DEVELOPMENT OF THE DATA BASE FOR TEAK FOREST MANAGEMENT IN JAVA, INDONESIA

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インドネシア・ジャワ島のチーク生産林地
管理のためのデータベースの構築

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和 文 要 旨

　インドネシア国ジャワ島のチーク材生産林地は50年以上前からインドネシア林業公社で管理されている。インドネシア林業公社ではチーク生産林地を保続原理と最大生産原理に基づいて管理していることはよく知られている。この方法を行うには森林の状況に関する情報を定期的に，かつ継続的に得る必要があり，現在までに膨大な量の森林に関する情報が蓄積されている。

　一方，最近になって，チーク生産林地の管理について多様な問題が生じつつある。しかしこれらの問題解決に当って，公社では未だに伝統的な方法しか用いられておらず，成果を挙げていない。最近の進歩したコンピューター技術を用いることが出来るならば，情報の蓄積，更新，編集或いはそれらの表示，出力を効果的に，かつ安価な経費で行うことが可能であろう。そのようなデータベースが構築されると森林計画，管理に当る者にとって大変有効であり，それによって効率よく問題解決のための意志決定が行えるであろう。

　ここで構築しつつあるチーク生産林地の管理のためのデータベースは林班を単位として，森林の状況，土壌型，土地利用，地形状況などの情報から構成されている。そこには多くの林地管理に役立つ情報を持ち，問題解決に必要な情報を迅速に取り出すことが可能である。1例として中部ジャワのマンティンガン地域のデータベースについて検討する。

1. Briefly description of Teak Forest in Indonesia

Indonesia is an agrarian country with total population of approximately 164 million people and an increase of 2.15% annually. About 82-85% of the population lives in rural areas, 70% of which is dependent on agriculture for its livelihood. Java Island (including the island of Madura) has a total land area of 13,218,700 ha. It is inhabited by almost 100 million people (about 60% of the total population). Average population density of Indonesia as a whole is about 85 people per square kilometer while that of Java Island is about 755 people per square kilometer (1988).

Forest land in Java Island is 18.47% of the total land area. Perum Perhutani State Forest Corporation (Perhutani SFC) manages 2,803,549 ha of the forest land. The other forest land is administered by Directorate General of Forest Protection and Nature Conservation and Regional Office.

Perhutani SFC has three unit of management which follow province administrative units i.e., Perhutani SFC of Central Java (unit Ⅰ), East Java (unit Ⅱ) and West Java (unit Ⅲ). Unit Ⅰ has 20 Forest Districts, 25 Forest Subdistricts, 150 Forest Ranger Districts and 595 Forest Working Ranger Districts. Unit Ⅱ has 23 Forest Districts, 38 Forest Subdistricts, 185 Forest Ranger Districts and 697 Forest Working Ranger Districts. Unit Ⅲ has 14 Forest Districts, 23 Forest Subdistricts, 107 Forest Ranger Districts and 363 Forest Working Ranger Districts.

The range managed by each Forest Districts is between 10,000 ha and 50,000 ha. Table 1 shows that 53.23% of the total forest land is Teak forest class management which produces the highest income for the corporation. That is an important reason why the corporation intensively manages the teak forest in comparison with other species.

Tabel 1. Areal distribution of species in forest land of Java.

Species class management	Unit Ⅰ (ha)	Unit Ⅱ (a)	Unit Ⅲ (ha)	Total (ha)	%
Teak	304,280	578,580	170,390	1,053,250	53.23
Pinus sp.	174,540	190,069	161,651	527,260	26.64
Agathis sp.	28,472	39,173	14,240	81,885	4.13
Melaleuca sp.	3,158	6,556	—	9,174	0.46
Dalbergia sp.	23,616	697	25,580	49,393	2.49
Mangrove	12,343	—	32,530	44,873	2.26
Maesopsis sp.	—	11,924	—	11,924	0.60
Mahogany sp.	20,610	—	56,841	77,451	3.91
Altingia sp.	—	—	57,985	57,985	2.93
Others	10,503	45,165	19,639	65,306	3.30

Source: The History of Indonesian forestry (1987).

The area of teak forest in unit Ⅰ of central Java is 304,280 ha; unit Ⅱ of East Java 578,580 ha and unit Ⅲ of West Java 170,390 ha. The annual report of Perhutani SFC in 1986 showed that a total export of teak sawn timber in 1986 was 33,734 cubic meter with revenue about US$ 20,315,130. The total revenue of Perhutani SFC in 1986 from unit Ⅰ, unit Ⅱ and unit Ⅲ was Rp 141,673,494,400. or about US$ 82,000,000.

On unit Ⅰ a forest cutting area in 1987 was 33,962 ha for the teak forest and 7,010 ha for non-teak forest. The area of regenerated with tumpangsari system[1] in 1987 was 14,124 ha and 4,991 ha with non-tumpangsari system. Tending[2] operation were

[1]Tumpangsari system means to plant teak trees by forest farmers or villagers who at the same time are allowed to cultivate staple crops, mainly dryland rice and corn, for about two years between rows of young teak forest trees

[2]Tending system means to take care young teak trees with proper spacing and good condition and to remove any kind of wild shrubs or others from the plantation area.

carried out for about 13,601 ha and Thinning operation for 25,109 ha.

According to An Instruction of a Planning Bureau of Perhutani SFC, the cutting cycle for the Teak forest is 80 years. However, it is quite difficult for the corporation to keep the teak forest healthy and in good quality during 80 years. There are many disturbances against the teak forest. Illegal grazing might affect young teak plantation. Girdled[3] teak trees might invite teak thieves to cut the trees. Table 2 shows six kind of disturbances in one forest area.

Table 2. Damaged caused by the disturbances in teak forest area.

Kind of disturbances	Estimated damaged equivalent to the Rupiah in year	
	1985	1986
Illegal trees cutting	948,292,692,-	1,100,667,586,-
Forest burned	67,495,603,-	27,133,729,-
Illegal grazing	1,698,541,-	3,400,426,-
Illegal firewood-cutting	37,829,743,-	6,280,600,-
Illegal crops-plantation in forest	35,458,443,-	35,230,056,-
Natural disaster	1,550,067,263,-	364,430,174,-

Source: annual report Perhutani 1986

2. Teak forest management planning.

The objective of teak forest management is to obtain and improve forest productions, especially teak woods for contributing national economic development and prosperity of people based on sustained yield and maximum yield principle.

Sustained yield principle means that timber production of a forest area is stable continuously. Maximum yield principle means that timber production of a forest area is maximum without any damaged forest area.

There are two management planning in regional basis. A long term planning covering 10 years and a short term planning for each year. Bureau of Planning of each unit prepares the long term planning of each Forest District. Each Forest District is subdivided into several Forest Management Divisions (FMD) for determinating allowable cut and making a cutting plan. Manager of each forest district will carries out all aspect of management using annual planning.

Based on this system, forest stands would become the same age in the next period. Therefore the Perhutani SFC handles the forest areas with timber classes of 10 years

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[3]Girdled trees is teak trees carried out circle cut on the bottom part of the trees (less than 50cm above forest soil) for decreasing water contents for two years before cutting time.

interval each. However, some times several parts of forest area include non-teak forest and another areas include bareland. The Teak forest management planning requires a determination of the smallest management unit for calculating the forest productivity. Perhutani SFC stated that a sub-compartment is the smallest management unit which has an average acreage between 10.0 ha and 20.0 ha. Several sub-compartments composes a compartment which has an average acreage between 20.0 and 60.0 ha. And every sub compartment is clasified by timber class. Table 3 shows the types of timber classes with short explanation. The important classes for the corporation are teak productive classes. Managers of Perhutani SFC are trying to extend these areas. (See Timber class chart no. 1.1.1 in Table 3).

Table 3. Chart of Types of the timber classes.

A. Not for production.
   1. Unusable for production.
   2. Land for special purposes.
   3. Wildlife forest or tourism area.
   4. Protection forest.

B. For production.
   1. For teak production.
      1.1. Suitable for clear cutting areas.
         1.1.1. Productive class areas.
            a. Timber age class (KU) from 1 to XII.
            b. Timber mature class (mt).
            c. Low increment class (mrm, mrs, mrt)
               includes: natural regenerated teak forest.
         1.1.2. Unproductive class areas.
            a. The bareland after cutting in last period.
            b. Bareland.
            c. Non-teak forest areas.
            c.1. Undesirable non-teak forest.
            c.2. Natural non-teak forest.
            d. Teak forest with lesser yield/growth.
            d.1. Teak plantation with lesser yield.
            d.2. Natural regenerated teak forest with lesser yield.
      1.2. Unsuitable for clear cutting areas.

   2. Not for teak production.
      2.1. Unsuitable for teak forest.
         2.1.1. Bareland in unsuitable land for teak forest area.
         2.1.2. Non-teak forest in unsuitable land for teak forest area.
            2.1.2.1. Non-teak forest plantation in unsuitable
                  land for teak forest area.
            2.1.2.2. Natural non-teak forest in unsuitable land
                  for teak forest area.
         2.1.3. Damaged teak forest.
            2.1.3.1. Damaged teak forest plantation.
            2.1.3.2. Natural regenerated damaged teak forest.
      2.2. Non-teak forest plantation
         includes: mahogany; dalbergia; and others.
      2.3. Limited protection forest.

The most important timber class for the corporation is the productive timber classes and unproductive classes in a suitable class for clear cutting areas.

The determined factors of timber class in each sub-compartment are an average age, a site index and a basal area. Forest survey are carried out in each sub-compartment, measuring the diameter, average height of each tree in circular sample plot and counting basal area of teak trees of each sub-compartment. The intensity of sampling survey is usually between 0.5% and 2.5% of the area. Site index of each compartment is determined with a graphic table of Wolff Von Wulfing (1932) from the average height measured at the forest survey and the age of plantation derived from the plantation record book. And the basal area factor of teak trees can be calculated with comparing a basal area of teak trees from the survey with a basal area from the table of Wolff Von Wulving.

The volume of each timber class can be calculated with Wolff Von Wulfing yield table based on the site index.

Because of many factors which influence stand condition for the period of forest growth, the estimation of timber volume of each sub-compartment must be corrected with correctional factors such as stand factor, stand quality, and exploitation factor.

Table 4 and 5 are examples of calculating the allowable cut and the timber volume of Forest Management Division: X. The area of Forest Productive class of the Forest Management Division is 15,345.1 ha and the cutting cycle is 80 years. So the allowable cut area is $15,345/80 = 191.8$ ha per year. The allowable cut volume is 2,128,030 cubic meter per year. The formula for estimating volume of forest stand is:

$$V = Bhf \qquad (1)$$

V = volume of forest trees in cubic meter per ha
B = basal area of forest trees in square meter per ha
h = average height of dominant trees in meter per ha
f = form factor of trees depend on the species.

Based on the forest survey and the yield table, we can calculate the volume of forest trees in each Forest Management Division by using the formula:

$$Vt = BVyC \qquad (2)$$

Vt = volume of total production in cubic meter per ha
B = basal area factor which calculated from basal area survey divided by basal area yield table (1932)
Vy = volume of forest trees from yield table in cubic meter per ha
C = correction factor.
The annual production is Vt/80.

By using the table, we can calculate a basal area factor, a number of trees of normal growth, an average height, a volume of thinning stand, a volume of residual

stand and a volume of total production per hectar.

Timber class was determined by the basal area factor and the age. If the basal area factor is more than 0.6, the compartment is categorized in one class depend on its age. Timber class= I means the age plantation of teak trees in one compartment between 1 years to 10 years and the basal area factor is more than 0.6. Timber class= II between 11 years to 20 years; timber class = III between 21 years to 30 years, and etc. Another timber class, i.e., timber class = 15 means bareland area after cutting, and timber class = 16 is an actual bareland area. Timber class = 26 is mahogany tree class and timber class = 27 is dalbergia tree class and timber class = 28 means another tree class. Timber class = mrm[4], mrs[5], mrt[6] means regenerated teak forest class with low increament and bad quality.

Table 4. Estimated timber volume of each timber class
on the average cutting year old from
the Forest Management Division: X

Timber class	forest area (ha)	Average		Average cutting year old (year)	Volume	
		site index	Baf		per ha (cu. m)	total (cu. m)
a) mrt	203.0	-	-	-	138	28,014
mrs	2,411.8	-	-	-	130	313,534
mrm	1,155.0	-	-	-	61	70,455
total a)	3,769.8	-	-	-	-	412,003
b) mt	37.7	3.5	0.64	110	145	5,466
KU IX	95.7	3.0	0.67	101	120	11,484
VIII	1,342.1	3.5	0.72	94	149	199,972
VII	1,084.2	3.0	0.68	91	114	123,598
VI	1,190.7	3.5	0.68	86	134	159,553
V	1,216.0	3.5	0.75	82	143	173,888
IV	1,767.4	4.0	0.73	80	166	293,388
III	1,331.2	4.0	0.81	80	185	246,272
II	1,669.7	3.5	0.86	80	162	270,491
I	1,840.6	3.0	0.81	80	126	231,915
Total b)	11,575.3	-	-	-	-	1,716,027
Total a) +b)	15,345.1	-	-	-	-	2,128,030

[4]The assumption average age is between 80-90 years old
[5]The assumption average age is between 90-100 years old
[6]The assumption average age is between 100-120 years old

Table 5. Cutting Timber Planning for cutting cycle 80 years of Teak forest

Timber Class	mrt		mrs		mrm		mt		IX		VIII		VII		VI	
Period	138 cu.m./ha		130 cu.m./ha		61 cu.m.ha		145 cu.m./ha		120 cu.m./ha		149 cu.m./ha		114 cu.m./ha		134 cu.m./ha	
	ha	cu.m	ha	cu.m	ha	cu.m	ha	cu.m	ha	cu.m	ha	cu.m	ha	cu.m	ha	cu.m
I	203		1862.8													
		28014		242164												
II			549		1155		37.7		95.7		747.7					
				71370		70455		5466		11484		111407				
III											594.4		1084.2		433	
												88565		123598		58022
IV															757.7	
																101531
V																
VI																
VII																
VIII																
Total area	203	28014	2411.8	313534	1155	70455	37.7	5466	95.7	11484	1342.1	199972	1084.2	123598	1190.7	159553

V		IV		III		II		I		Cutting forest area per period		Forest plantation in unproductive area	Total forest plantation area per period
143 cu.m./ha		166 cu.m./ha		185 cu.m./ha		162 cu.m./ha		126 cu.m./ha					
ha	cu.m	ha	cu.m	ha	cu.m	ha	cu.m	ha	cu.m	ha	cu.m	ha	ha
										2065.8		934.2	3000.0
											270200		
										2585.1		414.9	
											270200		3000.0
										2111.6		-	2111.6
											270200		
1179.4										1937.1		-	1937.1
	168654										270200		
36.6		1596								1632.6		-	1632.6
	5234		264936								270200		
		171.4		1306.6						1478.0		-	1478.0
			28452		241721						270200		
.				24.6		639.7				1664.3		-	1664.3
					4551		265631				270200		
						30		1840.6		1870.6		-	1870.6
							4860		231915		236800		
1216	173888	1767.4	293388	1331.2	246272	1669.7	270491	1840.6	231915	15345.1	2128200	1349.1	16694.2

3. Development of a data base

3.1. Introduction

Perum Perhutani SFC has long term data about the teak forest. On the other hand their teak forest is still managed by conventional methods and has been received much pressure from outside of non-forestry field and other management problems. For the solution of various problems mentioned above, a new approach is needed to analyze data more efficiently and easily. Advanced computer technology has capability for efficiently and economically storing, analysing and displaying of accumulated data in graphical form.

3.2. Study area.

5 Forest District at the east edge of Central Java, which has the heighest productivity
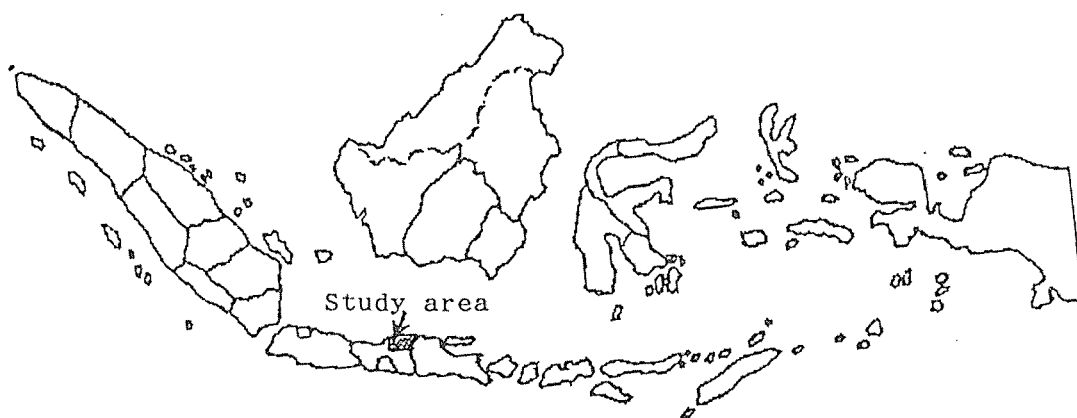
Figure 1. Location of the study area of Central Java, Indonesia.

in the teak forests were chosen as study areas (Figure 1).

    a). The area of Mantingan Forest District (16,633 ha), consists of:
1. Forest Management Division (FMD) Sulang Barat: 127 Compartments.
2. Forest Management Division (FMD) Sulang Timur: 118 Compartments.
3. Forest Management Division (FMD) Kalinanas: 130 Compartments.

    b). The area of Cepu Forest District (33,058 ha), consists of:
1. Forest Management Division (FMD) Cabak: 122 Compartments.
2. Forest Management Division (FMD) Nanas: 97 Compartments.
3. Forest Management Division (FMD) Ledok: 135 Compartments.
4. Forest Management Division (FMD) Kedewan: 165 Compartments.
5. Forest Management Division (FMD) Kedinding: 132 Compartments.
6. Forest Management Division (FMD) Payaman: 95 Compartments.

c). The area of Kebonharjo Forest District (15,092 ha), consists of:
1. Forest Management Division (FMD) Balo: 97 Compartments.
2. Forest Management Division (FMD) Tuder: 173 Compartments.
3. Forest Management Division (FMD) Merah: 165 Compartments.
d). The area of Randublatung Forest Districts (32,439 ha), consists of:
1. Forest Management Division (FMD) Doplang: 127 Compartments.
2. Forest Management Division (FMD) Bekutuk: 129 Compartments.
3. Forest Management Division (FMD) Ngliron: 146 Compartments.
4. Forest Management Division (FMD) Banyuurip: 126 Compartments.
5. Forest Management Division (FMD) Randublatung: 151 Compartments.
e). The area of Blora Forest District (14,998 ha), consists of:
1. Forest Management Division (FMD) Kunduran: 160 Compartments.
2. Forest Management Division (FMD) Banjarrejo: 118 Compartments.
3. Forest Management Division (FMD) Ngawen: 164 Compartments.

3.3. Elements of Forest Data base.

a). Forest inventory data which consist of the number of compartments, the number of sub-compartments, the acreage of sub-compartment, the survey date, the average height, the age of plantation, the site index, the basal area factor, the stand quality, the timber class, the plantation year and slope class. Current data and those of 10 years before were provided. The data have been inputted to computer with readable form in sequential data format.

b). Forest maps with scales of 1:25,000 of each forest management division (FMD) were used for spatial data. There are 22 forest management division maps. All maps have already inputted in format compatible with digital computer by using digitizer. Polygon format was used for transforming map data of compartment boundaries. Line format was used for the date of capturing contour, roads and rivers.

c). Land use maps and topographical maps with scales of 1:50,000 were inputted to the computer with computer readable form. Both data were inputted in grid format or mesh format.

d). And other information data related to the forest management planning of the study area which were inputted in numerical data.

Among 12 items of the forest inventory data stored on a floppy disk. The number of compartment and sub-compartment, the acreage of sub-compartment, the survey date, the average height, the age of plantation are reliable and representative. The site index and the basal area data are also representative with some justifications. Some examples of forest conditions can be seen in Table 6.

3.4. An example of analysis from the Data base.

Forest data base of Mantingan Forest district and Randublatung Forest district are explained as an examples.

Mantingan Forest district covers 16,633 ha of forest land. The topography of

Table 6. Distribution of various kind of forest
condition in study area
(in average value) in 1989.

FMD	Height (m)	Age (yrs)	S.I.	Baf	Basal area (sq. m/ha)	Volume (cubic m/ha)
Blora 1	13.9	26.9	3.02	0.62	8.09	101.9
Blora 2	16.2	28.8	2.96	0.74	9.72	120.0
Blora 3	15.3	27.9	2.88	0.73	8.84	99.9
Mtng 1	20.2	36.2	3.43	0.97	14.27	206.8
Mtng 2	15.2	26.1	2.66	0.58	7.71	105.0
Mtng 3	17.6	29.4	3.11	0.74	10.02	138.4
Cepu 1	18.3	26.5	3.29	0.74	9.86	127.3
Cepu 2	20.2	31.6	3.59	0.84	12.33	177.5
Cepu 3	19.9	35.6	3.28	0.89	12.74	177.8
Cepu 4	13.8	25.1	2.85	0.68	8.33	99.5
Cepu 5	18.0	32.2	3.30	0.77	11.43	162.2
Cepu 6	12.0	21.2	2.92	0.61	7.20	84.9
Cepu 7	21.0	32.2	3.63	0.89	13.23	196.0
Rdbt 1	17.8	26.6	3.23	0.84	11.48	154.8
Rdbt 2	20.1	36.1	3.36	0.87	12.08	163.9
Rdbt 3	21.9	41.6	3.48	1.00	14.79	216.3
Rdbt 4	20.5	36.3	3.21	0.99	14.11	197.3
Rdbt 5	20.4	36.9	3.30	0.98	13.68	183.2
Rdbt 6	19.1	30.1	3.48	0.98	12.34	162.5

Mantingan forest area is from flat to hilly and the altitude is between 10 and 300 meter above sea level. The soil types are Latosol, Mediteran, alluvial and Grumosol. The highest rate of rainfall is 296mm/month at January. The lowest rate of rainfall is 26mm/month at July. The total rate of rainfall is 1,745mm/year. The rainy season is usually from October to May and the dry season from June to September.

The Randublatung Forest district covers an area of 32,439 ha of forest land. It is located for greater part in the Blora Regency and for minor part in Grobogan Regency, Central Java, Indonesia. The Topography of Randublatung is from flat to hilly and the area is transferred by Lusi and Bengawan Solo Rivers. The altitude is between 10 and 250 meter above sea level. The soil types of Randublatung are Latosol, Mediteran, Alluvial and Grumosol. The highest rate of rainfall is 228mm/month at February and the lowest rate is 42mm/month at July. The total rate of rainfall is 1,594 mm/year.

3.5. Analysis of data.

As mentioned above data used for the analysis are current data and those of 10 years before of 5 Forest Districts. Figure 2, 3 and 4 show results of tabular data analysis of Mantingan Forest District. The abscissa of the figure represents the current age and the ordinate represents the age ten years before. If both data are fitted and each dot is on a line, it means that the growth of teak trees on that compartment is normal.
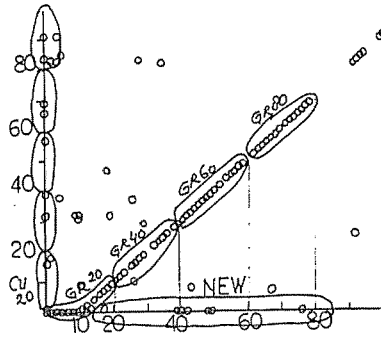
Figure 2. The growth of teak plantation
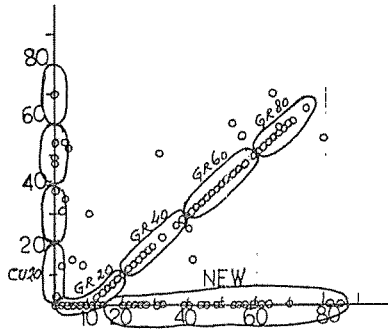in Mantingan FMD 1 based on age

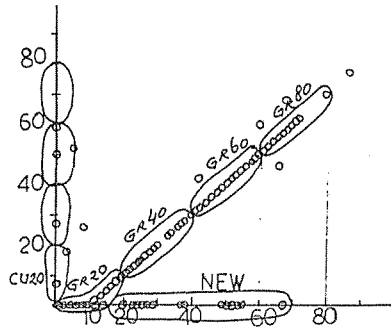Figure 3. The growth of teak plantation
in Mantingan FMD 2 based on age

Figure 4. The growth of teak plantation
in Mantingan FMD 3 based on age.

Absis X = Forest inventory of the current data.

Ordinate Y = Forest inventory of the ten years data before.

Figure 2, 3, 4

GR20 = The compartments which has teak trees with average age $\leq$ = 20 years.
GR40 = The compartments which has teak trees with average age $\leq$ = 40 years.
GR60 = The compartments which has teak trees with average age $\leq$ = 60 years.
GR80 = The compartments which has teak trees with average age $\leq$ = 80 years.
CU20 = The compartments which the teak trees on the age $\leq$ = 20 years have already cut.
CU = The compartments which the teak trees on the age from 60 years to 80 years have already cut.
NEW = The compartments which have new teak plantation.

The compartments which are located on the ordinate line of age more than 60 years old are the ordinary cutting forest areas. While the compartments located on the ordinate line of age less than 20 years old are abnormal cutting forest areas. In these compartments the growth of teak forest is not enough or too young to cut. Miscellaneous data is located outside of the line. These kind of data might be come from forest survey.

Figure 5, 6, 7, 8, 9, 10, 11 and 12 show the comparative forest growth conditions of Mantingan Forest District and Randublatung Forest District. The abscissa of the figure with class code 1, 2, 3 and 4 represent the forest area which has teak trees with average age less than 20, 40, 60, 80 year each. Class code 5, 6, 7, 8 mean the cutting forest area on the age less than 20, 40, 60, 80 year each. Class code 9 means the forest area which has new teak trees plantation. And class code 10 means the forest area which has miscellaneous data. The ordinate of the figure means the percentage of each forest area.

Figure 5 and 9 indicate that in Mantingan and Randublatung Forest District teak forests with site index less than 3.5 have a good growth. Randublatung Forest district has relatively wide areas of a good growth forest with site index greater than 4.5 in comparison with Mantingan Forest District. Mantingan and Randublatung Forest District have already cut teak forest widely at the age less than 20 years old with site index less than 2.5. It means the forest areas with low density and bad condition have already cut. It might mean that the forest area has been damaged severely from the outside of forest.

Both Mantingan and Randublatung Forest District have cut the teak forest at the age 80 years old about 80% with site index less than 3.5. These cutting operation were done properly. Figure 6 and 10 indicate the change of site index condition. $SI<0$ means the site index of the current forest inventory lowered in comparison with which of ten years before. $SI=0$ means the value of the site index is the same as before. $SI>0$ means the site index of the current forest inventory data have improved in comparison with which of ten years before. Randublatung Forest District and Mantingan Forest District have quite similar conditions of site index. However, Randublatung Forest District has the area of new teak trees plantation in the site index higher than before.

Figure 7 and 11 show the growth of teak plantation based on basal area factors. The area under 0.75 of basal area factor are dominant in both forest districts. If the basal area factor gradually increase to equal 1, the condition of forest areas become good and health. From this point Mantingan Forest District is widely suffering from very poor conditions in comparison with Randublatung Forest District, especially in the cutting forest areas with the age less than 20 years old (class code 5).

Figure 8 and 12 show the change of the basal area factor of Mantingan and Randublatung Forest District. In Randublatung Forest District the cutting forest areas of teak trees with the basal area factor higher than before were widely cut in comparison with Mantingan Forest District. On the other side, Mantingan Forest District area

has the new teak plantation areas with basal area factor same as before more wider than Randublatung Forest District.

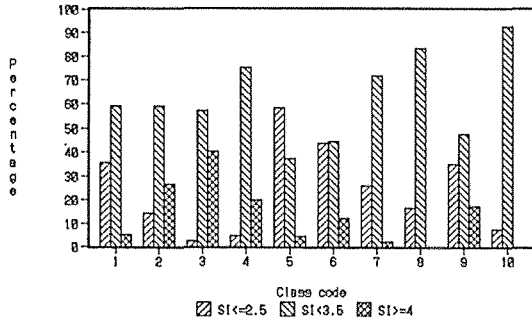Fig 5. The areal distribution of each class code in The Mantingan District.

Fig 6. The change of the SI of each class code in The Mantingan District.

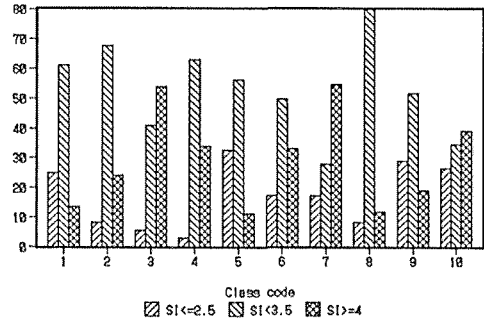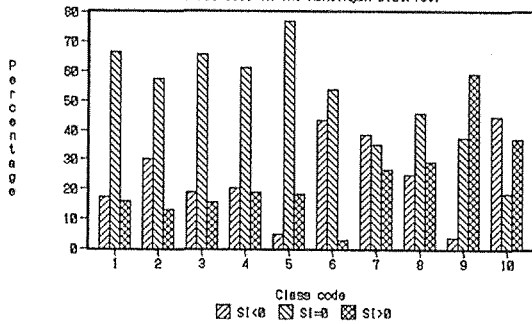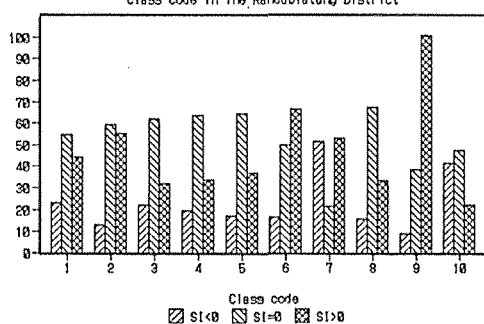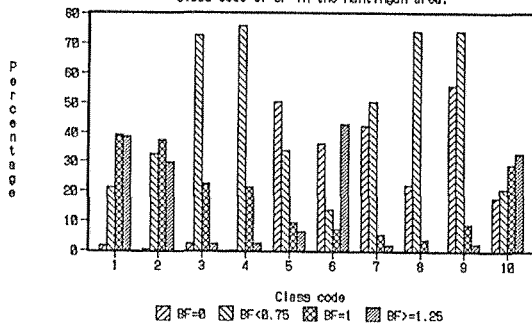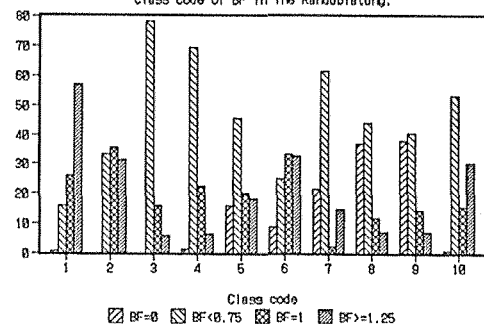Fig 7. The areal distribution of each class code of BF in the Mantingan area.

Fig 8. The change of the BF of each class code in The Mantingan District.

Fig 9. The areal distribution of each class code in The Randublatung District

Fig 10. The change of the SI of each class code in The Randublatung District

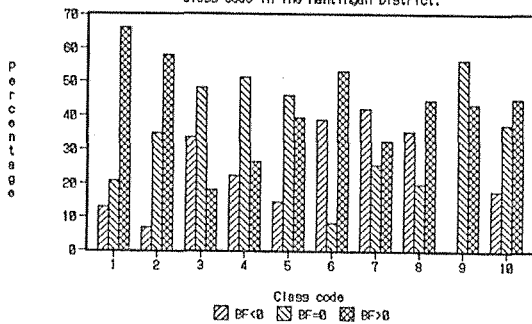Fig 11. The areal distribution of each class code of BF in The Randublatung.

Fig 12. The change of the BF of each class code in The Randublatung District

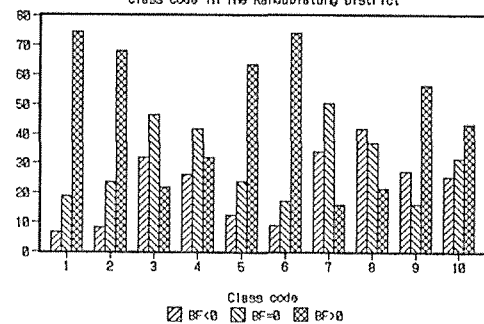Figure 5, 6, 7, 8, 9, 10, 11, 12
Class Code:
    1.＝The compartments which has teak trees with average age ＜＝20 years.
    2.＝The compartments which has teak trees with average age ＜＝40 years.
    3.＝The compartments which has teak trees with average age ＜＝60 years.
    4.＝The compartments which has teak trees with average age ＜＝80 years.
    5.＝The compartments which the teak trees on the age ＜＝20 years have already cut.
    6.＝The compartments which the teak trees on the age ＜＝40 years have already cut.
    7.＝The compartments which the teak trees on the age ＜＝60 years have already cut.
    8.＝The compartments which the teak trees on the age ＜＝80 years have already cut.
    9.＝The compartments which have new teak plantation.
    10.＝Miscellaneous data.

Figure 5, 6, 7, 8, 9, 10, 11, and 12 demonstrated the analysis of tabular data. However, It is still quite difficult to take an easy conclusion. In this paper, the graphical form of the data base of teak forest has proposed to make easy understanding of the data.

Figure 13 shows the graphic presentation of Mantingan Forest District in polygon format combined with Forest inventory data. The area in the outside of the boundary are villages or dry land. It shows that isolated part of Mantingan (Mantingan FMD 2) is located quite far from the center and is bounded with villages or dry land areas. We can easily show the condition of teak forest in color. GR20 (yellow) is the compartments of the teak forest under 20 years old. GR40 (light blue) is the compartments of the teak forest under 40 years old. GR60 (green) is the compartments of the teak
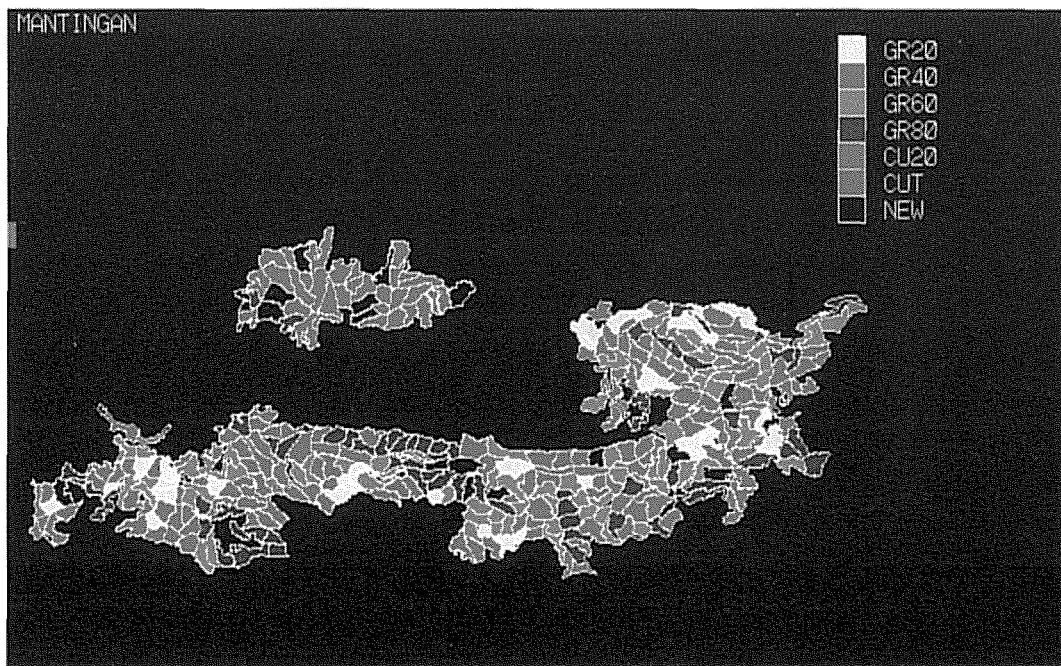

Figure 13. Forest map of Mantingan Forest District in compartment unit which shows the growth of teak forest condition.

forest under 60 years old. GR80 (violet) is the compartments of the teak forest under 80 years old. CU20 (red) is the compartments of the teak forest where all of teak forest under 20 years old have already cut. These compartments might be always disturbed from outside of the forest. CU (pink) is the compartments of the teak forest where all of teak forest have cut on the cutting time (80 years). NEW (blue) is the compartments of the teak forest which have new regenerated teak. We can see that the yellow color is scattered widely of the area. The light blue color is dominantly located in the central part of the area. And the violet color is also located in the central part of the area. This map shows that the growth of teak forest is still normal with the average age of teak forest between under 20 years and 80 years old, except of the isolated part (red color).

Figure 14 shows the graphic presentation of Mantingan Forest district overlaid with topographical map with interval contour of 50 meter. The circle form represent the number of compartment and location of each Forest Management Division. It shows that Mantingan FMD 1 (the left part) is located on the plain areas with the altitude less than equal 150 meter. In the hilly areas there is no clear effect with the condition of teak forest. Mantingan FMD 3 (the right part) is located on the highest areas which has quite similar condition with Mantingan FMD 1.
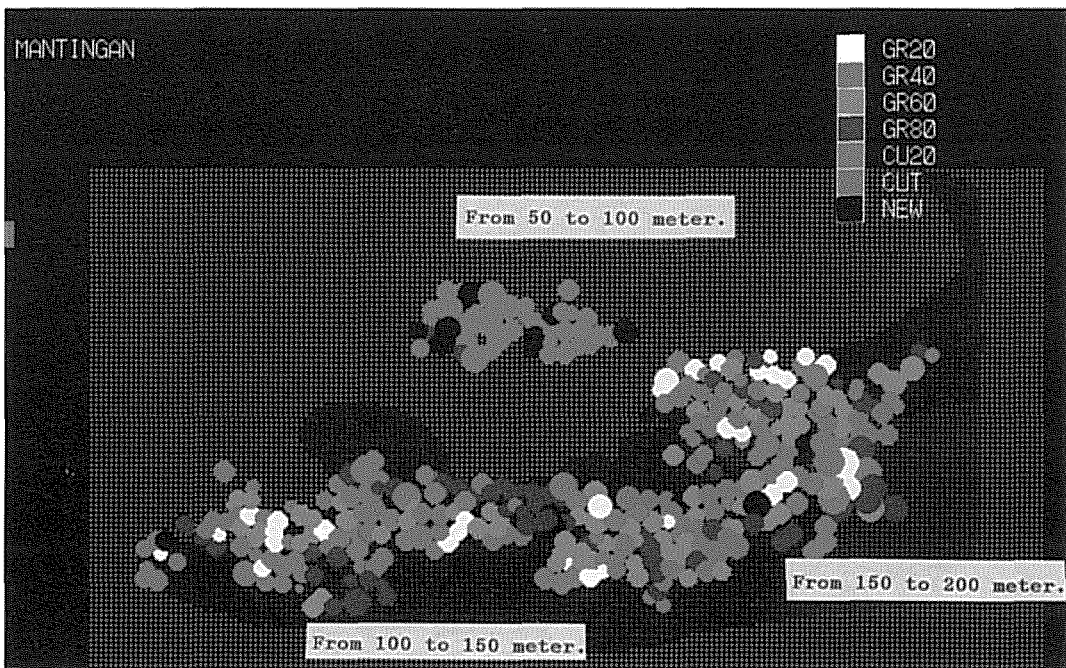

Figure 14. Forest map overlaid with topographic data of Mantingan Forest District.
Interval of contour is 50 meter.
Topographic unit is 200 meter square mesh.

4. Conclusive Remark.

This paper demonstrated a development of forest data base by using forest inventory data combined with forest maps and topo-graphical maps. Traditionally the teak forest management planning has been analysed by conventional method and it requires much time and labor.

This study has not been finished yet and it will continue to combine with Landsat MSS data in multi date and other data. Many questions have not been answered yet. We need more data base to consider what kind of factors affect the condition of each forest district. For examples: the number of villages, the number of cattles, the soil type of each forest district, the stand density of each compartment etc.

Resume

The teak forest on Java Island, Indonesia has been managed by Perum Perhutani State Corporation for more than 50 years. It is well known that the Corporation is following the sustained yield and maximum yield principle to manage the teak forest. These methods require much data on the periodical forest inventory.

Up to now a great number of inventory data have been accumulated. Recently various problems have been occured in the teak forest management. However, the corporation is still using traditional methods for solving the problems. Advanced computer technology offers a new aproach for storing, retrieving, editing and displaying data with relatively efficiency and low cost. Such kind of data base is very useful for forest planners or forest managers to make decision to solve the problems efficiently. The data base for the teak forest presented here gives information about the forest inventory, soil type, land use and topography regarding each compartment of the forest.

In this paper, data base of Mantingan Forest district in Central Java will be discussed as an example. It would provide us with a lot of useful information for the teak forest management planning. We can also pick it up rapidly for solving the problems.

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