Degradation of tropical mountain forest in the upper watershed of the river Konto (East Jawa, Indonesia): a qualitative and quantitative approach

(with two maps)

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Groningen, March 1990

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DOCTORAALVERSLAG/SCRIPTIE

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SUMMARY

Tropical mountain forest on Jawa is degrading fast because of the increasing demand for timber, fuelwood and fodder by the growing human population. In the upper watershed of the river Konto (total 233 km^2), 113 km^2 is covered by natural forest (65 km^2) or scrubland (39 km^2).
Monitoring of aerial photograph interpretations of 1979 and 1984 showed almost no reduction of total 'natural vegetation', but big changes in structural density in the forest and transition of forest to scrub. Structure degradation seemed to be concentrated in the zone between 1400 and 1700 m on Mt. Kawi and Andjasmoro, while recuperation of the forest structure occured below 1400 m, especially on Mt. Dorowati.
In a qualitative analysis of the vegetation composition, distinction has been made between two main forest types: *Casuarina junghuhniana* forest above 2000 m altitude on Mt. Kawi and Butak (fire climax vegetation), and mixed oak forest (*Lithocarpus ssp.*) below 2000 m. The mixed oak forests have been subdivided according to composition differences related to altitudinal zonation and basal structural differences. The distribution of height of saplings and trees has been analyzed per species group per vegetation type to test the probability of transitions between types.
By combining results of the monitoring of aerial photograph interpretations and the vegetation analysis, processes of degradation and regeneration have been described roughly for the different parts of the area. The most important cause of degradation appeared to be the selective cutting of economical valuable species for timber, which gradually induces a change in composition to a secondary forest without primary forest species. The forests on lower altitude are not interesting for timber any more, here some recuperation of structure has been found. In this zone collection of fuelwood and fodder seemed to be important, because cutting of saplings has disturbed the age distribution of the trees. In some parts of this forest, natural gaps will be taken too easily by *Eupatorium inulifolium* because a new canopy can not be formed quickly enough, regeneration of forest from dense *Eupatorium* scrub is very difficult.
The present processes probably result in the vanishing of primary species within a few years period, while steadily more scrubland develops from secondary forest. Big management changes will be necessary to save the forest from further degradation. However, this is only possible when less people are dependent on the natural forest products to have a living.

ACKNOWLEDGEMENTS

This project would not have existed without the support of a lot of people and organisations, all of them I want to thank very much. Some of them I like to mention seperately:
At first I want to remember Dik Thalen, who proposed this project to me and was going to be my supervisor. Unfortunately, before I started Dik Thalen suddenly died. I hope his ideas are still visible in my work.
Professor Jelte van Andel (Lab. of Plant Ecology, Groningen) has motivated me to go on with the project and has supported me always when I needed it.
Willem van Wijngaarden (I.T.C., Enschede) was a great support in the starting up of the project and later on he motivated me a lot during enthusiast discussions about the work.
Fred Smiet (S.E.C.M., Bogor) replied my asking for help with much information and very enthusiast support; as well as by letter as in conversations in Bogor. Without his effort I probably had not got the allowance to work in the Konto area.
When looking for an opportunity to get a visum, I asked help to Chris Geerling (Dep. of Nature Management, Wageningen). He supported me immediately as much as he could.
DHV consultants and their Indonesian counterparts allowed me to do this project as an apprenticeship in the Kali Konto Project (ATA 206) in Malang and arranged my visum and housing. Especially Sjaak Beerens, the teamleader of the DHV consultants in Malang I thank a lot for all his effort to help me, although this project was not direct related to the present activities of the Kali Konto Project.
The fieldwork would not have been possible without my great helpers Pak Wagi and Pak Rukian, and our driver Pak Basuki. We had a nice time together, terima kasih banyak.

CONTENTS

1. INTRODUCTION

In Indonesia, and in Jawa in particular, there is a growing imbalance between population size on the one hand and carrying capacity of agricultural and forest land on the other. The increasing labour force cannot be absorbed by the available opportunities for employment, so that the rural population has to depend almost entirely on agricultural and forest land to find themselves a living. To fulfil the demand for fuelwood and fodder, the pressure on forests is increasing. Besides the rapid decline in production from the forests, this can cause disturbances in the ecological balance; characterized by increased soil erosion, decreasing water availability for irrigation and domestic purposes, and the flooding of downstream areas.
To improve the capacity for watershed management, the Indonesian Government applied for donor assistance. In 1979 the Kali Konto Project was initiated as a development cooperation project between the Governments of the Republic of Indonesia and the Kingdom of the Netherlands. The original project activities were restricted to the official forest area and were formulated as follows: 'Draw up a masterplan for forestry and agro-forestry for the upper watershed of the Kali Konto in such a way that a proper balance is achieved and can be maintained between the functions of the forests and the needs of the population.' After some initial findings and institutional changes the objective for Phase II was not any more only scoped on forest land, but on the formulation of a watershed plan for the whole Kali Konto Upper Watershed.
Phase III (1986-1990) is the implementation phase. It is directed at:
- Implementation of measures recommended in the plan for watershed management development prepared in phase II
- Further development of the methodology for watershed planning as applied in the Upper Konto Watershed Area to suit watershed areas with other characteristics
- Research and monitoring activities to support the other project activities
- Training of staff of the cooperating Indonesian Agencies

(P.K.K. 1987)

Especially in Phase I and II much research has been carried out in the natural mountain forest of the Kali Konto Upper Watershed. This work can be subdivided in two parts, the vegetation survey (Anonymus 1985b) and the transect survey (Smiet 1989).
The vegetation survey (Anonymus 1985b) aimed to study the impact of human activities on the forest vegetation and to asses the capacity of the forest land, both to maintain its protection function and to fulfil local demand for forest products. A lot of data throughout the entire forest area have been collected and with the aid of these a vegetation map on scale of 1 : 50,000 was prepared. During this survey much time has been put in collecting plantmaterial, identification and composing of a fieldherbarium.
Moreover, in selected areas, a much more detailed transect survey has been carried out (Smiet, 1989). In these transects, with a total length of approximately 3 kilometer, the structure of the treelayer and the morphology of each tree individually has been drawn carefully. After 6 years this procedure was repeated on the same spots. With these data more detailed insight on the process of degradation and regeneration of the natural forest has been gathered.

However, the vegetation data can probable provide more information than given in the reports. Further interpretation of the data can give important information for a qualitative description of degradation and regeneration processes.
The transects covered only 0.07% of 5089 ha montane rainforest occurring in the study area, while 6860 ha scrub area was not covered at all. In order to estimate the area affected in the whole project area, another method is needed.
Aerial photographs of the project area on a scale of 1 : 20,000 are available for 1979 and 1984. Interpretation of aerial photographs of these two years will give the possibility of monitoring differences in forest types between these two years.
Combination of data from earlier studies with this aerial photo interpretation gives the possibility to make a landscape ecological map of the area, in which the position of the forest in the study area is more obvious.

Thus, the aim of the present study is to provide a better overview of the state of the natural forest in the whole project area and to give a quantitative and qualitative description of the degradation processes in the forest.
The following questions will be tried to answer:

1. Can the spatial distribution and relations of the main landcover and landform types in the study area (landscape ecological survey based on aerial photograph interpretation, I.T.C. method) give more inside in the position of the forest in the study area.

2. Can monitoring of aerial photograph landcover interpretations (scale 1 : 20,000, 1979 and 1984) provide reliable quantitative data on forest degradation for the whole study area.

3. Is it possible to describe the processes of degradation and regeneration of the vegetation in the area qualitatively by integration of the vegetation data and the monitoring results.

In Chapter 2 a description of the study area (topography, climate, geology, hydrology, landuse and socio-economic situation) is given which shows the context in which the forest area must be seen in the total area.
Chapter 3 describes the methods of photointerpretation and vegetation study and in Chapter 4 the results can be found. Chapter 5 gives a short conclusion for the forest in the area, Chapter 6 a discussion of this study.

2. DESCRIPTION OF THE STUDY AREA

2.1 Topography

The study area is situated in the Kabupaten Malang in East Jawa (Indonesia), about 90 km south of Surabaya and 20 km northwest of Malang (fig 1).
The area (fig 2) is covering the upper watershed of the river Konto, which is one of the tributary rivers of the river Brantas, the biggest riversystem of East Jawa. It comprises a mountain landscape of volcanic origin with three steeply sloping mountain systems with in between an upland plateau. The upper borders of the study area follow the watershed border over ridges and mountain peaks. The lower border of the upper watershed is the dam in the artificial storage lake Selorejo. Totally the area covers 233 km² or 23326 ha.
The range in altitude in the study area is from 620 m above sealevel at the Selorejo dam till 2800 m on the northern slope of Gunung Butak (just below the top: 2868 m).

2.2 Climate

Climatical data of the study area are mainly based on the one official meteorological station in Selorejo and on additional data from the D.A.S. Brantas Watershed Management Authority in Malang. But due to topographical circumstances great climatic variations occur through the area. Rainfall data over the period 1950-1978 show differences is annual mean between Sekar (700 m) and Pujon (1150 m) of 27 percent (resp. 2737 mm and 2163 mm).
In general can be concluded that rainfall is seasonally distributed: June till September are the driest months, May and October have an intermediate rainfall and November till April are wet months. Annual variations are especially large in the dry season, rainfall can be abundant in the dry season in one year and zero in another.
Related to altitude and relief larger variation occurs higher up the mountains. Northern and eastern exposed slopes receive less rainfall than southern and western exposed slopes, due to rainshadow and rainfacing (stemming effect). Higher up the mountains, rainfall is not as clear distributed in wet and dry seasons, it is more distributed over the year. On the top of the mountains the intensity of rainfall is lesser, because most of the rainfall falls in drizzle and light showers.
Mean year temperature in Selorejo is 22-24°C. But, while situated at the lowest part of the area, these data are not representative. Average temperature decrease with increasing altitude: every 100 m rise in altitude corresponds with a 0.6°C temperature fall. Night time frost has been repeatedly reported from the summits of Gunung Kawi and Butak (2600-2800m).

2.3 Geology & geomorphology

The area is situated in the Solo Zone, a longitudinal volcanic area between the Tertiary geanticline of the Southern limestone hills and the geosyncline of Northern Jawa. The zone is filled and capped by a series of giant quarternary volcanoes and intervolcanic plains. (Anonymus 1984a)

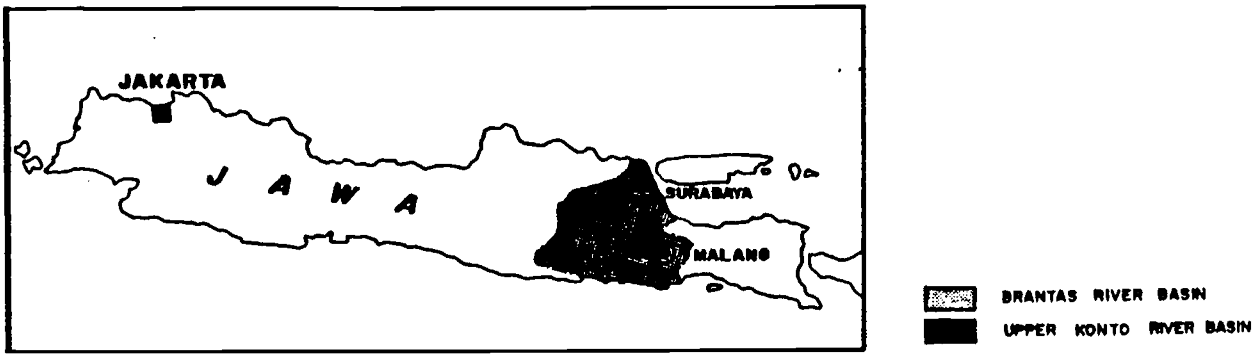


Figure 1 : Location of the study area.

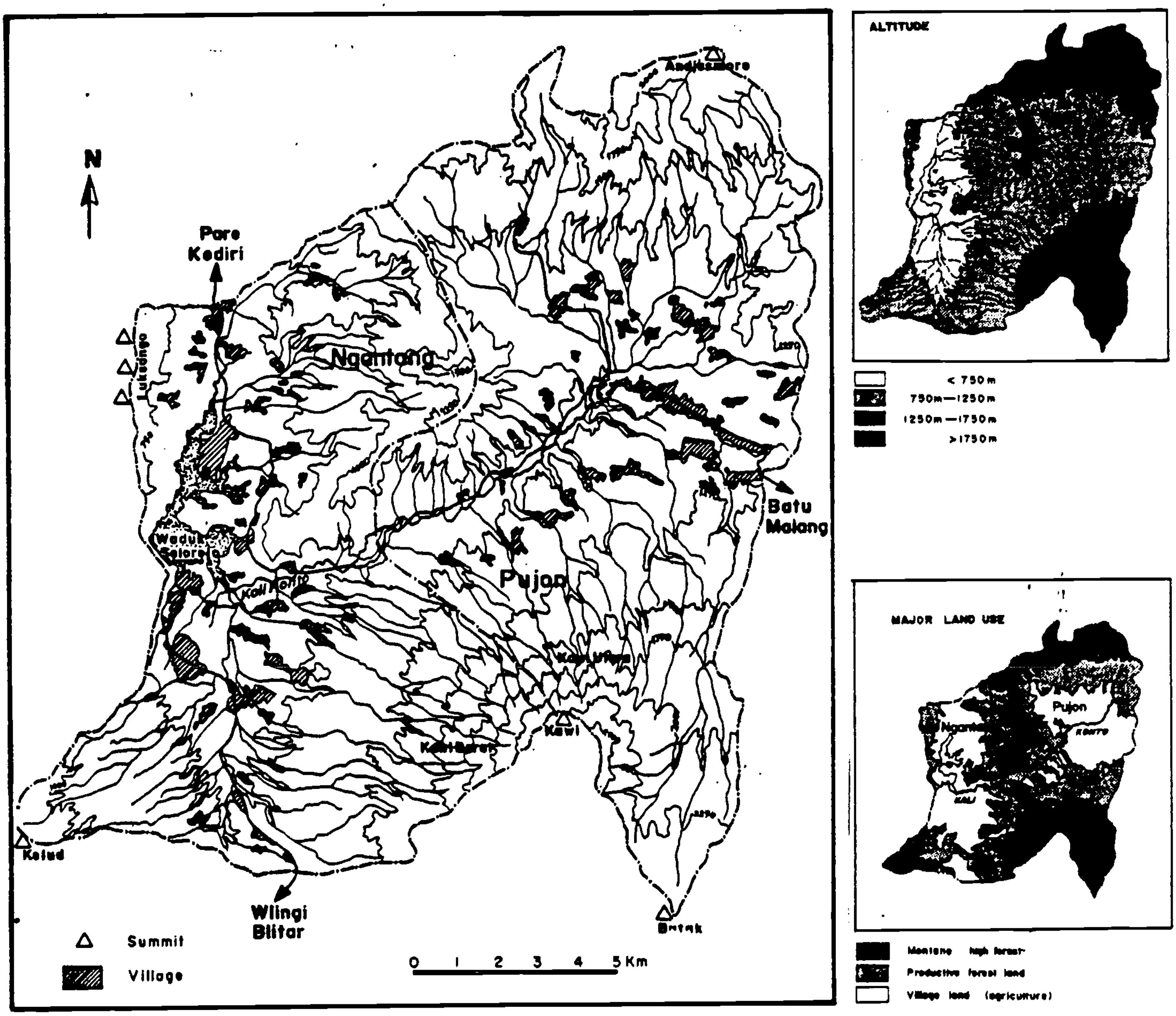


Figure 2 : The topography of the upper watershed of the river Konto, with main altitudinal distribution and major land use.

The oldest volcanic complex in the area is the Andjasmoro mountain range. Van Bemmelen (1949) considers the mountains to be formed during the Upper Pleistocene, though others consider the range to be formed somewhat earlier (Middle Pleistocene). The base consists of thick layers of basaltic and intermediate lava flows, covering the older rocks and sediments. On top of the flows a number of volcanic cones developed. Due to faulting and folding, the Andjasmoro volcanoes broke down in a number of irregular blocks. One of the old Andjasmoro craters is the Gunung Parangklakah, situated within the area. The rim of the almost perfect circular crater is still well intact. The western section of the rim collapsed, possibly under the weight of the lake resulted in a huge lahar flow of mud, volcanic debris blocks and boulders, which covered the lower intervolcanic plain.

The twin volcanoes Butak (2868m) and Kawi (2631m) belong to a group of younger, holocene volcanic structures which partly cover and mask the older upperpleistocene complexes. They are situated on a small N-S transverse fault. The complex consists of successive and overlapping shields and layers of andesitic rocks, breccias, agglomerates, tuff and ash. Alternated resistent and less resistent layers favour the formation of steepsided valleys and undercutting of less resistant layers give rise to the formation of waterfalls.

Although both volcanoes are considered extinct, the Butak is probably younger than the Kawi. The cone of the Kawi is strongly dissected by radial, extremely deep and steep ravines with sharp edges and crests. The Kawi has a well formed and deep crater, which is open towards the south-west, as a result of the collapse of the crater rim. The northern rim of the crater is part of the watershed boundary.

The Kelet and the Amping-Amping are two small volcanic cones on the intervolcanic plain of Pujon. The Kelet is a single lava eruption cone, build up of andesitic rocks. The Amping-Amping is a volcanic spatter or cinder cone, consisting mostly of loose cindery volcanic material. Both cones are covered by thin covers of volcanic ash.

The Kelud volcano is the youngest and only one still active volcano of the area. It has over the centuries brought both prosperity and tragedy to the region: prosperity in the form of regular volcanic ashes enriching the surrounding lands and tragedy as a result of violent eruptions, hot and cold lahars and periodic floods creating havoc in populated areas.

The Kelud has a crater filled with rainwater. Eruptions generally start with the formation of a steam pillow at the bottom of the lake produced by increasing heat and mounting pressure. When the eruption takes place, the whole lake is ejected. A cold lahar mud and boulder stream will run down through the ravines, soon followed by hot lahar formed by the hot deeper water layers of the lake. Most lahar valleys are found on the southern and western slopes of the Kelud, outside the study area. The one small lahar valley on the north eastern slope is no longer recognized as active.

Recent eruptions have taken place in 1811, 1826, 1835, 1848, 1864, 1901, 1919, 1951 and 1966. The 1919 eruption killed over 5000 humans and destroyed 104 villages, all in a time span of 45 minutes. After this the lake is drained by a number of tunnels on the Blitar side of the mountain. The last two eruptions caused significant less damage than usual, but destroyed also the tunnels. So at present lahars are again a potential danger.

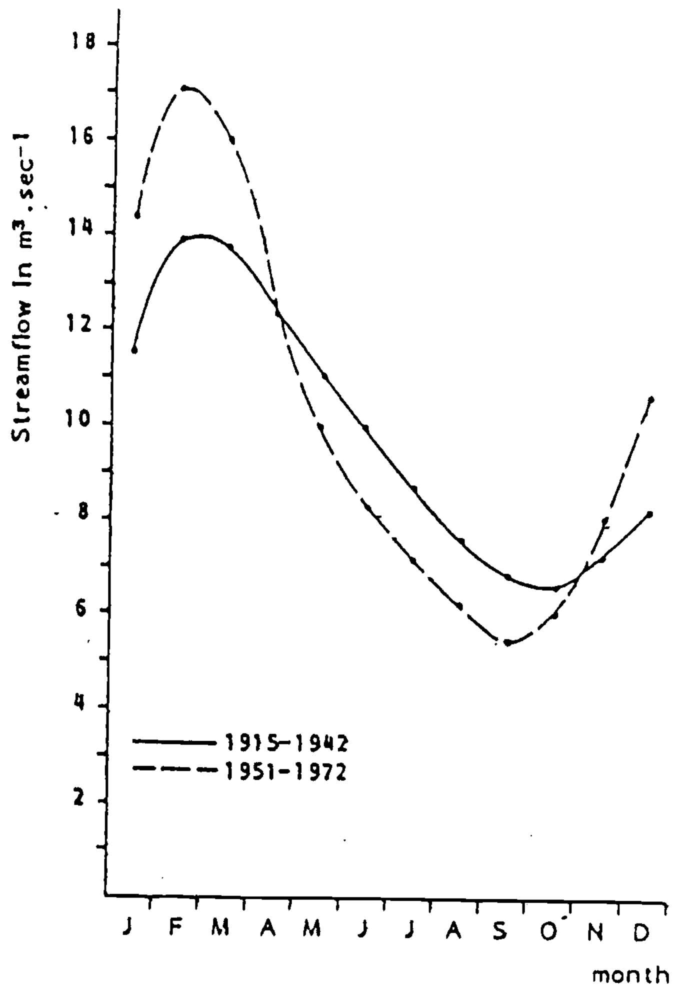
During writing of this report (February 1990) a new eruption has taken place. Again 16 humans have been killed and about 500 injured. If this eruption has

affected the north eastern slope (the study area) is not yet known.
All slopes of the Kelud are covered with thick layers of pumice and ash.

2.4 Hydrology

In the area consists of three subcatchments: the Kali Konto with a catchment area of 13.700 ha, the Kali Kwayangan of 5.300 ha and the Kali Pinjal of 4.300 ha. These three catchments come together in lake Selorejo. The artificial storage lake Selorejo is formed after completion of the Selorejo dam in 1970.(Anonymus 1985a)
Reliable streamflow data from the Kali Konto are available for an extended period. In fig 3 streamflow data of pre-war records, when more forest was still present, and for the 1951-1972 period are shown. In this second period show higher flows during the rainy season, probably caused by decreased infiltration opportunities caused by the increased area occupied by impervious surfaces as roads, yards, roofs, etc. rather than increased surface runoff from agricultural land. Water thus lost as direct runoff does not contribute to deep percolation, causing the diminished flow rates observed during the dry season. (Bruijnzeel 1988)
Another possible explanation for the streamflow differences is methodically, the modern measuring units can register continuingly, the old ones had to be switched on during rainfall or drought causing less confident total amounts.

Figure 3 :
Change in streamflow regime with time for Konto River (from Bruijnzeel 1988).



2.5 Landuse

The forest lands, according to the official forest boundary, covers approximately 15.625 ha.
About 7000 ha is covered by natural montane forests, 7800 ha by scrub land and remnants of the original natural forest (Smiet 1989). Not all scrub land is the result of direct degradation. Between 1860 and 1880 large area of natural vegetation on the lower and even middle slopes of the mountain complexes were transformed into coffee plantations. Around the turn of the century a devastating fungus disease killed most of the coffee and caused that most plantations were abandoned. Restoration of forest vegetation on these lands apparently failed, most are now scrub land.
About 1100 ha of the forest land is covered by plantation forests. Most are situated on the old abandoned coffee plantations, which are not too steep and well accessible. Species planted are *Pinus merkussii* (pinus), *Eucalyptus spp.* (ekalyptus), *Agathis loranthifolia* (damar), *Anthocephalis cadamba* (jabon), *Calliandra spp.* (kaliandra) and *Swietenia ssp.* (mahoni).
Perum Perhutani, the State Forest Corporation, is responsible for the management of the forest area which is carried out mainly in the plantation forests. In addition a range of unauthorized uses are made of the natural forest by the local population. Numerous people enter the forest land daily in search of timber, fuelwood and fodder. It is estimated that at present 4750 manyears are spent annually on unauthorized activities in the forest area (table 1).(Smiet 1989)
The village lands cover approximately 7.420 ha of which 5.950 ha is farmland: sawah (irrigated rice) 2.160 ha, tegallans (annual crops) 3.785 ha and homesteads with kebun (perennial crops and fruit trees) 1.475 ha.(Anonymus 1985a)
In the area are two major agricultural areas, one around Lake Selorejo (Ngantang), one around Pujon. They are situated in different agro-ecological zones and have different types of agricultural and cropping systems.

Table 1 : Total annual forest produce of unauthorized activities in the study area (Smiet 1989, modified after Nibbering 1987).

Activity	Quantity	Manyears	% of local demand
Fuelwood collection	74.300 m3	3000	86
Timber collection	30.000 m3	250	150 1)
Fodder collection	50.000 ton	1500	29

1) an estimated 10.000 m3 is exported from the area

In Ngantang large tracts of land have a continuous and abundant water supply, permitting two rice crops a year or even five per two years. Where the water supply does not permit continuous wetland rice cultivation, maize and other crops are cultivated during the dry season. In the not irrigated areas mixed perennial crop and coffee gardens are typical. These include coconut, clove, citrus, avocado, banana, jackfruit, durian, papaya, vanilla and some food and vegetable crops. Also tegallans occur, in which maize is the dominant crop. Intercropping with cassava is common. On the lower slopes of the Kelud tobacco is an important cash crop.

Photo 1 : Selective cutting of economical valuable species.

The Pujon area is a major vegetable growing area with cabbage, irish potatoes, carrots, onions, beans, chinese cabbage and red pepper. Vegetables are cultivated on both irrigated or semi-irrigated land and on tegallans. Subsistence crops in the Pujon area are maize, wetland rice, cassave and sweet potatoes.
Agroforestry projects have been set up in the study area as well. Most widely spread is the socalled 'tumpangsari' system. The purpose is to allow farmers, for a restricted period during the establishment phase of the forest plantation, to cultivate annual food crops and forage crops in between the rows. In exchange, the farmer tends the forest plantation. Because this system appeared to be not very successful (with the farmers and the crops most young trees disappear as well), the Project developed some other agroforestry systems. In these systems villagers must be able to fulfil their fodder and fuel needs, as well as to develop their responsibility for the management of forest land resources.

2.6 Socio-economic situation

The area is situated partly in the Kecamatan Pujon (12,505 ha) and partly in the Kecamatan Ngantang (10,820 ha).
The population in the whole area (1985) is approximately 95,000 (P.K.K. 1987). Comparing the data of 1980 with those from 1972 indicate an average annual population growth of 1.75 % (at present approximately 1.0 %). The average population density, or the number of inhabitants per square kilometer agricultural land, was about 1150/km^2 in 1980. All people live in desas or kampongs, and although the space between the already densely packed houses still produce considerable amounts of fruits and vegetable crops or are used for animal and dairy production, the urbanized villages in the area cover 1475 ha or 20% of the available farmland. The average farmsize is 0.56 ha, 29 % of the households is without land.

3. MATERIALS AND METHODS

3.1 Aerial Photograph Interpretation

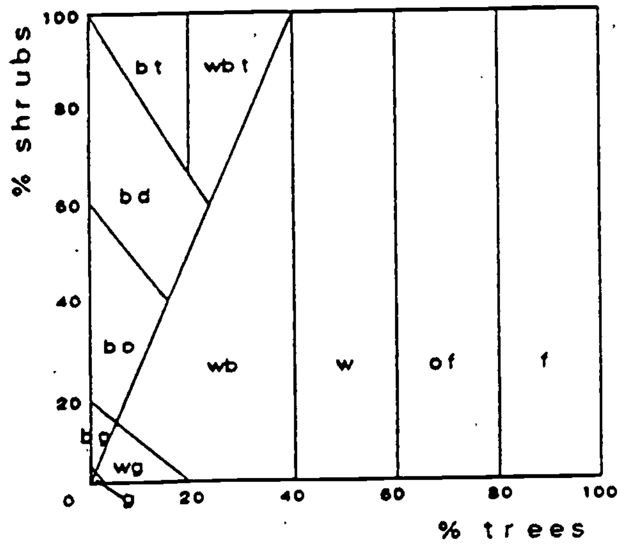
3.1.1 Materials

Aerial photographs of 1979 and 1984 are available on scale 1 : 20,000.
The photographs of 1979 have been taken by PENAS on the 4th of July 1979, under good weather conditions. A panchromatic black and white film was used. The photographs have a very good contrast, but parts of Gunung Kawi show deep shade, particularly on the west side and in deep valleys, due to the time the photos of these area were taken (7.30 - 8.00 a.m., when the sun is still rather low). Interpretation of the cover of these shaded areas is impossible. The photographs of 1984 were also taken by PENAS under good weather conditions on the 22nd of August 1984. Again a panchromatic black and white film was used. Prints of the film were slightly overexposed, resulting in a rather narrow range of greytones with less contrast than the photos of 1979. This series shows less shade on Gunung Kawi and only 1 or 2 small clouds.
From the aerial photos of 1979 an orthophotomosaic has been composed by Hansa Luftbild in May 1981. Hereby rectification for scale and radial displacement has taken place. The quality is only slightly lesser than the original quality. With photogrammetrical techniques detailed contourlines are added by ITC in 1981.

3.1.2 Methods

An interpretation of the aerial photographs has been carried out according to the method of the ITC Rural and Landecology Department (Van Gils et al. 1987). After some orientation, a legend has been made in which most emphasis was put on the natural forest types. Between these types especially differences in tone, texture and structure have been described. A structural diagram (fig 4) has been used with slight modification after Van Wijngaarden (1983) (In: Van Gils et al. 1987). Also covertypes outside the forest border have been included in the legend, but with less detail.
A terrainlegend has been used after the landunitmap (Anonymus 1985a), while information about the units has been added from the soil map (P.K.K. 1984). In this way the relation with terrain could be included, while no double work was done. The units of this terrainlegend could be easily recognized, but sometimes small border-differences with the original map may occur.
It has been noticed that scale differences between photos could cause differences in interpretation of tree-crown size which is not real. Still this is included because, especially near the forest border, differences in crown size are an important difference between forest types.
In fig 5 the method of monitoring is schematically drawn. In a 4 weeks period both series of photographs have been interpreted by the same person. Because most borders between types are subjective, this was not an easy job. Sometimes differences in contrast and tone of the photos was so big that it was not clear if this caused different interpretation or that really something had changed. After delineation of the photos the interpretation-lines have been transferred by free hand to the orthophotomosaic. Both years were transferred

on separate orthophotos. Because after this transfer scale differences are excluded, both interpretations could be monitored. The monitoring was done on skyclear tracing paper, dividing the area in smaller parts. In this way detailed monitoring maps were made, which were used during fieldwork.
After fieldwork two maps could be drawn:
- a landscape ecological map, based on the most recent (1984) photographs and some minor corrections from fieldsurvey, in which spatial relations of landcover with topography, landform and soils could be drawn
- a landcover monitoring map, on which differences between landcover interpretation of the photographs of 1979 and 1984 could be drawn. This is only done for the 'natural' landcover types, not for the agricultural land, villages and plantations, which are of minor importance in this study (for landuse changes: see Heetman 1989)
From both maps, quantification of units was possible using freehand planimetric measurements. The accuracy of these measurements is reasonable: differences with earlier measurements is unavoidable, but the quantitative relation between different units and the spatial distribution is useable.



g - grassland
bg - bushy grassland
wg - woody grassland
bo - open bushland
bd - dense bushland
bt - thicket bushland
wbt- woody thicket bushland
wb - woody bushland
w - woodland
of - open forest
f - dense forest

Figure 4 : Structural diagram (from Van Gils et al. 1987, after Van Wijngaarden 1983).

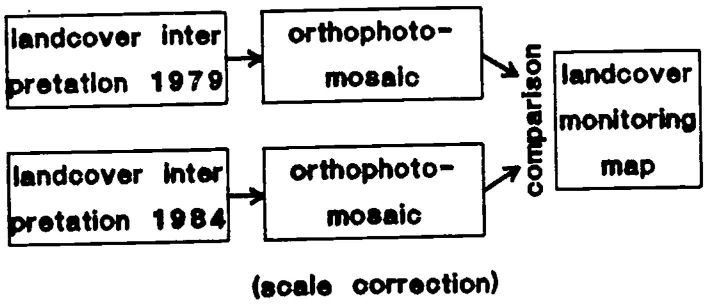


Figure 5 : Method of monitoring: both separate landcover interpretations are transferred to the orthophotomosaic (scale corrections), after this they are compared and a landcover monitoring map is composed.

3.2 Fieldsurvey

Fieldwork was carried out in the project area from August till October 1989. The geology, geomorphology, soils and hydrology in the area are already described sufficient in earlier studies. Also the vegetation survey should have been enough, but locations of the (over 900!) plots appeared to be only very roughly known, so it was not possible to relate them with the coverunits from the aerial photograph interpretation. So the aim of the fieldwork was to sample the natural coverunits, described from the aerial photographs, on composition and structure of trees and herbs in different parts of the area. Next to that, human and natural influences in different vegetations had to be sampled, especially on spots where differences were found while monitoring the interpretation of 1979 and 1984. Combination of both aims lead to a stratified random sampling method in which the forest border got special emphasis. In this zone different important vegetation types were relatively close together, while also most changes appear there. Because time for fieldwork was short, sampling is mostly carried out near paths. It would have been very timeconsuming to go to many places where paths were absent.
These choices have the following consequences:
- Special vegetation types higher up the mountains have been sampled only sparsely, because their importance for the study of human influence on degradation and regeneration processes is limited.
- Not all spots where something seemed to have happened could be sampled because of inaccessibility of the terrain.

The size of the sample plots is chosen as 20x20 m2 or 400 m2. The main reason for this choice was that during the vegetation survey this size has been used in the forest area as well. The size of a sample plot must depend on two criteria: it should be even with the minimum areal needed to represent most of the variation in species of the particular area, but also a homogenous area of environmental variables.
Meijer Drees (1954) proposes ¼ ha (2500 m^2) as maximum surface for a relevee in a tropical lowland rain forest, because bigger surfaces are too large to make a relevee. But, in his opinion, this means already a slight change in the meaning of the relevees: they are no more complete examples (associates) of some community but 'fragments'. But in each community these fragments are comparable, though in a association table the presence data will tend to be lower than normal.
This last point is probably also true in this survey. Compared with tropical lowland rainforest, this tropical mountain forest is far less complex. On the small ridges and steep slopes surfaces over 400 m^2 are already very difficult to cover as a homogenous plot, ¼ ha is impossible.
In the scrub area without or with few trees, 10x10 m2 or 100 m2 seemed enough according to both criteria.

Principally the position of the sampling plots has been chosen using the stratified random sampling method described by Van Gils et al. (1987). However, because it was not known in front where paths exists and what was their condition, exact planning of the route to follow was not possible in front. The detailed monitoring maps have been used in the field, in combination with a decision on the spot on homogeneousness of composition and representiveness for a larger area.

In the sampling plots the following is described:
- altitude above sealevel, exposition, slope and terraintype
- total cover percentage of trees, of shrubs and small trees and of herbs separately
- total cover percentage of all vegetation together
- for trees > 5 meter: diameter on breast height (dbh), height, crownsize and coverpercentage-class. For this a decimal scale is used in which for low percentages density also counted (table 2). With the dbh-values basal area could be calculated.
- for herbs: coverpercentage-class of each species
- epiphytes and lianes were not recorded, only approximate total frequency was noted
- number of stumps, dead or cut trees with species name, diameter and cause (human or natural)
- evident influences on the vegetation: fodder or fuelwood collection, burning, landslides etc.

Table 2 : Sampling scale used during fieldsurvey.

Code	Density	Coverpercentage
r	rare	< 5 % cover
p	few	< 5 % cover
a	abundant	< 5 % cover
m	many	< 5 % cover
1	irrelevant	about 10 % cover
2	,,	about 20 % cover
3	,,	about 30 % cover
4	,,	about 40 % cover
5	,,	about 50 % cover
6	,,	about 60 % cover
7	,,	about 70 % cover
8	,,	about 80 % cover
9	,,	about 90 % cover
10	,,	about 100 % cover

Two local treespotters were available. They knew local names of almost all trees and herbs. Together with the fieldherbarium of the earlier vegetation survey and lists of local names used by these two men with connecting scientific names, only a few species needed to be collected for later determination.
In fieldwork 96 sample plots have been made, with a total of about 118 treespecies and 90 herbspecies (appendix 1). From about 85 % of these, scientific names are known. Most of the rest is collected for eventual later identification.
The agricultural, village and plantation forest areas are not sampled. Enough is already known from other surveys to fill this part on the map roughly.
To connect this study with the transect study, the transects near the forest border have been revisited and a plot was laid out according to the just described method.

3.3 Processing of the vegetation data

The vegetation types in this study are described as plant-communities. This implies that floristic composition is considered as a basic feature of the vegetation. This is not a point of general agreement among vegetation ecologists. Some of them, especially those from the 'Anglo-American' tradition consider a plant community as less practical or unscientific (Mueller-Dombois and Ellenberg 1974), others doubt the suitability of the concept in the (humid) tropics (Van Steenis 1961, Jacobs 1981). The arguments against the plant community approach are listed by Van Steenis (1961):

- The very large number of species of which in general none is dominant implies an extremely large minimum area, which is not only impractical, but also difficult because of homogeneity of abiotic factors within the plot. Hommel (1987) states that vegetation-scientists are not very interested to know all the rare and dispersely occurring species of a given stand or region. They are primarily interested in knowing the characteristic combination of the more frequently occurring species. This concerns the ones which usually make up the bulk of the vegetation, as well as the ones that statistically show sufficient affinity with specific species-combinations and thus become good diagnostic characteristics for vegetation types. In fact, it is obvious that a plot may contain more species (and its size can thus be kept with reasonable limits) if there is no dominance of one species, occupying the room within the plot which could be occupied by many other species growing in low densities. One might even state that the lack of dominance in rain forests may facilitate plant-sociological studies.
  Austin & Greigh-Smith (1968) state that in tropical rain forest with high diversity and low species predominance, rare species provide little information (unless data external to the study are available) and qualitative data are likely to be more satisfactory than quantitative.
- Within the forest one finds very complex mosaics, caused by local regeneration processes and resulting in capricious patterns in the floristic composition. Hommel (1987) admits that this is a problem, but it often is unnecessarily exaggerated if one ignores all plants, but the fully-grown trees. Therefore in this study in principal all sizes of trees and herbs have been included (as far as recognizable).
- In many cases we are dealing with very gradual transitions, as far as the abiotic factors are concerned, resulting likewise in gradual transitions in the species composition. Hommel (1987) states that this problem is not restricted to the tropics. As Van Steenis himself points out, in the species-rich tropical forests one finds many species with a more or less identical autecology, from which can be assumed that the problem is relatively small.

Hommel (1987) concludes that the arguments against defining strict plant-communities in a tropical forest area are not very firm. The lack of such studies in many tropical countries, Indonesia included, seems to originate from scientific tradition rather than from scientific theory.
In this study it is just tried to see how it will work out.
Also in the processing of the vegetation data it was not possible to combine the data with the earlier recorded dataset, in this case due to my own time restrictions.
The vegetation data were processed using the computerprogrammes TWINSPAN and CANOCO, with coverclass as a weighing factor.
TWINSPAN (Hill 1979a) is a clustering program, which put together samples and

species most alike in the set. But using TWINSPAN is not like using a objective calculation method, you already can to put in subjective parameters like differences in indicator-value of species. In this case this caused problems, because not very much is known about the species found. TWINSPAN has been run with seven levels of pseudospecies (table 3), so more abundant species got a heavier weight than species only sparsely present.

Table 3 : defined levels of pseudospecies used in TWINSPAN

Level	Sampling scale (see Table 2)
1	r
2	p
3	a, m
4	1
5	2, 3
6	4, 5, 6
7	7, 8, 9, 10

Using programs like TWINSPAN must be done with some hypothesis in your mind. Otherwise you get results which you can not interpret or whose interpretation is meaningless for your project hypothesis. In this dataset, two main factors have to be separated. These are the natural gradient in the vegetation, altitude, and the human influence on this, structure degradation. Only when this has been separated while grouping, conclusions to degradation processes can be expected.
Using the CANOCO indirect detrended canonical correspondence analysis (DCCA) (Ter Braak 1987), a method based on the DECORANA ordination method (Hill 1979b), the relation between these two factors and the samples and species in the dataset can be discovered. CANOCO calculates distances between samples (or species) which results in an ordination diagram where these have x and y coordinates based on similarity in the set. The included environmental factors (in this case: altitude and % trees which are more than 20 meters in height) are shown as vectors, whose direction shows direction of influence of the vector and whose length shows the importance of the factor related to the other vector. But CANOCO also is really a subjective method, species or samples can be excluded or can be given negligible weight. Chosen is to exclude only those samples and species which are really not important for the hypothesis; the bush- and forest-plantation samples and species. No further transformation was done, the sampling scale was already a logarithmically transferred scale in relation to normal percentage cover. Rare species have been downweighted by the computerprogram.
While comparing groups from TWINSPAN with the ordination diagram, some groups seemed to be grouped influenced by other factors or combinations of factors. To make the grouping interpretable to the above mentioned factors, some rearrangement of samples in the vegetation table has taken place. After this the composition of vegetation types and species groups are determined.
Until this moment no difference was made between trees and saplings, only cover percentages counted. With help of the data about frequency of saplings and trees, the importance of saplings and/or trees was checked for each species group of a vegetation type. In this way more could be discovered about the process the vegetation type was part of.
The vegetation types could also be used to show the possible composition of vegetation in landcovertypes described with the aerial photo interpretation.

4. RESULTS

4.1 Aerial Photograph Interpretation

4.1.1 Landunits in the study area

The landunits described in the study area are combinations of a landformtype and a landcovertype.

The landformtype is based on the landunitmap in Anonymus (1985a). The typology is a little generalized (less different steepness types), because these were not all very clear recognized on the photographs.
The legend of the used landunitmap was a little rough. Therefore combination of this legend with the legend and map of the soil map (P.K.K. 1984) has taken place.
The area outside the forest border, which was not covered by the R.I.N. landunitmap, was interpreted using the same legendunits.
The used landformtypes (table 4) can be divided in five main units: valleys, intervolcanic plateaux, footslopes, hilly area and volcanic mountain area.
In the valleys subdivision has taken place into colluvial valleys (Vc) and lahar valleys (Vl). Lahar valleys are formed by lava or mudstreams, they are mostly U-shaped valleys with much deposition of large boulders. In the area three lahar valleys can be recognized: two very old ones on Gunung Andjasmoro and Gunung Dorowati; one more recent on Gunung Kelud. The colluvial valleys in the area are V-shaped in the upper part of the area, near lake Selorejo they are wide and U-shaped. Soils found in the valleys are cambisols or, in the colluvial valleys, fluvisols.
The intervolcanic plateaux are subdivided into a upper plateau (Pu) between 1100 and 1250 m altitude, a middle plateau (Pm) between 800 and 100 m altitude, a lower plateau (Pl) below 800 m altitude, a strongly dissected plateau (Pd) located between the plains of Pujon and Ngantang and deep valleys with steep valley sides in the plateaux (Pv). The upper and middle plateaux cover the agricultural area of Pujon and are subdivided into several individual plateaux by the Kali Konto and its tributaries. Soil are well drained cambisols or padisols on irrigated parts of the middle plateau. On the lower plateau (the Ngantang agricultural lands) also cambisols, mediteran soils and on the irrigated parts padisols occur. The dissected plateau is traversed by a series of parallel, uniform and ravine type of V-valleys, with the valley sides intersecting in sharp-edged parallel ridges. Soils here are cambisols. Steep valley slopes (25-75 %) of deep valleys in the plateaux have complex soils.
The footslopes (Hc) are not further subdivided. The soils on the colluvial footslopes and foothills are, depending on local conditions and setting, luvisols, phaeozems or cambisols.
The hilly landforms cover a large part of the study area. They are found between the intervolcanic plains and the mountainous areas. Subdivision has taken place into hilly area with moderate till steep slopes (< 50 %) (H1), hilly area with very steep till extremely steep slopes (> 50 %) (H2), remnants of old volcanic cones (Hi) and hillspurs (Hp). The hills of the moderate till steep slope type have generally cambisol soils which are deep to very deep and well drained. The hills of the very steep till extremely steep slope type have

Table 4 : Landformtypes used in the landscape ecological map, based on the R.I.N. landunitmap (Anonymus 1985a) and the soil map (Anonymus 1984b).

LANDFORMTYPES

main unit (RIN 1985)	sub unit (based on RIN 1985)	slope (P.K.K. 1984)	main soil type (RIN 1985)	altitude (sealevel)
Vc Valleys	Colluvial valley	3-8 %	cambisols/fluvisols	
Vl ,,	Lahar valley	3-12%	cambisols	
Pl Intervolcanic plateaux	Lower plateaux	3-8 % single slopes	luvisols	600-800 m
Pm ,, ,,	Middle plateaux	3-8 % single slopes	cambisols	800-1100 m
Pu ,, ,,	Upper plateaux	3-8 % single slopes	cambisols	1100-1250 m
Pv ,, ,,	Deep valley with steep valley sides	25-75% single convex slopes	complex soils	
Pd ,, ,,	Dissected remnants of plateaux	20-50% single straight slopes	cambisols	
Hc Hilly area	footslopes	5-40% concave footslopes/ single slopes	luvisols/cambisols	
H1 ,, ,,	(Moderately) steep slopes	<50% single or complex slopes	cambisols	
H2 ,, ,,	Very steep till extremely steep slopes	>50% single or complex	andosols/lithosols	
Hi ,, ,,	Remnants of old volcanic cones	30-75%	cambisols/andosols	
Hp ,, ,,	Hillspurs	8-30% convex slopes	andosols	
M1 Volcanic mountain area	Moderately till steep slopes	<50% slight/moderately dissected slopes	andosols	
M2 ,, ,, ,,	Very steep till extremely steep slopes	>50% moderately/dissected slopes, landslide surfaces	andosols/ complex soils	

Table 5 : Landcovertypes used in the landscape ecological map, based on photointerpretation and fieldsurvey.

LANDCOVERTYPES

name	structural type	vegetation type	fieldpattern
h Village/ homestead garden	woody grassland	-	-
a1 Wet agricultural field	grassland	-	terraces/blocks
a2 Dry agricultural field	grassland	-	blocks
pk Kebun (Perr. garden)	dense/open forest/ bushland	-	blocks
pf Plantation forest	dense/open forest	-	blocks/ -
pb Bush plantation	(woody)(thicket) bushland	-	blocks
s Shaded cover	-	-	-
bg Bushy grassland	bushy grassland	Casuarina/Dodovis (CaD) possibly also others	-
wg Woody grassland	woody grassland	idem	-
t1 Thicket bushland	thicket bushland	Eupatorium/Lantana (EpL)	-
t2 Woody thicket bushland	woody thicket bushland	Eupatorium/Ocinum (EpO)	-
wb Woody bushland	woody bushland	Casuarina/Dodovis (CaD) possibly also others	-
w1 Casuarina-type woodland	woodland	Casuarina/Dodovis (CaD)	-
w2 Mixed oak woodland of higher altitude	woodland	Eugenia/Litsea (EuL), fragm. Litsea (Lit), Ocinum/Antidesma (OcA)	-
w3 Mixed oak woodland of lower altitude	woodland	Ocinum/Antidesma (OcA), Celtis/ Ocinum (CeO), Celtis/Eupatorium (CeE)	-
of1 Open Casuarina-type forest	open forest	Casuarina/ Dodovis (CaD)	-
of2 Open mixed oak forest of higher altitude	open forest	Eugenia/Litsea (EuL), fragm. Litsea (Lit), Ocinum/Eugenia (OcE)	-
of3 Open mixed oak forest of lower altitude	open forest	Ocinum/Eugenia (OcE), Celtis/ Ocinum (CeO), Celtis/Eugenia (CeE)	-
f1 Dense Casuarina-type forest	dense forest	Casuarina/Dodovis (CaD)	-
f2 Dense mixed oak forest of higher altitude	dense forest	Castanopsis (Cas), Eugenia/Litsea (EuL) fragm. Litsea (Lit), Ocinum/Eugenia(OcE)	-
f3 Dense mixed oak forest of lower altitude	dense forest	Ficus/Celtis (FiC)	-
f4 Dense Engelhardia-type forest	dense forest	Engelhardia (Eng)	-
f5 Dense low forest (Kelud-type)	dense forest	Celtis/Ocinum (CeO), Celtis/ Eupatorium (CeE)	-

complex ap : 50% a2, 50% pb

generally soils of the andosol or lithosol type. In the area two remnants of old volcanic cones are present: Gunung Kelet and Gunung Amping-amping. They stand out resp. 300 and 60 meter above the surrounding plains and are characterized by their very steep slopes (30-75 %) and smooth surface. Gunung Kelet is a single eruption cone and has an andesitic rock core with shallow andosols and cambisols. Gunung Amping-amping is a spatter cone with cambisols. Hillspurs and other small, isolated hill plateaux, often situated on crests are gently till moderately steep sloping (< 35 %) with deep andosols.
The mountainous landforms cover the steep middle and upper slopes of Gunung Kawi/Butak, Gunung Kelud and the highest peaks of the Andjasmoro range. Most lands are steeply dissected by V-shaped ravines. Subdivision has taken place into two types: mountainous area with moderately till steep slopes (M1) and mountainous area with very steep till extremely steep slopes (M2). Most soils have been developed in thin covers of volcanic ash over weathered andesitic rock and mixed with some creepwash from above. In the extremely steep slopes is a precarious balance between vegetation and soils and removal may easily result in a collapse and the formation of landslide surfaces. The number of open landslide surfaces in the area is limited, only on Gunung Butak, some parts near the top of Gunung Kawi, a steep ridge on Gunung Andjasmoro and the south western slope of Gunung Kukusan (Dorowati) recent landslides have been noticed.

The landcovertypes (table 5) are only based on the interpretation of the aerial photographs. The subdivision is according to structural types (% trees, shrubs) combined with other typical photocharacteristics (texture, tone, fieldpattern and crownsize of individual trees). Relations with floristic composition (only for the 'natural' landcovertypes), based on the fieldsampling, are given in fig 10.

The 'cultural' landcovertypes, covering the village and plantation lands, are:
h homestead garden (village with fruittree-gardens in between the houses). Blocky streetpattern, less trees than mixed gardens.
a1 wet agricultural land. Sawahs or terraced lands that are part of the year irrigated rice lands, part of the year used for other crops. Subdivision from dry agricultural land was most on tone patterns, drowned land (f.i. just planted rice) is dark on the photo, while dry land (almost fullgrown rice or other crops) is more light. Mottled patterns of these two tones in terraces are probably pointing to sawah land. Because the photographs are taken in the dry season, only a little dark probably already points at more irrigation in the wet season.
a2 dry agricultural land. Tegallans with annual crops like maize, cassave, sweet potato, cabbage, carrots, shallots and chillies. Sometimes the cultivation of annual crops on tegal is largely restricted to the rainy season; during the driest months of the year a part has to be left fallow. Some of them have trees growing in the boundaries to be used for fodder, timber or as firewood. Subdivision from dry agricultural land was on tone difference, from bushland plantations on texture. Mixture up of these last two units is possible: fullgrown maize can look like shrubs, young plantations and especially tumpangsari systems may look like dry agricultural land.
ap complex of dry agricultural land and mixed gardens of bushland plantations; too small to delineate separately.
pk mixed gardens (kebun). Perennial gardens or mixed annual/perennial gardens. Perennial crops are coffee, clove, vanilla, different fruit trees and fuel/feed crops, annual crops can be the same as on the tegallans. Coffee is

predominating. Bamboo plantations are combined with the mixed gardens in the interpretations, both are mostly close to the villages.
pb bushland plantations. Young tree or shrub plantations, f.i. with *Calliandra* (for fuelwood). This type is subdivided from the 'natural' thicket bushlands by presence of clear fieldpatterns or terraces. In Chapter 2 is already described that many thicket bushlands have still fieldpatterns and terraces because it are former coffeeplantations. Mixing up with thicket bushland is therefore very likely. Above was already pointed at mixing up with dry agricultural land.
pf forest plantations. Plantations of trees for special purposes: timber, fuelwood, pulp etc. In the Plantation Forest Report (Anonymus 1985c) information about the tree species and planting year is provided. Species used are *Agathis*, *Mahony*, *Pinus*, *Eucalyptus*, etc.. Subdivision of this type in the interpretation is because of the homogeneity and the tree density of the forest, while also fieldpatterns are sometimes visible.

'Natural' landcovertypes described in the aerial photograph interpretation have no fieldpattern. The following types have been subdivided:
bg, wg ,wb ,bo and bd bushy grassland, woody grassland, woody bushland, open bushland and dense bushland. Covertype in recently disturbed areas due to landslides, fire or cutting. Especially in between the *Casuarina* forest, where regular fires occur, rare in the mixed oak forests (regular in gaps, which are too small to delineate.
tl thicket bushland. Dense thicket of *Eupatorium inulifolium* about 3 m height, without or with less than 20 % trees. Large areas between the agricultural lands and the mixed oak forests are covered with this landcovertype.
t2 woody thicket bushland. Same as above but with 20-40 % trees.
wl, w2 and w3 woodland, individual tree crown diameter resp. small, intermediate and large (more than 30 meter). The first one is a *Casuarina junghuhniana* woodland. The trees (conifers) have small crown diameters. This landcovertype can be found on the top of Gunung Kawi and Butak, on the saddle in between and on the east exposed steep ridge slopes on the North Kawi. The second and the third are composed of mixed oak forest woodland. The one with intermediate crowns has a strong relation with the vegetation types EuL, Lit and OcA of the vegetation survey: mixed woodland of high or intermediate altitude. The one with large crowns has strong relations with the vegetation types OcA, CeO and CeE: mixed woodland of intermediate or lower altitude. So in general w2 is composed of species of higher altitude, w3 of species of lower altitude. However, the division is not complete.
ofl, of2 and of3 open forest, individual tree crown diameter resp. small, intermediate and large (more than 30 meter). The first one is a open *Casuarina junghuhniana* forest (CaD) on Gunung Kawi or Butak. The second and the third are open mixed oak forests. These types are related resp. with vegetation types Eul, Lit and OcE, and OcE, CeO and CeE: mixed oak forests of high and intermediate,and of intermediate and lower altitude.
fl, f2, f3, f4 and f5 dense heterogenous forest with resp. small, intermediate and large crown diameter, homogenous dense forest and low height heterogenous forest. fl is the *Casuarina forest*. f2 is mixed oak forest, related with the vegetation types Cas, EuL, Lit and OcE: mixed oak forests of high and intermediate altitude. f3 is very strong related with the vegetation type FiC (lower altitude). f4 is the Engelhardia spicata forest (Eng), very clear recognizable from the photographs. f5 is not very clear differentiated. It is a forest type completely composed of small trees, found on Gunung Kelud. The photo image characteristics show comparison with the f2 type (no large

crownsizes), while it has a relation with the vegetation types CeO and CeE (lower altitude).
s shaded areas. Shaded areas on the aerial photograph of which no landcovertype could be distinguished.

The relation between landformtypes and landcovertypes in the study area can be found in table 6. This matrix shows (in hectares) the occurrence of the combinations of landformtypes and landcovertypes. The foresttypes 1 (*Casuarina*) and 2 (mixed oak, high altitude) are almost totally restricted to landformtype M2 (mountainous, very-extremely steep slopes), while foresttype 3 is located in the hilly area on very-extremely steep slopes (H2) and footslopes (Hc). The scrublands (t1, t2) are located in the hilly area (H1, H2, Hc) and on the steep valley sides in the plateaux (Pv). The plantations are located in the same landformtypes as the scrublands and also on hillspurs (Hp) and dissected plateaux (Pd). The village lands are located on the less steep part of the hilly area (H1) and the plateaux (Pu, Pm, Pl, Pd).

Table 6 : Relation between landform and landcover (in ha) in the total study area (based on free hand planimetric measurements of the landscape ecological map).

(ha)	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	pf	pb	pk	ap	a2	a1	h
M2	254	229	162	201	105	1766	491	373	8	19	8	95	49	25	3	-	-	-	-	-	-
M1	10	6	-	14	33	87	22	21	-	68	74	141	8	43	18	-	-	-	-	-	-
H2	6	-	-	39	-	88	16	229	146	373	1166	-	927	1102	360	145	36	24	50	2	-
H1	-	-	-	-	-	-	-	7	-	-	47	-	216	384	586	753	155	563	271	258	60
Hc	-	-	-	-	-	-	-	10	-	109	199	34	196	226	236	392	43	39	52	24	41
Hp	-	-	-	-	-	7	16	-	-	19	38	-	6	28	42	116	-	-	47	348	-
Hi	-	-	-	-	-	-	-	4	-	-	-	-	2	-	15	42	-	-	714	439	-
Pu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	33	163	33	164	473	162
Pm	-	-	-	-	-	-	-	-	47	13	-	-	8	-	-	16	26	8	477	8	64
Pl	-	-	-	-	-	-	-	-	-	-	-	-	44	21	4	6	484	309	273	551	532
Pd	-	-	-	-	-	-	-	8	47	7	9	-	47	24	84	222	119	-	214	774	30
Pv	-	-	-	-	-	-	-	-	23	34	43	-	135	199	79	313	260	-	56	-	6
Vc	-	-	-	-	-	-	-	16	-	-	32	-	95	33	21	43	-	-	2	-	24
Vl	-	-	-	-	-	-	6	14	-	-	43	-	42	22	66	25	2	-	-	-	-
Total	270	235	162	254	138	1948	551	682	271	642	1659	270	1775	2107	1534	2106	1288	976	2320	2877	919

4.1.2 Monitoring of the appearance of the forest area in 1979 and 1984

Monitoring results of the landcovertypes of the 1979 and 1984 interpretations have been quantificated using freehand planimeter measurements. This resulted in an total study area of 23,843 ha, 2.2 % more than the 23,326 ha measured by earlier surveys. The deviation is 5 km^2, a large area compared with most units. Though, this must be accepted, the relations in this monitoring study will be reasonable accurate.
No important change between forest/scrubland and village land of plantations have been noted (table 7). The border between scrubplantations and scrub is already not very clear, so real change would have been very hard to detect. Thus, most changes which influence forest appearance have taken place in the forest/scrubland area itself.

Table 7 : Total measured area of village land, plantations and forest/scrubland in the 1979 and 1984 interpretation.

	1979	1984
Lake Selorejo	321 ha	321 ha
Village land	8,593 ha	8,593 ha
Plantations	3,640 ha	3,687 ha
Forest/scrubland	11,289 ha	11,242 ha
Total area	23,843 ha	23,843 ha

In different parts of the study area the altitudinal distribution of village land, plantations and forest scrubland is different. To show this, the area in subdivided into 6 subareas: Kawi-N (5487 ha), Kawi-W (3749 ha), Andjasmoro (5704 ha), Dorowati (4788 ha), Kelud (2169 ha) and Luksongo (1945 ha), a subdivision in different mountainranges and exposition. Borders are approximately following subwatersheds.

Table 8 : Total measured area of village land, plantations and forest/scrubland in different subareas in relation to altitude.

Village land

	<1150	1150-1400	1400-1700	1700-2200	>2200	Total
Andjasmoro	960 ha (48%)	1059 ha (52%)	-	-	-	2019 ha (100%)
Kawi-N	1391 ha (92%)	125 ha (8%)	-	-	-	1516 ha (100%)
Kawi-W	1222 ha (100%)	-	-	-	-	1222 ha (100%)
Dorowati	1508 ha (100%)	-	-	-	-	1508 ha (100%)
Kelud	988 ha (100%)	-	-	-	-	988 ha (100%)
Luksongo	1339 ha (100%)	-	-	-	-	1339 ha (100%)
Total area	7408 ha (86%)	1184 ha (14%)	-	-	-	8593 ha (100%)

Plantations

	<1150	1150-1400	1400-1700	1700-2200	>2200	Total
Andjasmoro	-	792 ha (100%)	-	-	-	792 ha (100%)
Kawi-N	436 ha (36%)	698 ha (58%)	74 ha (6%)	-	-	1209 ha (100%)
Kawi-W	501 ha (100%)	-	-	-	-	501 ha (100%)
Dorowati	751 ha (83%)	139 ha (15%)	11 ha (1%)	-	-	900 ha (100%)
Kelud	173 ha (100%)	-	-	-	-	173 ha (100%)
Luksongo	64 ha (100%)	-	-	-	-	64 ha (100%)
Total area	1925 ha (53%)	1629 ha (45%)	86 ha (2%)	-	-	3640 ha (100%)

Forest/scrubland

	<1150	1150-1400	1400-1700	1700-2200	>2200	Total
Andjasmoro	-	824 ha (34%)	1384 ha (48%)	686 ha (24%)	-	2893 ha (100%)
Kawi-N	221 ha (8%)	389 ha (2%)	496 ha (18%)	1078 ha (39%)	577 ha (21%)	2762 ha (100%)
Kawi-W	1391 ha (69%)	370 ha (18%)	160 ha (8%)	105 ha (5%)	-	2026 ha (100%)
Dorowati	1692 ha (71%)	629 ha (26%)	59 ha (2%)	-	-	2380 ha (100%)
Kelud	954 ha (95%)	54 ha (5%)	-	-	-	1008 ha (100%)
Luksongo	220 ha (100%)	-	-	-	-	220 ha (100%)
Total area	4477 ha (40%)	2267 ha (20%)	2099 ha (19%)	1869 ha (17%)	577 ha (5%)	11289 ha (100%)

In Table 8 results based on the 1984 interpretation are shown: in the Andjasmoro subarea the village lands and plantations are situated on the highest altitudes compared with the other subareas, in the Kawi-N subarea the forests reach the highest altitudes (Gunung Butak), but the village lands are on low altitudes (in between a large area of plantations), Kawi-W and Dorowati are situated on low altitude with small higher forest/scrub areas and Kelud and Luksongo are totally situated on low altitude. These differences have consequences for the human activity on different altitudinal zones for the six subareas, because the distance from nearest villages or roads to an altitudinal zone in the forest is different.

The different landcovertypes and therefore also the occurring changes in landcovertype while monitoring have a distribution related with altitude, so differ for the six subareas. In appendix 2a matrices can be found in which change of the landcover in 1979 and 1984 for the total area and the different subareas. In this the cover (ha) of the different transitions is given,

From these matrices can be read if there is a degradation of landcovertypes according to this monitoring (change to a landcovertype with a lower % trees) and which is the most important change on the given altitudinal range.
Also normal transition matrices, in which the % transition of a certain landcovertype to another can be found are shown (Appendix 2b).
When looking at the results for the whole study area, every altitudinal zone seems to have its own specific landcover degradation process, but over the whole gradient degradation occurs. In the lowest altitudinal zone the change from open forest via woodland and woody thicket bushland to thicket bushland is the most important degradation process. The open forest and woodlands are here of the mixed oak forest type described for lower altitudes (of3, w3). However, these changes are also often found in the reverse direction, so probably often due to interpretation difficulties. Therefore, this change does not seem to be an important forest degradation process for the study area between 1979 and 1984. In the zone between 1150 and 1400 meter altitude, change from dense forest via open forest to woodland occurs both for the lower altitude mixed oak forest type (f3, of3, w3) and the higher altitude mixed oak forest type (f2, of2, w2). The reverse change sometime occurs, but not as much as on the lower altitudinal zone. The change from woodland (especially w3) to woody thicket bushland to real thicket bushland seems also a important process in this zone. Between 1400 and 1700 meter altitude the change from dense via open forest to woodland and thicket for the mixed oak forest type of higher altitudes is the only important one. Relatively little reverse change is described. In most of the area this is the zone where nowadays much human woodcutting activity is present.
Above this zone, between 1700 and 2200 meter altitude only part of the dense mixed oak forest of higher altitude changes to open forest, while much reverse change occurs (possible when secondary forest grows older and is recognized as forest).
In the highest zone only the degradation of dense *Casuarina* forest via open forest and woodland to woody or bushy grassland or woody bushland is an important process. The mixed oak forest area in this zone has not been changed during the studied period.

In the Andjasmoro subarea is below 1400 meter altitude degradation of woodland (w3 type) to woody thicket bushland and real thicket most important. Between 1400 and 1700 meter change of mixed oak forest of higher altitudes from dense forest via open forest to woodland and from woodland through to thicket is most important, although also the reverse changes can be found. Above 1700 meter no real changes occur in this subarea, the described degradation is compensated with almost as much reverse changes.
For the Kawi-N subarea this is the same below 1400, above this already degradation of *Casuarina* forest (f1, of1, w1, bg/wg/wb) can be found, probably by forest fires which occurred on these steep dry slopes for instance in 1984

in the zone between 1400 and 1700 meter (mentioned by local people). Above 1700 meter also here no real changes occurred in the mixed oak forests (f2, of2) and in the *Casuarina* forests, above 2200 meter only *Casuarina* forest degradation is important. The *Engelhardia* forests (f4) are very stable.
In the Kawi-W subarea much degradation of high altitude mixed oak forest occurs already above 1150 meter altitude, until about 1700 meter. Changes in the mixed oak forests of lower altitudes (f3, of3, w3) are in both directions, so no real degradation seems to occur. Above 1700 meter altitude no degradation occurs in this subarea.
In the Dorowati subarea changes from low altitude open forest via woodland and woody thicket bushland to real thicket occur in the whole forest/scrub area. Above 1150 meter altitude more change in the degradation direction is described than reverse changes. The scarce high altitude forest has changed to woodland.
In the Kelud subarea change from low altitude open forest via woodland and woody thicket bushland to real thicket occurs below 1150 meter altitude. Above this, the special Kelud type of secondary forest not really has changed.
In the Luksongo subarea finally, change from woody thicket bushland to real thicket occurs.
Concluding, most degradation according to this study occurs between 1400 and 1700 meter altitude in the Kawi-N subarea, Kawi-W subarea and the Andjasmoro subarea in high altitude mixed oak forest.

4.2 Vegetation survey

4.2.1 Flora & plantgeography

The species found during the vegetation survey have been named using local names used by fieldassistents combined with the fieldherbarium which was present. Because of this, the accuracy of this method is related to the accuracy of the naming by the fieldassistents and the reliability of the relation of a species with a local name in the fieldherbarium. So, many times, more value has to be given to the familyname or genus than to the speciesname. In this study, ecology of the species is more important than taxonomy. In the next paragraph the used species names are analyzed on known floral and plantgeographical distribution.
Totally 208 species have been described, of which 87 herb- and shrub- and 121 treespecies. The named species originate from 68 families, of which 10 occur with more than five different species. These are: *Asteraceae* (10), *Euphorbiaceae* (11), *Fabaceae* (11), *Lauraceae* (9), *Moraceae* (8), *Myrtaceae* (8), *Poaceae* (10), *Rubiaceae* (8), *Solanaceae* (6) and *Urticaceae* (8). Van Steenis (1972) describes the *Euphorbiaceae*, *Moraceae*, *Poaceae* and *Urticaceae* together with the *Ulmaceae* and the *Verbenaceae* as families with secondary growth species (short-lived weed trees): they grow fast, produce flowers and seed at early age and throughout the year and are rather indifferent for climate and soils.
Of the 125 species of which information can be found (so only those with complete speciesnames) in the Flora of Java (Backer & Bakhuizen v.d. Brink 1963-68) are 12 (10 %) specifically mentioned for East Jawa. However, 7 (6 %) of the species are specifically mentioned for West Jawa.
The altitudinal range given in the Flora of Java for these 125 species is

shown in table 9 in which for each altitudinal range the percentage possible occurring species is shown. The altitudinal distribution in which these 125 and the other species have been found in this study in given in the same table. It shows that the found distribution of the described species is almost the same as given in the Flora of Java, the distribution of the sampling plots seems with respect of this factor satisfactionary.

Table 9 : Altitudinal distribution of 125 described species (in % of n) according to the Flora of Java and this study, the rest of the species in this study and the sampling plots.

		altitude above sealevel				
	n	> 2100	1700	1400	1150 m <	
species Flora of Java	125	29	42	62	74	82
same species found	125	16	41	72	69	75
rest species found	84	12	39	74	81	73
sampling plots	96	2	8	32	31	26

4.2.2 Description of vegetation types

From the vegetation table (appendix 4, fig 7) it is obvious a lot of the vegetation types are close related, there is a lot of overlap. Roughly three groups are present : the cemara forest or woodland (*Casuarina junghuhniana* type), the mixed oak forests and woodlands (*Lithocarpus* ssp. group) and the thicket bushlands (*Eupatorium inulifolium* and *Lantana camara* group). Especially in the mixed oak forests and woodlands group much subdivision is necessary to get an inside in processes of regeneration and degradation in these forests. Hopefully it is possible to check the used differentiating criteria with a large dataset from the same area before further publication. At this moment this was impossible.

I. Cemara forest and woodland

CaD *Casuarina junghuhniana type*

In this type only three sample plots are laid out because minor importance of this type for degradation processes by human treecutting in the area and already (too) much emphasis for this type in the earlier vegetation survey.

The composition of this vegetation type is fairly homogenous, a dominant open tree cover of *Casuarina junghuhniana* with a lot of herbs, shrubs and small trees of *Dodonea viscosa*. In the vegetation survey (Smiet 1989) also the tree *Albizzia lophanta* is mentioned as typical for this vegetation type. Many of the *Casuarina* trees in this type have a blackened bark, showing recent fire has taken place. *Casuarina junghuhniana* is known to be a fire resistent species (Van Steenis 1972). Its seed germination and regeneration are triggered by fires, which at the same time destroy seeds and regeneration of other species. The

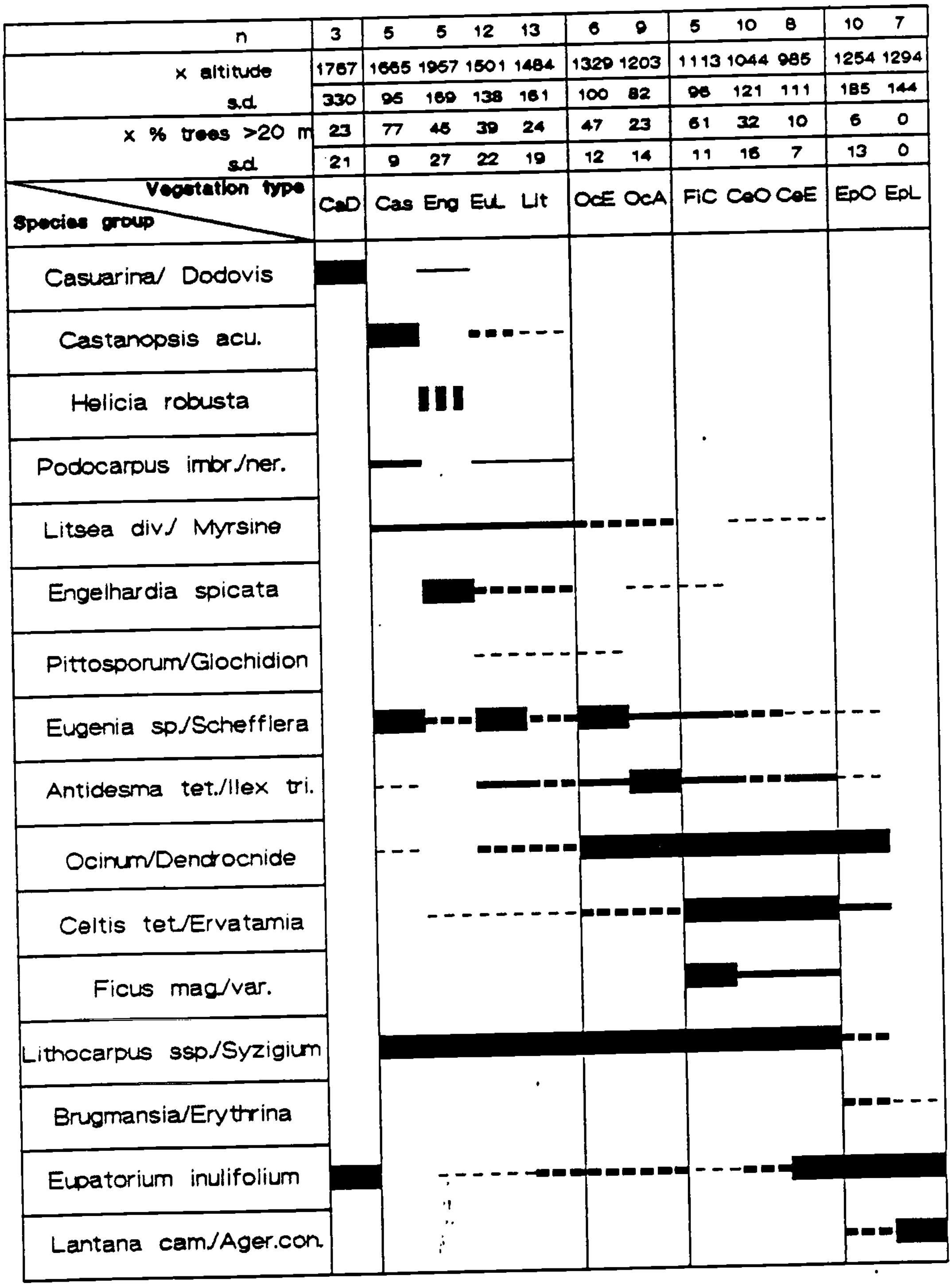


Figure 7 : Short vegetation table. Thickness of the line is related with coverpercentage.
---- at least one species of this group may occur
—— at least one species of this group should occur

regeneration capacity of *Casuarina* is fabulous. Completely burnt trees can sprout from latent buds under the scorched bark. It also sprouts from damaged superficial roots and most young trees in old *Casuarina* forest are root sprouts, not seedlings (Van Steenis 1972). In the dry season, when field survey has been carried out, areas under cemara forest were very dry, herbs mostly brown coloured. Fire can take place easily in this season, and local people know exactly when fires have taken place. Smiet (1989) stated that the fires can have natural causes,but are mainly caused by man, either deliberately (for hunting or charcoal burning) or by accident (cigarette butts, cooking fires).
This vegetation type is covering a large area on the top of Gunung Butak and Kawi, most part over 2000 m altitude. Only on the dry north-eastern exposed slopes of Gunung Kawi, it is found also below this altitude.
There is a strong relation between this type and the landcover types fl, ofl, wl and **wg**. This is based not only on the three samples, but far more on fieldobservations during work in the area.
In places where fire has not taken place for a long time, other tree species cause *a* more closed canopy. Probably *Casuarina junghuhniana* is disappearing after a few decades without fire and mixed oak forests appear.

II **Mixed** oak forests and woodlands

The mixed oak forest group is characterized by a large group of trees, f.i. *Lithocarpus ssp.*, *Syzigium sp.*, *Ficus fistulosa*, *Pyrenaria sp.*, *Macropanax dispermum* and *Psychotria sp.*; and also herbs like *Chloranthus elatior* and *Chloranthus officinalis*. However also a lot of differentiating species occur. In general this results in three subgroups relating to different altitude ranges.
Inside these three subgroups some subdivision is possible in different degradation stages and in the first subgroup two dominance types.

II-1 <u>Mixed oak forests of high altitude</u>

The forests of high altitude are characterized by species from the *Litsea diversifolia/ Myrsine hasseltii* group. Most of these forests have been found on altitudes between 1400 m and 2000 m.

<u>Cas</u> <u>*Castanopsis acuminatissima* type</u>
This forest type is predominated by the tree species *Castanopsis acuminatissima*. This tree forms trunks with several thick shoots on about 150 m height and a canopy closure >80% on 25-30 meter height. Next to this dominant species, also other treespecies are abundant. Typical are *Podocarpus imbricatus* and *Podocarpus nereifolius* trees, probably more abundant in the past, because they are popular trees for cutting. Also species from the *Litsea diversifolia/ Myrsine hasseltii* group and, especially saplings, from the Eugenia sp. (bimo)/ Schefflera rugosa group are commonly present.
Dominance of *Castanopsis acuminatissima* has been found only on the steep, southern exposed slopes of Gunung Andjasmoro. The presence only with this typical exposition can point at an indication for specific environmental situation at these sites. Van Steenis (1972) describes

Castanopsis acuminatissima as very common on West Jawa; where the climate is more moist than in the present study area. In this area south exposition means the rainfacing side of the mountain. Next to that, with the sun in the dry season in the north (but very high), the soil on steep south exposed slopes will dry out less than on north exposed or less steep slopes. However, according to Van Steenis (1972), differences in dominance of treespecies on different mountain forests are due to some disturbing events in the past, which will peter out with time to become a mixed stand. So if this type is really limited to a certain environmental situation is unclear.
This type is included in the landcovertype f2 in the aerial photograph interpretation.

Eng *Engelhardia spicata* type
Also a dominance type, with dominance of the tree species *Engelhardia spicata* with a canopy closure >70%.
Engelhardia spicata can be a very large tree with a crown on 25-30 m height. Near the top of Gunung Kawi and in the saddle between Gunung Kawi and Gunung Butak, just below the *Casuarina* type, locally almost pure stands of *Engelhardia spicata* occur. Especially saplings and young trees from the *Litsea diversifolia/ Myrsine hasseltii* group, *Helicia robusta* and some species from the *Eugenia sp.*(bimo)/ *Schefflera rugosa* group have been found with high frequency in between.
It has been observed that some stands in the saddle are much alike mossy forests, trunks and branches loaded with moss.
Lower on the northern slope of Gunung Kawi are also some almost clear stands of *Engelhardia spicata*. However, these are not composed of very old trees, but of younger trees with a relatively homogenous height of about 13 m. It seems as if all these trees have the same age, very strange in the further very heterogenous mixed forest. In both types of stands of *Engelhardia spicata*, almost no saplings have been found. Van Steenis (1972) describes *Engelhardia spicata* as an early invader of the cemara forest, grassland and savanna woodland. In the stands on the slope just below the cemara forest a few *Casuarina junghuhniana* trees can indeed be found in the *Engelhardia* type. However, young *Engelhardia* trees have not been found in cemara forests, while it sounds very strange that mossy forest should have been dry cemara forest in the past. So it is possible, but not necessarily following cemara forest.
This type is easy recognizable from aerial photographs by the homogenous, sometimes cauliflower-like crowns. It is included in the interpretation as covertype f4.

EuL *Eugenia sp.*(bimo)/ *Schefflera rugosa* type
This forest type is a typical mixed forest. Frequent occurring species (especially saplings) come from the *Litsea diversifolia/ Myrsine hasseltii* group and from the *Antidesma tetrandum/ Ilex triflora* group.
The locations from where the samples originate are spread through the almost whole project area: near the top of Gunung Kukusan (Dorowati), Andjasmoro, the higher western slopes of Gunung Kawi and North Kawi.
The vegetation structure of this type varies from open forest till dense forest. Also some secondary forests with species from the above mentioned groups are within this type.
In the aerial photo interpretation this type is related to covertypes w2, of and f2.

Photo 2 : Casuarina junghuhniana type (CaD) in the sadle between the Kawi and the Butak.

Photo 3 : Mixed oak forest

Photo 4 : Gigantic polypode Ficus tree in the Ficus/ Celtis type (FiC), Kawi NW.

Photo 5 : Eupatorium/ Lantana scrub (EpL), Andjasmoro near Dk Borah.

Lit Fragmented *Litsea diversifolia/ Myrsine hasseltii* type
This are disturbed forests from the D-type. The composition of this type is in principal the same as the above described 'EuL'-type, only the cover of most species groups, especially the *Eugenia sp.*(bimo)/ *Schefflera rugosa* group, is lower and the frequency of saplings and trees is also low. Only saplings of the *Litsea diversifolia/ Myrsine hasseltii* group can be found with a high frequency.
In this type vegetations belong where a lot of (recent) tree cutting activity is noticeable: recent gaps and open forests and woodlands with some big, recent stumps.
All samples in this vegetation originate from Gunung Andjasmoro and the northern slopes of Gunung Kawi; here the tree cutting activity zone can be found on these high altitudes.
Also this type is related to the covertypes **w2**, **of** and **f2** of the aerial photograph interpretation. Gaps for instance are mostly too small for separate delineation. Differences between EuL and Lit are probably differences on a bigger scale than possible to delineate on 1 : 20.000.

II-2 Mixed oak forests of intermediate altitude

The forests of intermediate high altitude are characterized by species from the *Ocinum sanctum/* Dendrocnide sp. group in combination with the *Eugenia sp.*(bimo)/ *Schefflera rugosa* group or the *Antidesma tetrandum/ Ilex triflora* group. These forest are mostly found on altitudes of 1150-1400 m.

OcE *Ocinum sanctum/ Dendrocnide sp.* type with *Eugenia sp.*(bimo)/ *Schefflera* group
This forest type is characterized by a high frequency and cover of both low trees and saplings the *Ocinum sanctum/ Dendrocnide sp.* group with a high frequency of high and low trees from the *Eugenia sp.*(bimo)/ *Schefflera* rugosa group.
Samples from this type originate from the western slopes of Gunung Kawi and Dorowati.
The type is related to covertypes **f2** and **of** in the aerial photograph interpretation.

OcA *Ocinum sanctum/ Dendrocnide sp.* type with *Antidesma tetrandum/ Ilex triflora* group
Characteristic for this type is a high frequency and cover of both high and low trees and saplings of the *Ocinum sanctum/ Dendrocnide sp.* group and high frequency and cover of low trees from the *Antidesma tetrandum/ Ilex triflora* group.
Also samples from this type originate only from the western slopes of Gunung Kawi and Dorowati.
This type is related to both covertype **w2** as **w3** in the aerial photograph interpretation.

II-3 Mixed oak forests of lower altitude

The mixed oak forest of lower altitude are characterized by both trees and saplings of the *Celtis tetranda/ Ervatamia sphaerocarpa* group. The altitudes these forest types can be found are below 1150 m, sometimes even very close to villages.

FiC *Ficus magnoliaefolia/ Ficus variegata type*

This is a forest type which can be characterized by a upper canopy formed by some gigantic *Ficus* trees with crown diameters of 25 till 50 meter. Below this especially species from the *Celtis tetranda/ Ervatamia* group occur. Many saplings can be found here, especially from the *Ocinum sanctum/ Dendrocnide sp.* group, but also, in a lower frequency from the *Antidesma tetrandum/ Ilex triflora* and the *Eugenia sp.*(bimo)/ *Schefflera* rugosa group.

The big polypode *Ficus* trees are not very interesting for treecutters. That is probably the only reason that still closed canopies can be found on this altitude. A consequence of this is that *Eupatorium inulifolium* scrub, which is light demanding, does not yet get the chance to dominate. That is the reason why saplings of other mountain forest trees have an opportunity of regeneration in this type. At this moment, because of a very intensive human use of this forest type by fodder and fuelwood collection, not many saplings will get a chance to become a tree; interesting species are already cut before that, while others are used for fuelwood. However, with more control of these activities, these forest type has a great potential of regeneration. Only when the old *Ficus* trees disappear (naturally or after all by human cause), probably *Eupatorium inulifolium* scrub takes over very quickly, because another canopy is almost absent.

This forest type has been found only on the forested lower flanks of Gunung Kawi (north west) and Dorowati.

It has a strong relation with covertype f3 from the aerial photograph interpretation.

CeO *Celtis tetranda/ Ervatamia sphaerocarpa* type with *Ocinum sanctum/ Dendrocnide* group.

This, more open, forest type is characterized by both trees and saplings from the *Celtis tetranda/ Ervatamia sphaerocarpa* group and the *Ocinum sanctum/* Dendrocnide group. Some big *Ficus* trees occur in this type, but have no dominance. Some *Celtis tetranda* trees have big crown diameters like the *Ficus* trees in type FiC, but the *Celtis tetranda* loses his leaves in the dry season, so cover percentages are much lower and more other trees can be found in the upper and middle canopy.

This type can be found on different places on the Dorowati, western slopes of Gunung Kawi and north eastern slopes of Gunung Kelud.

This type is interpreted as landcovertype w3 or of in the aerial photograph interpretation.

CeE *Celtis tetranda/ Ervatamia sphaerocarpa* type with *Ocinum sanctum/ Dendrocnide sp.* group and *Eupatorium inulifolium*

This vegetation type is characterized by low trees and saplings of the *Celtis tetranda/ Ervatamia sphaerocarpa* and the *Ocinum sanctum/ Dendrocnide sp.* group, with a high cover of *Eupatorium inulifolium* shrubs.

Samples of this type originate from Gunung Kelud, northwest and west

Kawi and Dorowati.
In the aerial photo interpretation this type is also included in landcovertypes **w3** and **of**.

III Thicket bushlands

The thicket bushlands are characterized by a dominance of the shrub *Eupatorium inulifolium*, with none or very few trees. In the study area thicket bushlands are very common. In part of them fieldpatterns and terrace building are still recognizable, pointing at an agricultural use in the past (f.i. coffeegardens). But in general, thicket bushlands will be too far degradated forestland, although sometimes already a long time ago.
The range of altitude where thicket bushlands are sampled in the project area goes from 800 - 1500 m, dependent on the location in the area.

<u>EpO</u> <u>*Eupatorium inulifolium* type with *Ocinum sanctum/ Dendrocnide sp.* group</u>

These are thicket bushland with some remaining trees, in these samples the treecover is 5-40%. The thicket is formed dominantly by the shrub *Eupatorium inulifolium*. Depending on the position of this type in the study area, the trees are from different species groups. At this moment this type has been found most on altitudes between 1150 and 1400 m, most trees are from the *Ocinum sanctum/ Dendrocnide sp.* group.
Below the trees the *Eupatorium* thicket is always more open; here can be found most saplings. Inside the thicket almost no saplings can be found. This type is strong related to the t2 covertype in the aerial photograph interpretation.

<u>EpL</u> <u>*Eupatorium inulifolium* thicket bushland with *Lantana camara/ Ageratum conyzoides* group</u>

This is real thicket bushland, without trees. In between the *Eupatorium inulifolium*, species from the *Lantana camara/ Ageratum conyzoides* group can be found with high coverpercentages. This type covers an extremely large part of the study area.
Clason (1934) describes this type already for Gunung Dorowati, partly as abandoned coffee gardens (he describes Erythrina as an shadow tree in these former gardens), partly just as grass and shrub wilderness of 'kirinjoe'(= krinyu: *Eupatorium inulifolium*).
Eupatorium inulifolium and *Lantana camara* are both invaded species from South America (Van Steenis 1972). At present they can be found in a large part of South East Asia and Australia. Williams et al. (1969) describes that *Lantana camara* reached pest proportions in the humid tropical and subtropical areas of eastern Australia; research on methods of biological control has been actively pursued. However, this provided no suggestion as to how land whose natural succession has been blocked by *Lantana* can be reclaimed. It only shows that the sensitive phase of *Lantana* is the pioneer phase; *Lantana* will appear after clearing, but will not survive in shade. A temporary canopy, ensuring continued regeneration of the other light-demanding pioneers, is essential.
Van Steenis (1972) describes regeneration in *Eupatorium* thickets of some primary, shadow tolerant forest species of which seed is present, secondary species need more light. In the *Eupatorium* scrub in this area, a nearby seed resource of primary species is almost never present.

4.2.3 Processes of degradation and regeneration of the forest

Using the data of height and frequency of saplings and trees in the different vegetation types and species groups (appendix 5) possibly points out if transitions of different vegetation types due to 'succession' or degradation processes could be expected. When the first axes in the ordination (fig 8), which correlates with altitude, is a pure natural gradient, only transitions in vertical directions must be expected. However, because the data are just a moment view, also transitions between f.i. high altitude and intermediate altitude vegetation types could not be excluded in front.
In table 10 relative high amounts of saplings or trees (>5m) have been marked in the shortened vegetation table. Transitions seems to be possible if saplings of a species group (which is a characteristic group (as tree) of another type) are present in a vegetation type. Transitions seem very unprobable when almost no saplings of these characteristic group are present. Within the mixed oak forest vegetation types much transitions seem possible. Between the three altitudinal groups transition seems less probable than within these groups. In the high altitude group, the dominance types (Cas and Eng) show to be characterized by trees of this species, almost no saplings can be found. The saplings which are present point at a possible transition to a mixed *Eugenia sp./ Litsea diversifolia* type. The transition to the Lit type is just a fragmentation, no high frequencies can be mentioned in this type. In the intermediate altitude group, transition between the two types is not probable because in both types saplings of the characteristic group of the other type do not occur in high frequency. In the low altitude group transitions seem possible in vertical direction. In fig 9 the still possible transitions are shown.
Also the herblayer is important for degradation processes. Meyer (1959) describes for his vegetation plot in Cibodas (West Java) that the occurrence of saplings depends not only on a change in the light factor but also on microbiological activities in the soil connected with greater humus decomposition. On locations where a dense 'secondary' herb layer is developed, concurrency for young trees seems to be difficult. In this study this aspect could not be emphasized, because detailed humus data have not been collected.

When combining the landcovertypes of the aerial photograph interpretation and the described vegetation types from fieldsurvey, it must be obvious there is a scale difference between both typologies, especially in the mixed oak forests group. The smallest unit that can be mapped on scale 1:20.000 is about 0.5 cm^2 or 2 ha. Degradation processes in a forest induced by gaps, which are usually not larger than 500 m^2, can not be mapped on this scale; only the density of gaps can influence interpretation of cover.
In fig 10 the relation between landcover types and vegetation types is given. In the description of the vegetation types this relation is already included. The interpretation of the altitudinal gradient in mixed oak forests is in the two typologies comparable: three classes in the vegetation types, two in the landcovertypes. The scale difference occurs using structure as an differentiating factor. From the vegetation types it appeared that composition of a forest can change after structural change, secondary species can substitute economically valuable species. This change is not recognizable from aerial photograph, many times it occurs on gap-scale. Because secondary growth also can form dense forest, while reasonable primary species can form woodland, the relation of the degradating vegetation types with structural types of the aerial photograph interpretation is not very strict.

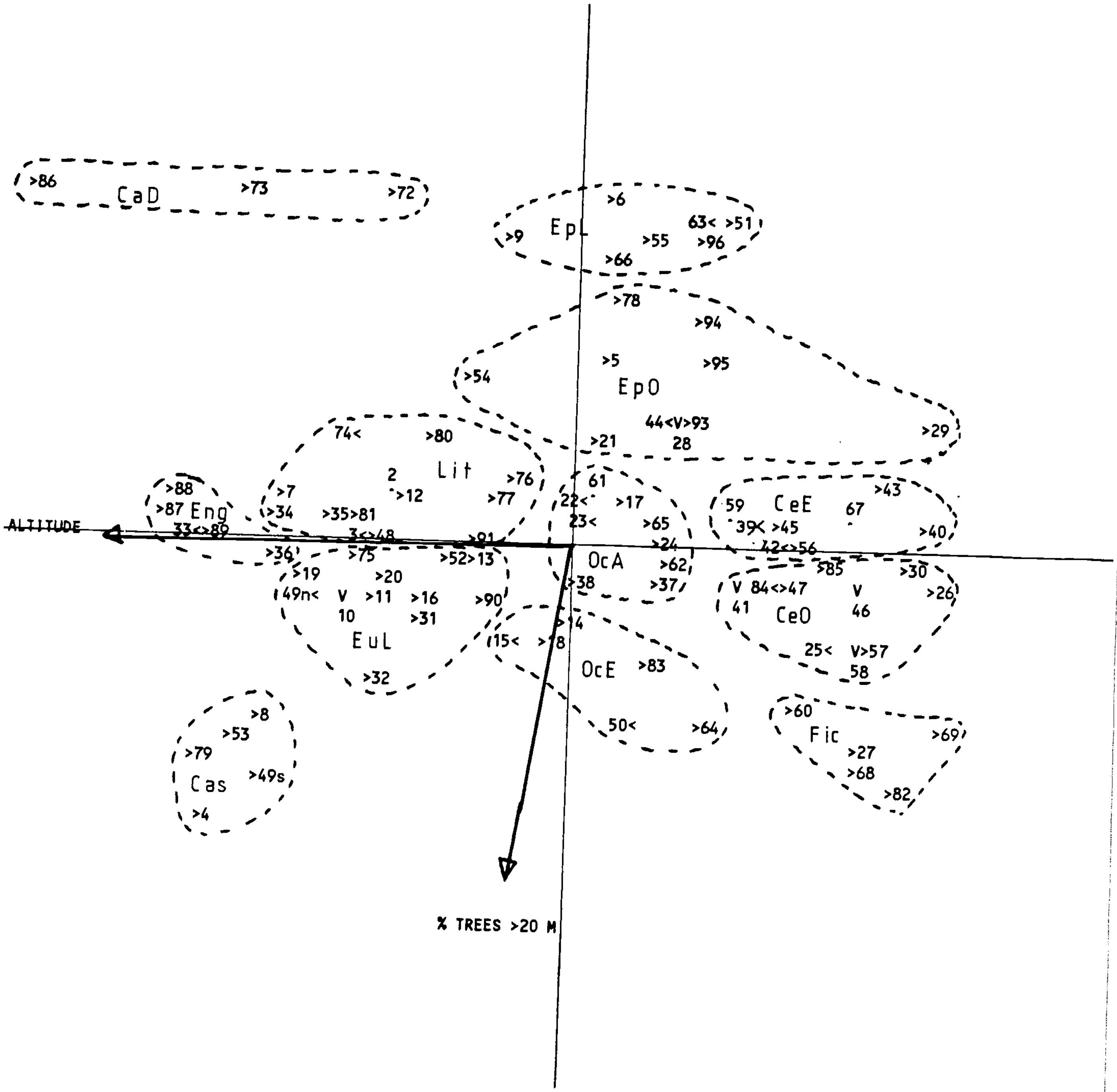


Figure 8 : Ordination diagram (CANOCO, option DCCA): sample plots (plotnr.), vegetation types ( ) and included environmental factors altitude and % trees >20m as vectors.

Table 10 : Short vegetation table with high frequent trees (**T**, >5m), saplings (**s**, <5m) or both (●).

Vegetation type / Species group	CaD	Cas	Eng	EuL	Lit	OcE	OcA	FiC	CeO	CeE	EpO	EpL
n	3	5	6	12	13	6	9	5	10	8	10	7
x altitude	1767	1665	1957	1501	1484	1329	1203	1113	1044	985	1254	1294
s.d.	330	95	169	138	161	100	82	96	121	111	185	144
x % trees >20 m	23	77	45	39	24	47	23	61	32	10	6	0
s.d.	21	9	27	22	19	12	14	11	16	7	13	0
Casuarina/ Dodovis												
Castanopsis acu.												
Helicia robusta												
Podocarpus imbr./ner.												
Litsea div./ Myrsine												
Engelhardia spicata												
Pittosporum/Glochidion												
Eugenia sp./Schefflera												
Antidesma tet./Ilex tri.												
Ocinum/Dendrocnide												
Celtis tet/Ervatamia												
Ficus mag./var.												
Lithocarpus ssp./Syzigium												
Brugmansia/Erythrina												
Eupatorium inulifolium												
Lantana cam./Ager.con.												

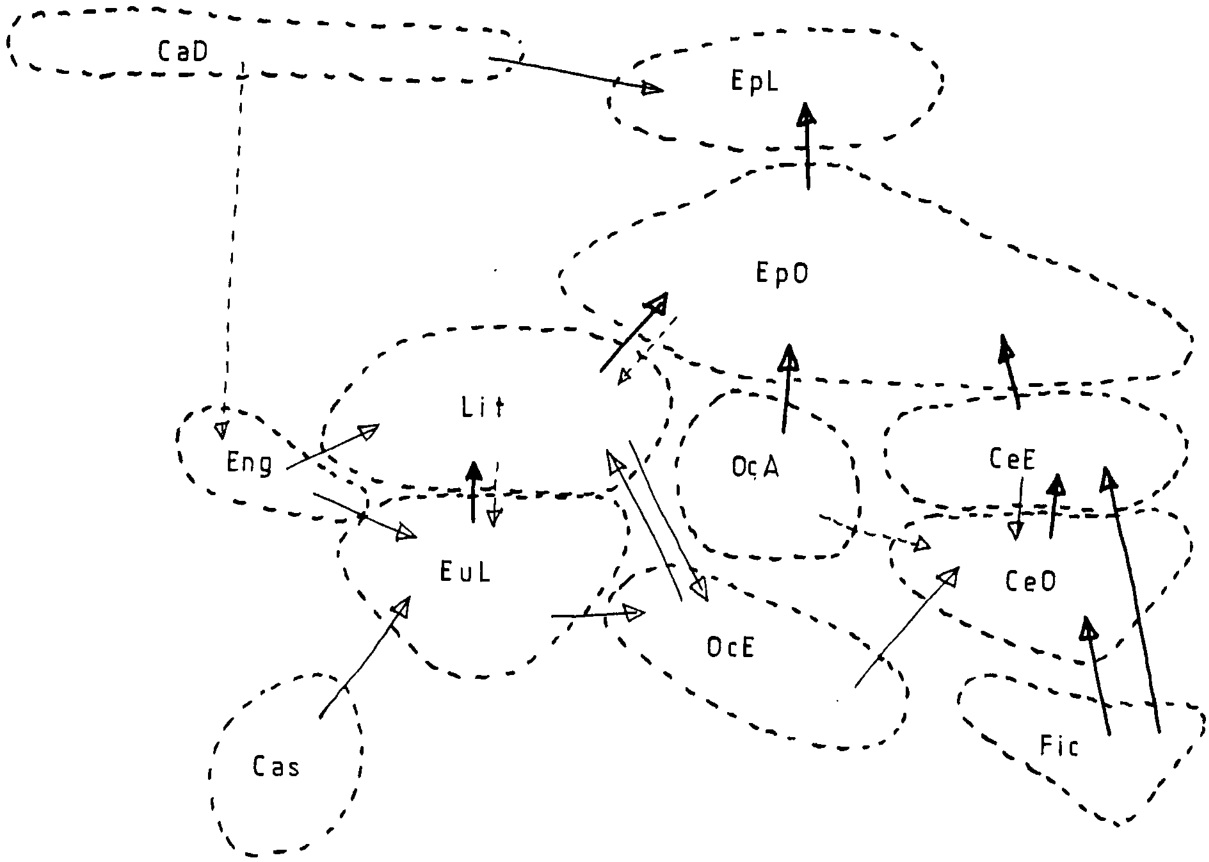


Figure 9 : Still possible transitions between vegetationtypes after sapling/tree frequency interpretation.

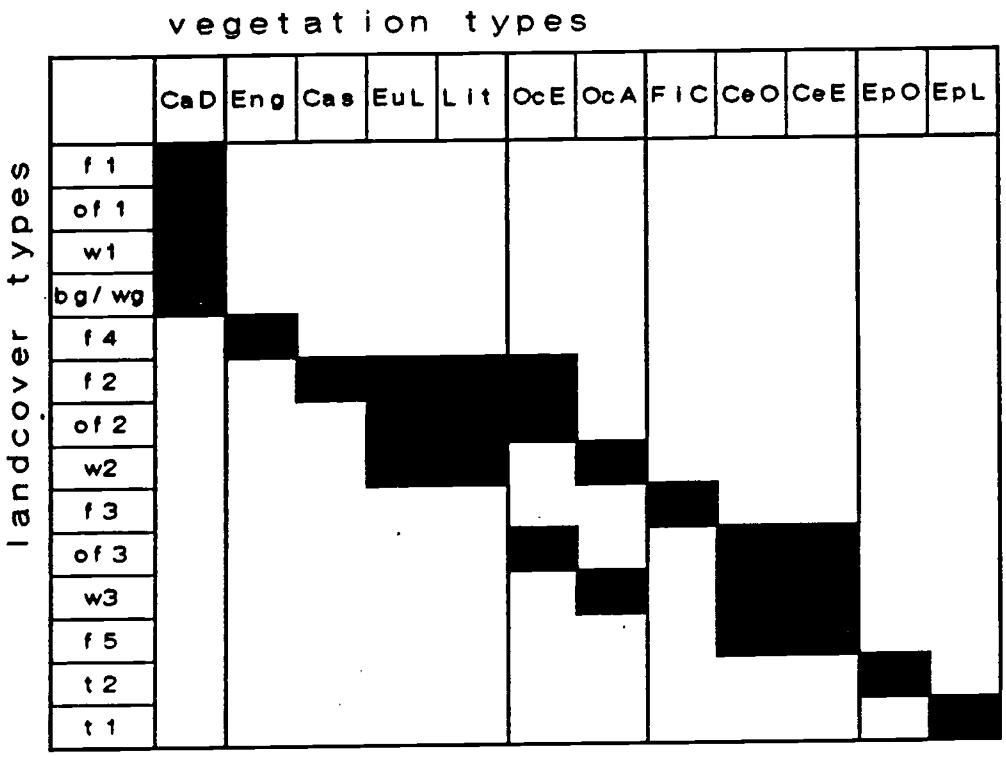


Figure 10 : Relation between landcovertypes (landscape ecological map) and vegetationtypes.

The processes and their causes which can be described (table 11 and 12):
1. On the top of Gunung Butak and Kawi and the steep, east-exposed slopes on the north side of the Kawi: *Casuarina junghuhniana/ Dodovis* forest which, most by human impact, goes on fire. Other species, but probably also sometimes *Casuarina junghuhniana* burn to ashes, regeneration of *Casuarina* is triggered. The wood is sometimes used for charcoal. On very steep slopes landslides can be a natural cause of vanishing of the vegetation cover. On these sides herbs and bushes can flourish, till the next fire will destroy them.
2. Between 1400 and 1700 meter on Gunung Kawi and Andjasmoro: mixed oak forest of the *Castanopsis*, *Engelhardia* or *Eugenia sp.*(bimo)/*Litsea diversifolia* type which can be fragmentated to a type in which none of the groups is very important. This is caused by selective cutting of economical valuable species (see appendix 1), which make up a large part of the characteristic species. The described *Eugenia sp.*(bimo)/*Litsea diversifolia* type is probably already not the real primary forest, the most valuable species are already very rare (f.i. *Podocarpus*), while locally an immense number of old stumps can be found (*Podocarpus*: N-Kawi, probably about 30 years old).
This distance of the location of this forest type to the villages is rather large. Crews of woodcutters stay for a few days in the forest: cut a tree (manpower), build a sawing place, saw the wood in planks and carry them on their shoulder back to the village. It is amazing that this very intensive method yet has a great impact on the forest, wherever you are in the forest, you can hear people working, find old sawing places etc.

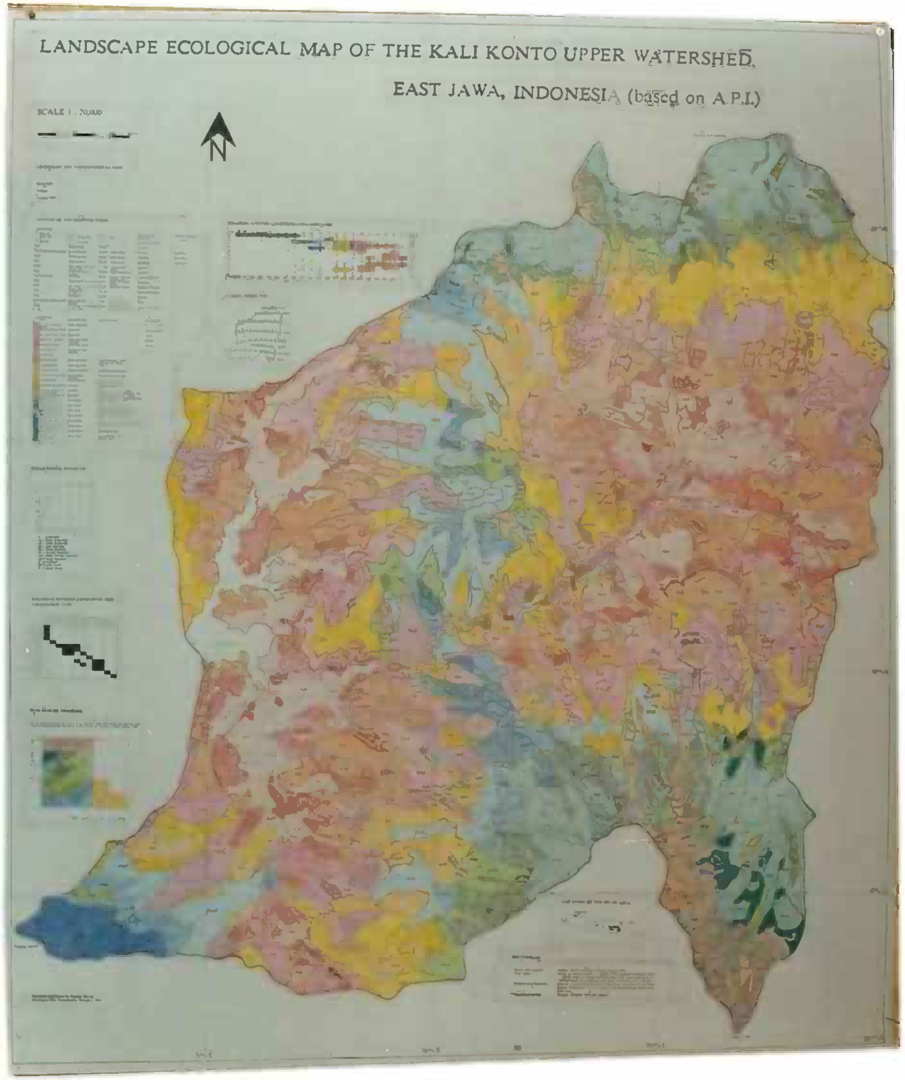
Table 11 : Description of processes 1 and 2.

	Processes I	Processes II
Location	Top Kawi/Butak and steep east exposed slopes Kawi-N	Kawi and Andjasmoro, 1400 - 1700 m
Vegetation type	Casuarina Junghuhniana/ Dodovia, pioneer vegetation	Mixed oak forest: Engelhardia, Castanopsis or Eugenia/Litsea type. Old secondary forest with primary forest species
Cause 1	Fire, mostly human cause; deliberately (charcoal) or by accident (cigarette bud)	Selective cutting of economically valuable species
Further development	Fire triggers regeneration Casuarina, while other species disappear. Result : grasslands and scrubs with Casuarina as the only canopy species.	On the gap regeneration of secondary species, on the whole forest fragmentation (fragmented Litsea type), probably developing to forest-types which now can be found on lower altitude (Ocinum types). If gaps too large : development to Eupatorium scrub
Importance for the future of the forest	Much regeneration of Casuarina. Frequency of fires already for ages too high for further regeneration to primary forest	High, slow regeneration of primary and old secondary forest species while quick degradation. Economically interesting species (f.i. Podocarpus) already very rare as a tree in the area, while many stumps of these species can be found
Cause 2	Landslide	
Further development	Dependent on presence of seedresources. Possibly first developing to scrub.	
Importance for the future of the forest	Limited, rare occuring	

The speed of the degradation process induced by this cutting is not known. Based on the monitoring study (so only structure degradation) the following degradation has taken place in this altitudinal zone between 1979 and 1984 (appendix 2a): from forest to open forest 5.4 % of the total forest/scrub land (reverse 3.4 %), from forest to woodland 2.2 % (no reverse), from open forest to woodland 3.4 % (reverse 1.2 %), from open forest to woody thicket 0.8 % (reverse 0.2 %), from woodland to woody thicket 2.2 % (reverse 1.1 %) and from woody thicket to real thicket 7.8 % (reverse 0.3 %). Totally this means that 21.8 % of the area should have been degradated (reverse 6.2 %). If the reverse change shows the errormargin (reverse change in 5 year is very unlikely for large areas) this method still results in more than 15 % of the total forest/scrub land in this altitudinal zone which is severely affected in the 5 year period!
Around 1400 meter mixed oak forest of the *Ocinum sanctum/ Eugenia sp.*(bimo) type occurs which probably can change into the *Ocinum sanctum/ Antidesma tetrandum* type. The economical value (see appendix 1) of the characteristic species of this type is lower than of the type with *Eugenia sp.*(bimo), so this change is probably due to selective cutting and secondary growth which occupies the open space.
3. Below 1400 meter on Gunung Kawi, Dorowati and Kelud: fluctuation between different structures of the *Ficus/ Celtis* type, the *Celtis/Ocinum* type and the *Celtis/Eupatorium* type. In the monitoring period there is no real direction of change. This could be explained with the fact that probably these forest types are already secondary, although the primary forest type of these altitudinal range is not well known, because it disappeared quit a long time ago on most mountains in East Java. In the present described forest type almost no species with economical value occur. Degradation of these forests is therefore not really determined by cutting of economical valuable tree species but seems to have a more natural speed: old trees disappear after storm or just because they are dead. A problem for these forests is that regeneration is on a very low level because humans collect saplings for fuelwood or cut young trees in which they are interested before they can grow old. With the present human pressure on these forests, they will probably only a restricted period survive as forests and after that change in scrublands.
4. In the scrublands the last trees can disappear, regeneration to forest is a very slow process, if already possible.

Table 12 : Description of processes 3 and 4.

	Processes III	Processes IV
Location	Western slope Kawi, Dorowati, Kelud : < 1400 m	Kawi, Dorowati, Andjasmoro, Kelud, Luksongo: < 1400m
Vegetation type	Mixed oakforest: Ficus/ Celtis or Celtis/Ocimum type	Eupatorium/ Ocimum type, dense scrub with some trees
Cause 1	Selective cutting of economically valuable species	Cutting or natural fall tree
Further development	On the gap regeneration of secondary species, on the whole no real transition of vegetation type (already a secondary forest type).	Transition to Eupatorium/ Lantana scrub. Regeneration of trees only possible when shade tolerant (primary) species: probably not much seed available (distance) and chance of cutting already as sapling or young tree high In short term no forest development can be expected
Importance for the future of the forest	Limited, not many economically valuable species present as high tree (often only as sapling or young tree	
Cause 2	Collection of fuelwood and fodder	
Further development	No transition between vegetation types	
Importance for future of the forest	Regeneration slowed down by cutting of saplings. Especially for regeneration of primary, slow growing species important. Disturbance of the age distribution of trees.	
Cause 3	Natural death big tree	
Further development	Possibly regeneration of secondary species on the gap, but in many of the (big) gaps Eupatorium will be a tough competitor. Possibly transition to Celtis/ Eupatorium type; Eupatorium will slow down regeneration of secondary species (light shortened).	
Importance for the future of the forest	Relatively high, probably definitive end of forest structure. At this moment a very slow process, but with further disturbance of the age distribution (fuelwood collection) it will probably occur more often.	



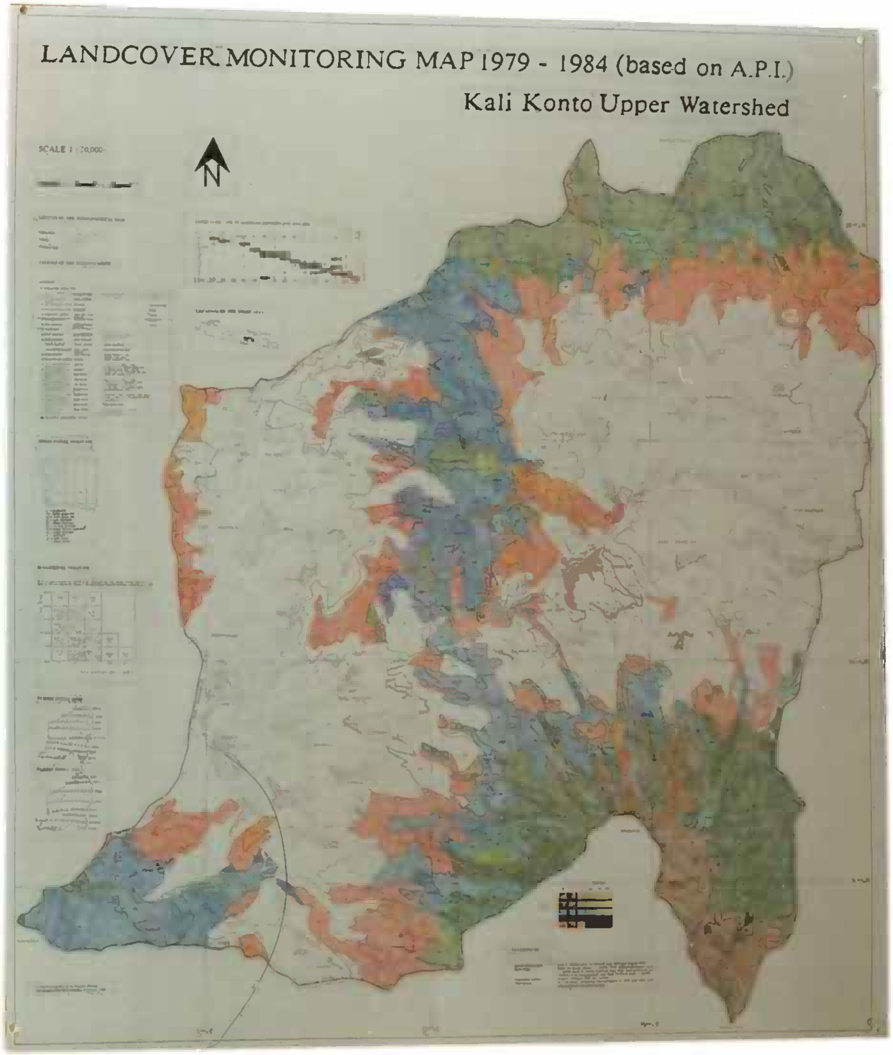


Photo 6 : Coloured maps :

a. Landscape ecological map: forest types in brown(1), green(2) and blue (3), scrub in yellow and cultural landcovertypes in red, purple and pink.

b. Landcover monitoring map: forest types in the same main colours, scrub in red. Per main type colouring on difference of % trees between the two years: a more light colour means degradation, a darker colour means regeneration (colour scheme below the map).

5. CONCLUSION FOR THE FUTURE OF THE FOREST AREA

For the present circumstances (much human activities):

- quick disappearance (probably within 20-40 years) of primary forest species that at this moment still appear in the forest between 1400 and 1700 meter, a transition to a more stable secondary type.

- if gaps too big: also between 1400 and 1700 meter direct change to *Eupatorium* scrub possible.

- also in the relative stable secondary forest in which fuelwood collection occurs a transition in time to scrub.

- only regeneration of secondary, economically invaluable species has a chance.

If human activities would be slowed down:

- regeneration to a less disturbed forest type above 1400 meter possible, but regeneration to real primary forest will take a very long period.

- regeneration in the forest below 1400 meter maybe possible, dependent on the present disturbance of age class distribution (see 4.2.2 process 3).

6. DISCUSSION

The methods of the aerial photograph interpretation showed to be a very quick and useable method to get inside in spatial relations of landform and landcover types in this area; which is not very surprising because the method has been tested already all over the world by the I.T.C. Rural and Landecology Department. The resulting landscape ecological map would have been very useful as a base for planning in the beginning of the project, at this moment it only combines other information with the landcover interpretation, which already had to be done for the monitoring study.

The monitoring study showed the importance of the quality of the used series of aerial photographs; tone had to be skipped as a distinguishable factor in the typification because tone ranges of the used two series were very different. Next to this, the fact that interpretation of both series is done be the same person is very important, otherwise it would be very difficult to get the same decisions in both interpretations.
However, the method of monitoring of two series of aerial photograph showed to be useful for getting a quantitative overview of forest degradation and especially of activity zones. At first side reverse development (regeneration, % trees >) seemed very unprobable in the five year period of the monitoring. The map showed however that this happened especially in the relatively stable, secondary forest types, in which regeneration is more probable in 5 years time. Maybe even the fact that the project was going on in the monitoring period has influenced the illegal human activity in the area and relatively more secondary growth has reached tree sizes in this period than in other periods.

The use of local names in the vegetation study was in this case the only possibility to make a reasonable number of plots. In my opinion, ecological interpretation of vegetations is more important for understanding forest degradation than a 100 % reliability of the taxonomy. But of course my way of working was only possible because of the composition of the fieldherbarium in the earlier study; without this much more time should have been put in collecting plant material and determination of names.
Of some local names it is known that their use is not very strict. An example is the difference made between 'pasang merah'(*Lithocarpus sp.*) and 'pasang putih'(*Lithocarpus sundaicus*), according to others (pers. comm. A.C. Smiet) mostly not taxonomically correct. Still they are not combined during processing; in this way eventual ecological difference between them should appear. (For this example no difference appeared to be present.)

The plotsize is still a difficult matter. It seems that a choice of plotsize for each specific area must be based on a weight of the complexness of the vegetation (minimum area concept) and the heterogeneousness of the abiotic and biotic factors. Because of the steep slopes and thus very heterogeneous circumstances because of exposition, 400 m² was the maximum homogenous size on crests and in valleys. On mid-slopes bigger plot sizes would have been possible, but in practice most of these locations could not be used for plots.

The use of coverclass as a weighing factor in the processing was a difference with the earlier vegetation survey, in which basal areas have been used. In my opinion cover gives a better ecological representation of the vegetation than basal area. When using basal area, one big tree in a plot overrules in weight all other present trees and herbs. In cover, also other layers can be high in weight. For instance: for the light distribution in the forest. Below thick high trees which have a low crown cover a dense shrub or herb cover can occur, while below thick high trees with a dense cover probably only a very open herblayer occurs. This ecologically totally different vegetations can however have comparable basal area data.

The processing of the data resulted in interpretable vegetation types and species groups, although a lot of overlap of species groups occurred. The benefit of the vegetation approach becomes evident in the interpretation of the sapling/tree data and the linking with the aerial photograph interpretation: the processes of degradation and regeneration can not only be described as structural changes, also some changes of vegetation composition became evident.
The use of only structural features for typification of forest degradation (Webb et al. 1970) seems in this area only to point at developments which are temporally (quickly a new, secondary, forest is established) or so big that no regeneration could be expected in many years (forest to scrub changes). The floristic composition however shows more clearly the gradual degradation and chance of regeneration.
Of course the final descriptions of the processes are still very general, but they show a context of thinking which can be sharpened with further data analysis or experiments. The combination of structural and compositional vegetation analysis with aerial photograph interpretation seems to be very promising.

The impact of the conclusions for the forest area on the local people seem evident: with present human activities the timber production will be dried up within a few years, while the scrubland must produce most of the fuelwood and fodder. The present policy of lowering the pressure on the natural forest be establishment of plantations is good, but still fuelwood and fodder are easier taken free from the natural forest than for some money from the plantations, because manpower is so cheap.
The land use policy evaluations (Thalen & Smiet 1985) of the Phase II watershed plan seem very theoretical. The conservation-centered option;just 'manage the forest land as protection forest'; this option is chosen in areas which 'guarantee a long-term conservation of renewable resources'. They conclude that 'the potential of the forest land leaves enough flexibility for the decision-makers to choose an acceptable compromise, meeting at the same time the demands of the local population in terms of fuelwood and timber, the requirements for proper conservation of soil and water and leaving intact the yet remaining natural montane high forest'.
A more reasonable future is in my opinion the disappearing of the primary montane high forest in the area, because the forest lands are already toofar disturbed and real changes in landuse can not be expected the next few years. In my opinion real big changes are necessary on Java, probably from an agricultural to a more industrial employed population, to reduce the pressure on the natural forests structurally. At present a better management and guarding is the only option for maintaining the present state.

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APPENDICES

Appendix 1		Species list with scientific names, local names and local economical value for trees.
Appendix 2	a	Matrices monitoring 1979-1984 in ha for total area and subareas.
	b	Transition matrices monitoring 1979-1984 for total area and subareas.
	c	Map with used subareas.
Appendix 3	a	Map with location sample plots.
	b	Example of plot data sheet.
Appendix 4		Complete vegetation table.
Appendix 5		Frequency distribution of saplings and trees over the species groups (per vegetation type)
Appendix 6		Vegetation map R.I.N., reduced. (Anonymus 1985b)

Appendix 1 Species list with scientific names, local names and local economical value for trees.

HERBS

LATIN NAME	FAMILY	LOCAL NAME
Acacia villosa	FABACEAE	lamtoro
Achyranthes bidentata	AMARANTHACEAE	cungkup
Ageratum conyzoides	ASTERACEAE	wedusan
Bambusa sp.	POACEAE	perin petuh
Blumea balsamifera	ASTERACEAE	menjing, pohsor
Buddleja asiatica	LOGANIACEAE	sembung gilang
Carex baccans	CYPERACEAE	lantingan
Carex remota	CYPERACEAE	teki putih
Catimbium malaccensis	ZINGIBERACEAE	tepus
Centella asiatica	APIACEAE	cowekan
Cestrum nocturum	SOLANACEAE	arum dalu
Chloranthus elatior	CHLORANTACEAE	lombokan
Chloranthus officinalis 1	CHLORANTACEAE	jengon merah
Chloranthus officinalis 2	CHLORANTACEAE	jengon putih
Chloranthus sp.	CHLORANTACEAE	palu dengan
Colocasia gigantea	ARACEAE	krombang
Commelina paludosa	COMMELINACEAE	deworan wara
Cordyline druticosa	AGAVACEAE	andong
Cyanotis ciliata	COMMELINACEAE	kremah
c.f. Elephantopus scaber	ASTERACEAE	tapa liman
Dumasia villosa	FABACEAE	kacangan
Elastostema sp.	URTICACEAE	loyoran
Elatostema integrifolium	URTICACEAE	banyon
Emilia sonchifolis	ASTERACEAE	cemondelan
Equisetum debile	EQUISETACEAE	lorokan aji
Erigeron sumatrensis	ASTERACEAE	kecir
Eupatorium inulifolium	ASTERACEAE	krinyu
Eupatorium sp.	ASTERACEAE	remujun
Festuca nubigena	POACEAE	kebut
Gynostemma pentaphyllum	CUCURBITACEAE	granggam
Hydrocotyle javanica	APIACEAE	timunan
Imperata cilindrica	POACEAE	alang-alang
Iresine herbstii	AMARANTHACEAE	bayem abang
Isachne sp.	POACEAE	laronan
Lantana camara	VERBENACEAE	wa'u
Laportea stimulans	URTICACEAE	jingkat
Leersia hexandra	POACEAE	kolomento
Leucas javanica	LAMIACEAE	legetan
Microstegium sp.	POACEAE	resap
Moghania strobilifera	FABACEAE	oto-oto
Oplismenus compositus	POACEAE	pedesan
Paederia scandens	RUBIACEAE	simbuan
Pandanus sp.1	PANDANACEAE	pandan gloso
Pandanus sp.2	PANDANACEAE	pandan rankan
Pandanus sp.3	PANDANACEAE	pandan serih
Paspalum conjugatum	POACEAE	blembem
Passiflora edulis	PASSIFLORACEAE	legeri
Perrottetia alpestris	CELASTRACEAE	codo ijo
Physalis peruviana	SOLANACEAE	cimploan
Pinanga kuhlii	ARECACEAE	umbut
Piper cilibracteum	PIPERACEAE	suruh-suruhan

Polygonum chinense	POLYPODIACEAE	tebu sawur
Raphidophora pinnatum	ARACEAE	jalu mampang
Rubus chrysophyllus	ROSACEAE	celing kepu
Rubus sp.1	ROSACEAE	celing
Rubus sp.2	ROSACEAE	celing murbei
Saccharum spontaneum	POACEAE	gelaga
Selaginella sp.	SELAGINELLACEAE	temos
Smilax zeylanica	SMILACACEAE	riwono
Solanum involucratum	SOLANACEAE	contom
Solanum nigrum	SOLANACEAE	ranti
Solanum torvum	SOLANACEAE	pokak
Stephania japonica	MENISPERMACEAE	buntu
Tetrastigma hookerii	VITACEAE	krepek
Tylophora villosa	ASCLEPIADACEAE	simbuan wara
Wedelia montana	ASTERACEAE	kentul
	LILIACEAE	anggrek tanah
	ORCHIDACEAE	anggrek
	POACEAE	bambu
	URTICACEAE	mencok rambang
ferns ssp.		pakis
rotan sp.		penjalin
		sinte weri
		kitangan
		perkok
		watur
		teh hutan
		bakun
		plumpung
		jenu
		rendet
		kecang
		boboan
		sengreng
		serunen
		lombongan

TREES

LATIN NAME	FAMILY	LOCAL NAME	ECON. CLASS
Acer laurinum	ACERACEAE	nyampu awu	2
Acmena acuminatissima	MYRTACEAE	tingan,nogosari	0
Acronychia trifoliata	RUTACEAE	rondo kawak	3
Albizzia mollucana	FABACEAE	pokek,sengon pekik	0
Alyxia sp.	APOCYNACEAE	bimo ranti	0
Anthocephalis cadamba	RUBIACEAE	jabon	3
Antidesma tetrandum	EUPHORBIACEAE	ande-ande	0
Astronia spectabilis	MELASTOMATACEAE	baderan	3
Baccaurra minutiflora	EUPHORBIACEAE	juwet macing	2
Bischoffia javanica	EUPHORBIACEAE	gintungan	3
Breymia cernua	EUPHORBIACEAE	imer	0
Brugmansia candida		kecupung	0
Calliandra callothyrsus	FABACEAE	kaliandra merah	0
Calliandra tetragona	FABACEAE	kaliandra putih	0

Castanopsis acuminatissima	FAGACEAE	meranak	2
Casuarina junghuhniana	CASUARINACEAE	cemara	0
Celtis tetranda	ULMACEAE	trete	0
Cestrum elegans	SOLANACEAE	lemuran	0
Claoxylon plot	EUPHORBIACEAE	ketupuk	0
Cleidion javanicum	EUPHORBIACEAE	berasan	2
Cordia obliqua	BORAGINACEAE	kendal	0
Debregeasia longifolia	URTICACEAE	mencok	0
Dendrocnide sp.	URTICACEAE	kemadu	0
Dendrocnide stimulans	URTICACEAE	brunya	0
Dodonea viscosa	SAPINDACEAE	kesek tanjang	0
Dysoxylum sp.	MELIACEAE	gendis	2
Elaeocarpus stipularis	ELAEOCARPACEAE	genitri	3
Engelhardia spicata	JUGLANDACEAE	kesek gompong	3
Entada phaseoloides	MIMOSACEAE	bendo	2
Ervatamia sphaerocarpa	APOCYNACEAE	cenggirit	0
Erythrina microcarpa	FABACEAE	dadap	0
Eucalyptus alba	MYRTACEAE	ekaliptus	1
Eucalyptus sp.	MYRTACEAE	trestania	0
Eugenia sp.1	MYRTACEAE	bimo	2
Eugenia sp.2	MYRTACEAE	kelis	2
Eugenia sp.3	MYRTACEAE	klampok krikil	3
Eugenia sp.4	MYRTACEAE	sendung	2
Euodia latifolia	RUTACEAE	sampang,kajar	3
Eurya acuminata	THEACEAE	urang urangan	3
Ficus ampelas	MORACEAE	rempelas	0
Ficus drupacea	MORACEAE	bulu kowang	0
Ficus fistulosa	MORACEAE	dampul	0
Ficus grossularioides	MORACEAE	kebek	0
Ficus magnoliaefolia	MORACEAE	truh	0
Ficus sinuata	MORACEAE	epri	0
Ficus sp.	MORACEAE	beringin	0
Ficus variegata	MORACEAE	gondang	0
Flacourtia ramontchi	FLACOURTIACEAE	saratan	0
Fraxinus griffithii	OLEACEAE	gagar	3
Glochidion macrocarpum	EUPHORBIACEAE	lamer	2
Glochidion rubrum	EUPHORBIACEAE	mangir	0
Guioa diplopetala	SAPINDACEAE	riwut	0
Harmsiopanax aculeatus	ARALIACEAE	cemporang	0
Helicia robusta	PROTEACEAE	kendung	0
Hydrangea aspera	SAXIFRAGACEAE	putihan	0
Hypobathrum frutescens	RUBIACEAE	kopen	0
Ilex triflora	AQUIFOLIACEAE	kutut	0
Leea sambucina	LEEACEAE	kadut	3
Leucaena glauca	MIMOSACEAE	kemlandingan	0
Lindera plyantha	LAURACEAE	regisi	3
Lithocarpus sp.1	FAGACEAE	pasang	2
Lithocarpus sp.2	FAGACEAE	pasang merah	2
Lithocarpus sundaicus	FAGACEAE	pasang putih	2
Litsea diversifolia	LAURACEAE	nyampu krompol	0
Litsea sp.1	LAURACEAE	nyampu	2
Litsea sp.2	LAURACEAE	nyampu kuning	2
Litsea sp.3	LAURACEAE	nyampu merah	2
Litsea sp.4	LAURACEAE	nyampu punyit	2

Litsea sp.5	LAURACEAE	nyampu combor	2
Macaranga rhizinoides	EUPHORBIACEAE	tutup besi	3
Macropanax dispermum	ARALIACEAE	adem ati	0
Maesa latifolia	MYRSINACEAE	meniran	0
Maesopsis eminii	RHAMNACEAE	mesopsis	2
Manglietia glauca	MAGNOLIACEAE	baros	3
Melastoma sp.	MELASTOMATACEAE	senggani	0
Melochia umbellara	STERCULIACEAE	senu	0
Michelia champaca	MAGNOLIACEAE	cempoko, cepaka	0
Michelia montana	MAGNOLIACEAE	coko	2
Mysine hasseltii	MYRSINACEAE	krakas	3
Neolitsea sp.	LAURACEAE	nyampu krangean	2
Neonauclea excelsa	RUBIACEAE	kupu ketek	2
Nephelium lappaceum	SAPINDACEAE	rambutan	3
Ocimum sanctum	LAMIACEAE	trasean	0
Omalanthus giganteus	EUPHORBIACEAE	tutup	3
Omalanthus populneus	EUPHORBIACEAE	tutup kecil	0
Persea rimosa	LAURACEAE	nyampu krikil	2
Pittosporum ferrugineum	PITTOSPORACEAE	jassan	2
Pittosporum moluccanum	PITTOSPORACEAE	klajan,blacan,glacan	0
Podocarpus imbricatus	PODOCARPACEAE	jamuju	1
Podocarpus nereifolius	PODOCARPACEAE	dukut	1
Pometia tomentosa	SAPINDACEAE	sapen	2
Postudes paniculata		lansepan	3
Prunus arborea	ROSACEAE	kenangan	2
Psychotria sp.	RUBIACEAE	kepel	0
Pterospermum javanicum	STERCULIACEAE	wadang	2
Pyrenaria sp.	ESCALLONIACEAE	gempur	3
Radermachera gigantea	BIGNONIACEAE	dali	3
Richardia brasiliensis	RUBIACEAE	lenglengan	0
Saurauia pendula	ACTINIDIACEA	didil	0
Schefflera rugosa	ARALIACEAE	nyampu payung	3
Schima wallichii	THEACEAE	puspo	3
Stachytapheta mutabilis	VERBENACEAE	laler	3
Sterculia coccinea	STERCULIACEAE	poh gunung	2
Syzigium sp.	MYRTACEAE	jambulir	2
Tarenna laxiflora	RUBIACEAE	tarenna	3
Toona sureni	MELIACEAE	suren	2
Trema orientalis	ULMACEAE	anggrung	3
Turpinia sphaerocarpa	STAPHYLEACEAE	lembayungan	3
Vernonia arborea	ASTERACEAE	sembung	3
Villebrunea rubescens	URTICACEAE	mencok jurang	0
Wendlandia densiflora	RUBIACEAE	walik lar	0
Wikstroemia androsaemilfolia	THYMELACEAE	pulutan	0
	ASTERACEAE	sembung lanjur	0
		tutup lumbu	3
		kopi	0
		kirang	0
		tuyo	0
		kapasan	3
		penjalinan	2
		keningar	0
		kuniran	3

Appendix 2 a Matrices monitoring 1979-1984 in ha for total area and subareas.

TOTAL AREA

1 9 8 4

ha	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	s	Total
f1	228	53	40	31	-	-	6	-	-	-	-	-	-	-	-	358
of1	7	181	40	8	-	-	-	-	-	-	-	-	-	-	-	236
1 w1	16	16	74	116	-	-	-	-	-	-	-	-	-	-	-	222
9 bg/wg/wb	2	2	-	67	-	-	6	-	-	-	-	-	-	-	-	77
7 f4	-	-	-	-	123	-	-	-	-	-	-	-	-	-	-	123
9 f2	5	6	-	-	9	1515	228	100	-	-	-	-	-	-	-	1863
of2	-	-	-	12	6	133	214	135	-	-	-	-	16	8	4	528
w2	-	-	-	-	-	3	51	366	-	-	-	-	102	-	-	522
f3	-	-	-	9	-	-	-	-	156	62	58	-	-	-	-	285
of3	-	-	-	-	-	-	-	7	92	362	236	24	51	9	-	781
w3	-	-	-	6	-	4	-	-	27	152	1190	-	198	4	-	1581
f5	-	-	-	-	-	-	-	-	-	-	-	246	-	-	-	246
t2	-	-	4	5	-	-	5	29	-	23	156	-	1298	473	-	1993
t1	-	-	4	-	-	-	-	-	-	-	8	-	88	1614	-	1714
s	7	-	-	-	-	207	39	6	-	17	11	-	11	-	308	606
Total	265	258	162	254	138	1862	549	643	275	616	1659	270	1764	2108	312	

ANDJASHORO

Total forest/scrub area 2893 ha

1 9 8 4

ha	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	s
f1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 w1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	-	-	-	32	-	-	6	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 f2	-	-	-	-	-	787	113	33	-	-	-	-	-	-	-
of2	-	-	-	6	-	98	135	57	-	-	-	-	16	3	-
w2	-	-	-	-	-	-	24	119	-	-	-	-	40	-	-
f3	-	-	-	-	-	-	-	-	32	12	22	-	-	-	-
of3	-	-	-	-	-	-	-	-	-	60	5	-	-	-	-
w3	-	-	-	-	-	-	-	-	-	7	87	-	31	-	-
f5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t2	-	-	-	-	-	-	-	23	-	-	5	-	240	197	-
t1	-	-	-	-	-	-	-	-	-	-	-	-	14	529	-
s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	148

KAWI-N

Total forest/scrub area 2762 ha

1 9 8 4

ha	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	s
f1	228	53	40	31	-	-	6	-	-	-	-	-	-	-	-
of1	7	181	40	8	-	-	-	-	-	-	-	-	-	-	-
1 w1	16	16	74	66	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	2	2	-	31	-	-	-	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	123	-	-	-	-	-	-	-	-	-	-
9 f2	5	6	-	-	9	538	24	3	-	-	-	-	-	-	-
of2	-	-	-	-	6	118	72	19	-	-	-	-	-	-	-
w2	-	-	-	-	-	3	28	85	-	-	-	-	29	-	-
f3	-	-	-	-	-	-	-	-	-	34	-	-	-	-	-
of3	-	-	-	-	-	-	-	-	-	34	21	-	-	-	-
w3	-	-	-	-	-	-	-	-	-	-	163	-	34	-	-
f5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t2	-	-	4	-	-	-	5	-	-	-	-	-	178	27	-
t1	-	-	4	-	-	-	-	-	-	-	-	-	-		168
-															
s	7	-	-	-	-	82	-	6	-	17	9	-	-	-	122

KAWI-W

Total forest/scrub area 2026 ha

1 9 8 4

ha	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	s
f1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 w1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 f2	-	-	-	-	-	156	91	26	-	-	-	-	-	-	-
of2	-	-	-	-	-	4	27	59	-	-	-	-	-	-	-
w2	-	-	-	-	-	-	-	75	-	-	-	-	-	6	-
f3	-	-	-	-	-	-	-	-	97	8	18	-	-	-	-
of3	-	-	-	-	-	-	-	-	92	114	36	-	19	3	-
w3	-	-	-	-	-	-	-	-	-	28	151	-	19	4	-
f5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t2	-	-	-	-	-	-	-	-	-	-	17	-	391	22	-
t1	-	-	-	-	-	-	-	-	-	-	-	-	41	250	-
s	-	-	-	-	-	125	39	38	-	27	3	-	10	-	19

DOROWATI
Total forest/scrub area 2380 ha

1 9 8 4

ha	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	
f1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 w1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 f2	-	-	-	-	-	34	-	39	-	-	-	-	-	-	-
of2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
w2	-	-	-	-	-	-	-	73	-	-	-	-	21	-	-
f3	-	-	-	9	-	-	-	-	23	8	18	-	-	-	-
of3	-	-	-	-	-	-	-	-	-	9	89	-	24	-	4
w3	-	-	-	6	-	4	-	-	27	107	627	-	12	-	-
f5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t2	-	-	-	5	-	-	6	-	23	134	-	-	322	123	-
t1	-	-	-	-	-	-	-	-	-	8	-	-	34	434	-
s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45

KELUD
Total forest/scrub area 1008 ha

1 9 8 4

ha	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	
f1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 w1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 f2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
w2	-	-	-	-	-	-	-	14	-	-	-	-	12	-	-
f3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of3	-	-	-	-	-	-	-	7	-	144	85	24	8	6	-
w3	-	-	-	-	-	-	-	-	-	10	162	-	6	-	-
f5	-	-	-	-	-	-	-	-	-	-	-	246	-	-	-
t2	-	-	-	-	-	-	-	-	-	-	-	-	140	28	-
t1	-	-	-	-	-	-	-	-	-	-	-	-	-	115	-
s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

LUKSONGO
Total forest/scrub area 220 ha

1 9 8 4

ha	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	
f1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 w1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 f2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
w2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
f3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
w3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
f5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t2	-	-	-	-	-	-	-	-	-	-	-	-	26	76	-
t1	-	-	-	-	-	-	-	-	-	-	-	-	-	117	-
s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

- . -

b Transition matrices monitoring 1979-1984 for total area and subareas.

TOTAL AREA

1 9 8 4

	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	s
f1	0.64	0.15	0.11	0.09	-	-	0.02	-	-	-	-	-	-	-	-
of1	0.03	0.77	0.17	0.03	-	-	-	-	-	-	-	-	-	-	-
1 w1	0.07	0.07	0.33	0.52	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	0.03	0.03	-	0.87	-	-	0.08	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	1.00	-	-	-	-	-	-	-	-	-	-
9 f2	0.00	0.00	-	-	0.02	0.81	0.12	0.05	-	-	-	-	-	-	-
of2	-	-	-	0.02	0.01	0.25	0.41	0.26	-	-	-	-	0.03	0.02	0.01
w2	-	-	-	-	-	0.01	0.10	0.70	-	-	-	-	0.20	-	-
f3	-	-	-	0.03	-	-	-	-	0.55	0.22	0.20	-	-	-	-
of3	-	-	-	-	-	-	-	0.01	0.11	0.46	0.30	0.03	0.07	0.01	-
w3	-	-	-	0.00	-	0.00	-	-	0.02	0.10	0.75	-	0.13	0.00	-
f5	-	-	-	-	-	-	-	-	-	-	-	1.00	-	-	-
t2	-	-	0.00	0.00	-	-	0.00	0.02	-	0.01	0.08	-	0.65	0.24	-
t1	-	-	0.00	-	-	-	-	-	-	-	0.00	-	0.05	0.94	-
s	0.01	-	-	-	-	0.34	0.06	0.01	-	0.03	0.02	-	0.02	-	0.51

ANDJASMORO

Total forest/scrub area 2893 ha

1 9 8 4

	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	s
f1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 w1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	-	-	-	0.84	-	-	0.16	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 f2	-	-	-	-	-	0.84	0.12	0.04	-	-	-	-	-	-	-
of2	-	-	-	0.02	-	0.31	0.43	0.18	-	-	-	-	0.05	0.01	-
w2	-	-	-	-	-	-	0.13	0.65	-	-	-	-	0.22	-	-
f3	-	-	-	-	-	-	-	-	0.48	0.18	0.33	-	-	-	-
of3	-	-	-	-	-	-	-	-	-	0.92	0.08	-	-	-	-
w3	-	-	-	-	-	-	-	-	-	0.06	0.70	-	0.25	-	-
f5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t2	-	-	-	-	-	-	-	0.05	-	-	0.01	-	0.52	0.42	-
t1	-	-	-	-	-	-	-	-	-	-	-	-	0.03	0.97	-
s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0

KAWI-N

Total forest/scrub area 2762 ha

1 9 8 4

	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	s
f1	0.64	0.15	0.11	0.09	-	-	0.02	-	-	-	-	-	-	-	-
of1	0.03	0.77	0.17	0.03	-	-	-	-	-	-	-	-	-	-	-
1 w1	0.07	0.07	0.33	0.52	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	0.06	0.06	-	0.89	-	-	-	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-	-
9 f2	0.01	0.01	-	-	0.02	0.92	0.04	0.01	-	-	-	-	-	-	-
of2	-	-	-	-	0.03	0.55	0.33	0.09	-	-	-	-	-	-	-
w2	-	-	-	-	-	0.02	0.19	0.59	-	-	-	-	0.20	-	-
f3	-	-	-	-	-	-	-	-	-	1.00	-	-	-	-	-
of3	-	-	-	-	-	-	-	-	-	0.62	0.38	-	-	-	-
w3	-	-	-	-	-	-	-	-	-	-	0.83	-	0.17	-	-
f5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t2	-	-	0.02	-	-	-	0.02	-	-	-	-	-	0.83	0.13	-
t1	-	-	0.02	-	-	-	-	-	-	-	-	-	-	0.98	-
s	0.03	-	-	-	-	0.34	-	0.03	-	0.07	0.04	-	-	-	0.5

KAWI-W

Total forest/scrub area 2026 ha

1 9 8 4

	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	s
f1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 w1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 f2	-	-	-	-	-	0.57	0.33	0.10	-	-	-	-	-	-	-
of2	-	-	-	-	-	0.04	0.30	0.66	-	-	-	-	-	-	-
w2	-	-	-	-	-	-	-	0.93	-	-	-	-	-	0.07	-
f3	-	-	-	-	-	-	-	-	0.79	0.07	0.15	-	-	-	-
of3	-	-	-	-	-	-	-	-	0.35	0.43	0.14	-	0.07	0.01	-
w3	-	-	-	-	-	-	-	-	-	0.14	0.75	-	0.09	0.02	-
f5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t2	-	-	-	-	-	-	-	-	-	-	0.04	-	0.91	0.05	-
t1	-	-	-	-	-	-	-	-	-	-	-	-	0.14	0.86	-
s	-	-	-	-	-	0.48	0.15	0.15	-	0.10	0.01	-	0.04	-	0.0

DOROWATI

Total forest/scrub area 2380 ha

1 9 8 4

	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	s
f1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 w1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 f2	-	-	-	-	-	0.47	-	0.53	-	-	-	-	-	-	-
of2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
w2	-	-	-	-	-	-	-	0.78	-	-	-	-	0.22	-	-
f3	-	-	-	0.16	-	-	-	-	0.40	0.14	0.31	-	-	-	-
of3	-	-	-	-	-	-	-	-	-	0.07	0.71	-	0.19	-	0.0
w3	-	-	-	0.01	-	0.00	-	-	0.03	0.12	0.70	-	0.14	-	-
f5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t2	-	-	-	0.01	-	-	0.01	-	0.04	0.22	-	-	0.53	0.20	-
t1	-	-	-	-	-	-	-	-	-	0.02	-	-	0.07	0.91	-
s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0

KELUD

Total forest/scrub area 1008 ha

1 9 8 4

	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	
f1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 w1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 f2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
w2	-	-	-	-	-	-	-	0.54	-	-	-	-	0.46	-	-
f3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of3	-	-	-	-	-	-	-	0.03	-	0.54	0.32	0.09	0.03	0.02	-
w3	-	-	-	-	-	-	-	-	-	0.06	0.91	-	0.03	-	-
f5	-	-	-	-	-	-	-	-	-	-	-	1.00	-	-	-
t2	-	-	-	-	-	-	-	-	-	-	-	-	0.83	0.17	-
t1	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00	-
s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

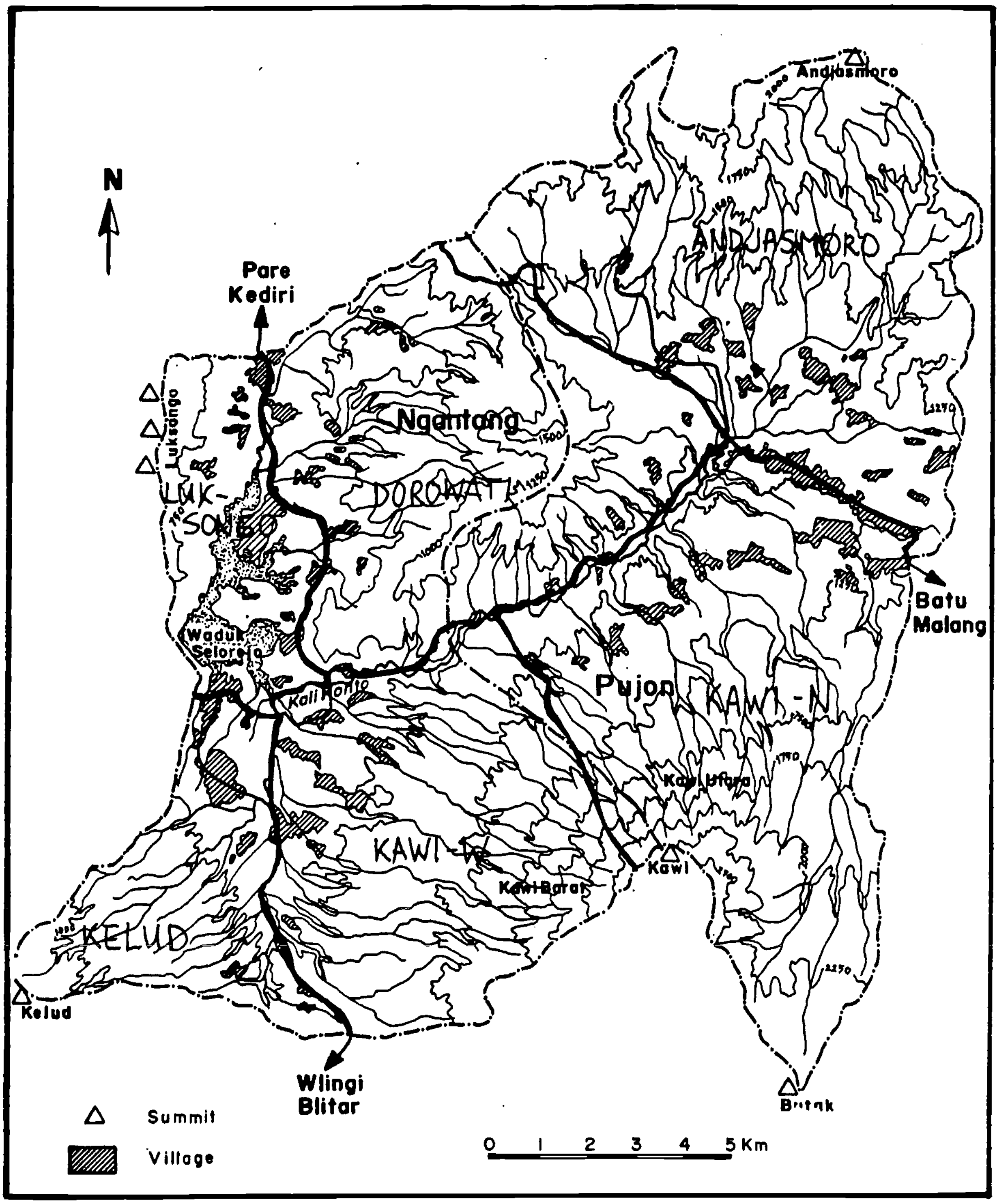
LUKSONGO

Total forest/scrub area 220 ha

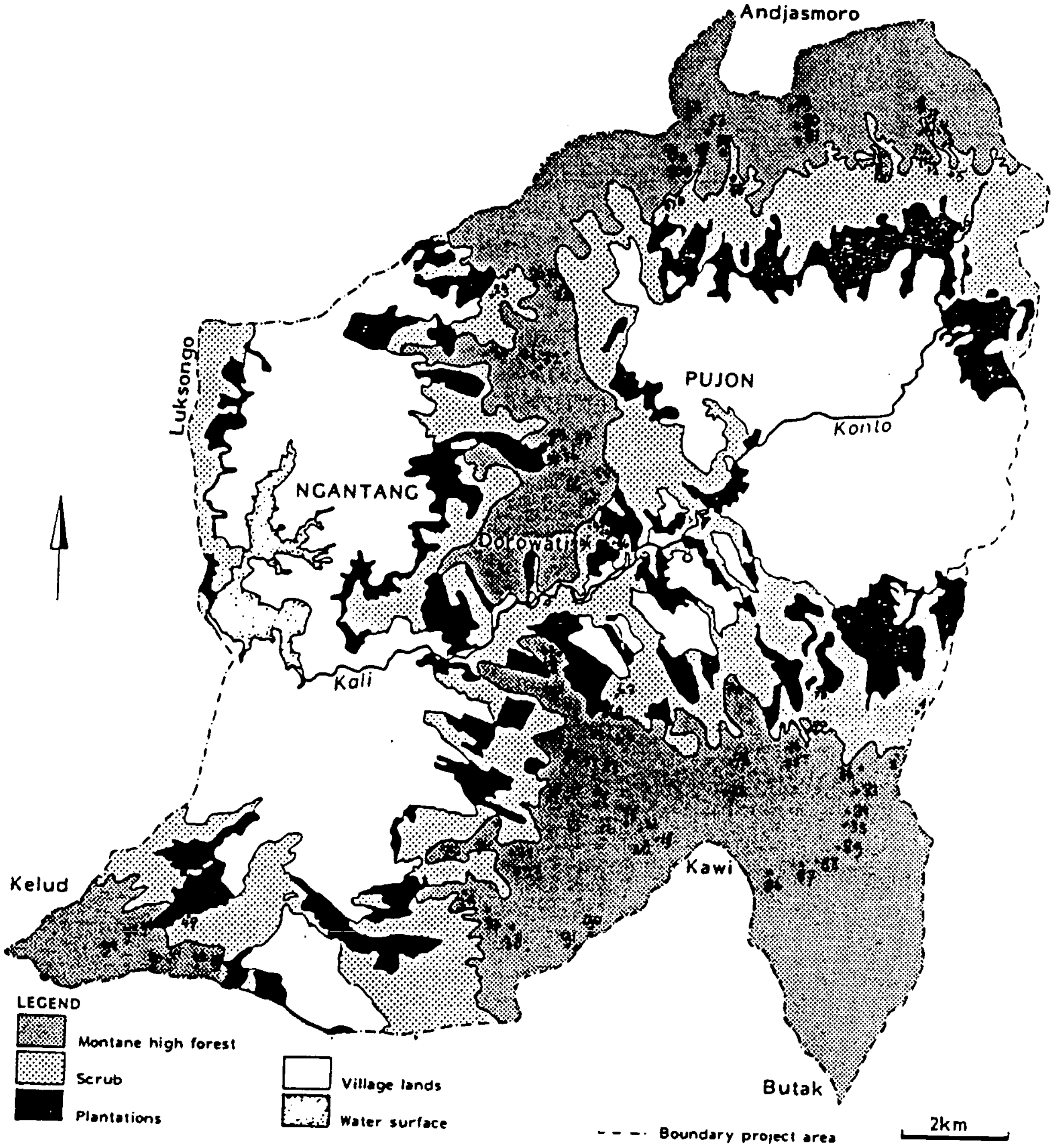
1 9 8 4

	f1	of1	w1	bg/wg/wb	f4	f2	of2	w2	f3	of3	w3	f5	t2	t1	
f1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 w1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 bg/wg/wb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 f4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 f2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
w2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
f3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
of3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
w3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
f5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t2	-	-	-	-	-	-	-	-	-	-	-	-	0.25	0.75	-
t1	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00	-
s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

c   Map with used subareas.



Appendix 3 a Map with location sample plots.



b Example of plot data sheet.

ITC Land Ecology- and Land Use Survey

ITC RELEVÉ DATA SHEET

PHOTO No. (run, type etc.)	Area, Country, etc. Dk Jerkle, Kawi NW	DATE 6 / 10 / 89 day month year	No. 85
PRELIMINARY LEGEND SYMBOL: HS8Df → f6	SIZE SAMPLE m^2 20x20	ALTITUDE IN m: 1190	
PRELIMINARY LANDUNIT NAME:	OBSERVER(S): PH, Pak Wagi, Pak Ru		

FINAL CLASSIFICATION (not for fielduse)

FINAL LANDUNIT NAME:	FINAL MAP SYMBOL
LANDFORM - (HYDROLOGY)	SYMBOL
SOIL	SYMBOL
VEGETATION structure	SYMBOL
composition	SYMBOL
LAND USE	SYMBOL

TERRAIN DATA

SITE/ELEMENT	MAPPING UNIT
ROCK LITHOLOGY:	ROCK LITHOLOGY/GEOLOGICAL FORMATION
LANDFORM/TOPOGRAPHIC POSITION WITHIN MAPPING UNIT crest	LANDFORM hilly
SLOPE TYPE straight, concave, convex, irregular	RELIEF TYPE - Very flat - Almost flat (< 2%) - Undulating (3 - 7%) - Rolling (8 -13%) - Hilly (14-20%) - Steeply dissected (21-55%) - Mountainous (> 55%)
SLOPE: 8° (15°) LENGTH: 30 m; EXPOSURE N.NE.E.SE.S.SW.W.NW. 150	RELIEF INTENSITY
MICRO-MESORELIEF (Cl. Bridge later weeks NW)	

SOIL AND WATER DATA

EROSION TYPE	RATE	AREA AFFECTED	SOIL DRAINAGE	WATER SOURCE	RUNOFF	FLOODING/PONDING DEPTH	AGENT	FREQUENCY	DURATION
none sheet rill gully eolic	very low low moderate strong severe	<25% 20-50% 50-75% >75%	excessive, somewhat excessive, well, mod.well, imperfect, poor, very poor	rain, run-on, aquifer, irrigation	very rapid, slow, rapid, very slow, medium		none rain run-on river lake sea	...per .....years month week	days weeks months

HORIZON symbol	DEPTH cm	TEXTURE	COLOUR	PH	HCL	MOTTLING	CONSISTENCE	SURFACE SEAL	SURFACE STONINESS/ ROCK OUTCROPS (%)	REMARKS
									effective soil depth (cm)	groundwater depth (cm) .....

PRELIMINARY SOIL CLASSIFICATION

LAND COVER/USE DATA (semi-)natural or planted

SAMPLE PLOT

STRATA	HEIGHT	COVER %	DOMINANT SPECIES (for details p.t.o.)
trees >5 m	30	30	frete
50			
shrubs 5>h>0.3	0.4-2	13	cenggirit
70			
herbs <0.3 m	0.3	20	palu dengan
60	0.2	17	pedesan

total real cover % 90

PRELIMINARY COVER CLASSIFICATION:
structure :
composition:

LAND USE
type:
field size/shape:

SITE/ELEMENT	MAPPING UNIT
general cover/use type (if complex, estimate % cover of each type)	general cover/use type (if complex, estimate % cover of each type)

Serial number here No. 85	LIST OF SPECIES		cover	H(m)	Ø dbh	ØC	%
POHON	gendis		r	9	35	1½	60
	sampang		r	13	55	1½	75
	lembayungan		l	14	57	2	50
	〃			20	110	3	90
	trete		3	12 / 30	97 / 46	2½ / 15	90 / 20
	laler		p	20	83	2½	56
	ny payung		r	7	23	1½	25

BA : 45.02 m^2/ha

SAMPLE SIZE:	TOTAL NO. OF TAXA:	NO: of epiphytes	no of climbers/ lianas
20x20	56	15	20

	COVER		COVER
palu dengan	2	contom	a
pedesan	2	kacangan	a
jengon putih	a	dewaran	a
jengon merah	1	krepek	a
tepus	a	simbuan	a
riwono	1	granggam	a
suruh surahar	1	pakis	1
tebu sawur	a	anggrek	a
watul	a	pretok	a
oto oto	a	resap	a
		umbut	a
		kinyu	a
		[illegible]	a

OBSERVATIONS/INTERVIEWS ON VEGETATION, CROPS, ANIMALS AND MANAGEMENT ASPECTS (SAMPLE SITE)

SEMI-NATURAL VEGETATION

burning

fuel wood collection

range condition ⅔

grazing traces

fences

watering points

dropping/footmarks/ tracks

stumps/dead trees/ felled trees (diameter, human or natural)

stomp
wadang Ø 10 cm hum. 1
〃 Ø 10 cm 〃
adem ati Ø 10 cm 〃

COVER	NR	POHON KECIL	HEIGHT
p	3	baderan	1½, 2, 2½
l	16	cenggirit	0.4, 0.6(2x), 0.8(2x), 1(8x), 1½(2x), 2
p	7	mangir	0.3, 0.7, 0.9, 1, 1½, 2, 3
r	1	ketupuk	0.7
p	9	cepaka	1(5x), 2, 4(3x)
p	6	kirang	0.8, 1, 1, 1½, 2, 3
p	5	lembayungan	0.9(2x), 1½, 2(2x)
p	8	cemporang	0.6, 1(4x), 1½, 2(2x)
r	1	gagar	1
p	4	trasean	0.5, 1, 1, 3
r	2	gendis	1, 2
r	2	laler	1, 1½
p	4	pasang putih	0.6, 0.7, 1, 2
p	4	brunya	1(3x), 3
r	1	ny combor	2½
p	9	sampang	1(9x), 2(2x), 2½(2x), 3(2x)
p	5	wadang	1, 1, 2, 2½(2x)
r	1	jambulir	1½
p	5	kelis	1(3x), 1½, 2
r	1	ny krangean	1½
p	4	kepel	~~1, 1, 1, 1~~ 1, 2(3x)
r	1	ande ande	3
r	1	semburg	0.9
r	1	kopen	2
r	2	klampok krikil	2, 3
p	3	rempelas	1, 2, 2
r	1	tarenna	0.8
p	9	kenadu	1, 1½(5x), 2½, 3, 4
r	1	kesek gempong	1
r	1	dadap	1

Appendix 4 Complete vegetation table.

	CaD	Cas	Eng	EuL	Lit	OcE	OcA	FiC	CeO	CeE	EpO	EpL
	877	475	88383	411331219751	49 338 17787	111568	336622261	86266	2554848423	45345644	529429 297	6 5 965
	632	49938	78396	901219060523	3817451227406	584043	872543217	28709	5871475660	26959730	4134855948	6956631
		s		n								
odonea viscosa	552	-----	2----	------------	-------------	------	---------	-----	----------	--------	----------	-------
isuarina junghuhniana	646	-----	2----	------------	-------------	------	---------	-----	----------	--------	----------	-------
eh hutan (jav.)	5--	-----	53---	------------	-------------	------	---------	-----	----------	--------	----------	-------
crostegium sp.	665	-----	55---	------------	--4-------4--	-3---4	---------	-----	------2---	--------	4-4--3-3--	--4----
istanopsis acuminatis.	---	77777	-----	55635-------	5-----5-5--2-	---2--	---------	-----	----------	--------	2---------	-------
elicia robusta	---	-----	55-4-	----------2-	--2---2------	------	---------	---22	----------	--------	2---------	-------
odocarpus imbricatus	---	22-2-	2-2--	32--2-2-----	------2----2-	------	---------	-----	----------	--------	----------	-------
indanus sp.(p.rankan)	---	43-32	-----	3----64-6-3-	2432--52---44	------	---------	-----	--3-------	--------	----------	-------
odocarpus nereifolius	---	--22-	-----	-----2------	---2---------	------	---------	-----	----------	--------	----2-----	------
tsea diversifolia	---	222-2	22242	42-2-2222222	-225232-2--22	22----	2--2----2	22---	--------22	--------	-2--------	-------
estuca nubigena	---	-----	22-2-	------------	--6--2-------	------	---------	-----	----------	--------	----------	-------
yxia sp.	---	-2--2	--222	-2--222-2---	---242-----2-	------	---------	-----	----------	--------	-2--------	-2-----
rsine hasseltii	---	-244-	4222-	32234222-2-5	222-2-2-2-242	---2--	2--22-222	-----	--2--2-22-	--------	2---2-----	-------
ronychia trifoliata	---	22-2-	2-322	22-222222222	--2-22--2---2	--22--	22-----42	--2--	-------5--	22-----2	----------	-----2-
ernonia arborea	---	-----	--2--	-22--2--26--	--2-22---22-4	--5--2	-------2-	---2-	----2-2---	2-------	----------	-------
cus grossularioides	---	---2-	-----	2--22----2--	222---2-2--22	-2----	-2----222	-----	----------	--------	2---2-2---	2------
igelhardia spicata	---	-2-2-	67627	-2-52-45-42-	2-4--2252-6--	2----2	2-22---2-	--222	------2--2	----4---	4----2---5	---2---
ttosporum ferrugineum	---	-----	-----	4----5-46---	-42----------	2--22-	---------	-----	----------	--2-----	2---------	-------
laginella sp.	---	-----	-----	-------23---	--32---------	------	------2--	-----	----------	--------	----------	-2-----
lophora villosa	---	-----	-----	------------	-------------	-22---	--------2	-----	----------	--------	----------	-------
ochidion macrocarpum	---	2----	-----	------2-----	--2----------	---2--	-------4-	-----	----------	--------	----------	-------
igenia sp.(bimo)	---	24242	4-24-	352652542452	5442224-2--22	656264	2--22-222	-2---	---4------	-22-2--2	22----2---	-------
hefflera rugosa	---	2254-	-----	22244--2---2	2-2-----4--2-	2522--	2--22---2	-222-	-----222--	--------	22--2-----	-------
olitsea sp.	---	-222-	----2	4---22222222	-22---2-2---2	2-22--	222----22	---22	---22-2---	--------	24--------	-------
nanga kuhlii	---	-----	-----	--2----24222	322----------	22-32-	--2222-22	2--22	-22---2---	-4-2----	-2----4---	-------
onauclea excelsa	---	-----	--2--	-2-22-42--2-	22-2--------2	-2----	----2----	-----	---2-2---2	--2---2-	-4--2-2---	-------
dermachera gigantea	---	---2-	-----	---2---2---2	-------------	------	---------	--2--	----------	--------	----------	-------
achytapheta mutabilis	---	-2---	-----	---2--42----	--4----------	-52---	2------25	-----	-262--24--	---4----	----------	-------
tangan (jav.)	-4-	-----	-----	-----222----	-------------	522---	3----2---	-----	----------	--------	-2--------	-------
LIACEAE ssp.	---	22-2-	--2-3	22222-223---	2-2---2---22-	-2----	3------22	---2-	-------2--	---2----	2--22-2---	---2---
tur (jav.)	---	22-2-	-----	222--2424-32	-24---2-2--23	-22---	3322-----	2----	--2--22-22	3-3322--	-22-2-----	----2--
itidesma tetrandum	---	-2-4-	--2--	--22-522---2	2-2-----2--2-	222222	242--2225	22-22	---42-2---	2-2---2-	22--22--2-	--2----
ex triflora	---	-2-2-	----2	22222--2-222	-22-----2-2-2	-25-2-	2-22--222	---2-	---222-22-	---22--2	2--4222--2	---2---
axinus griffithii	---	-----	-----	---45-22---2	-----------2--	22-232	22262-22-	24222	2-22222-22	-22-----	2-2-25----	--2-2--
lastoma sp.	-2-	-2-22	2----	-222-----2--	-22-2-2-2--2-	-22---	---------	-----	----------	-----2--	2--22-----	4--2---
ndlandia densiflora	---	2----	----2	222--22-----	--------2--2-	2--2--	--2------	-----	----------	2-2---2	22---2---2	---2---
bizzia mollucana	---	-----	-----	---24------2	-2-----2----	-22--2	4-------2	-----	--2-2-----	--------	----------	--2----
eidion javanicum	---	-----	-----	--2-2-2-----	--------2-22-	---2--	2--22---2	-2---	----------	-2---2--	2---------	-------
bregeasia longifolia	---	-----	-----	----2---2---	--------22222	22-2--	-------22	-----	---2-----2	--2---2-	-2--2-----	2------
rang (jav.)	---	----2	-----	2--22-------	----------2--	222--2	2222222--	22222	2222222222	22242-24	---422222-	-------
imum sanctum	---	222--	--2--	-2--2---2--2	---------2--2	-22-62	4242242-2	422-2	-424-42422	22244-22	-2-22---2-	3---2--
immelina paludosa	---	----2	-----	---22--23---	----22-------	224-22	3----2222	32232	232-232322	333322-3	-232----24	-------
icaranga rhizinoides	---	-2-2-	-----	---2-----2--	-2--------2-2	2-5---	24-224422	----2	-422-----4	252---24	---22-----	3------
schoffia javanica	---	-----	-----	------------	----------2--2	------	-2-2-----	-2-22	-2-4---62-	22-22-22	-----4----	-------
ispalum conjugatum	---	-----	-----	---2--------	---------3----	33--2-	--224---4	-----	4--4-4-4-2	5-4-2-33	---4-3-5--	--4----
iodia latifolia	---	-----	-----	---2-----2-2	2------------	222-22	2-22--24-	22242	-5424-2-2-	2---2--2	----4-----	-------
etrastigma hookerii	---	-----	-2-2-	-----2--2---	--3----------	2---22	3322--22-	--222	222-2-2-2-	----22-2	-2-2------	-------
irmsiopanax aculeatus	---	-----	-----	------------	2--2-----2---	2--22-	--52-----	522-4	422-2-2--5	222---2-	----2-----	-------
iioa diplopetala	---	-4---	-----	2--22-------	---------2---	---2--	2------2-	--22-	---2-2-52-	-2-6---2	2--42-----	-------
olanum involucratum	---	-----	-----	------------	---------2---	--2---	------2--	-2--2	------2--5	--------	-2--------	-------
indanus sp.(p.gloso)	---	-----	-----	---32----2-2	-------------	------	3--2222-2	-----	-------2--	---3----	---4------	-------
acourtia ramontchi	---	-----	-----	------------	---4---------	-----2	---22---2	2-22-	---2------	2-----2	----------	-------
erculia coccinea	---	-----	-----	2-------2-2-	-------------	---2--	2---4----	--2--	6-----52-	--4-2---	----------	-------
iyo (jav.)	---	-----	-----	--------2---	-------------	-----2	----2---2	2---2	2----2--2-	--------	----------	-------
tsea sp.(n.punyit)	---	-----	-----	--------2---	-------------	-----2	---------	-----	--------22	--------	----------	-------
hyranthes bidentata	---	-----	-----	--------2---	----2--------	-----2	---------	----2	----------	-3---2-2	----------	-2-----
tsea sp.(n.combor)	---	-2---	-----	------222---	----------22-	222-22	---22----	22222	-2222-2---	222-2222	----------	-----2-
indrocnide stimulans	---	--2--	-----	-----------2	---------5---	22-244	22-222-2-	2-2-2	2242222222	222-2222	--2-2---4-	-------
soxylum sp.	---	-----	--2--	-----------2	-------------	---2--	24-2222-2	22222	2242-2224-	22-22222	------2---	-------
cus drupacea	---	-----	-----	-----2----2-	--------2----	------	---2--2-2	-----	--2-2--2--	22--2-22	------2---	-------
itada phaseoloides	---	-----	-----	------------	-------------	------	----4-4--	-----	---4------	------2-	----------	-------
oboan (jav.)	---	-----	-----	------------	-------------	------	-3-------	-----	--2-2-----	------3-	----------	2------

	CaD	Cas	Eng	EuL	Lit	OcE	OcA	FiC	CeO	CeE	EpO	EpL
	877	475	88383	411331219751	49 338 17787	111568	336622261	86266	2554848423	45345644	529429 297	6 5 965
	632	49938	78396	901219060523	3817451227406	584043	872543217	287D9	5871475660	26959730	4134855948	6956631
		s		n								
Celtis tetranda	---	-----	-----	2--2--22---2	2222-----22--	-22-2-	--22---2-	-2422	-22-525245	----22--	2-2-2-22-2	--2----
Ervatamia sphaerocarpa	---	-----	-----	------------	-------------	-----2	---2-----	55--5	2252-24255	254-2545	-------2--	-------
Chloranthus sp.	---	-----	----2	------24-3--	-22---2------	----22	--323243-	44554	2555525256	-5542345	---322--3-	----2--
Catimbium malaccensis	---	-----	-----	---2-22-2--2	---------2-2-	2----2	---22----	222-2	22-2222322	3-3-22-2	-2-2---22-	-------
Persea rimosa	---	-----	----2	----2-------	----------2--	--2---	-2-2-----	-24-4	-22--2-523	-2-4--22	----2-2---	-------
Eugenia sp.3 (kl.krikil)	---	-----	-----	2----------2	--------2----	-22-2-	--22---2-	2-22-	-2222422--	24-24-22	-----2----	-------
Ficus ampelas	---	---2-	2-2--	---------22-	------2--2--2	------	--2----2-	-5--2	-22-2-2---	-2--22--	2-2-----2-	-------
Dumasia villosa	---	-----	--2-3	---------3--	2---2-4----2-	----22	--2------	22-32	--3---2--2	-3--2---	2----3-22-	--3----
Villebrunea rubescens	---	-----	2----	------------	-------------	----42	-------2-	-----	-24-------	-4--2---	-----2----	42-----
Ficus variegata	---	-----	-----	------------	-------------	------	---------	-5-25	-65--5----	----2---	----------	-------
kapasan (jav.)	---	-----	-----	------------	---2---------	------	---------	-2-22	-----2----	-2---2--	----------	-------
sinte weri (jav.)	---	-----	-----	------------	-------------	----2-	---------	32---	----2-----	----22--	----------	-------
Tarenna laxiflora	---	-----	-----	------------	-------------	------	---------	--2-2	------2-2-	--------	----------	-------
Eurya acuminata	---	-----	-----	------------	-------------	------	---------	-----	-22-------	-2------	----------	-------
Ficus magnoliaefolia	---	-----	-----	---4--------	-2-----------	---6--	---------	76665	---4------	4-4-4---	--6-------	-------
ORCHIDACEAE ssp.	---	-----	-----	------------	-------------	------	---------	22---	2---2222-	3--3-2-4	---------2	-------
Moghania strobilifera	---	-----	--2--	-------2---	-------------	------	--2------	----2	2----23-2	-----2--	-------2--	-------
Dendrocnide sp.	---	-----	-----	------------	--------2----	------	--2---4--	-----	222--22---	-22-2--2	----------	----5--
bakun (jav.)	---	-----	-----	----2-------	-------------	------	---------	--2--	---3-2-3--	------2-	----------	-------
Acer laurinum	---	24222	-424-	22252254-2-2	2-5-22--2--22	2--2--	222----22	---2-	-------2--	---2--22	-----2---	-------
Chloranthus off.(putih)	---	--4-4	-363-	-32--442----	---552---6---	--23-2	-----454-	3----	----4-3---	--------	-2--2-----	-------
Eugenia sp.(sendung)	---	22223	--242	222422-2-222	--25442-2--2-	2-22--	24-222222	-----	2222-2--22	-224----	22-22-----	-------
Turpinia sphaerocarpa	---	--222	---2-	2-2---22-222	442-22-42--42	222--2	22---4-22	2-22-	---22242--	5-2----2	2---2-----	-5-----
Chloranthus elatior	---	22--5	---2-	244424444452	65342543-4-24	2224-2	434-22-52	-5--3	233-2---22	-34-22--	4---2-2---	-3-----
Ficus fistulosa	---	-2-22	--2--	-22--222222-	52222-2222-2-	22-2--	2-2222222	2-22-	--22-2----	222-2-22	22--2-5---	-2-----
Elaeocarpus stipularis	---	2--25	--24-	---2--42-242	4522--252---2	4222-2	5-54--422	-----	----------	-64-----	22--------	-------
Lithocarpus sp.(p.merah)	---	---2-	4266-	-22226244655	-62265--2---2	222--4	422252222	-22-2	22-524-422	--24-2--	2--52-2---	-------
Syzigium sp.	---	-2222	2-2-2	222222222-22	-22-24--2---2	2224-2	222222242	--22-	--2-222-2-	222---22	----2-----	2------
Lithocarpus sundaicus	---	2----	-22--	222222222222	-234-2--22--2	222227	432232222	22222	4-24522224	3242-222	2--22---2-	-------
penjalin (jav)(rotan)	---	22-2-	-----	22-2-2533-2-	-33---4----3-	22---4	4--23---2	--4--	---3-2-332	3-3-2--2	------2---	-------
Pyrenaria sp.	---	-2-2-	----2	22-222225222	-23--22-2-2-2	222222	22-222222	2-222	-2222---22	22---222	-2--2-----	-------
Manglietia glauca	---	22---	-----	2--------2--	2--2--2----2-	-2----	---22-2--	2----	-2222-----	422---2	----------	-4-----
Astronia spectabilis	---	--2--	-----	---------2-2-	-------2----2-	---222	2--22-22-	---2-	-2--2-2---	--------	----2-----	-5-----
Chloranthus off.(merah)	---	44---	-----	4--2-----342	------4----23	422343	3344--2--	45-52	-3--4-4---	4-4--53-	3-------2-	-------
Eugenia sp.(kelis)	---	--2--	-2-4-	5--24-2-222-	-22---2----4-	-2--24	22-2---2-	22-22	--2-2-2--2	-2--4---	---2------	-------
Omalanthus giganteus	---	2----	4--2-	-2----------	-2------2----	------	-----52--	-----	----------	2-------	----2-----	-------
Michelia champaca	---	-2---	-----	2--22--252--	-46------2---2	222--5	24-25-252	-2222	2-235-2-22	542--2-5	-2--------	-------
Pandanus sp.(p.serih)	---	32---	-----	222---2-22--	-22---------22	222---	-3-22--22	--22-	-223-2--2-	--3--23-	----2-----	-------
penjalinan (jav.)	---	-----	-----	-2---222----	------------2	2-----	22-------	--2-5	----------	--------	-2-2------	-------
Psychotria sp.	---	-2-2-	--222	2-2342222222	-22-22----222	2224-2	2-222--22	22222	2222442542	2-222-22	422522----	---2---
Hypobathrum frutescens	---	--22-	--22-	222--2222---	--2222----2--	22-222	22222222-	22222	-22222222-	222--22-	-2--22----	-------
Macropanax dispermum	---	--2-2	--22-	222--42-42--	-----2222222-	2-24-2	2-2222222	---2-	-2422-----	-2--2---	----2-22--	-2-----
Pterospermum javanicum	---	-2-2-	2----	---22222-2-2	2-2--------2-	222-2-	22-22-222	-22-2	2222222422	222-4-2-	22------2-	-------
perkok (jav.)	---	-2---	--2--	222--2-2-222	22------2--23	2-23-2	33-22-2--	-22-2	-2232-2222	-3-32---	--222-2---	-------
Piper cilibracteum	---	-----	-22-4	----22-23332	----22------3	232334	44-322242	34244	-443-24-22	33--4332	-22-----3-	-------
Glochidion rubrum	---	--22-	--2-2	2-2222-2--22	----2---2---2	222222	22222-222	22222	2-22222222	22-4-22-	22-22-----	2-22---
Brugmansia candida	---	-----	-----	------------	-------------	------	--2------	-----	2---------	----64--	---------5	----5-5
Erythrina microcarpa	---	-----	-----	------------	-------------	---2--	--2------	-2--5	------2---	----22--	-------4-2	--22-2
Passiflora edulis	---	-----	-----	------------	-------------	------	---------	--2--	----------	--------	----------	-----2
URTICACEAE ssp.	---	-----	-----	-------2----	-------------	------	--3------	43---	----------	--------	--4-----3-	----2-5
Eupatorium inulifolium	335	---3-	3-22-	-44----2234-	432---4-24444	22-33-	--334--42	3--3-	2334--24-2	4-542553	5264657565	425665
Lantana camara	-3-	-----	-----	------------	---------4---	------	--------2	-----	2---------	---3-3--	2-3-24-445	--4446
Ageratum conyzoides	---	-----	-----	------------	-------------	------	--2------	-----	----------	--------	--------2-4	4--22-
Physalis peruviana	---	-----	-----	------------	---------2---	------	--2---2--	-----	----------	--------	-----2---22	--4-3-
Blumea balsamifera	---	-----	-----	------------	-------------	------	2--------	----2	----------	--------	-------2--	-----2
Calliandra callothyrsus	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	----------	---5--
Wedelia montana	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	-------2--	--3---
Isachne sp.	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	----------	4--3--
Equisetum debile	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	---------2	5------
Solanum nigrum	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	----------	--3--2
Saccharum spontaneum	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	----------	4------
Leersia hexandra	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	----------	5------
plumpung (jav.)	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	----------	4------
Solanum torvum	---	-----	-----	-2----------	-------------	------	---------	-----	----------	-----2--	----------	3------

	CaD	Cas	Eng	EuL	Lit	OcE	OcA	FiC	CeO	CeE	EpO	EpL
	877	475	88383	411331219751	49 338 17787	111568	336622261	86266	2554848423	45345644	529429 297	6 5 965
	632	49938	78396	901219060523	3817451227406	584043	872543217	28709	5871475660	26959730	4134855948	6956631
DIFFERENT SPECIES:		s		n								
ıbus chrysophyllus	-33	22-2-	--2-4	222-22424424	233-2232234-5	2423-4	3-332-244	3224-	--2324-2-2	3-33--43	222222--2-	3--2-4-
atostema integrifolium	---	243-6	---43	445-25556456	253543-6-5-44	566544	554545--2	4----	65-4-5-3-2	534-54--	--3-546-4-	-2--4-2
:rns ssp.	43-	33534	42-33	324332235434	225423-234344	445424	553444435	32444	-434434235	344444-4	343543323-	4333343
ıilax zeylanica	--2	-222-	22223	2-222222343-	-32-222---322	22-3-2	3-4-2--32	-2232	2-23224222	3-3322-2	2-22232-34	---2-3-
ıederia scandens	---	-2-3-	3--23	2---222-42--	--3-22----2--	----33	3--22-24-	2323-	23333-2-2-	-333323-	2--322-2-2	-23222-
ılygonum chinense	---	-----	-32--	-------2--2-	----2222-22-2	2--32-	-------22	--2-2	2---322-22	5-333233	-222------	--32-23
ılismenus compositus	---	2---3	444--	-2-2223-3243	233-4223-3--4	353524	444445333	4-244	4554553525	55464434	2335343-42	4-46-3
ıpatorium sp.	-57	--24-	36333	-44-5-22-232	-22--25555444	32--3-	--56-2254	-----	---4------	--5-44--	5455252-56	6256644
:rex baccans	--4	-232-	43223	24243222-323	334-332-24424	222-2-	--22---34	---2-	----2--3--	---42--3	3425433-23	4-33323
eymia cernua	--2	-----	-----	-22-2---2-2-	------2-2----	2-----	2--2---22	-----	-2--------	--2-2---	2--22-----	2-22--2
ıurauia pendula	---	2--22	--2-2	-----22-22--	-2----------2	--2---	-2-222---	-----	2------2--	22---2--	-2--224-5-	2------
ndet (jav.)	3-2	---2-	2-2--	-------3----	-2----2--2-2-	------	----2----	-----	-2--------	-3------	----------	-------
nostemma pentaphyllum	---	-----	-----	-------2----	-2--22---2---	-----2	---------	----2	--2-2-2---	-3---2--	-2--------	-2----2
unus arborea	---	----2	-----	------------	---2---2-----	------	------2--	--4--	----------	----4---	----2-----	---2---
astostema sp.	---	-----	-----	------------	-2-----------	2--3--	------2--	-----	2---------	--4----4	----------	-7----2
studes paniculata	---	-----	-----	------------	-------------	--4---	-----22-2	-----	----------	--------	-2--------	-------
locasia gigantea	---	-----	-----	------------	---------2---	------	---------	-----	--------2-	--------	-2-----2--	-------
runen (jav.)	---	-----	-----	------------	----------2--	------	---------	-----	----------	--------	----------	-2-----
cus sp.(beringin)	---	-----	----2	------------	-------------	------	---------	-----	----------	--------	----------	-------
rrottetia alpestris	---	-----	----4	------------	-------------	------	---------	-----	----------	--------	----------	-------
ccaurra minutiflora	---	-----	-----	------------	-------------	------	-------5-	-----	----------	--------	----------	-------
chardia brasiliensis	---	-----	-----	------------	-------------	4-----	---------	-----	----------	--------	----------	-------
alanthus populneus	---	-----	----2	-----------2	--------2----	------	---------	-----	----------	--------	----------	-------
strum nocturum	---	-----	-3---	------------	-------------	------	---------	-----	----------	--------	----------	-------
ephania japonica	---	-----	-----	------------	---2---------	------	---------	-----	----------	--------	----------	-------
phidophora pinnatum	---	-----	-----	------------	---------2---	------	---------	-----	----------	--------	----------	-------
portea stimulans	---	-----	-----	------------	-----2-------	------	---------	-----	----------	--------	----------	-2-----
ucaena glauca	---	-----	-----	------------	-------2-----	------	---------	-----	----------	--------	----------	-------
anotis ciliata	---	-----	--2--	------------	-------------	------	---------	-----	----------	--------	----------	-------
mbongan (jav.)	---	-----	-----	------------	---------2---	------	---------	-----	----------	--------	----------	-------
mbu (jav.)	---	-----	-----	------------	-------------	---3--	--4------	-----	-----2----	--------	3----2-4--	-------
phelium lappaceum	---	-----	-----	------------	----2--------	------	---------	-----	6---------	--------	----------	-------
rdyline druticosa	---	-----	-----	------------	-------------	------	----2----	-----	----2-----	--------	----------	-------
esine herbstii	---	-----	-----	------------	-------------	------	---------	-2---	----------	--------	----------	-------
ntella asiatica	---	-----	-----	------------	-------------	------	---------	-----	----------	-3------	----------	-------
thocephalis cadamba	---	-----	-----	------------	-------------	------	---------	-----	----------	----5---	----------	-------
ea sambucina	---	-----	-----	------------	-------------	------	---------	----5	----------	--------	----------	-------
cang (jav.)	---	-----	-----	------------	-------------	------	---------	-----	----2-----	--------	----------	-------
pi (jav.)	---	-----	-----	------------	-------------	------	---------	---2-	----------	--2-----	----------	-------
ndera plyantha	---	-----	-----	------------	-------------	------	---------	--2--	----------	--------	----2-----	-------
TERACEAE ssp.	-4-	-----	-----	----------2-	-------------	------	---------	-----	----------	--2-----	----------	-------
nu (jav.)	---	-----	-----	------------	----------2--	------	---------	-----	----------	--------	----------	-------
acia villosa	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	-------2--	-------
kstroemia androsae.	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	----------	--2----
f. Elephantopus scaber	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	-------2--	-------
asean (jav.)	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	-------2--	-------
bus sp.(murbei)	--3	-----	-----	------------	-------------	------	---------	-----	----------	--------	----------	-------
drangea aspera	--2	-----	-----	------------	-------------	------	---------	-----	----------	--------	----------	-------
tsea sp.(nyampu)	---	-----	-----	-----------2	-------2-----	------	---------	-----	----------	--------	----------	-------
thocarpus sp.(pasang)	---	-----	-----	------------	-------2-----	------	---------	-----	----------	--------	------2---	-------
ddleja asiatica	---	-----	-----	------------	------2--2--2	------	---------	-----	----------	--------	----------	-------
tup lumbu (jav.)	---	-----	2----	--------2--2	--------42---	-22---	---------	----2	----------	--------	----------	-------
ningan (jav.)	---	-----	-----	--22--------	-------------	------	---------	-----	----------	--------	----------	-------
rdia obliqua	---	---2-	-----	------------	-------------	------	---------	-----	----------	--------	2---------	-------
bus sp.(celing)	---	-----	-----	------------	-----2----3--	2-2---	---------	-----	-----2----	4-------	-6--------	4------
tsea sp.(n.kuning)	---	-----	-----	-------2----	-------------	------	---------	--2--	----------	--------	----2-----	-------
mbusa sp.	---	-----	-----	------------	-------------	------	----22---	-----	----------	--------	-2--------	-------
niran (jav.)	---	-----	-----	------------	-------------	----2-	2--------	-----	-----4----	--------	----------	-------
mena acuminatissima	---	-----	-----	------------	-------------	----2-	---2--2--	-----	----------	--------	----2-----	-------
esopsis eminii	---	-----	-----	------------	-------------	------	---------	-2--2	----------	--------	----------	-------
cus sinuata	---	-----	-----	------------	---------2---	------	---------	-----	----------	-----5--	----------	-------
ona sureni	---	-----	-----	------------	-------------	------	---------	2----	----2-----	-----2--	----------	--2----
metia tomentosa	---	-----	-----	------------	---------6---	------	-2-------	-----	----------	2-----2-	----------	-------
ngreng (jav.)	---	-----	-----	--------22--	-------------	-----2	-------3-	-----	----2-2---	--------	----------	-2-----
lochia umbellara	---	-----	-----	------------	-------------	------	---------	-4---	----------	--------	-----2----	--5----
ttosporum moluccanum	---	-----	-----	------------	-------------	------	---------	-----	---------2	--------	------2---	---2---
drocotyle javanica	---	-----	-----	------------	-------------	------	---------	-2---	22--------	--------	-------2--	----4--
ucas javanica	---	-----	-----	------------	-------------	------	---------	-----	2---------	--------	-------2--	-------
ıilia sonchifolis	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	----------	--3----
igeron sumatrensis	---	-----	-----	------------	-------------	------	---------	-----	----------	--------	----------	--3----
perata cilindrica	-5-	-----	-----	--4---------	--------6----	------	---------	-----	-------4--	---3----	---3-2----	4--3---
tsea sp.(n.merah)	---	-----	-----	-------2----	-------------	2-----	---------	-----	----------	--------	----------	-------
chelia montana	---	-----	-----	--2---------	-------------	------	---------	-----	22--------	--2-----	----------	-------
ema orientalis	---	-----	-----	----2-------	--------2----	------	-2-------	4----	----------	---4----	----------	2-2----
ıesa latifolia	---	-----	-----	------------	--------2----	------	---------	-----	----------	---2----	2--2------	---2---
aoxylon plot	--2	-----	--2--	------------	-------------	------	---------	22---	-----2----	--------	----------	-------

(number/ha)

Appendix 5 Frequency distribution of saplings and trees over the species groups (per vegetation type)

CaD	< 1 m	1 < < 3 m	3 < < 5 m	5 < < 20 m	> 20 m
Casuarina/Dod.	11	500	311	78	156
Castanopsis acu.					
Helicia rob.					
Podocarpus im/ner					
Litsea div/Myrsine					
Engelhardia spi.					
Pittosporum/Gloch.					
Eugenia sp/Scheffl					
Antidesma/Ilex tri			11		
Ocinum/Dendrocnide					
Celtis/Ervatamia					
Ficus mag/var					
Lithocarpus/Syzig.					
Brugmansia/Erythr.					
Eupatorium inulif.					
Lantana cam/Ager.					

Cas	< 1 m	1 < < 3 m	3 < < 5 m	5 < < 20 m	> 20 m
Casuarina/Dod.					
Castanopsis acu.	28	50	72	161	89
Helicia rob.					
Podocarpus im/ner	11	44	11	11	6
Litsea div/Myrsine	72	183	72	44	6
Engelhardia spi.	6	22			
Pittosporum/Gloch.				6	
Eugenia sp/Scheffl	461	350	122	61	
Antidesma/Ilex tri		39	33	17	
Ocinum/Dendrocnide		50	33	11	
Celtis/Ervatamia		11			
Ficus mag/var					
Lithocarpus/Syzig.	44	261	228	17	22
Brugmansia/Erythr.					
Eupatorium inulif.					
Lantana cam/Ager.					

Eng	< 1 m	1 < < 3 m	3 < < 5 m	5 < < 20 m	> 20 m
Casuarina/Dod.		5	15	10	
Castanopsis acu.					
Helicia rob.	460	285	25	5	
Podocarpus im/ner		10		5	
Litsea div/Myrsine	110	405	110	80	
Engelhardia spi.	5		15	125	80
Pittosporum/Gloch.					
Eugenia sp/Scheffl	5	25	5	35	5
Antidesma/Ilex tri	5	5	5	15	
Ocinum/Dendrocnide		5	5		
Celtis/Ervatamia		20	15	5	
Ficus mag/var					
Lithocarpus/Syzig.	120	215	105	240	10
Brugmansia/Erythr.					
Eupatorium inulif.					
Lantana cam/Ager.					

EuL	< 1 m	1 < < 3 m	3 < < 5 m	5 < < 20 m	> 20 m
Casuarina/Dod.					
Castanopsis acu.	6	60	50	42	10
Helicia rob.				4	
Podocarpus im/ner	19	4	13	4	
Litsea div/Myrsine	48	200	94	29	4
Engelhardia spi.	4	31	6	8	13
Pittosporum/Gloch.				13	10
Eugenia sp/Scheffl	54	213	173	121	13
Antidesma/Ilex tri	1038	33	13	33	
Ocinum/Dendrocnide	8	48	21	19	
Celtis/Ervatamia	2	19	6	2	
Ficus mag/var					2
Lithocarpus/Syzig.	119	623	294	144	29
Brugmansia/Erythr.					
Eupatorium inulif.					
Lantana cam/Ager.					

Lit	< 1 m	1 < < 3 m	3 < < 5 m	5 < < 20 m	> 20 m
Casuarina/Dod.					
Castanopsis acu.	4	44	15	13	8
Helicia rob.		2	6	2	
Podocarpus im/ner	2	8		4	
Litsea div/Myrsine	177	163	40	29	4
Engelhardia spi.		10	2		6
Pittosporum/Gloch.		2		8	
Eugenia sp/Scheffl	19	158	40	23	4
Antidesma/Ilex tri	4	58	21	2	
Ocinum/Dendrocnide	12	88	17	8	2
Celtis/Ervatamia	10	10	2	6	
Ficus mag/var		2	4		
Lithocarpus/Syzig.	87	377	146	144	27
Brugmansia/Erythr.					
Eupatorium inulif.					
Lantana cam/Ager.					

OcE	< 1 m	1 < < 3 m	3 < < 5 m	5 < < 20 m	> 20 m
Casuarina/Dod.					
Castanopsis acu.		4			
Helicia rob.					
Podocarpus im/ner					
Litsea div/Myrsine	13	25	25	13	4
Engelhardia spi.		4	4		
Pittosporum/Gloch.				25	
Eugenia sp/Scheffl	8	129	58	83	33
Antidesma/Ilex tri	21	100	29	8	8
Ocinum/Dendrocnide	188	575	183	79	
Celtis/Ervatamia	8	58	8	8	
Ficus mag/var					4
Lithocarpus/Syzig.	242	938	358	150	21
Brugmansia/Erythr.		4			
Eupatorium inulif.					
Lantana cam/Ager.					

OcA	< 1 m	1 < < 3 m	3 < < 5 m	5 < < 20 m	> 20 m
Casuarina/Dod.					
Castanopsis acu.					
Helicia rob.					
Podocarpus im/ner			3		
Litsea div/Myrsine	19	69	33	19	3
Engelhardia spi.	8	17	3		
Pittosporum/Gloch.				3	
Eugenia sp/Scheffl	19	64	50	36	3
Antidesma/Ilex tri	33	125	53	53	8
Ocinum/Dendrocnide	142	703	214	114	19
Celtis/Ervatamia	14	64	6	11	
Ficus mag/var		281		3	
Lithocarpus/Syzig.	161	1431	286	136	25
Brugmansia/Erythr.		8			
Eupatorium inulif.					
Lantana cam/Ager.					

FiC	< 1 m	1 < < 3 m	3 < < 5 m	5 < < 20 m	> 20 m
Casuarina/Dod.					
Castanopsis acu.					
Helicia rob.			5	5	
Podocarpus im/ner					
Litsea div/Myrsine	5	40			
Engelhardia spi.		30			
Pittosporum/Gloch.					
Eugenia sp/Scheffl	15	115	5		
Antidesma/Ilex tri	35	205	25		
Ocinum/Dendrocnide	245	590	245	20	
Celtis/Ervatamia	65	420	80	100	20
Ficus mag/var		35	10	15	55
Lithocarpus/Syzig.	55	770	125	15	5
Brugmansia/Erythr.	10	120	10		
Eupatorium inulif.					
Lantana cam/Ager.					

CeO	< 1 m	1 < < 3 m	3 < < 5 m	5 < < 20 m	> 20 m
Casuarina/Dod.					
Castanopsis acu.					
Helicia rob.					
Podocarpus im/ner					
Litsea div/Myrsine	111	24	8	5	
Engelhardia spi.		3	5		
Pittosporum/Gloch.					
Eugenia sp/Scheffl	22	27	24	22	8
Antidesma/Ilex tri	22	35	27	5	
Ocinum/Dendrocnide	168	419	69	127	16
Celtis/Ervatamia	173	351	65	84	22
Ficus mag/var	8	62	30	5	14
Lithocarpus/Syzig.	500	895	273	78	11
Brugmansia/Erythr.	3	3			
Eupatorium inulif.					
Lantana cam/Ager.					

CeE	< 1 m	1 < < 3 m	3 < < 5 m	5 < < 20 m	> 20 m
Casuarina/Dod.					
Castanopsis acu.					
Helicia rob.					
Podocarpus im/ner					
Litsea div/Myrsine	3	3		9	3
Engelhardia spi.				3	
Pittosporum/Gloch.					3
Eugenia sp/Scheffl	13	6	6	9	3
Antidesma/Ilex tri	16	38	9	9	
Ocinum/Dendrocnide	1347	472	278	156	3
Celtis/Ervatamia	113	319	41	109	
Ficus mag/var	6	31	13	22	3
Lithocarpus/Syzig.	94	1438	216	100	22
Brugmansia/Erythr.		481	6	3	
Eupatorium inulif.					
Lantana cam/Ager.					

EpO	< 1 m	1 < < 3 m	3 < < 5 m	5 < < 20 m	> 20 m
Casuarina/Dod.					
Castanopsis acu.	7	3			
Helicia rob.			3		
Podocarpus im/ner					
Litsea div/Myrsine	13	27	20	10	
Engelhardia spi.		17	13	20	3
Pittosporum/Gloch.				7	
Eugenia sp/Scheffl	23	93	30	17	3
Antidesma/Ilex tri	67	117	43	7	
Ocinum/Dendrocnide	43	240	33	7	
Celtis/Ervatamia	60	37	7	3	3
Ficus mag/var					3
Lithocarpus/Syzig.	60	357	110	63	7
Brugmansia/Erythr.	13	23	10		3
Eupatorium inulif.					
Lantana cam/Ager.					

EpL	< 1 m	1 < < 3 m	3 < < 5 m	5 < < 20 m	> 20 m
Casuarina/Dod.					
Castanopsis acu.					
Helicia rob.					
Podocarpus im/ner					
Litsea div/Myrsine	10	40			
Engelhardia spi.		10			
Pittosporum/Gloch.					
Eugenia sp/Scheffl		10			
Antidesma/Ilex tri	90	170	10		
Ocinum/Dendrocnide	40	170	20		
Celtis/Ervatamia	50	180			
Ficus mag/var	20	190	90		
Lithocarpus/Syzig.	20	80		60	
Brugmansia/Erythr.	120	260	20	10	
Eupatorium inulif.		120			
Lantana cam/Ager.					

Appendix 6 Vegetation map R.I.N., reduced. (Anonymus 1985b)