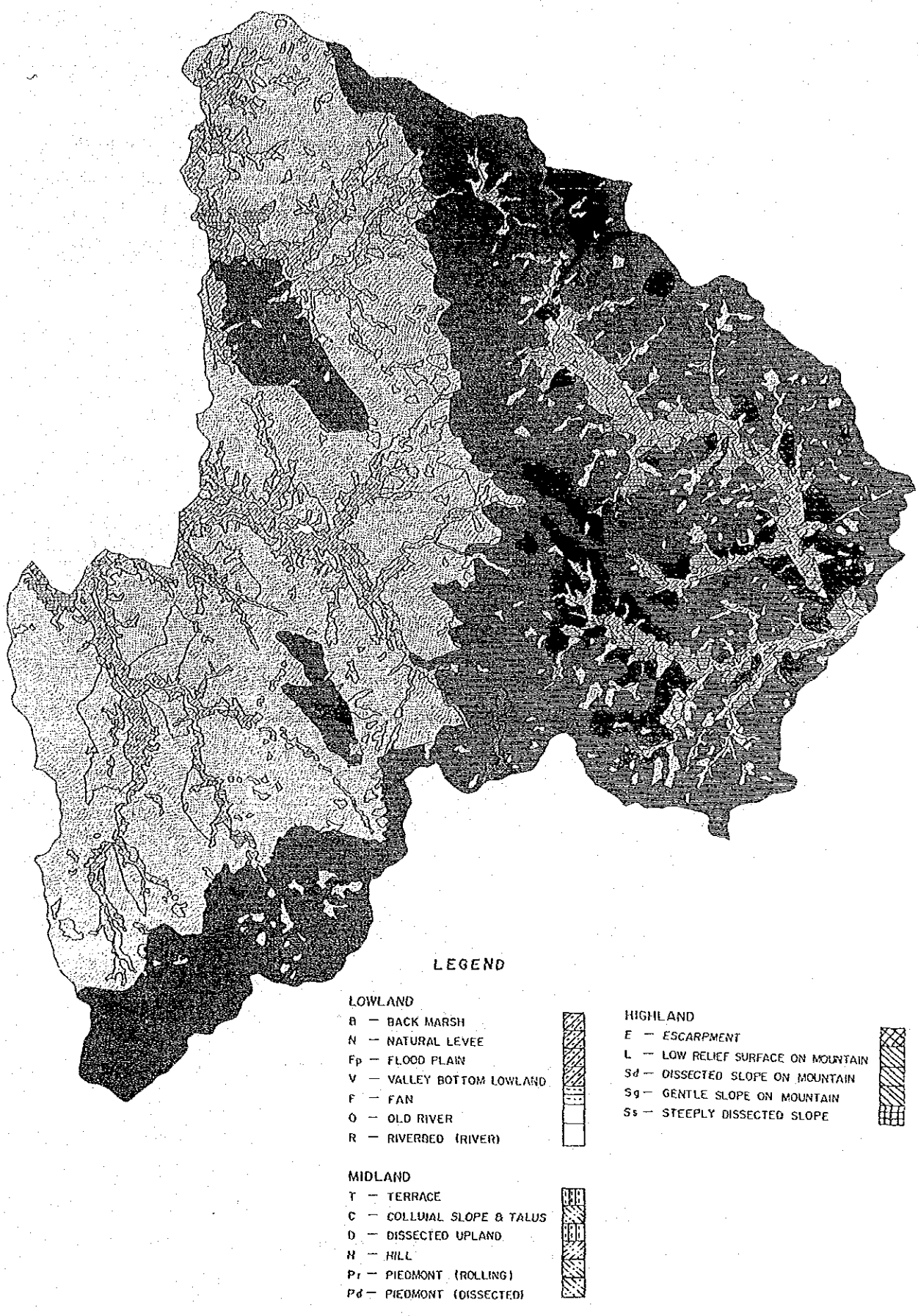


Fig. 6-2. Geomorphology

(3) Topography

1) Elevation

Elevations captured and made in files as approximately 250m x 250m grid cell based data were classified as shown in Table 6-4, and output in a gridded map as shown in Figure 6-3. Elevations were captured and made in files in the unit of 10 meters allowing further classification in any ranges. For the purpose of this study, they were classified according to the geomorphology classifications which was based on 400m and 800 m as criteria.

Table 6-3. Classification of Elevations

Elevation Classifications	Area (km^2)
400m or less	74
401–800m	242
801–1,200m	158
Over 1,201m	16
Total	490 km^2

From the above table, it can be seen that the area ranging 401–800m is the largest followed by those of 801–1,200m and 400m or less, in that order. Elevations of 401–800m occur in the mountains in the Dupax area and in the hills in the Kasibu area.

Elevations of over 1,201 meters are distributed in the Magat (the Dupax side) and Cagayan (the Kasibu side). River basins at the ridges and, in the Model Area, at the ridges in the northern and southern parts.

2) Slope

Slopes were calculated for each grid cell based on the elevations associated with each cell and compiled into the Slope Classifications as shown in Table 6-4 and the Slope Classification Map in Figure 6-4.

Table 6-4. Slope Classifications

Slope Classification		Area (km^2)
0 – 4%	(0° – 2°)	11
5 – 8%	(2° – 6°)	22
9 – 18%	(6° – 10°)	66
19 – 25%	(10° – 14°)	107
26 – 50%	(14° – 26°)	234
51 –	(26° –)	50
Total		490 km^2

The above table shows that the area with 26°–50% slopes is the largest, followed by those of 19°–25% and 9°–18%, in that order. Charcteristically,

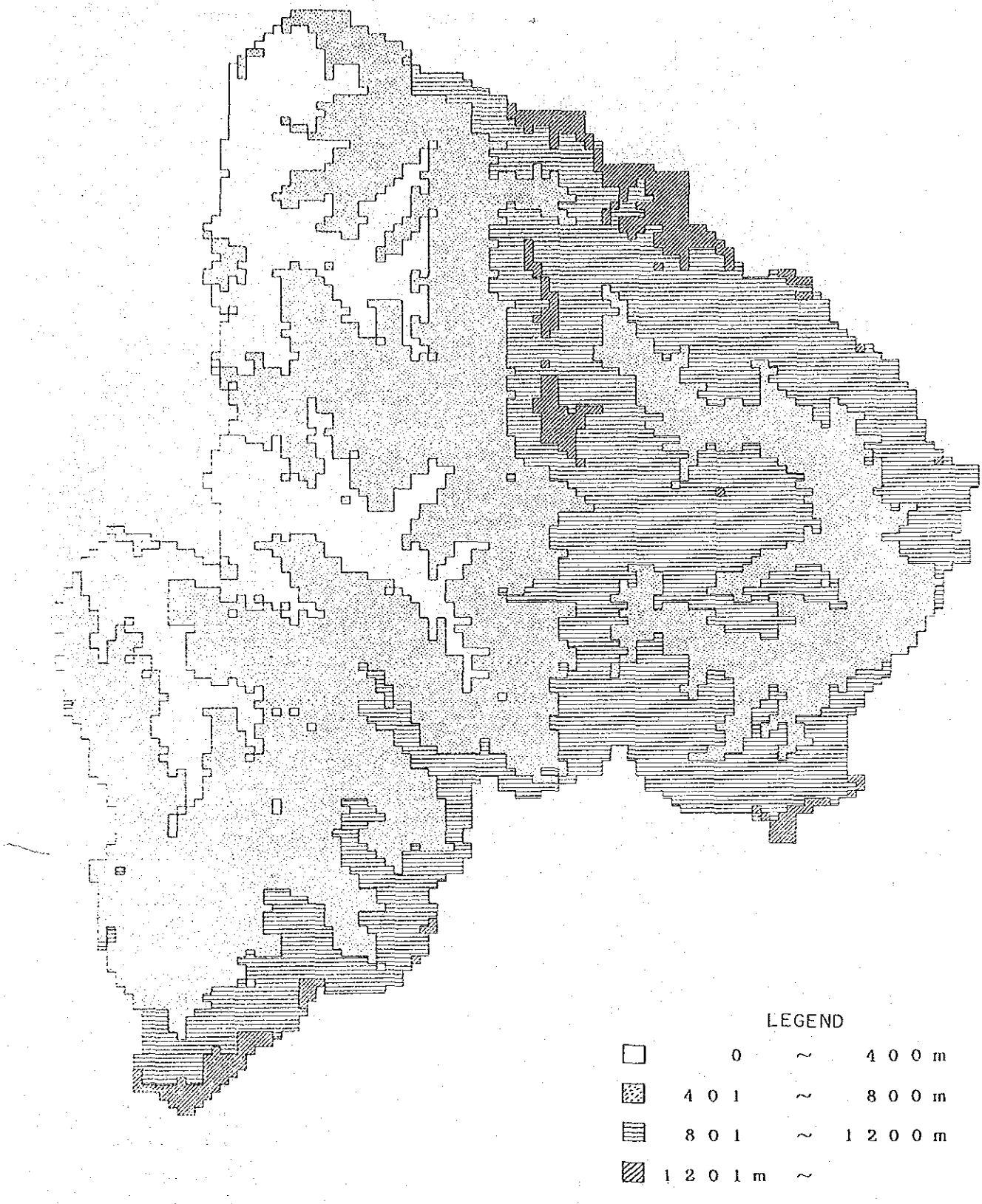


Fig. 6-3. Elevation

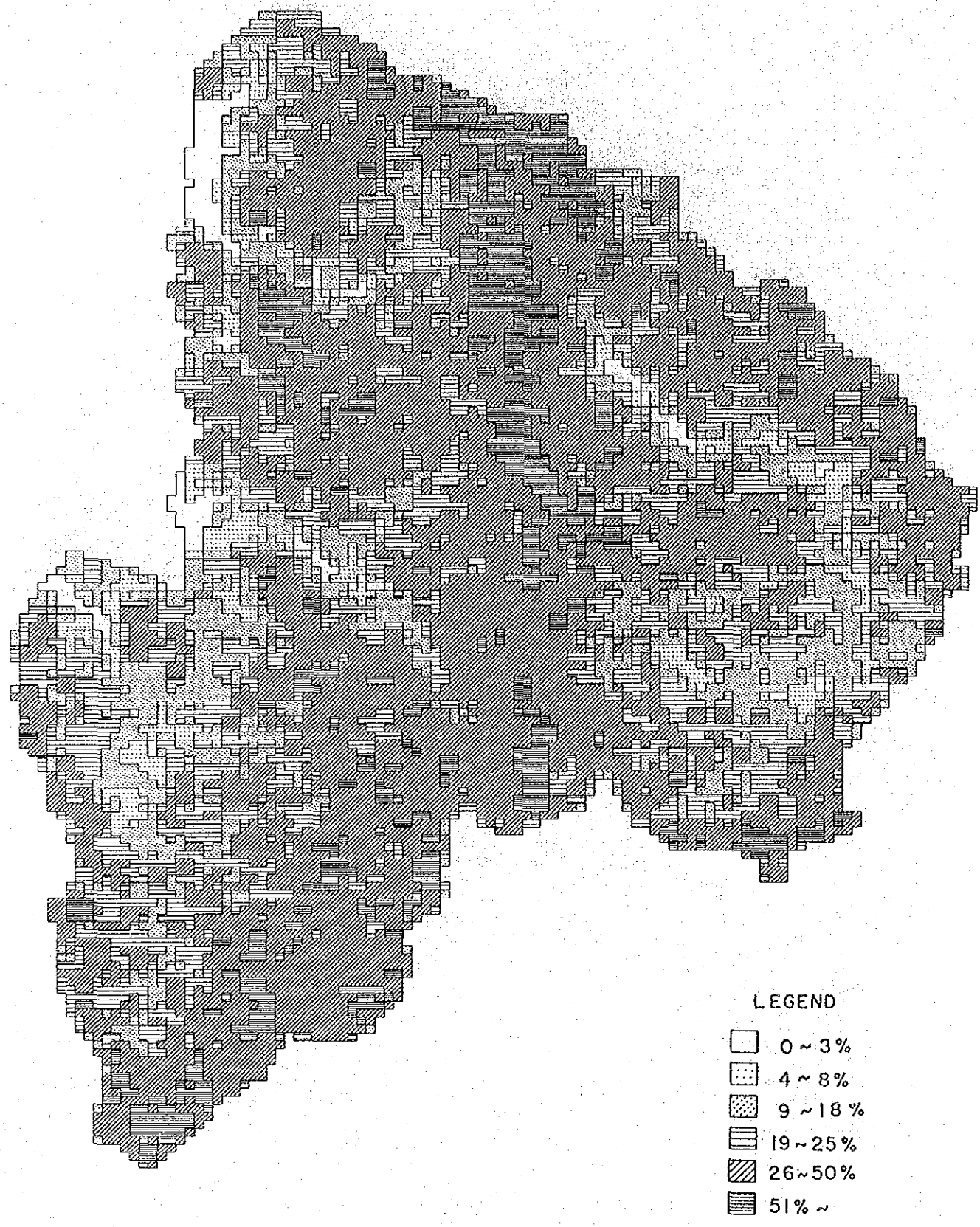


Fig. 6-4. Slope

the Dupax area, as compared with the Kasibu area, has a larger area of steep slopes. Particularly from halfway up to the ridges extremely steep slopese are distributed extensively.

c) Exposure

Exposure defines area in grid cells which are visible from a certain given cell by computations based on elevations and represent them in the map. With respect to the Model Area, the exposure maps were prepared for the Bambong, Dupax and Kasibu Areas for siting a forest fire watch station for each area. (See Figure 5, 6, 7.)

(4) Drainage and Catchment Area

These are two rivers running in the Model Area; Manga River (Dupax side) and Cagayan River (Kasibu side). It falls in Watersheds I-2-b-2, Magat River (highland) and II-2-b-2, Main Cagayan River (highland) as defined in the Wide Areas, it covers 3 units of the Magat River Watershed and 2 of the Main Cagayan River Watershed.

(5) Geology and Soils

From aerial photo interpretations and observations of outcrops at site, the Surface Geology and Soil Texture Map as shown in Figure 6-8 was prepared.

The surface geology consists mainly of granite rocks, volcanic rocks, and unconsolidated alluvial/diluvial deposits. Granite rocks are distributed in the vicinity of Dupax to the west and heavily weathered. Distributed extensively in the east-central parts, volcanic rocks are complexes of andesitic-basaltic tuff breccia, lava, intrusive rocks.

Soil textures are characteristically sandy soils attributive to heavily weathered granite rocks and clay typed soils developed from moderately to heavily weathered volcanic rocks.

Table 6-5 shows Soil Textures as related to Landform Types. The findings of the field surveying of geology and soils are summarized below.

a) Present Conditions of Soil Erosion

Soil erosion is in fast progress in Grassland which is based on granite type rocks and heavily weathered volcanic rocks (particularly tuff breccia). The process is particularly active at Dupax and in the surrounding areas, mountain foot near the provincial road pass and south of Kasibu. Cattle foot paths in Pasture Lands also are considered to be a contributing factor.

b) Present Conditions of Land Collapses and Slides

Land collapses concentrate in areas of granite type rocks in the Dupax area, most of them being a surfacial sliding type. There are large scale collapses on the western slopes south of San Fernando and they appear to be expanding. In areas of weathered tuff breccia, there were occurrences of collapsible type slides.

c) Deposition of Sands and Earth in River-bed

In the Dupax area with distributions of granite type rocks, reflecting the large number of land collapses, there are substantial amounts of mainly small-grained deposits in the river-beds. In areas of volcanic rocks, river-bed deposits are mainly gravels (10cm–several meters in diameter). Generally, deposition and movement of sands and earth are active.

d) Conditions of Soils and Rocks

In the Model Area, there are largely two types of rock distributions having strong influence on soils and base rocks.

Granite type rocks are distributed in the Dupax area in the western part of the Model Area, and cut through by NE dykes. Due to heavy weathering, granite rocks are decomposed and there are large amounts of medium to coarse graind sandy earth outflow.

Volcanic rocks occur extensively in the east and central parts of the Model Area. They are comprised mainly of andesitic and basaltic tuff breccia and lavas. They are partly heavily weathered becoming clayish, and particularly in gentle sloped foothills, weathering is advanced.

e) River Flows

In the Model Area in general, river water flows are substantial in amount. Flowing water was observed in all of medium sized rivers of five meters or more in width. Considering forests occupy less than 50% of the area, weathering of base rocks (granite type rocks and volcanic rocks) must be progressing and, furthermore, there are many NE joints and lineaments, so that it can safely be assumed that ground water is effectively retained. On the other hand, in small rivers of several meters in width, particularly in fans, colluvial slopes and talus, located at lower foot hills, they are mostly under flows and there are many areas where supposedly surface running water is as much as barely to form pools.

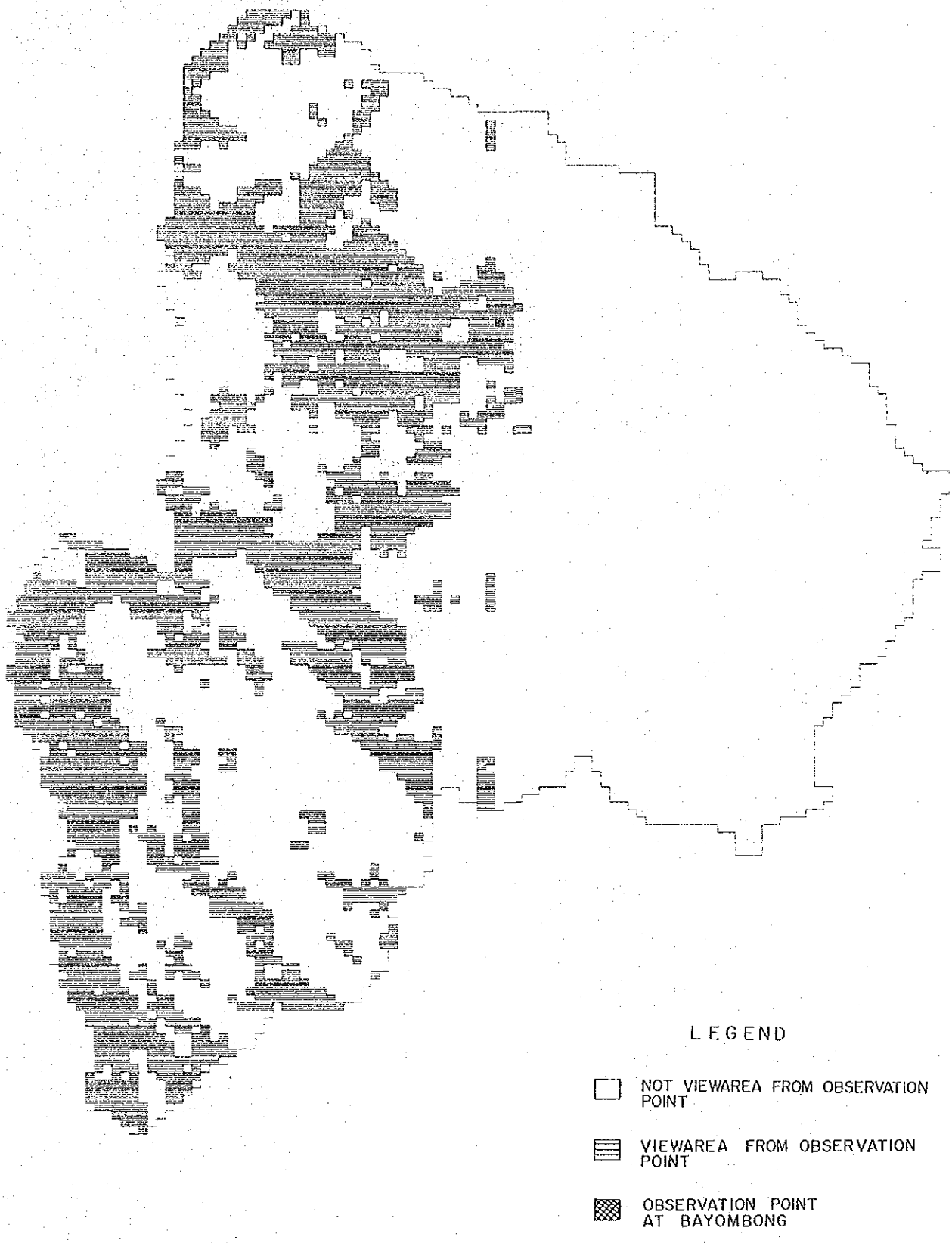


Fig. 6-5. Exposure (1)

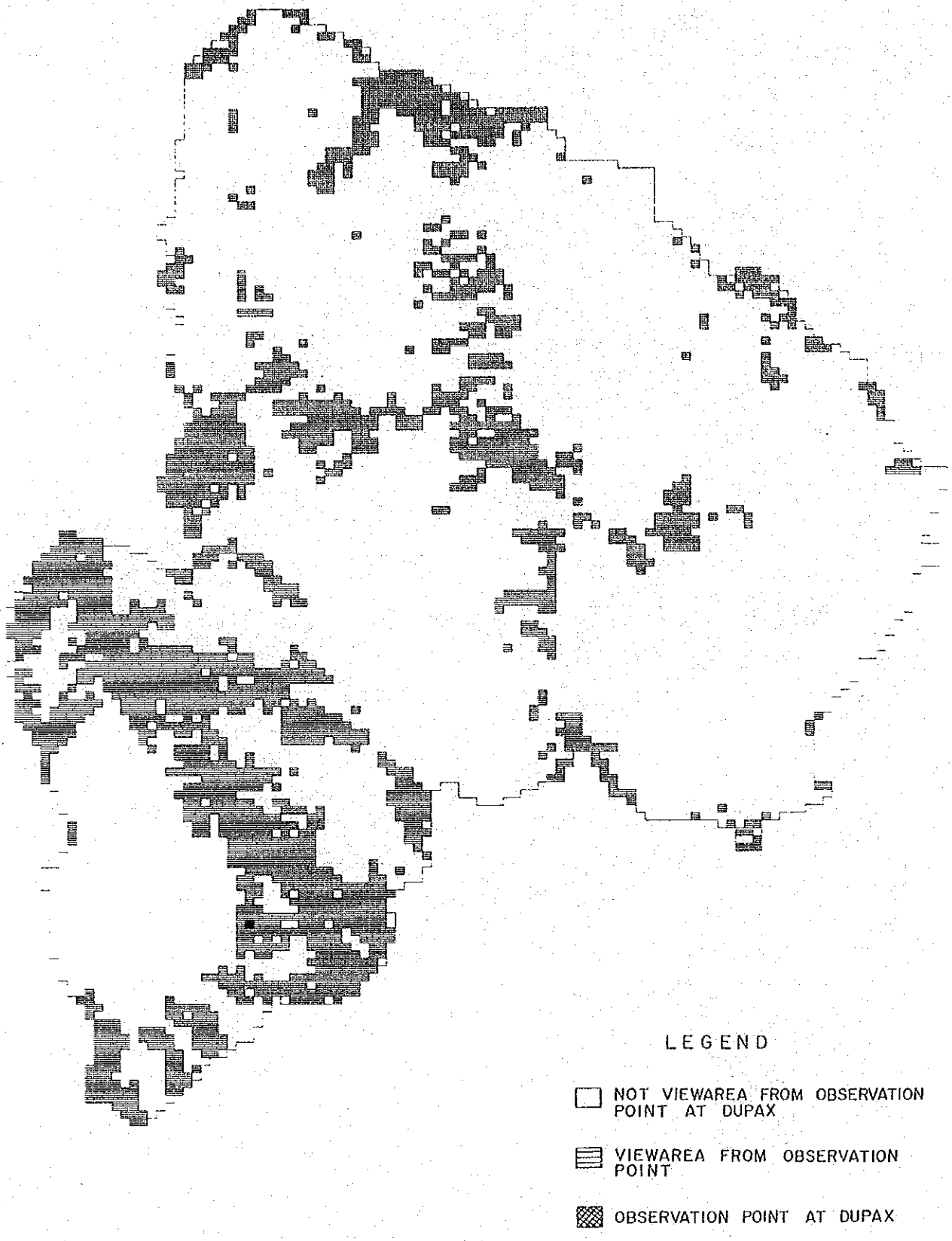


Fig. 6-6. Exposure (2)

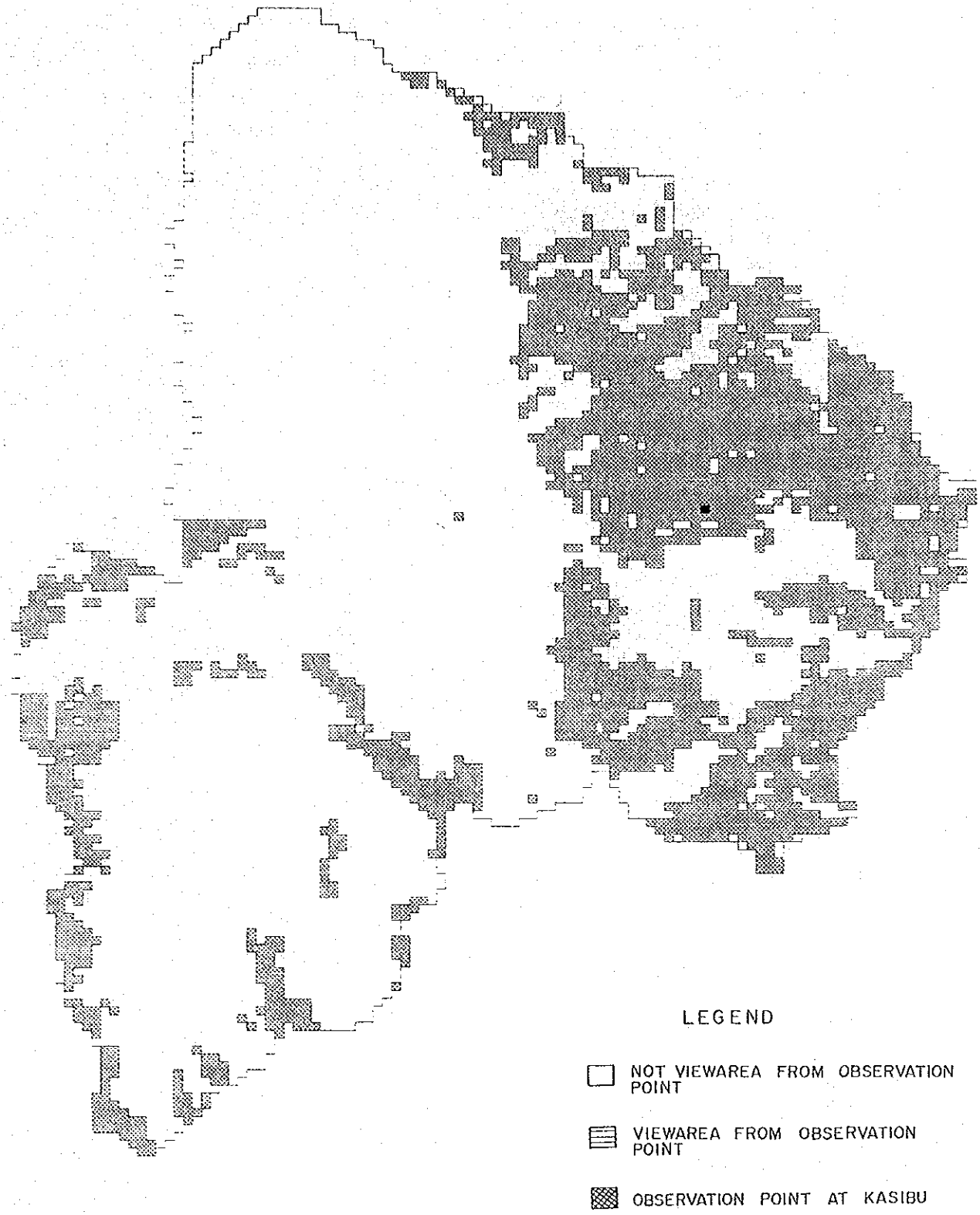


Fig. 6-7. Exposure (3)

Table 6-5. Soil Texture as related to Landform Type

Landform type	Soil texture	
	Volcanic area	Granite area
Lowland		
B – Back marsh	Clay	
N – Natural levee	Loam	Sandy loam
Fp – Flood plain	Silty clay loam	Sandy clay loam
V – Valley buttom lowland	Sandy loam	
F – Fan	Sandy loam	
O – Old river	Clay	Cay loam
R – River	River	
Midland		
T – Terrace	Sand~Gravel	
C – Collurial slope & Talus	Sand~Gravel	Sandy loam
D – Dissected upland	Clay loam	Sandy clay loam
H – Hill	Clay loam	Sandy clay loam
Pr – Piedmon (rolling)	Clay loam	
Pd – Piedmont (dissected)	Silt~Loam	
Highland		
E – Escarpment	Rock	
L – Low relief surface on m.	Silt~Loam	
Sd – Dissected slope on m.	Sandy loam	
Sg – Gentle slope on m.	Silt~Loam	
Ss – Steeply dissorted slope	Sand~Gravel (rock)	

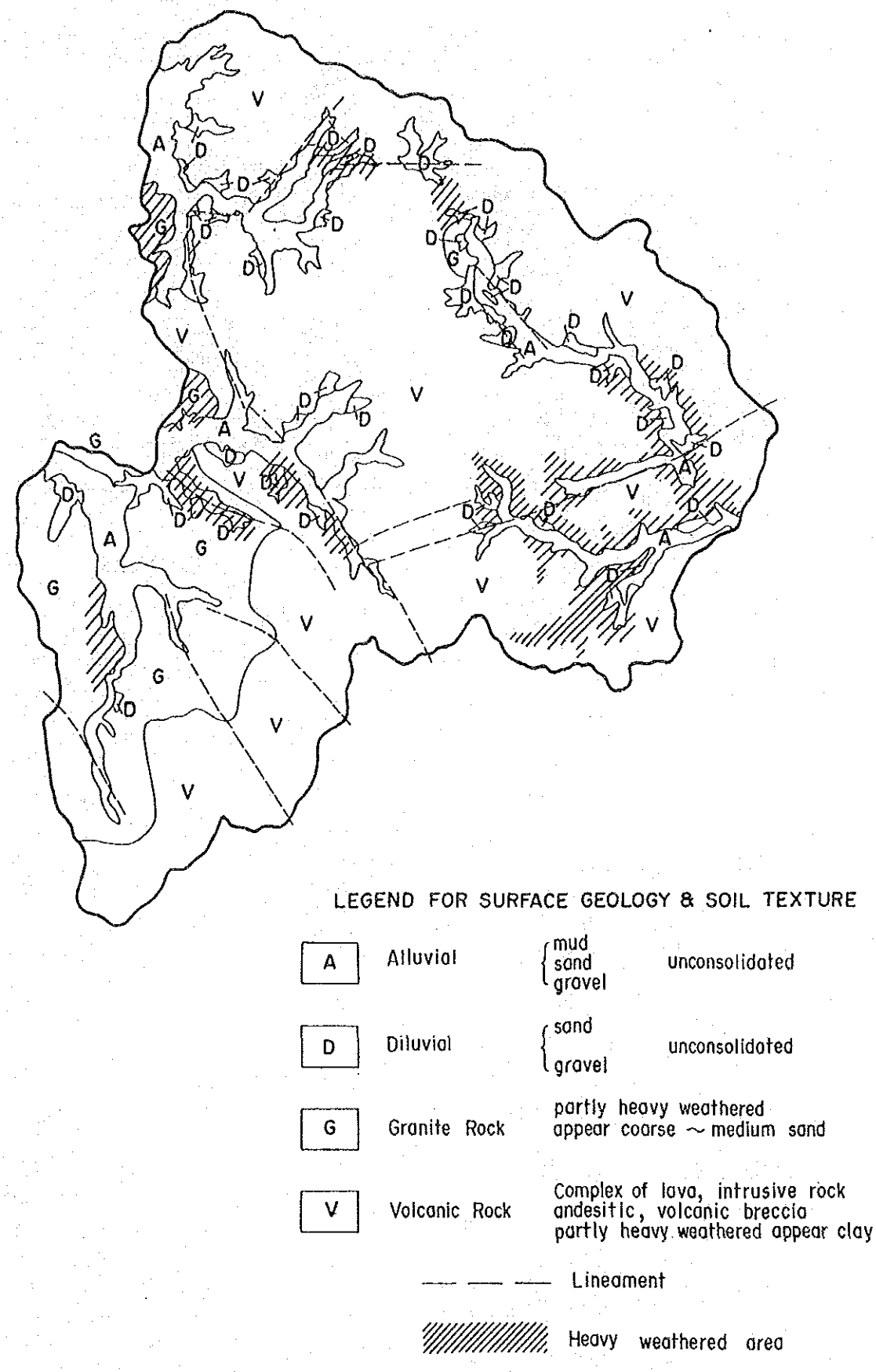


Fig. 6-8. Surface Geology & Soil Texture

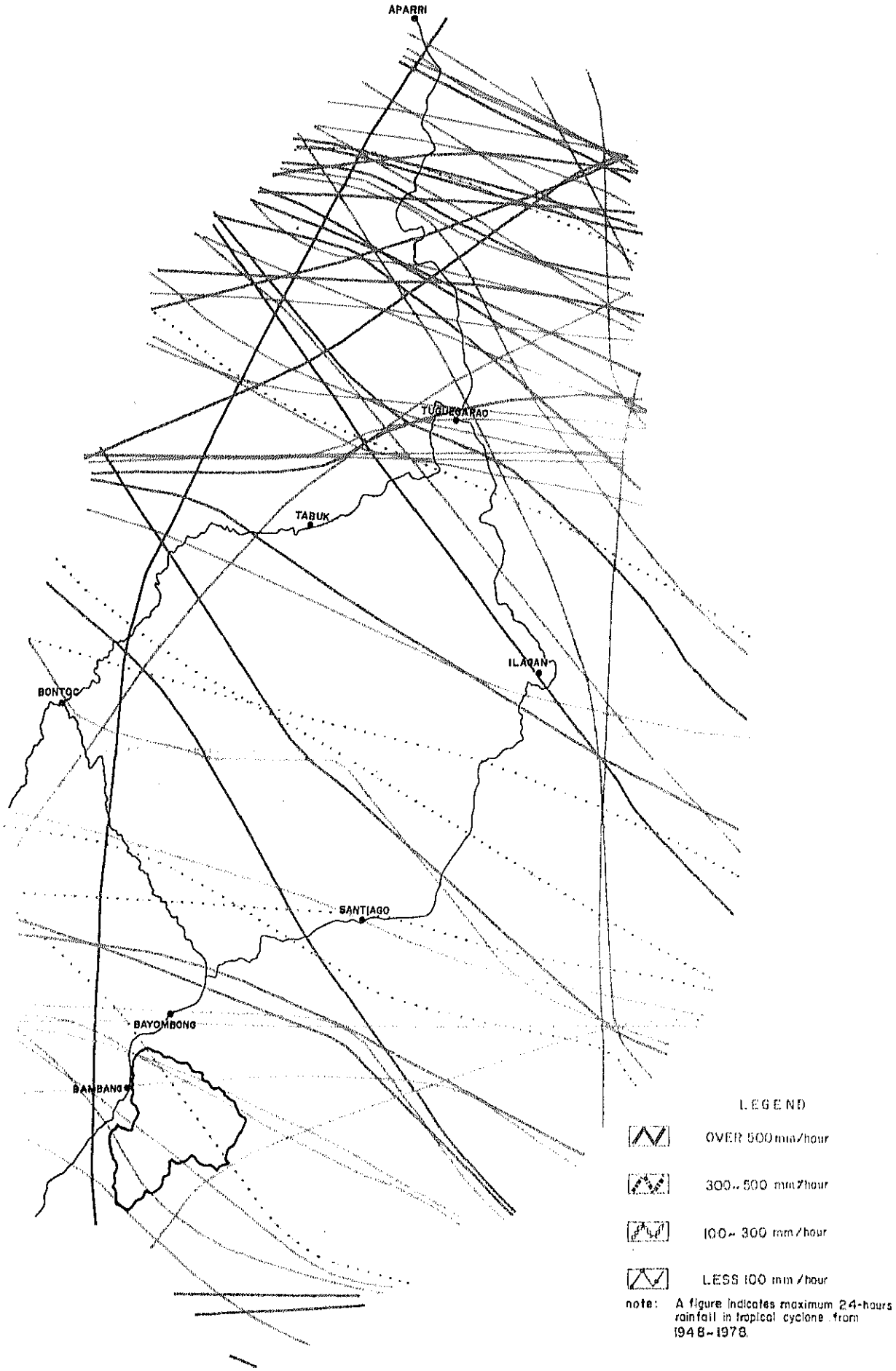


Fig. 6-9. Rainfall and Tropical Cyclone

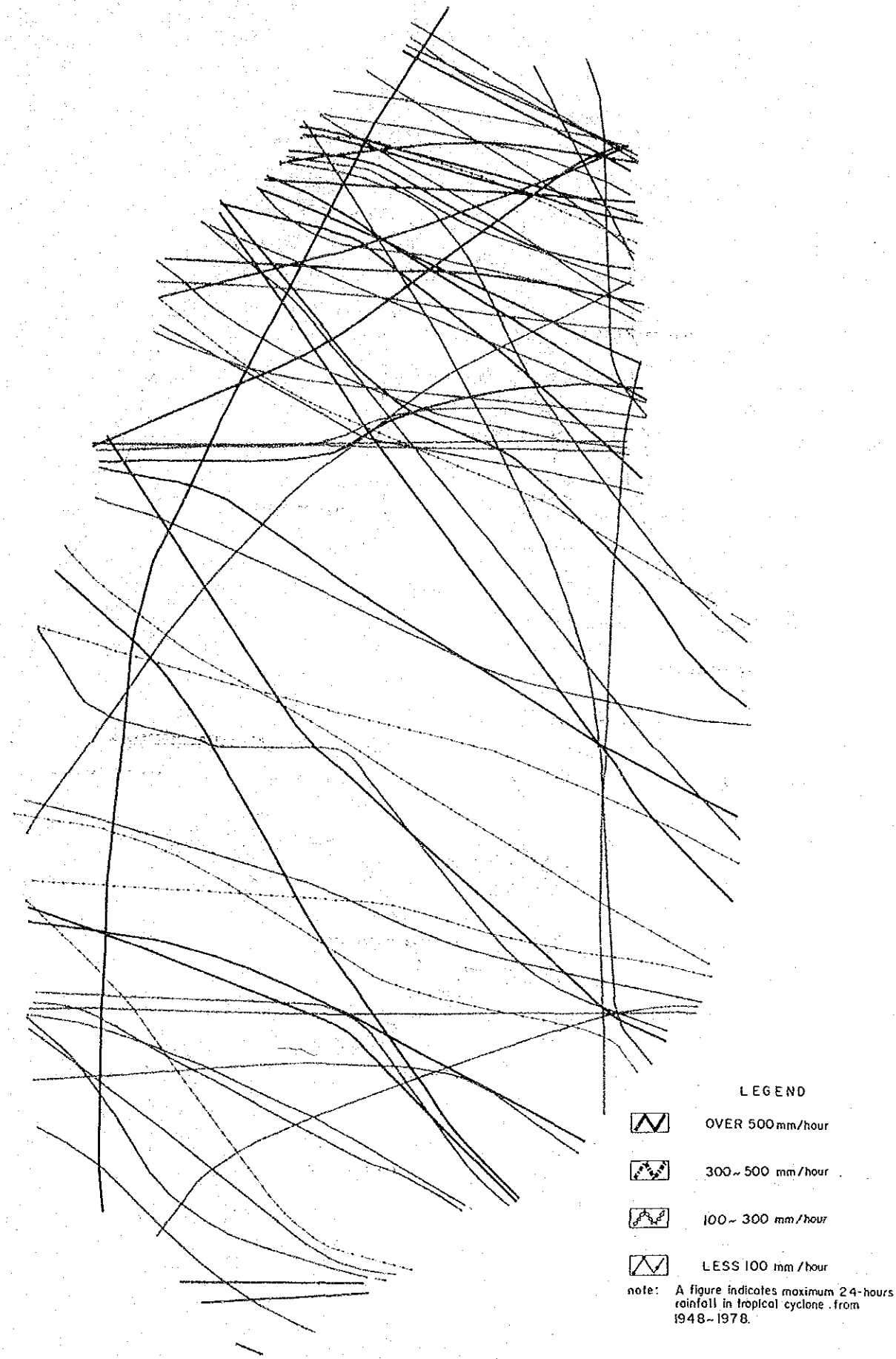


Fig. 6-9. Rainfall and Tropical Cyclone

(6) Meteorology

1) Temperature

There is no observatory in the Model Area, the closest ones being located at three locations of Bayombong, Bambang, and Consuelo, all in Nueva Vizcaya Province. The annual temperatures average 26.0 °C at Bambang and 23.6 °C at Consuelo. From these observatory data as well as geographical locations of Dupax and Kasibu, it is estimated that, the average annual temperatures should be in the range of 23 °C–25 °C. The highest temperature of 34.4 °C has been recorded in May at Bayombong (according to 1886–1893 and 1922–1933 data).

2) Rainfall

Rainfall varies significantly from one area to another depending on topographical conditions, courses of tropical cyclones, etc., averaging annually 1,539.8mm at Bayombong, 1,682.1mm at Bambang, and 2,318mm at Consuelo. According to the Average Annual Rainfall Map, prepared from the meterological data made available, the annual temperatures average 2,500–3,000m in the Model Area.

3) Tropical Cyclone

Basic study has been made of tropical cyclones in terms of the months they hit and the maximum 24-hour rainfalls that accompanied then, on the basis of past records. The study shows that the maximum 24-hour rainfalls resulting from the tropical cyclones which hit the Model Area mostly range 100–300mm/hour.

There were more cyclones passing through the area in the months of July and August than any other months, followed by September, November, and April in that order. The most common direction was southeast to northwest followed by east-sout-east to west-south-west. They hit the northern part of the Model Area most frequently.

(7) Vegetation and Land Use

Vegetation and land use classifications and their areas were compiled from aerial photo interpretations and field surveys as Table 6-6, and the vegetation and Land Use Map (Figure 6-10) prepared. In terms of tree species, there exists no natural Pinus insularis Forest. Except for the absence of Mangrove Forest quite obviously, the area has no outstanding characteristics of distribution compared with the Cagayan River Basin. Up to 800 m in elevation, Dipterocarp Forest is predominant but from 1,000 m. It is replaced by Mossy Forest in distribution. There are sporadic growths of bamboos but they are not large enough in space to be represented. Results of aerial photo interpretations are given in Annex 12. Their characteristics are categorically described below.

1) Logged-over, secondary (NL)

Most of the areas delineated as Forest (except for Mossy Forest) are Logged-over or Secondary Logging in Progress. Usually, after first and secondary logging, succeeding stands continue to grow to form the secondary forests for subsequent logging in a continuous process. But in the Model Area, after logging the sites are mostly cultivated for farming (kaingin) by burning and eliminating the trees. Logged–over, secondary, areas were further subdivided into thin stands and close stands.

2) Reproduction and Brushland (NR)

This represents brushland and young low forests. Forests of this type are only scatteredly distributed in the grasslands, occupying only 732 ha. or 1.5% of the Model Area.

3) Mossy Forest (NY)

Distributions of Mossy Forest were observed in parts of the uppermost areas of forests. Being medium to low in height, Mossy Forest remains intact from logging. But there are such areas turned into cultivated area (grassland) by burning.

4) Seasonal Cropland (Mc_1)

Seasonal Cropland refers to rice paddies and farms, accounting for some 5,400 ha. or 11% of the Model Area. This type of land use exists not only in A & D but also in forestland. Seasonal Croplands of 1 ha. or more are are shown in Vegetation and Land Use Map and those of less than 1 ha. are not represented. Presently, a significant number of such Seasonal Croplands of less than 1 ha. and distributed sporadically in the forestlands.

5) Permanent Cropland (Mc_2)

Permanent Cropland is mainly where fruits are grown. It amounts to 53 ha. or 0.1% of the Model Area.

6) Grassland (including Pasture) (G)

Grasslands occupy approximately 55% of the Model Area as shown in Table 6-6. Field verification revealed that what had been interpreted as Reproduction and Brushland were mostly Grassland.

Most of Brush as interpreted turned out to be graminacea such as Cogon and Talahip. They were misleading because they were 3 to 4 meters in height appearing to have crowns.

In most Grasslands, except for the western part of the Model Area which is covered all over by Grassland, there are scattered growths of Brush, but in the presence of such vigorous vegetations like Cogon and Tarahibu, plant succession to high forests (mostly shade-bearing trees) is not very likely and, considering also the repeated kaingin, there appeared little possibility of

their growing into Reproduction Brush (Reproduction Stand), and therefore scattered growths of Brush were included in Grassland in delineation. Sporadic brushes are included in Grassland.

7) Built-up Area (B)

The built-up areas as represented in the map are those of Dupax and Kasibu. They amount to 163 ha. in area or only 0.3% of the Model Area. Those of less than 1 ha. are not represented in the map but there are many of them present throughout Seasonal Croplands.

8) Kaingin (K)

According to the Philippine Forestry Statistics, kaingin is defined as follows.

> Kaining – a portion of the forest land, whether occupied or not, which is subjected to shifting and or permanent slash and burn cultivation having little or no provision to prevent soil erosion (P.D. 705).

Statistically, kaingin is classified as cultivated land outside of A and D (Alienable or Disposable Lands).

According to Table 6-6, kaingin accounts for only about 2% of the total area, but it must be noted that there are many such areas that were not represented because they are not large enough to be expressed in terms of 5mm by 5 mm areal minimum units as specified for photo interpretation.

Therefore it must be understood that there are a substantial number of kaingins, too small in size to be represented, scattered and distributed in areas delineated as Forest and Grassland. Depending on how to look at cultivation in terms of its intensity, even among A and D, there are areas which are cultivated though loosely.

Table 6-6. Areas of Vegetation and Land Use

	(ha)	(%)
Logged-over, secondary (NL)	14,709	30.0
Reproduction and Brushland (NR)	732	1.5
Mossy Forest (NY)	39	0.1
	15,480	31.6
Seasonal cropland (Mc_1)	5,439	11.1
Permanent cropland (Mc_2)	53	0.1
	5,492	11.2
Grassland (include pasture) (G)	26,718	54.6
Built-up Area (B)	163	0.3
Kaingin (K)	1,127	2.3
	48,980	100.0

Note: The high density area in NL and NR is approx. 827 ha (5.4%). This fugures are measured on the map. Least area of interpretation is approximately one hectare in unit.

Distributions of forests in the vegetation & land use were classified by elevation for the Wide Area whereas for the Model Area they were distinguished by development (felling) status and conditions after felling.

(8) Land Use Changes over Years

By using LANDSAT images covering the Model Area of past years, study was made of the changes in vegetation and land use in the Model Area and its periphery so as to provide information to help develop the forest management plan for the area.

The LANDSAT data employed above were as follows.

1. August 26, 1976 (MSS, P124–R49)
2. February 21, 1979 (MSS, P124–R49)
3. April 15, 1983 (MSS, P116–R48)

For the above data, ratio computations based on the band ratio of Channel 5/Channel 7 as well as geometric corrections were performed to create images classifying forests, non-forests and rivers, for each period of time.

Distributions of forests and non-forests for the respective periods are as shown in the photos. The legend specifies green for forests, yellow for non-forests and blue for water bodies (mainly rivers).

A study of changes in land use in the Model Area and its periphery during the years from 1979 to 1983 indicates substantial reduction of forests and an increase in grassland to make up for the reduced forests. Within the Model Area, the decrease in forests is particularly conspicuous in the mountains of elevations ranging 400m–800m along the Magat River Basin (on the Dupax side) and the area from the Kongkong Valley to Tanap.

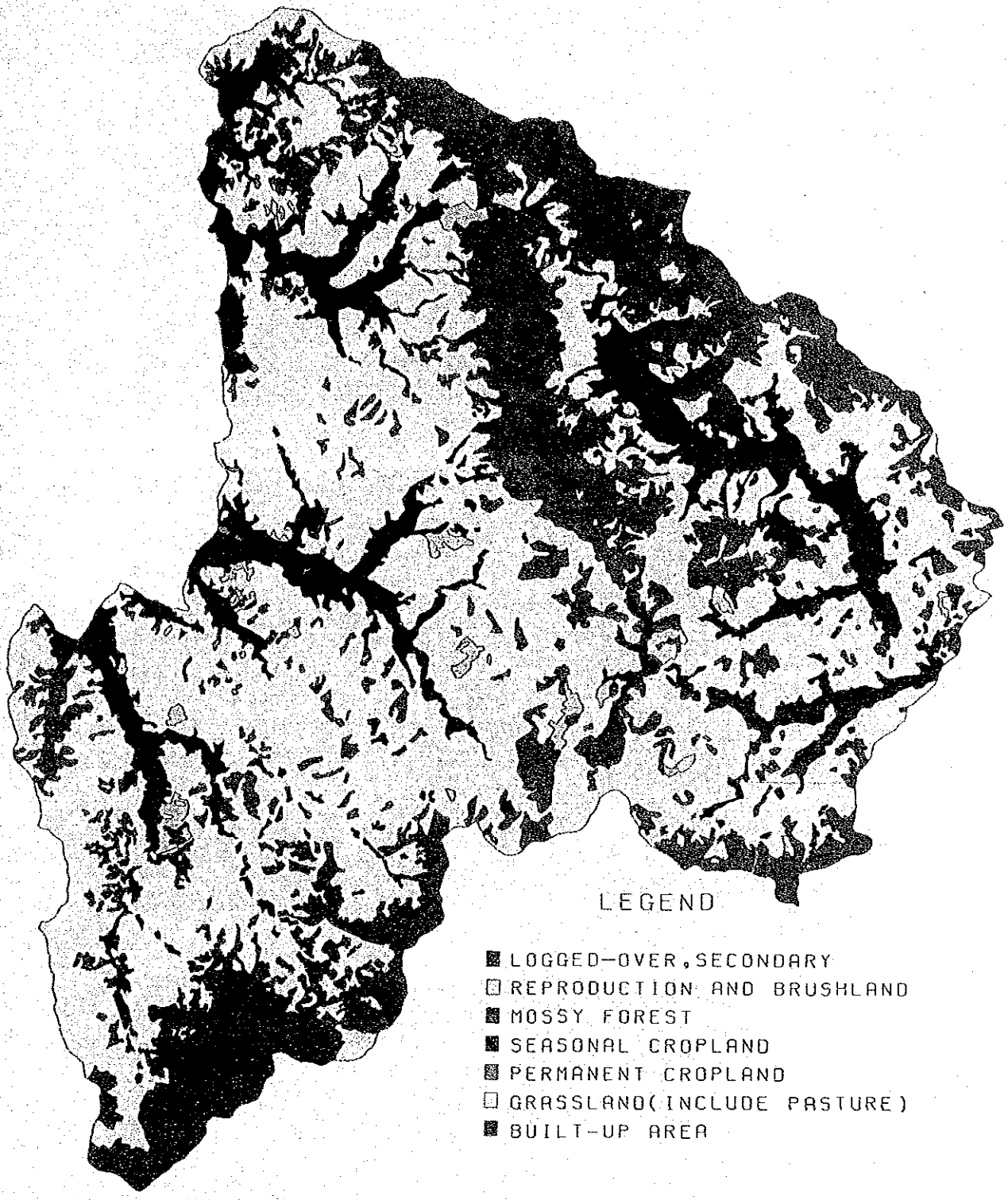
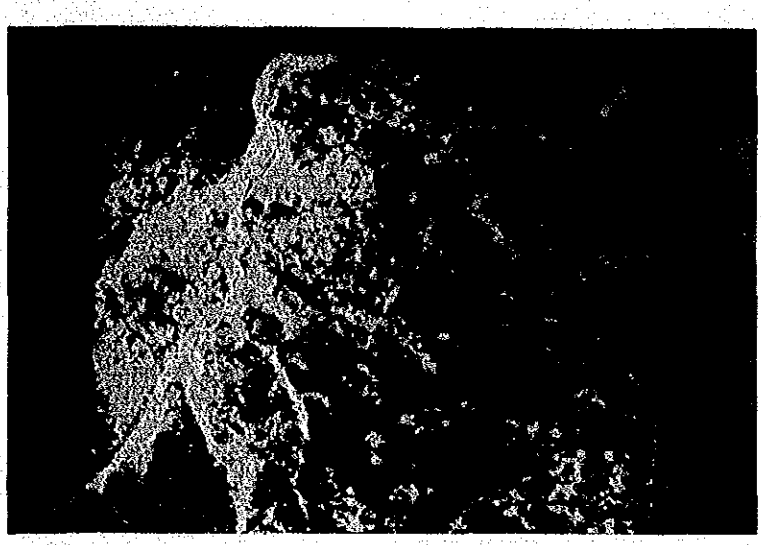
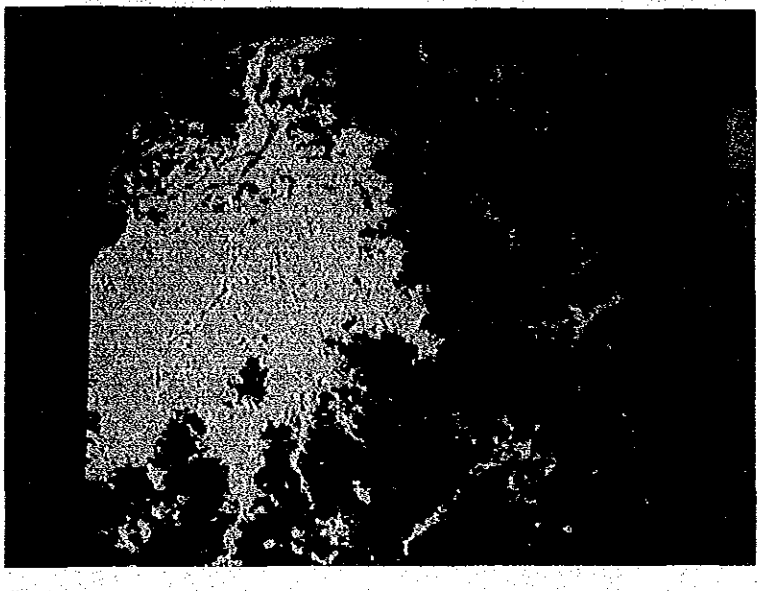


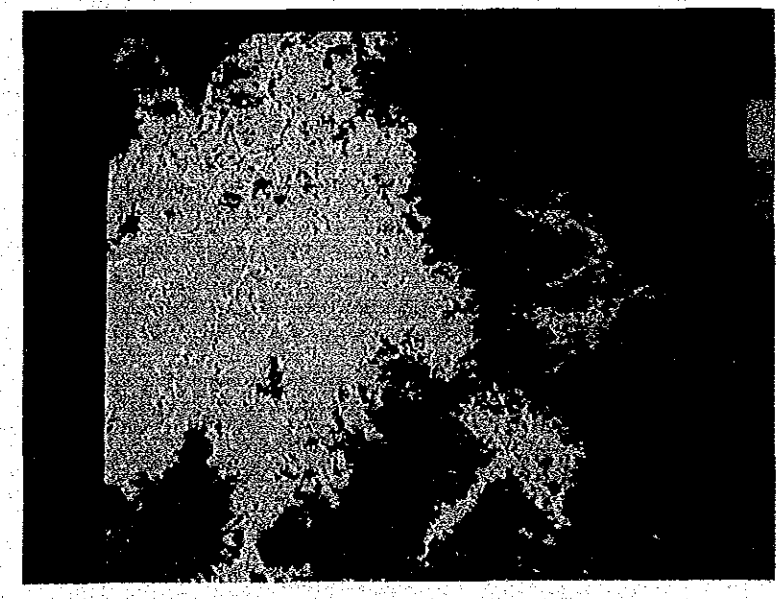
Fig. 6-10. Vegetation & Land Use



Aug. 26. 1976



Feb. 21. 1979



Apr. 15. 1983

Green: Forest
Yellow: Non-Forest
(Mainly Grass Land)
Blue: River