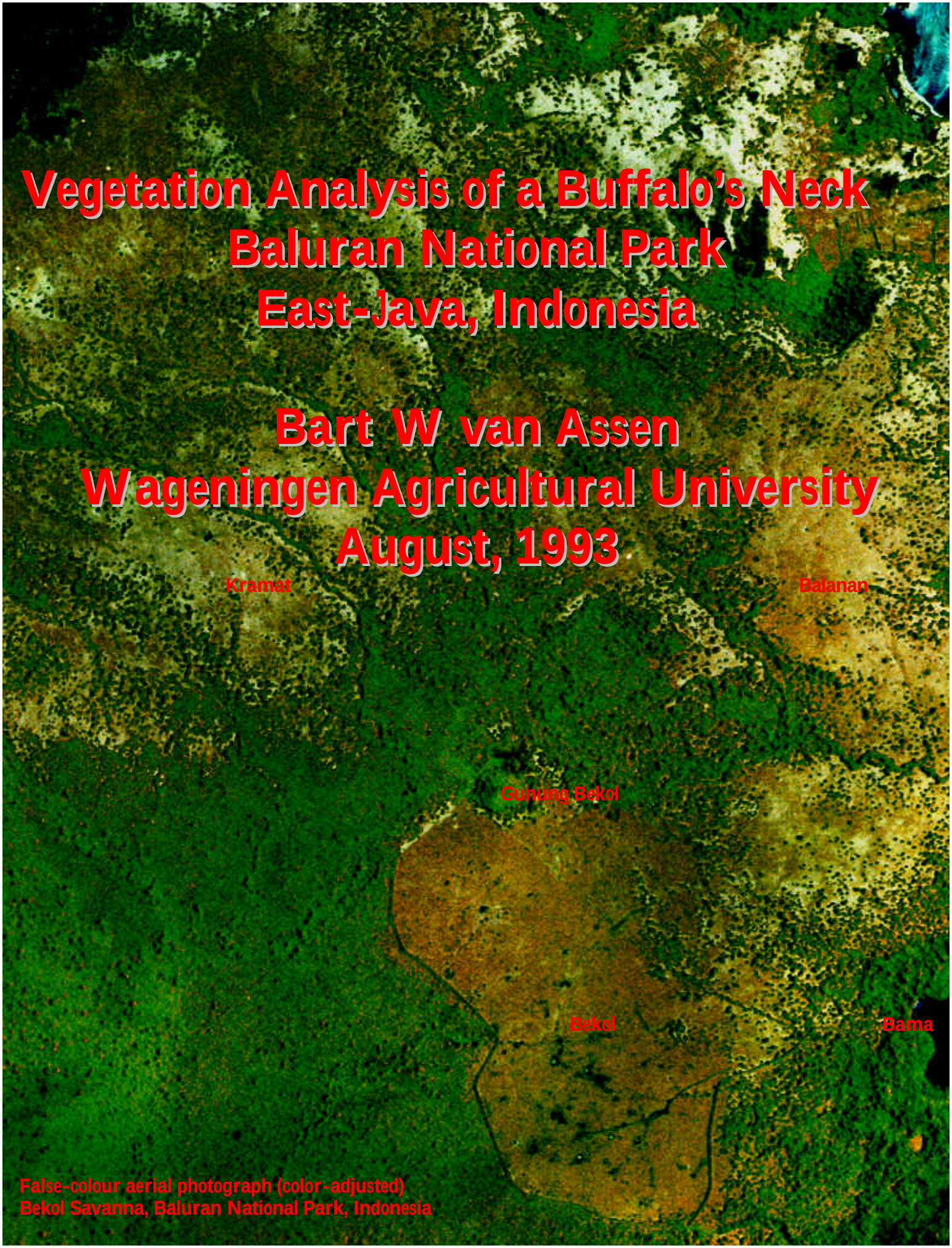
Vegetation Analysis of a Buffalo's Neck Baluran National Park East-Java, Indonesia

Bart W van Assen
Wageningen Agricultural University
August, 1993



False-colour aerial photograph (color-adjusted)
Bekol Savanna, Baluran National Park, Indonesia

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Als in het allerlaatst van December de regens beginnen door te komen, verandert de Afrikaans aandoende, volkomen droge, barre steppe in enkele weken tijds in het fraaiste lentelandschap. Het is zulk een snelle en een zóó grootsche metamorphose, dat elke Baloeran kenner er telkens weer door in verrukking gebracht wordt.
(Hoogerwerf 1972)

Daar het onbewoond is en niet voor cultures of ander economisch gebruik in aanmerking komt, denkt men er over om dit terrein tot wildreservaat te bestemmen.
(Clason 1933)

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Preface

On the flora and vegetation of Baluran National Park (BNP), situated in the northeastern extremity of Java (Indonesia), a very limited amount of information in the English language was available at Wageningen Agricultural University. Apart from the generality of this information, the information was not accurate anymore. On the current situation a relatively limited amount of information was available, so additional surveys on the current vegetation and flora of the park will, compared with information of the past, will be useful to gain more insight in the dynamics and management of BNP.

Since few information was available about the (present) composition and area of different vegetation structure types, the objective of this study was to describe three aspects of the vegetation and flora of BNP (a semi-detailed up-to-date description of vegetation structure and flora of the whole of BNP, a general description of the present vegetation forms in the park, and detailed descriptions of the four main grasslands in BNP) and compare them with information from the past. The method used to survey the vegetation structure and flora of the park was divided in a literature study, a vegetation and floral survey of BNP, the definition of the vegetation structure types, the determination of the places of each vegetation structure types in the park, and the classification of the entire area of BNP. The possible factors related to these changes will be briefly mentioned, but because the PhD-research of one of the supervisors, Ir. Soewarno Hasanbari of the Forestry Department of the Gadjah Mada University, focuses on these factors, most emphasis was placed on the inventories.

The word "baluran" refers to the slopes of the volcano in the park, which are compared to (the pleats in) a buffalo's neck. Therefor this word was, purposely, direct translated and used a an eye-drawer in the title (A vegetation analysis of a buffalo's neck). A part of a false-color aerial photograph of the set used during this survey, showing the Bekol savanna, is printed in black and white on the cover. Also, a cross-section of the park (from east to west straight through the vulcano on the odd and west to east on the even pages) presented by Lembinas (1986) is used in the headers of this report.

Two universities, the Universitas Gadjah Mada (UGM) in Indonesia and Wageningen Agricultural University (WAU) in the Netherlands, have supported this study. The following people working at these universities have to be thanked for their help during my survey: Prof Dr Ir Achmad Sumitro, Dr Ir Hasanu Simon, Dr Ir Sambas Sabarudin, and Dr Ir Agus Setyarso (dean and sub-deans at the UGM), Dr Ir Djuwantoko (head of the FONC-project at UGM) and all students working at the FONC-project (especially Mas Heru and Mas Gonzo), and Ir Soewarno Hasanbhari (supervisor of UGM). Special thanks goes to Dr Ketner (Dept. of Nature Conservation of WAU) for his supervision, often in an unexpected amount.

Within Baluran National Park, several people have made useful comments on my work. Of course there are the people permanently working in the park who came up with a lot of additional suggestions and information for my surveys, for which my gratitude. Furthermore I would like to thank the people working in Baluran National Park for the FONC-project during my stay, being "Kerbau sudah mati" Hedges, "Poedeltje" Rüter, "Great news" Tyson, and "Herbie" Schuurmans.

Several people living in Bogor (East-Java) also need to be thanked. Thanks goes to Smoky and all the Bandits for their help with the initial phase of the literature study, while Drs Tukirin Partomihardjo from the Centre for R&D in Biology of Indonesia has kindly supplied additional information on his research on Baluran National Park.

Last but not least I would like to thank FONA (a fund for nature conservation in The Netherlands), Buro Buitenland (the foreign affairs department at WAU), Nomad and Bever Sport (two suppliers of hiking articles), and Sony for their sponsorship of my survey.

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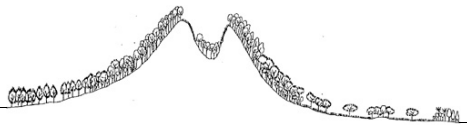

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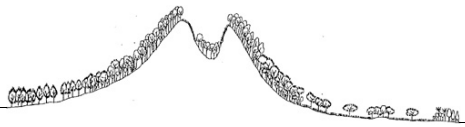


Summary

On the flora and vegetation of Baluran National Park (BNP), situated in the northeastern extremity of Java (7º42'-7º54' southern latitude, 114º17'-114º27' eastern longitude), a very limited amount of information in the English language was available at Wageningen Agricultural University. Apart from the generality of this information, the information was not accurate anymore (the most recent publication dated from 1977). On the current situation a relatively limited amount of information was available, so additional surveys on the current vegetation and flora of the park will, compared with information of the past, will be useful to gain more insight in the dynamics and management of BNP.

The objective of this report is to present a semi-detailed up-to-date description of vegetation structure and flora of the whole of BNP, a general description of the present vegetation forms in the park, and detailed descriptions of the four main grassland areas in BNP and a comparison of the current situation with past research. The method used to reach this objective can be divided in 5 parts. First a literature study was conducted, and a vegetation and floral survey of BNP was executed. Based on the study and survey, the vegetation structure types (Gils et al. 1985) and the determination of the places of each vegetation structure types in the park were defined. Then, with the help of a geographical information system, the entire area of BNP was classified. The general description of the present vegetation forms in the park was mainly based on a set of aerial photographs. First of all a vegetation form typification (Gils et al. 1985) was defined. Based on this typification the aerial photographs were classified and mapped. The detailed descriptions of the four main grasslands in BNP are based on a similar study done by Partomihardjo (1987/1988); they were inventoried in the dry season using the step-point method (Gils et al. 1985).

The survey resulted in a description of the vegetation and flora of BNP through 31 vegetation plots and a (concept) check-list and additional list of plant species in the park. Although nobody ever completely surveyed BNP, a minimum number of 604 different plant species are assumed to be found. It is very easy to refer to some of these species as exotics once they become a plague, but it might be possible that the arrival of they were only a consequence of a (semi) natural process of change. If the costs of removal of such a species is too costly or impossible, it should be accepted as part of BNP.

No additional information on the vegetation and flora of the park is now available through field surveys because vegetation descriptions from other publications were used, information that was only published in Bahasa Indonesia (and thus less accessible) can now be used in further research and surveys. Furthermore, a more complete set of descriptions was gathered than would have been possible to survey in the field.

The vegetation descriptions are not up-to-date and do not cover all vegetation structure types, whereas the form of the descriptions differed between authors. Yet more information on the vegetation and flora of BNP available in english and as such the vegetation descriptions are considered valuable.

On the preliminary vegetation structure map the exact locations of several areas are not clear, which created some misunderstandings during field trips, clouds and shadows cover a considerable part of BNP, and there was a strong focus on the eastern part of BNP. Along with the ignorance on the use of the available geographical information system and the fact that the map can hardly be compared to other maps it can be concluded that the quality of the map is limited, but it is still useful. The map units are clearly delineated and only limited additional surveys/research is necessary to process the map to an 'up-to-date vegetation structure map'. Also, an the area covered by *Acacia nilotica*, on which no information was available, was estimated for 1990, and it can be concluded that further research/surveys in this field will be rewarding.

It seems that the SPOT-image, in combination with ERDAS, has only limited use for this survey; the SPOT-image was too small scaled and ERDAS too complicated to work with. Yet, the possibilities of a remote sensing image like the SPOT-image are extensive, that it is assumed that only a very limited amount of the actual value of the SPOT-image was extracted. Based on these assumptions, the SPOT-image is considered very useful.

Comparing the vegetation map of 1977 with the tree cover map it seemed that the forest areas increased strongly in the period 1977-1990, but this is not acknowledged as such here. It is far more likely that the decrease in forest cover of 1946-1977 as presented by UNDP/FAO (1977) was too drastic. Although this map is difficult to compare with other similar maps by UNDP/FAO (1977), it is a very simple map, with a clear definition of the different units on the map. As such it is useful for further monitoring of BNP.

The grasslands seemed to have changed considerably over the last 7 years. In general the amount of species increased, while the amount of living biomass decreased. Yet, it was not clear if Partomihardjo (1986) only gives the species of the herb layer, or if he included the tree and shrub layer in his research. In this study it was presumed that he did, but it is possible he only presents data on the grass species, in which case the differences in the number of

species between both periods is too small to give any conclusions. Also, the survey of the grasslands was restricted to the dry period of 1992, through which many species could not be identified, and only four grasslands were surveyed. Both factors strongly reduced the quality of the survey and its actual value is very limited.

1 Introduction

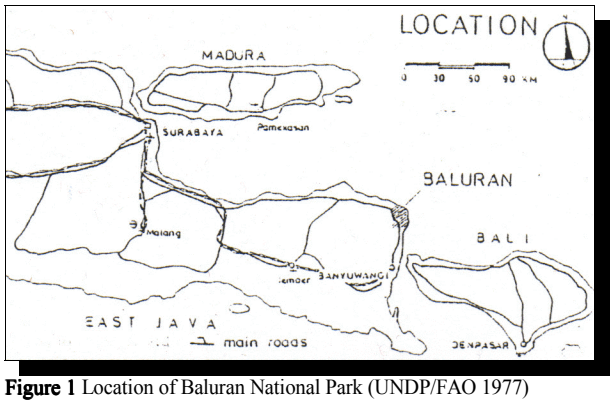


Figure 1 Location of Baluran National Park (UNDP/FAO 1977)

On the flora and vegetation of Baluran National Park (BNP), situated in the northeastern extremity of Java (7°42'-7°54' southern latitude, 114°17'-114°27' eastern longitude; see Figure 1), a very limited amount of information was available at Wageningen Agricultural University. Some literature on these subjects was available in the form of general descriptions on vegetation and flora from the period 1932 till 1977 (Clason 1933, Appelman 1937, Hoogerwerf 1948, Hoogerwerf 1972, Hoogerwerf 1974, and UNDP/FAO 1977). Apart from the generality of this information, it can be assumed that since the vegetation of BNP has been liable to changes. These changes have barely been surveyed and relatively few written records on it were available and additional surveys on the vegetation and flora of the park will, compared with information of the past, will be useful to gain more insight in the dynamics and management of BNP.

The objective of this survey, done in the period of June 1992 till January 1993 as part of an Ir-thesis for the Department of Nature Conservation of Wageningen Agricultural University (The Netherlands), was to describe three aspects of the vegetation and flora, in particularly those of the grasslands, of the park and compare the current situation with past research on the vegetation and flora of the park. These aspects are an semi-detailed up-to-date description of vegetation structure and flora of the whole of BNP, a general description of the present vegetation forms in the park, and detailed descriptions of the four main grasslands[1] in BNP. Together with other studies, the information obtained through this study will increase the understanding of the (processes of) change in BNP and the factors involved.

The method used to present the semi-detailed up-to-date description of vegetation structure and flora of the park can be divided in 5 parts. First a literature study was conducted, and a vegetation and floral survey of BNP was executed. Based on the study and survey, the vegetation structure types (Gils et al. 1985) and the determination of the places of each vegetation structure types in the park were defined. Then, with the help of a geographical information system, the entire area of BNP was classified.

The general description of the present vegetation forms in the park was mainly based on a set of aerial photographs. First of all a vegetation form typification (Gils et al. 1985) was defined. Based on this typification the aerial photographs were classified and mapped.

The detailed descriptions of the four main grasslands in BNP are based on a similar study done by Partomihardjo (1987/1988); they were inventoried in the dry season using the step-point method (Gils et al. 1985).

This report is divided in five chapters. The 1st chapter is this introduction. In the 2nd chapter a general description of the study areas (BNP and its grasslands) is compiled based on a literature survey and field trips. Also, the methods to reach the objectives of this report are discussed to a further extend. The 3rd chapter elaborates the literature study on the different vegetation structure types present in BNP. Based on this literature study an impression of the flora and vegetation of BNP in the period 1982-1987 is presented. The 4th chapter focusses on the surveys executed in BNP in 1992, which resulted in two maps (a vegetation structure map and a tree cover map) and a vegetation analysis of the four main grasslands in the dry season. The 5th chapter is a discussion of these results. First of all, the results are compared with other information, then the (dis)advantages and value of the results are discussed.

1 Many authors, like Partomihardjo (1986), use the term 'savanna' when they refer to the grassy areas of Baluran National Park, but in this report the term 'grassland' was preferred. This decision was mainly based on the definition given by Bourliére & Hadley in Bie (1991), who state that a savanna is 'a tropical formation where the grass status is continuous and important, but occasionally interrupted by trees and shrubs; the stratum is burned from time to time and the main growth patterns are associated with alternating wet and dry seasons'. Since no information was available on the fire frequencies of the different grasslands of Baluran National Park, it was not possible to determine which areas are savanna and which grasslands.

2 Study Areas and Survey Methods

Based on the description of Baluran National Park (BNP) presented by UNDP/FAO (1977) a general description of this study area was compiled. Furthermore, an additional sub-paragraph was prepared with information on the grasslands studied; this information was mainly obtained through field trips. Also, the methods to reach the objective of this study were prepared and are presented per aspect in the following paragraphs.

2.1 Baluran National Park; a General Description[1]

BNP is a rough square with its centre dominated by the extinct volcano, Baluran (see Figure 3, Chapter 3). The crater wall varies in height from some 900 to 1247 m, steeply enclosing the broad caldera of some 600 m in depth. At the west side of the mountain a low saddle links Baluran with the much larger Ijen/Raung massif to the south. The mountain slopes are dissected with deep valleys at the higher part of the mountain and with shallow stony gullies in the lowland part. At the eastern side of the crater there is a deep opening where the river Kacip flows out of the volcano at 150 m ASL While little is known in detail, it can be hypothesized that the upper and eastern part of the mountain exploded and blew large stones outwards (many can still be seen all around the volcano except in the flat southeastern part of the park); the central part of the volcano then subsided, forming a deep caldera with its spectacular solidified crater pipes at its bottom. Lava and porous ash layers from the strato-volcano filled up much of the surrounding area, followed by an upheaval of some 15 to 25 m which raised the limestone cliffs at Mesigit-Balanan along the north-northeast coast. Most of the lower area is flat to gently undulating except for some hills (Bekol, Lengseran, and Priyuk), and the Mesigit-Balanan area at the coast, where some steep limestone cliffs occur (Tanjung Sumber Batok, Tanjung Sedano, and Tanjung Candi Bang).

The coastline is about 40 km long, forming irregular peninsulas and embayments; the shallow seas harbour living coral areas, sandbanks, and mudflats. It is very broken, with the above mentioned cliffs, a large bay of about 100 by 200 m enclosed by a coral peninsula at Bilik on the north coast, and small islands offshore at the eastern part between Air Karang and Tanjung Candi Bang. The beaches are small and flat, only rising to a 2-3 m high sand dune at Tanjung Bedi in the southeast. The provincial road bends around the Baluran volcano, cutting through the southern and western parts of the reserve at a distance of up to 2.5 km within its boundaries.

Although connected to it, Baluran is quite separable from the Ijen/Raung massif, being geologically a part of the northern coastal zone where Plio-Pleistocene deposits are capped by small volcanoes, and which are only recently separated from Madura at about 80 years BC (Bemmelen 1949).

There are two major soil types in BNP: volcanic and marine. By far the most important are the volcanic soils, which are derived from weathered basalt, volcanic ash, and intermediary volcanic rock, forming a graded series of more rocky shallow soils at the highest and steepest sides of the mountain and deep alluvial soils in the lowlands. These soils are rich in minerals but poor in organic material. They have high chemical fertility but a low physical fertility because most are very porous and do not retain water very well. The black soils which cover about half the lowland and on which most of the savanna grassland is found are very fertile and support a variety of nutrient rich palatable grass species. These soils are highly erodible and very muddy in the wet season, but form a broken surface with deep cracks a few cm wide an more than 80 cm deep in the dry season. The wet alluvial soils in the southeast of the park are covered with swamp forest and grassy swamp and the marine soils are limited to a few areas along the coast on the salt flats and in mangrove swamps.

Baluran is the driest part of Java and has a typical monsoon climate with a long dry season (rainfall figures are summarized in Figure 2). It is influenced by strong southeast trades during the period of April to October/November. Two weather stations are situated near Baluran (Asembagus to the northwest and Bajulmati to the southeast), both at about sea level. They have an annual rainfall and an average dry period of respectively of 900/1200 mm and 9/4 months a year. Minimum and maximum figures differ much from the average and exceptionally wet or dry years occur. The substantial difference in the number of dry months between the two stations suggests that within the reserve such differences also exist; the northern and northeastern open savanna will probably have some 3 to 5 more dry months than the south and southeast monsoon forest area, while the wettest part of BNP will be the southern slopes and highest part of the mountain. According to Burger (1930, in Rappard 1973) all mountain forests in East-Java show the effect of a rain shadow, giving a sparse forest cover on the northern slopes and a denser cover on the southern slopes.

1 This sub-paragraph was, in a slightly edited form, directly taken from UNDP/FAO 1977

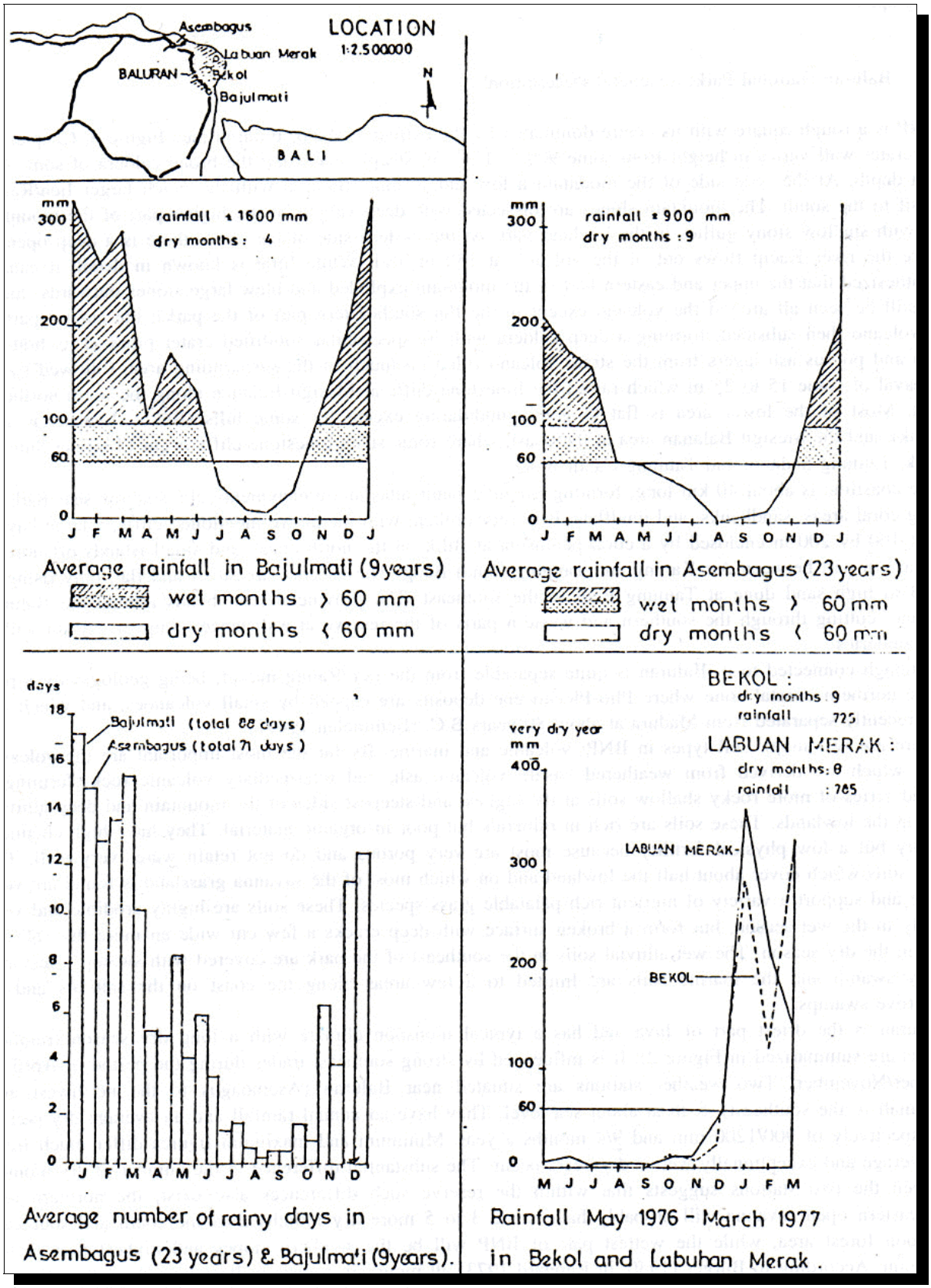


Figure 2 Rainfall figures in/near Baluran National Park (UNDP/FAO 1977)

As with most volcanic regions, the park has a radial drainage pattern. The biggest rivers include the Kacip river, which flows out of the crater to the south of Labuan Merak, the Kelokoran river and the Bajulmati river, which form parts of the western and southern boundaries of BNP. Most streambeds contain surface water during the short rainy season but much of the water seeps through the very porous volcanic ash layers, flowing over hardened lava-streams underground and appearing again as fresh water-sources at several places in the coastal area, in the foothills, at the very edge of the coast, or as freshwater springs in the sea. In the rainy season, the black soils are least permeable and water flows on the surface, forming many pools (especially south of a line from Talpat to Bama). In the dry season, fresh surface water supplies are very restricted and only the above-mentioned springs are still available. The rivers become totally dry within a few days of the beginning of the dry season, often in April, and water can then be found only in their upper reaches high on the mountain.

While the inner crater wall is bare on the steep sides, the mountain slopes are forested with seral monsoon forest (some 5 to 7 km at the north and east side of the volcano which becomes steeper above 200-250 m elevation), a vegetation type which is relatively transitory and will, if left undisturbed, develop into a more mature type of forest. The gently undulating lowland plains are covered with a fire-climax grass savanna, with scattered trees and a few areas of thorny secondary bush with many creepers and climbers. At the coast are swamps, mangrove forests, and salt flats present. Within the park along both sides of the provincial road, some 5,000 ha of forest is now being used as well-established teak plantations, including two small villages.

The four main grassland areas of BNP are Bekol, Kramat, Dadap, and Semiang. The Bekol area is undulating and originally covered about 420 ha east on the Baluran rim, but has during the last ten years been reduced to about 40 ha because of invasion by *Acacia nilotica*. The area has a big touristic value, mainly because the guest houses and the access road are situated on/around it (UNDP/FAO 1977, Partomihardjo 1986). Because of the high touristic value of this particular grassland, several methods, like cutting, burning and pulling out, are used to stop the invasion of *Acacia nilotica* (Watling 1991). The undulating grassland at Kramat lies west of Bekol and northeast of Mount Klosot. It is mainly a tree/shrub savanna and the actual grassland covers only a small part of this savanna (about 130 ha). The Dadap area lies in the southeast area of the park and covers 100 ha (it is considered a flat grassland). Because this grassland is close to the sea (on the way to the fisher man's villages) and the villages Pandean and Wonorejo, this area is strongly influenced by men. The grass is cut for fodder for the animals and fuel wood is taken out regularly. It seems that this grassland used to be bigger, but the northern part is now strongly invaded by *Lantana camara*. The Semiang area consists of a swamp grassland close to the Dadap area (a flat grassland). It covers about 80 ha and is bordered by *Corypha utan*, which are also thinly spread over this site. The form of this grassland (straight lines parallel to each other) suggests that this is man-made. The grassland is heavily grazed and cut.

An example of research conducted on the changes of the savanna vegetation of BNP was published by Partomihardjo (1986/1987). In 1985-1986, he studied the seasonal dynamics of the grassland vegetation of the park. In summary, ten plots of 1 x 1 m on a transect of 50 m (square method; see Greigh-Smith 1964) were placed on 7 different grasslands of BNP. The species of these plots were inventoried, height and cover was measured, and living and dead biomass weighed (total of 4 times in 1 year). Also, the index of dominance according to Simpson (see Naik & Mishra 1974) was calculated. Some of the results are presented in Table A. Partomihardjo (1987/1988) states that in general the cover of a grassland is positively related to the height of the species, and he found three factors that influence them: the dry season (some species die at the end of the rainy season), the grazing intensity (sometimes species are eaten before amphimixis takes place), and soil characteristics.

Table A Main species, relative frequency, closure, index of dominance, average height and number of species and biomass of several grassland in 1985-1986 (Partomihardjo 1987 and 1988)

	Bekol	Kramat	Dadap	Semiang
Main species	*Dichanthium caricosum*	*Dichanthium caricosum*	*Imperata cylindrica*	*Eulalia amaura*/ *Bothriochloa modesta*
Relative Frequency	15.62	29.10	33.33	7.02/4.78
Coverage (%)	85	85	44	16/9
Index of dominance	0.290	0.354	0.228	0.059
Average height (cm)	10	15	80	15
Number of species/biomass (g/m^2)				
begin rainy season	13/850	18/1500	11/1700	11/400
end rainy season	18/850	13/1600	7/1800	18/450
begin dry season	11/700	10/1000	6/1900	26/175
end dry season	5/25	5/30	3/50	-/25
Remarks	(strongly) disturbed	disturbed	disturbed	(strongly) disturbed

2.2 Survey Methods

The literature survey originally had an informative character only, but in Indonesia it quickly became obvious that much additional information on the vegetation and flora of the park was available. Especially a lot of more recent publications (1982-1991) was available in the Indonesian language. In these publications, two sets of publications with different objectives were recognized. The first, more recent, set (1989-1991) consists mainly of practical training reports (anonymous 1989a-c, Pratama 1989, Tefnai 1990, and JPB 1991) and obtain their information on vegetation and flora from the 2nd set of publications. The 2nd set of publications (Budiman et al. 1984, Riswan et al. 1984, Partomihardjo 1985a-b, Partomihardjo & Sinaga 1985, Partomihardjo et al. 1985, Sugardjito & Partomihardjo 1985, Lembinas 1986, Partomihardjo 1986, Partomihardjo & Mirmanto 1986, Riswan 1986, Partomihardjo 1987a-b, Pratama 1989) were mainly research reports on BNP by people related the National Institute of Biology of Indonesia (Lembaga Biologi Nasional). It also became obvious that, due to lack of time, a complete inventory of the vegetation structure and flora of the park was not feasible. Therefore, it was decided to use the data from the 2nd set of publications (1982-1990) to describe the different vegetation structure types (VST's).

In the set of publications used to describe the VST's, a total of 90 vegetation descriptions were presented. Because of the strong similarity between the descriptions and there position in BNP (Appendix I), they were reduced to a set of 31 vegetation descriptions (Appendix II). These descriptions are presented according to the habitat types mentioned by UNDP/FAO (1977) in Chapter 3 (see also Figure 3 and Table B). (Although the term 'grassland' was preferred over 'savanna', the last was used by all used publications. For this reason it was also used in the description of this VST.) The vegetation was described using the (binary) plant nomenclature according to Partomihardjo 1992 (this list of plant species is given in Appendix III). Additional species mentioned were written in their original names by Backer 1963 or Jansen et al. 1991 (Appendix IV). Sometimes only an Indonesian name was mentioned of which the matching binary name was doubtful/unknown to the author; in these cases the Indonesian name was added/used (the plural forms of these names are presented using a '2'; kudu[2]-an, for instance, is kudu-kuduan).

Because of the use of literature to describe the vegetation and flora of the park, the definition of VST's was thus dependent on the definitions used in these publications. Since all these publications (implicitly) make use of the habitat types as defined by UNDP/FAO (1977), it was obvious that this definition should be used as base for the definitions of VST's used in this report. Although habitat types are not quite the same as VST's (sea, for instance, can hardly be seen as a VST), the degree of similarity between both types was so high that these definitions are still used for the definition of the VST's. Yet, during the field trips it became clear that one additional VST needed to be defined, namely one for an area in BNP covered with *Acacia nilotica*, in order to estimate the dispersal of this 'new' species (defined as *Acacia nilotica*). Thus the following set of VST's and additional entities were defined for the classification of the SPOT-image: deep water, shallow water, coral, mudflats, beaches and beach associated vegetation, mangrove forest, grasslands, stony river bed and associated vegetation, upland monsoon forest, lowland monsoon forest, steep inside crater wall, crater bottom forest, plantation (mainly *Tectona grandis*), *Acacia nilotica*, and other (agricultural field, house, road, water course, cloud, shadow, etc.). This division is partly based on height above sea level (ASL.) and steepness of slopes, information that is not available on the SPOT image. It therefore seemed obvious that some VST's will be merged to a single VST in the initial phase of the classification, since they will show strong overlaps of information; this overlap was expected for upland monsoon forest, lowland monsoon forest, crater bottom forest, and plantation as one group and beach associated vegetation, mangrove forest, and river bed (associated vegetation) as another. On the other hand, the variation in tone of the different grasslands (Dadap and Bekol have quite different tones) makes it necessary to make further division of this VST.

For the determination of the places of each VST's in the park, a 9-track Computer Compatible Tape of a multi spectral SPOT-image[1] and a colour print were used. This image was recorded on 14 May 1990 around 2:42 GMT, with scene centre coordinates 008°01'10" southern latitude and 114°14'04" eastern longitude. The SPOT XS, or multi spectral, has a spatial resolution of about 20 x 20 m and contains 3 bands; a green band (0.50-0.59 m) corresponding to the green reflectance of vegetation, a red band (0.61-0.68 m) for discriminating between plant species as well as soil boundary and geological boundary delineations, and a reflective infrared band (0.79-0.89 m), especially responsive to the amount of vegetation biomass present in a scene and useful for crop identification and emphases soil/crop and land/water contrasts (Brown & Smith 1990). For more information about SPOT, see Combeau (1982), Hoeven (1989), Brown & Smith (1990), and Euroconsult (1990). In the field the SPOT-image was interpreted using the Photo-Guided Field Survey Method (Gils et al. 1985); the areas obviously differing in tone, texture, dimensions, shape, spatial pattern, and situation (called 'preliminary SPOT-image units') were delineated on the SPOT-image and

1 The SPOT (Systéme Probatoire d'Observation de la Terre) satellite, developed by the French Centre National d'Etudes Spatiales, was launched in early 1986. (Gils et al. 1985, Brown & Smith 1990)

as much as possible units were sampled during field trips, which were oriented on the eastern half of BNP, near the Batangan-Bekol-Bama road, due to problems with accessability and orientation in the field[1]. (The photo boundaries of the preliminary SPOT-image units were not confirmed or redrawn during these field trips, because these would later be defined by ERDAS.) After the survey the SPOT-image was reinterpreted with the aid of the **ERDAS** (version 7.4)[2] geographical information system. First of all, an inventory was made of tone values per VST on the SPOT-image by randomly choosing about 100 points in each VST. Based on these intervals, representative points were selected on the SPOT-image to generate 5-10 signatures of each VST. (A signature is the combination of band value intervals considered characteristic for a certain entity on the SPOT-image.) Based on the band intervals of the signatures, a new set of signatures was created by merging and/or dividing overlapping signatures. The SPOT-image was classified with the use **MAXCLAS**. **MAXCLAS** (classification with signatures) is the primary multi spectral classification program. It classifies an input LAN file (in this case the SPOT-image of the park) using one of the following decision rules: minimum (spectral) distance, Mahalanobis distance, or maximum likelihood/Bayesian (the last decision rule was selected for the classification of the SPOT-image). For information on **MAXCLAS**, see Brown & Smith (1990). This classification was executed twice, once with the *Acacia nilotica* signature and classification of points to far from the signatures to prepare the vegetation structure map, and once without the *Acacia nilotica* signature or classification of points too far from the signatures. The 2nd classification was executed to determine to what extend the *Acacia nilotica* signature was a characteristic entity on the SPOT-image.

The vegetation structure map was slightly simplified to reduce the 'salt and pepper' effect by a filtering analysis called **SCAN** (Brown & Smith 1990). Furthermore, additional a priori information on texture, dimensions, shape, spatial pattern and situation (see Gils et al 1985) on names, plot situation, etc. was extracted from the publications used to describe the VST's and added to the vegetation structure map (Chapter 4 and Appendix I).

In addition to the map of VST's, two additional vegetation form maps were compiled (Chapter 4). The first map was based on a set of 23 false-colour aerial photographs[3] made on July 21st and August 8th 1981 (scale around 1:35,000) by Bakosurtanal (Indonesian Institute of Remote Sensing Imagery Interpretation), and the preliminary map of landscape ecology by Hasanbhari (year unknown). First of all, a vegetation form typification (Gils et al. 1985) was defined. Although several typifications (like Eiten 1968, and UNESCO 1973) were elaborated by Gils et al. (1985), none were usefull for this map, because the tree stratum was the only differentiable stratum on the aerial photographs. It was therefore decided to use a typification based on this characteristic only; a simplification of the UNESCO vegetation form typification, using only the tree cover as differentiation (0-10% = grassland, 10-40% = woody grassland, 40-60% = open woodland, > 60% = woodland/forest) was of most use. Based on this differentiation, the aerial photographs were classified using the photo-key method (Gils et al. 1985), and mapped on a scale of 1:250,000 in the form of a tree cover map. (The comparison of the vegetation cover in the field with the corresponding photo characteristics was not been executed, because the cover was determined from the aerial photographs themselves.)

A 2nd, similar map (for 1990) on was based on the SPOT-image, field surveys, and the vegetation descriptions of the period 1982-1990 (see Chapter 3 and Appendix II). Because the SPOT-image only displays tone values, no vegetation covers and because it was not possible to determine these covers through field surveys due to lack of time, a set of conversion factors was used in which was assumed that the different VST's have specific tree covers (agriculture, crater wall, and grassland = 0-10%, *Acacia nilotica* and unclear = 10-40%, mangrove and monsoon forest > 40%). In addition to the compilation of these maps, an inventory of the available maps of BNP was made, which were then compared (paragraph 4.2 and 5.1.2).

The study of Partomihardjo (1987/1988) mentioned above (2.1) was used as the base of an additional survey of the four main grassland areas (Bekol, Kramat, Dadap, and Semiang) of the park (Chapter 4). These were inventoried in the middle of the dry season (14 October-10 November 1992; paragraph 4.3) using a stratified form of the step-point method (see Gils et al. 1985); i.e. based on the preliminary SPOT-image units mentioned above, the floral composition of each unit belonging to the grassland VST was inventoried for four height classes (0, 0-0.75. 0.75-1.50, and > 1.50 m). The (one dimensional) points were placed every 8 m on line transects 50 m apart. The SPOT-image units were then classified floristically according to the Braun-Blanquet manual tabulation method (Gils et al.

1 due to the small scale of the SPOT-Image and due to a very limited view in the field it was often not possible present to determine the exact location.

2 For information on ERDAS see Smith & Brown 1990

3 For information on aerial photographs see Gils et al. (1985).

1985), but without the use of the sociological species groups and the bar diagram because of the small amount of species. Furthermore, in each unit ten plots of 1 x 1 m were cut to determine the dry weight of the dead and living biomass per unit. The information on species composition, cover, and biomass of these areas (see Table F) was then compared with the data from Partomihardjo (1987/1988; Chapter 5).

3 The Flora and Vegetation of Baluran National Park; a Literature Study

Based on a literature study, comprising about 35 publications (an overview of the described plots and their position can be found in Appendices I and II), a first impression of the flora and vegetation of Baluran National Park (BNP) is presented (see also Figure 3 and Table B). Additional information by UNDP/FAO (1977 and 1979) had was also added.

3.1 Sea, Coral, and Mudflats

Very few marine algae are found in the sea around BNP; the red encrusting algae found belong to, or are associated with the genus Lithothammion; leaf-shaped algae are of minor importance.

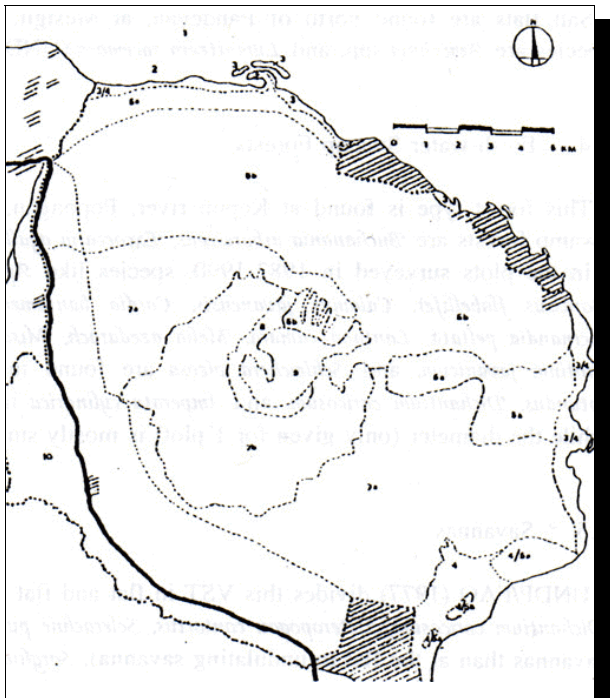
The vegetation on coral and mudflats mostly start with pure terrestrial species, sea grass beds (with at least two types of *Thalassia* spp.) are only found associated with the coral reefs in the intertidal zone (UNDP/FAO 1979).

3.2 Beaches

Beaches are found mainly at Tanjung Bedi (UNDP/FAO 1977). Only one site of beach vegetation is presented in Appendix II. For the beach at Bama, beside some of the species below, species of the **tree/shrub stratum** like *Ardisia humilis*, *Buchanania arborescens*, *Corypha utan*, *Polygonum* sp., and *Schleichera oleosa* are mentioned by UNDP/FAO 1977.

In general the beach vegetation is little disturbed and therefore looks more natural. In some areas, like the *Avicennia*-swamp forest, the vegetation is still in full development, with small sized trees (5-10 m). Beside the mangrove forests, separately mentioned in 3.3, 5 types of beach vegetation are recognized:

- Pes-caprae formation; This formation is mainly found on places with dry sand along the beach; *Ipomoea pes-caprae* forms a formation on new beach behind a strip of raised sand.
- Spinifex formation; sometimes the *Ipomoea pes-caprae* formation is alternated with a formation of *Spinifex littoreus*. Both formations are mainly found in the most southern part of the park and mixed with species like *Ardisia humilis*, *Desmodium umbellatum*, *Hernandia peltata*, *Ischaemum muticum*, *Pandanus tectorius*, and *Pongamia pinnata*, *Scaevola taccada*, and *Terminalia catappa*.
- Avicennia swamp formation; this formation is situated on the higher parts of the land side (up to 500-600 m ASL) on areas that were rarely flooded, with species like *Abutilon crispum*, *Avicennia alba*, *Avicennia marina*, *Bruguiera cylindrica*, *Ceriops decandra*, *Ceriops tagal*, *Hibiscus tiliaceus*, *Ipomoea pes-caprae*, *Pandanus tectorius*, *Rhizophora apiculata*, *Scaevola taccada*, *Sonneratia alba*, *Spinifex littoreus*, *Terminalia catappa*, and *Xylocarpus moluccensis*.
- Borassus forest; consists of pure stands of *Borassus flabellifer*, mainly on slightly undulating areas that are sometimes flooded during the dry season. Other vegetation is rare and almost no soil cover is found in these forests. In the rainy season the areas are sometimes flooded for longer periods.
- Borassus-Syzygium forest; on higher areas *Borassus flabellifer* is alternated with *Syzygium polyanthum* (25-30 m). Like the Borassus forests, there are almost no grass, herb or shrub species in these stands. As the land rises, less *Borassus flabellifer* is found and *Syzygium polyanthum* becomes the main spe-



1= sea, coral, mudflats 2= beach 3= mangrove, saltflats 4= swamp forest 4/5a= swampgrass 5= savanna (a= flat, b= undulating) 6= stoney streambeds 7= monsoon forest (a= lowland, b= upland) 8= crater wall 9= crater bottom forest 10= teak plantation = boundary reserve; shaded areas are settlements and concessions

Figure 3 Vegetation form map (1985) of Baluran National Park (UNDP/FAO 1977)

cies. Furthermore **trees** like *Mangifera* sp., *Tamarindus indica*, *Excoecaria* sp., *Protium javanicum*, *Streblus asper*, *Pongamia pinnata*, *Terminalia catappa*, *Calamus* sp., *Melia azedarach*, and *Ficus* spp. are found (Budiman et al. 1984, Partomihardjo & Mirmanto 1986).

Coral beeches are dominated by *Pemphis acidula*, like at Air Karang (UNDP/FAO 1977) and were found at several places along the coast.

3.3 Mangrove Forests and Salt flats

Mangrove forests are found at Bilik, Mesigit, and Tanjung Sedano (UNDP/FAO 1977). Five transects through mangrove forests are described by Budiman et al. (1986; see Appendix II), four at the mangroves between Bama and Kalitopo and one at Bilik. *Rhizophora apiculata* and *R. stylosa* are the main species of these transects, for density (D) as well as the importance value (IV). The majority of the trees have a diameter of 2-20 cm. Heights vary from 10-30 m. At the sea side of the mangrove forests an association of *Rhizophora apiculata* and *Rhizophora stylosa* is found, in which *Sonneratia alba* sporadically occurs. This association is followed by a mixture of species that differs in species due to local characteristics, but in which almost no *Rhizophora* spp. are found. Also the seedlings of *Rhizophora* spp. are rare, some seedlings of other species are found at the land side of the mangroves near mother trees.

Other species mentioned for the **tree/shrub strata** are *Anthocephalus* spp., *Ardisia* spp., *Avicennia alba*, *Bruguiera gymnorrhiza*, *Ceriops tagal*, *Dolichandrone spathacea*, *Echaria arborescens*, *Excoecaria agallocha*, *Glochidion* spp., *Gluta* spp., *Lumnitzera racemosa*, *Rhizophora mucronata*, *Sonneratia caseolaris*, *Sterculia foetida*, *Syzygium polyanthum*, and *Xylocarpus granatum* (the underlined species are dominating).

The **pole stratum** (juvenile trees) mainly consists of *Ceriops tagal*, *Dolichandrone spathacea*, *Excoecaria agallocha*, *Glochidion* spp., *Lumnitzera racemosa*, *Rhizophora apiculata*, *R. mucronata*, *R. stylosa*, and *Xylocarpus granatum*. The mangrove forest are still in good shape because there's not much death and the rejuvenation is enough; also 21 families of phytoplankton are found (PPMPA 1984, Lembinas 1986, Partomihardjo & Mirmanto 1986).

Salt flats are found north of Pandeyan, at Mesigit, west of Bilik, and few other places. The dominant species are *Avicennia* spp. and *Lumnitzera racemosa* (UNDP/FAO 1977).

3.4 Fresh-water Swamp Forests

This forest type is found at Kepuh river, Popongan, Kelor, Bama, and Gatal. Pronounced species of the swamp forests are *Buchanania arborescens*, *Excoecaria agallocha*, and *Syzygium polyanthum* (UNDP/FAO 1977).

In the plots surveyed in 1982-1990, species like *Aphanamixis grandiflora*, *Ardisia humilis*, *Azadirachta indica*, *Borassus flabellifer*, *Calamus javanensis*, *Cordia bantamensis*, *Dillenia pentagyna*, *Ficus* sp., *Glochidion rubrum*, *Hernandia peltata*, *Lantana camara*, *Melia azedarach*, *Mischocarpus sundaicus*, *Pongamia pinnata*, *Premna corymbosa*, *Protium javanicum*, and *Schleichera oleosa* are found in the **tree/shrub strata**, with *Apluda mutica*, *Cyperus rotundus*, *Dichantium caricosum*, and *Imperata cylindrica* in the **herb stratum**. Height varies from 5 to 30 m, while the diameter (only given for 1 plot) is mostly smaller than 20 cm.

3.5 Savannas

UNDP/FAO (1977) divides this VST in flat and flat to undulating savannas, of which the main species are *Dichantium caricosum*, *Heteropogon contortus*, *Sclerachne punctata* (greater frequency of this grass here at the flat savannas than at the flat to undulating savanna), *Sorghum nitidus*.

The savannas cover a total area of 4,500 ha. Few **trees** are found of the species *Acacia leucophloea*, *A. tomentosa*, *Azadirachta indica*, *Corypha utan*, *Ficus benjamina*, and *Vitex pubescens*, while *Acacia tomentosa*, *Azadirachta indica*, and *Schleichera oleosa* were also found in the **pole stratum**. The **stratum of saplings**[1] consists of *Acacia tomentosa*, *Corypha utan*, *Schleichera oleosa*, and *Vitex pubescens*; species without a scientific name are KUDU[2]-AN (*Morinda citrifolia*?), and TALOK (*Grewia* sp.). Joesoef (1982) does not differentiate between the **shrub and**

1 Some Indonesian authors use the expression SAPIHAN (individuals between seedling and pole phase), which can best be translated as saplings.

herb stratum, of which he mentions *Eulalia amaura*, *Physalis angulata* (CEPLIKAN), and *Polytoca bracteata*, as well as RUMPUT GAJIHAN (*Pennisetum polystachyon*?), RUMPUT KLITIKAN, KAPASAN (*Abelmoschus ficulneus* or *Thespesia lampas*), and PENDETA, with seedlings of *Acacia leucophloea*, *Albizia lebbeck*, *Corypha utan*, *Vitex pubescens*, and *Ziziphus rotundifolia*.

The flat savannas are situated on the younger (black) alluvial soils in the south-eastern part of the reserve, with 'gradual transitions from open grassland with *Borassus* palm to open forest, indicating a gradually diminishing influence of forest to the west'. 100 ha of *Imperata cylindrica* was found at a flat savanna south of Kepuh river, indicating heavy human use in the past (UNDP/FAO 1977).

Four plots are surveyed on these savannas, which consist of additional **grass species** like *Alysicarpus vaginalis*, *Bothriochloa modesta*, *Brachiaria mutica*, *B. reptans*, *Dactylotenium aegyptium*, *Dichantium caricosum*, *Echinochloa colona*, *Fimbristylis dichotoma*, *Imperata cylindrica*, *Setaria palmifolia*, *Sorghum nitidus*, and *Zoysia matrella*. For the **tree and shrub strata**, species like *Abutilon crispum*, *Aegle marmelos*, *Albizia procera*, *Grewia acuminata* are mentioned.

The flat to undulating savanna lie on the black soils with big boulders. About 8,000 ha is found in the north to northeastern part of the reserve (UNDP/FAO 1977).

These savannas, on which seven plots are surveyed, consist mainly of **grass/herb species** like *Arundinella setosa*, *Brachiaria reptans*, *Dichantium caricosum*, *Digitaria adscendens*, *Fimbristylis dichotoma*, *Heteropogon contortus*, *Panicum maximum*, *Sclerachne punctata*, *Setaria* spp., *Thelepogon elegans*, and *Themeda arguens*. Furthermore, **tree/shrub species** like *Helicteres* spp., *Hyptis* spp., *Lantana camara*, *Leucas* spp., *Melia azedarach*, *Morinda tomentosa*, *Schleichera oleosa*, *Schoutenia ovata*, *Tamarindus indica*, *Ziziphus rotundifolia* and KUDU[2]-AN (*Morinda* sp.?) occur (Partomihardjo & Sinaga 1984, PPMPA 1984, Partomihardjo & Mirmanto 1986). An additional **tree species** not mentioned below was *Ziziphus rotundifolia* (UNDP/FAO 1977).

According to Budiman et al. (1984), although none of the surveyed plots support this statement, 5 vegetation types with different **grass and herb species** are found on the savanna, namely:
- a *Zoysia matrella* and *Dichantium caricosum* type (this vegetation type is the most open; 2-10 cm height or sometimes just covering the soil),
- a *Themeda arguens* and *Mimosa invisa* type,
- a *Themeda arguens*, *Indigofera* sp., and *Vernonia* sp. type,
- a *Themeda arguens*, *Stachytarpheta* sp., and *Vernonia* sp. type, and
- a *Themeda triandra* type (*Themeda triandra* is often found in homogeneous stands up to 600 m ASL.; *Themeda arguens* and *Themeda triandra* reach 50-150 cm).

3.6 Stony Stream Beds (CURAH)

Stony stream beds are scattered all over BNP and contain riverine forest with an undergrowth of creepers and climbers like *Dioscorea hispida*, and only very few grasses (UNDP/FAO 1977).

On this VST, no known research was done in 1982-1990.

3.7 Monsoon Forests

These forests have a seral character with a rather open canopy and heavy undergrowth (immature state). They are 'particularly important as the habitat of the endemic DADAP or KELOR WONO [*Erythrina eudophylla*, BWA], known only from Baluran' (Jacobs in UNDP/FAO 1977). A division in lowland and upland monsoon forests is made, with a transition zone at about 250-400 m ASL.

The lowland monsoon forests are open woodlands to dense forest stands, depending on the influences of fire, grazing and cutting (UNDP/FAO 1977). The lowland monsoon forests is deciduous in areas <= 300 m ASL (mainly in the areas of Mount Montor, Mount Priuk, Mount Lengseran, and Mount Kembar). These areas have low variation in structure and composition. The Celungan area, at the foot of Mount Baluran, seem to be the main watershed of this mountain. It consists of trees of 15-30 m height (Budiman et al. 1984, Partomihardjo 1985a).

The eleven vegetation plots laid out in the lowland monsoon forest mention main species of the **tree stratum** like *Acacia leucophloea*, *A. nilotica*, *A. tomentosa*, *Atalantia trimera*, *Bridelia stipularis*, *Emblica officinalis*,

Eugenia jamboloides, *Ficus superba* (KRASAK), *Glochidion rubrum*, *Grewia eriocarpa*, *Homalium tomentosum*, *Kleinhovia ovata*, *Mallotus philippensis*, *Microcos tomentosa*, *Polyalthia lateriflora*, *P. rumpfii*, *Pterospermum diversifolium*, *Randia* sp., *Randia spinosa*, *Schoutenia ovata*, *Sterculia foetida*, *Streblus asper*, *Strychnos lucida*, and *Vitex pubescens*. **Pole/shrub species** like *Atalantia trimera*, *Capparis micracantha*, *Euphorbia* spp., *Glochidion* spp., *Randia spinosa*, *Schoutenia ovata*, *Streblus asper*, and *Strychnos lucida* are also found in this area, and *Emblica officinalis*, and *Vitex pubescens* for the **stratum of saplings**. The main species of the **herb stratum** are *Abutilon crispum*, *Achyranthes aspera* (RENDETAN), *Bidens biternata*, *Cleome viscosa*, *Dichantium caricosum*, *Dicliptera canescens*, *Eleutheranthera ruderalis*, *Heteropogon contortus*, *Passiflora foetida* (RAYUTAN), and *Rottboellia exaltata*; of one species, PUYANG (*Lantana camara*?), the scientific name is not give. **Seedlings** of *Flacourtia rukam* (RUKEM), *Schoutenia ovata*, *Vitex pubescens*, *Ziziphus rotundifolia*, and TALOK are also found in the **herb stratum**.

The trees reach 5-32 m, and the average diameters were smaller than 20 cm (Joesoef 1982, Partomihardjo 1985a, Partomihardjo 1985b, Partomihardjo et al. 1985, Sugardjito & Partomihardjo 1985, Lembinas 1986, Riswan 1986). The few mentioned **tree species** in addition to the surveyed plots were *Azadirachta indica*, *Flacourtia indica*, *Kleinhovia hospita*, *Schleichera oleosa*, and *Tamarindus indica* (UNDP/FAO 1977).

The upland monsoon forests cover all the slopes of Mount Baluran, except at Talpat, Klosot, and on the W slopes. They have a more evergreen character than the lowland monsoon forests, with an undergrowth of rattan in the wetter and steeper places. Locally bamboo patches are found on the western and southern slopes (UNDP/FAO 1977).

The upland monsoon forests, of which three plots are described, contains mainly species like *Aleurites moluccana*, *Buchanania arborescens*, *Capparis micracantha*, *Drypetes ovalis*, *Parameria laevigata*, *Polyalthia lateriflora*, *P. ramiflora*, *Pterospermum diversifolium*, *Streblus asper*, and *Sumbaviopsis albicans* in the **tree and pole strata**. No **grass/herb species** are given. Heights of 6-40 m and diameters greater than 20 cm were common in these forests. Additional species mentioned by UNDP/FAO (1977) are *Homalium foetidum*, *Schoutenia ovata*.

Tree species of the monsoon forests not mentioned above are *Albizia lebbeck*, *Cassia fistula*, *Celtis wightii*, *Cordia bantamensis*, *Erythrina eudophylla*, *Ficus* spp. (e.g. *F. superba*), *Pterospermum javanicum*, and *Syzygium* spp. with **shrubs** like *Capparis sepiaria*, *Helicteres isora*, and the **grasses** *Hackelochloa granularis*, *Oplismenus burmanii* (Partomihardjo & Sinaga 1984, Lembinas 1986, Partomihardjo & Mirmanto 1986).

Joesoef (1982) describes two slightly different areas of lowland monsoon forest. Apart from the 'lowland monsoon forest'-characteristic species mentioned above, the more levelled types of lowland monsoon forests consist of additional **tree/shrub species** like *Ficus benjamina*, *Garuga floribunda* (WIYU), and *Tamarindus indica*; several species are not identified, namely PANCAL KIDANG (*Aglaia odoratissima*, *Amoora grandiflora*, *Aphanamixis grandifolia*, *Mallotus philippensis*, or *Mischocarpus sundaicus*), TALOK, TIMONGGO, and TREMBESIAN, while the **pole stratum** is characterized by *Lantana camara* (WAUNG), PANCAL KIDANG, TALOK, and TIMONGGO. In the **stratum of saplings**, species like *Helicteres isora*, *Lantana camara* (WAUNG), *Schoutenia ovata*, *Streblus asper*, *Sterculia foetida*, *Ziziphus* sp. (WIDORO PUTIH), KENUNGGUAN, KLEDUNG (*Garcinia dulcis*?), TALOK, TAYUMAN, and TIMONGGO are characteristic for this kind of monsoon forest, as is *Olax scandens* (WANGON) for the **herb stratum**. A thick layer of litter with seedlings of *Artocarpus elasticus*, *Streblus asper*, KLEDUNG (*Garcinia dulcis*?), and PANCAL KIDANG, occupies the **herb stratum**.

The more hilly lowland monsoon forests (around Mount Klosot and Talpat) consist of additional **tree/shrub** species like *Aegle marmelos*, *Albizia lebbeck*, *Azadirachta indica*, *Cassia fistula*, *Erythrina fusca* (CANGKRING), *Flacourtia rukam* (RUKEM), *Piliostigma* sp. (KENDAYAKAN), *Schleichera oleosa*, *Ziziphus rotundifolia*, TALOK, TREMBESIAN, and WIYU, while the **pole stratum** is characterized by *Aegle marmelos*, *Emblica officinalis*, *Flacourtia rukam* (RUKEM), *Homalium tomentosum*, *Schleichera oleosa*, *Vitex pubescens*, and TALOK. In the **stratum of saplings**, species like *Aegle marmelos*, *Anomianthus dulcis* (KALAK MATANG), *Azadirachta indica*, *Flacourtia rukam* (RUKEM), *Helicteres isora*, *Homalium tomentosum*, *Schleichera oleosa*, *Schoutenia ovata*, DLUWAK, JATAHAN, KENDAYAKAN, KENG[2], and TALOK are found. **Shrubs, grasses and herbs** like *Cyperus rotundus*, *Dioscorea hispida*, *Eulalia amaura*, *Mucuna pruriens* (RAWE), and *Polytoca bracteata* are found, with seedlings of *Acacia leucophloea*, *Aegle marmelos*, *Albizia lebbeck*, *Anomianthus dulcis* (KALAK MATANG), *Azadirachta indica*, *Caesalpinia crista* (KUTU), *Emblica officinalis*, *Homalium tomentosum*, *Helicteres isora*, *Schleichera oleosa*, and KESAK (Joesoef 1982).

3.8 Steep (Inside) Crater Wall and Crater Bottom Forests

The crater walls are very steep and bare or covered with grass, ferns and mosses (UNDP/FAO 1977). No species are mentioned in any publication. The crater bottom forest consists of tall evergreen **trees** like *Aleurites moluccana*, *Buchanania arborescens*, and *Drypetes ovalis*. The undergrowth consists of low shrubs and climbers like *Dioscorea hispida* (UNDP/FAO 1977).

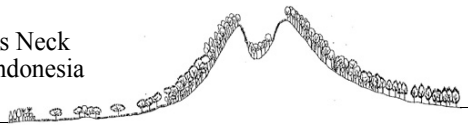
3.9 Teak plantations

Teak plantations cover the west to southeast of the park up to some 500 m ASL. (about 5,000 ha or 20% of BNP). The teak (*Tectona grandis*) forms, together with *Schleichera oleosa*, a natural vegetation type as found, for East-Java, only in Baluran. Furthermore there are uniform teak plantations with fire resistant *Leucaena leucocephala* on the borders, and thorn forests as in Mount Montor area (in the southeast of the park) with *Acacia tomentosa* and *Grewia acuminata*.

On a 500 m^2 plot, 8 and 9 species are found in the tree and pole strata respectively. The predominant **tree species** is

Table B Summary of data on trees (diameter more than 10 cm), poles and shrubs (1-10 cm), and grasses and seedlings for each chosen plot (each plot is 0.2 ha) in Baluran National Park derived from the publictions mentioned in appendix II)

Location	Height	Tree stratum			Pole/shrub stratum			Herb stratum	
	(m ASL.)	Species per ha	Ind. per ha	Basal Area	Species per ha	Ind. per ha	Basal Area	Species per ha	Average Height
Beach									
Bama	-	29	205	-	27	120	-	-	-
Mangroves									
Bama-Kalitopo and Bilik	0	-	-	-	-	-	-	-	-
Swamp forest									
Alas Malang-Gatal	5	6	520	87.38	9	500	665.75	14	0.10
Candi Bang-Dadap	25	8	180	28.10	4	-	-	25	0.20
Kelir-Pauli area	15	14	300	39.86	22	4300	1927.36	-	-
Flat savanna									
Dadap	10	-	-	-	1	8?	-	6	0.15-1.00
Mount Montor	-	-	-	-	-	-	-	-	0.02
Semiang	10	5	75	0.89	5	1180	690.43	26	0.02-0.05
Flat to undulating savanna									
Balanan	50	-	-	-	-	-	-	11	0.04-0.06
Bekol	30	-	-	-	1	220	136.34	11	0.02-0.05
Gatal-Kandang	30	3	20	-	4	120	-	7	0.50
Gentong	30	2	25	0.33	-	-	-	9	0.05
Gentong-Karangteko	30	2	25	-	-	-	-	19	0.05
Kandang savanna	20	-	-	-	4	480	491.78	7	50
Kramat	35	-	-	-	-	-	-	12	0.06-0.07
Labuan Merak	20	-	-	-	-	-	-	12	-
Paleran	50	3	25	0.41	9	1200	1362.92	19	0.50
Sumberwaru village	-	-	-	-	-	-	-	-	-
Lower Talpat	260	-	-	-	-	-	-	-	-
Lowland monsoon forest									
Batangan-Bekol road	-	27-32	-	-	-	-	-	-	-
Bekol I	-	5	278	-	-	-	-	-	-
Bekol II	20	11	540	234.94	13	2220	1235.24	15	0.05
Dadap-Mount Montor	40	6	425	45.78	14	1420	1304.97	29	0.15
Lengseran-Talpat	30	14	405	20.75	22	2700	1793.47	24	0.04
Kaloncing	335	18	345	52.50	27	1500	869.41	35	0.15
Mount Kembar area	160	7	90	5,507.3	7	-	-	20	>1.00
Mount Malang-Siruntuh	-	6	900	-	7	1275	-	-	-
Mount Montor	20	10	245	9.35	12	1200	621.56	30	0.10
Upland monsoon forest									
Mount Baluran-Musapah	600	24	620	31,935.0	18	1240	-	-	-
Kaloncing-Musapah	600	17	540	2,620.7	21	540	-	-	-
Pondok Sikesah	760	26	445	86,092.1	32	5525	-	-	-
Teak plantation									
Place unknown (500 m^2)	-	8	-	-	9	-	-	-	-
Other formations									
Candi Bang-Dadap ALANG[2]-field	25	8	36	-	-	-	-	6	1.00



Tectona grandis, with a minor development of the undergrowth. At some places *Tectona grandis* is mixed with dispersed groups of *Erythrina* sp. (up to 25 m) which follows the seasonal growth of *Tectona grandis*. Most trees are small sized (diameter of about 20 cm). Other **tree species** are *Albizia procera*, *Piliostigma malabricum*, *Butea monosperma*, *Dillenia pentagyna*, *Mallotus* spp., and *Schleichera oleosa*.

3.10 Other vegetation types

All other vegetation types lie mainly outside the borders of BNP, but several have quite a strong relation with it. Near Wonorejo, for instance, lies the area of P.T. DUA EMPAT, a concession on which *Ceiba pentandra* is grown. Near Labuan Merak and Mesigit concessions of P.T. GUNUNG GUMINTEN lie, where officially *Sesbania grandiflora* was planted (Lembinas 1986).

3.11 Exotic, Endemic, and Extinct Species

According to UNDP/FAO (1977) and Partomihardjo (1992,) a total of 36 species are/have been considered as exotics in the park (see also Table C, Appendix III, and Appendix IV). Important exotic species of BNP according to Watling (1991) were *Acacia nilotica*, *Lantana camara*, and *Leucaena leucocephala*. Of these species, *Acacia nilotica* is the most conspicuous exotic weed species of the park, for it is now spread out of control, but it's not the most serious one with respect to the animals. *Lantana camara* is more widespread, covering and displacing larger areas of potential grazing, especially the shaded areas under tree cover and must be controlled through a burning programme and/or biological control. *Leucaena leucocephala* is reasonably under control by a Psyllid bug (Watling 1991).

An important endemic species for (East) Java and Bali mentioned by many authors is *Erythrina eudophylla* (PPMPA 1982, Budiman et al. 1984, Partomihardjo & Mirmanto 1986, Schardijn 1991, Partomihardjo 1993). The last trees of this species is said to be present in BNP, although no hard evidence is available. This causes at least one author to wonder if this species is already extinct (Watling 1991), and a survey focussed on this particular species is necessary. Another species occurring in the park, *Hoya multiflora*, is considered endemic to Java (Backer 1963), but no information on the current situation of this species is available.

Table C Exotic species of Baluran National Park (UNDP/FAO 1977 and Partomihardjo 1992); the underlined species are only mentioned by Partomihardjo 1992

Agavaceae	*Cordylin fruticosa*		*Euphorbia hirta*		*Poincinia regia*
Amaranthaceae	*Cyathula prostata*		*Euphorbia prunifolia*		*Sesbania grandiflora*
Amarylidaceae	*Crinum asiaticum*		*Cleidion javanicum*	Mimosaceae	*Acacia nilotica*
Anacardiaceae	*Spondias cytherea*		*Jatropha curcas*		*Leucaena leucocephala*
Apocynaceae	*Thevetia peruviana*		*Jatropha gossypifolia*		*Mimosa invisa*
Asteraceae	*Eleutheranthera ruderalis*		*Ricinus communis*	Piperaceae	*Pothomorphe subpeltata*
	Gynura crepidioides	Fabaceae	*Aeschynomene americana*	Polygonaceae	*Antigonon leptopus*
Bignoniaceae	*Millingtonia hortensis*		*Cassia alata*	Rubiaceae	*Morinda citrifolia*
Cactaceae	*Opuntia elatior*		*Crotalaria mucronata*		*Morinda tomentosa*
Convolvulvaceae	*Ipomoea fistulosa*		*Delonix regia*	Tiliaceae	*Corchorus olitorius*
	Ipomoea triloba		*Phaseolus lathyroides*	Verbenaceae	*Lantana camara*
Euphorbiaceae	*Acalypha wilkesiana*		*Phaseolus vulgaris*		*Stachytarpheta jamaicensis*

4 Vegetation Surveys of Baluran National Park (1992)

The surveys executed in Baluran National Park (BNP) in 1992 resulted in a (preliminary) vegetation structure map, a tree cover map, and a vegetation analysis of the four main grasslands in the dry season. The following paragraphs elaborate the results of these surveys.

4.1 Vegetation Structure Map

During the initial process of merging and dividing of vegetation structure types it became obvious that an extra vegetation structure type (VST) had to added for certain areas in the northern part of BNP, which differ strongly with the other VST's on the SPOT-image. Because the field trips were oriented on the eastern half of the park, no information was available on this VST. Therefore this VST was named 'unclear' and the term 'preliminary' was added to the vegetation structure map. Thus, the whole process of merging and dividing resulted in the following set of signatures: deep sea, shallow sea, coral, beaches, mangrove, 6 types of grassland (of which one coincides with mudflat), 3 types of upland monsoon forest, 4 types of lowland monsoon forest (which include a part of the mangrove, upland monsoon forest, and plantation), steep inside crater wall, unclear, *Acacia nilotica*, and 5 other types. Based on this set of signatures, the entire SPOT-image was classified, and resulted in the preliminary vegetation structure map presented Appendix I (the band values and cover on the SPOT-image per signature are presented in Table D). The cover of each signature

Table D Band values and cover of the different units on the SPOT-image of Baluran National Park

		Band 1 (green)				2 (red)				3 (reflective infrared)				Cover
Unit	Total pixels	Min. Value	Max. Value	Mean Value	Stand. Dev.	Min. Value	Max. Value	Mean Value	Stand. Dev.	Min. Value	Max. Value	Mean Value	Stand. Dev.	(%)
deep sea	1237	33	35	33.97	0.52	16	18	17.31	0.48	7	8	7.68	0.47	7.4
shallow sea	1885	36	48	42.52	2.58	18	29	23.21	2.21	7	16	10.41	1.12	5.4
coral	35	53	62	57.89	2.35	33	46	39.46	3.06	12	24	16.03	3.21	0.2
sub-total														**13.0**
beach 1	6	69	79	75.33	3.34	60	70	65.17	3.33	78	84	81.33	1.88	0.0
beach 2	8	68	81	74.87	3.48	49	63	57.62	4.41	42	52	47.75	3.63	0.0
sub-total														**0.1**
mangrove	417	36	42	38.18	1.15	21	28	23.19	1.10	64	85	69.63	4.02	2.0
sub-total														**2.0**
grassland 1	69	50	56	53.25	1.51	34	42	38.99	2.01	93	104	98.17	3.27	3.1
grassland 2	95	43	48	46.05	0.79	28	32	29.15	0.95	93	105	100.44	2.77	2.0
grassland 4	21	56	63	60.38	1.56	51	56	53.81	1.66	47	54	49.57	1.93	0.0
grassland 5	180	46	52	49.01	1.46	34	41	37.20	1.59	43	52	48.51	1.98	0.6
grassland 6	762	46	56	51.49	1.89	37	47	42.43	1.95	52	72	64.71	3.48	4.0
sub-total														**17.9**
lowl. mons. forest 1	936	39	43	40.39	0.80	23	27	25.73	0.69	94	106	100.78	2.96	15.9
lowl. mons. forest 2	4263	39	46	42.21	1.05	24	33	27.87	1.30	70	86	76.45	3.29	9.9
lowl. mons. forest 3	127	40	44	42.12	0.66	28	32	29.84	0.77	52	66	59.39	4.01	0.9
lowl. mons. forest 4	37	40	43	41.73	0.63	26	29	27.49	0.72	77	85	81.41	2.18	7.8
lowl. mons. forest 5	129	41	48	45.71	1.35	25	32	28.91	1.15	95	108	101.00	3.18	8.3
sub-total														**34.5**
upl. mons. forest 1	4332	37	46	40.61	1.05	22	33	25.83	1.03	97	121	108.91	5.21	8.4
upl. mons. forest 2	187	35	42	37.98	1.26	21	27	23.17	1.00	66	78	70.63	2.87	1.2
upl. mons. forest 3	161	42	48	44.64	1.24	30	39	34.50	1.83	62	72	66.20	2.38	1.6
sub-total														**11.2**
crater wall	216	41	57	48.60	3.02	27	41	32.88	2.91	113	136	123.34	5.26	1.9
sub-total														**1.9**
unclear 1	27	59	64	61.48	1.49	55	63	59.22	2.34	84	93	88.48	2.30	0.3
unclear 2	1678	50	65	57.85	2.43	40	60	48.76	3.34	83	104	93.84	4.33	12.9
sub-total														**13.3**
acacia nilotica	520	44	49	46.45	1.14	31	38	34.11	1.49	65	72	67.88	1.71	2.2
sub-total														**2.2**
agriculture 1	125	43	48	45.93	1.15	35	41	36.94	1.31	32	39	35.71	1.86	0.2
agriculture 2	34	61	65	63.12	1.04	57	64	60.91	1.73	62	70	65.65	2.18	0.1
cloud	1573	87	254	168.00	35.24	73	254	153.73	37.69	85	226	146.03	24.74	2.6
shadow	1305	28	44	37.75	3.38	17	33	25.08	3.29	22	39	34.40	3.00	0.9
water course	11	54	58	55.73	0.98	45	48	46.45	0.95	52	65	60.09	3.91	0.3
sub-total														**4.0**

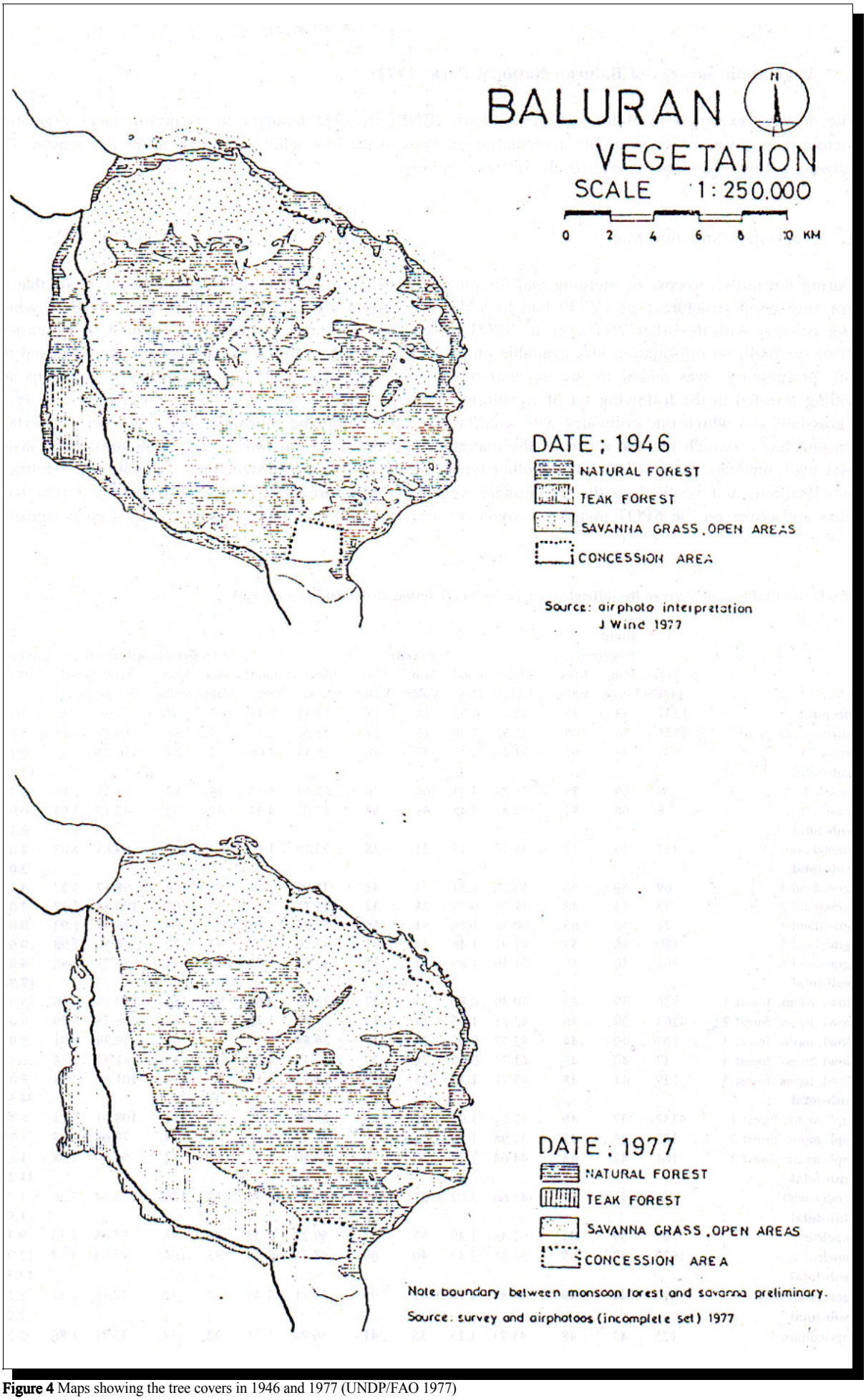


Figure 4 Maps showing the tree covers in 1946 and 1977 (UNDP/FAO 1977)

does, however, give only limited information on the cover of each VST in the field, since these values were not corrected for the third dimension (height).

The extra classification without the use of the *Acacia nilotica* signature or the classification of points too far from the signatures resulted in a group of points on the SPOTimage that were not classified. Most of these points had a lightpink tone on the SPOTimage and were situated in the center of areas now covered by *Acacia nilotica*. Based on this characteristic, it could be assumed that these areas indeed were areas covered with *Acacia nilotica* in 1990 and that signature was considered a characteristic signature.

As can be seen in Table D, the 1st (green; 0.500.59 m) band showed quite a lot of overlap between the different VST's due to the large amount of green vegetation, while the differences between the 2nd (red; 0.610.68 m) and the 3rd (reflective infrared; 0.790.89 m) band were most useful. But even the use of a set of two bands still show a lot of overlap. Within the complexity of overlapping values within each band, each signature is therefore only characteristic due to its set of three intervals.

One drawback became clearly visible on the SPOT-image. Along the borders of the clouds, their values interfere with the values of the vegetation. Because the map is mainly the result of the classification of the SPOT-image by the ERDAS-program through the use of defined signatures, some points have been misclassified. Several attempts were made to reclassify these points, but no satisfying improvements were obtained.

Another, more important, reduction in quality of the preliminary vegetation structure map was caused by the unfamiliarity with the available equipment to process the image; because of the ignorance on the use of ERDAS Version 7.4, a priori information on height and additional differentiation in the form of vectors and accretions was not possible. Due to this, differences between upland/lowland monsoon forest, grassland/mudflat/ plantation, and coral/beach could not be clearly presented. Also, the map could not be printed on a 1:50,000 scale; at Wageningen Agricultural University the maximum paper size to print on was A3, so the current scale of the preliminary vegetation structure map is about 1:70,000. In addition to this drawback, the differences in tone between the different classes on the computer screen are less clear on the printout (what you see is not what you get). Thus the texts and tone differences are sometimes difficult to read/see on the map and sometimes even entangling or not visible.

Additional reduction in quality was caused by two factors. The extreme northern part of BNP (about 7% of the park) is absent from the image. Further reduction is caused by the presence of clouds and shadows, especially around and north of the rim of the volcano. These entities cover a small part of BNP (about 3.5%) and influence data directly surrounding them. Due to these points it was estimated that of about 10% of the park no data is available.

4.2 Tree cover map

Several maps with references to the vegetation of BNP have been published (see Table E). These maps can be divided into a landscape ecological map, vegetation form maps, schematic topographic maps, sketch maps, and vegetation maps.

The sketchy vegetation maps of the years 1880, 1935, 1946 and 1977 made for UNDP/FAO (1977) are very general maps, but of importance for this survey because they provide information on the surface area of the vegetation types and their change. These maps show that, according through the combination of fire and cutting of firewood, the grasslands had steadily expanded (see also Figure 4).

The compilation of the vegetation form maps from the aerial photographs and the SPOT-image resulted in two maps that show the tree cover (0-10% = grassland, 10-40% = woody grassland, 40-60% = open woodland, > 60% = woodland/forest) of 1981 and 1990. The borders between the units on these maps only differ

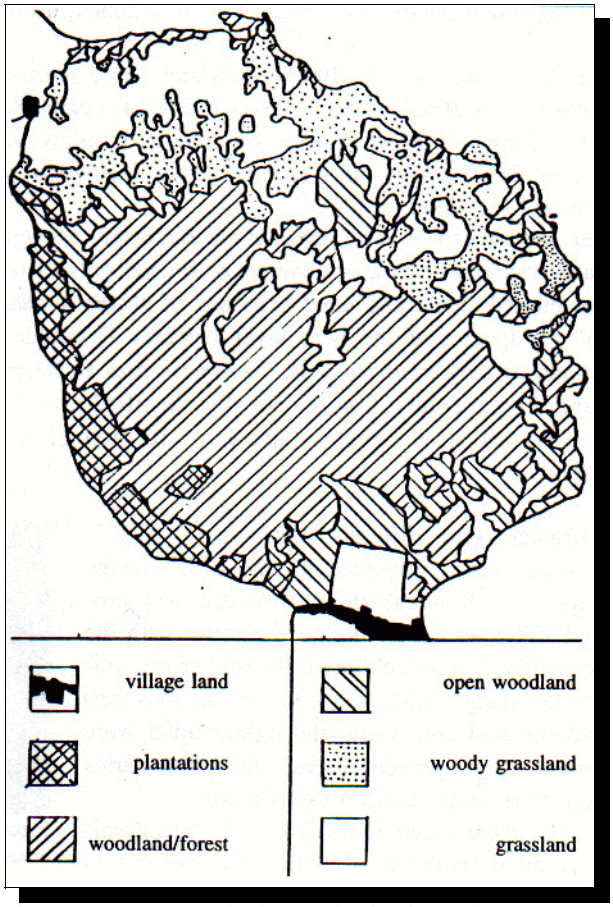


Figure 5 Tree cover map of Baluran National Park (1981/1990)

slightly, and it was not clear whether these differences were actual differences in area or that they are caused by the difference in interpretation between the aerial photographs and the SPOT-image. For this reason, only the tree cover map based on the aerial photographs is presented (Figure 5).

Table E Available maps of Baluran National Park (the **highlighted** maps were used during this survey)

Year	Map title	Scale	Author	Remarks
1880	**Vegetation 1880**	**1:250,000**	**UNDP/FAO 1977**	**General maps...**
1932?	Schematic topography	1: 50,000	Topografische Dienst 1932	-
1935	Vegetation	1:125,000	Appelman 1937	... showing 3-5...
1935	Vegetation 1935	1:250,000	UNDP/FAO 1977	... different units...
1946	Vegetation 1946	1:100,000	UNDP/FAO 1977	-
1946	**Vegetation 1946**	**1:250,000**	**UNDP/FAO 1977**	**... which seem to be...**
1977	**Vegetation 1977**	**1:250,000**	**UNDP/FAO 1977**	**... based on tree cover**
1977?	Drainage	1:100,000	UNDP/FAO 1977	-
1977?	Geology	1:200,000	UNDP/FAO 1977	-
1977?	Guarding development	1:100,000	UNDP/FAO 1977	-
1977?	**Habitat types**	**1:125,000**	**UNDP/FAO 1977**	**See also also Figure 3, Paragraph 3**
1977?	History of establishment	1:200,000	UNDP/FAO 1977	-
1977?	Land use	1:100,000	UNDP/FAO 1977	-
1977?	Proposed boundaries	1:200,000	UNDP/FAO 1977	-
1977?	Proposed zoning system	1:100,000	UNDP/FAO 1977	-
1977?	Scenic value	1:100,000	UNDP/FAO 1977	-
1977?	Schematic topography	1: 50,000	UNDP/FAO 1977	Drawn by Dir. PPA-UNDP in 1977
1977?	Schematic topography	1:100,000	Lembinas 1986	Same as 1977?, Schematic topography map
1977?	Soils	1:200,000	UNDP/FAO 1977	-
1977?	Tourism development	1:100,000	UNDP/FAO 1977	-
1981	**Preliminary map of landscape ecology**	**1: 50,000**	**Hasanbahri year unknown (presumably 1991)**	**Map showing landscape units, crown height and diameter, and forest functions**
1985?	**Vegetation**	**1:125,000**	**Partomihardjo et al. 1985**	**Likely to be based on 1977? Habitat types**

4.3 Vegetation Analysis of Four Main Grasslands in the Dry Season

In the dry season of 1992 Bekol grassland was a relative heterogeneous grassland, that's interspersed with small clusters of *Acacia nilotica*, *Acacia tomentosa*, *Calotropis giganthea*, *Vernonia cinerea*, and *Ziziphus rotundifolia* (see also Table F). Most species occurred in strongly varying densities and the relationship between the preliminary SPOT-image units and the actual vegetation was missing. This resulted the unstratified sampling of the Bekol grassland.

Acacia nilotica had a very dominating character, especially at the borders of Bekol grassland, since the grassland was almost bare or covered with dead grasses (of mainly *Vernonia cinerea* and *Eulalia amaure*). Many cut and burned stems and dead branches of *Acacia nilotica* were found in the eastern part of this grassland. One of the species of the herb layer (species 1) could not be determined, but species like *Brachiaria* sp., *Eulalia amaura*, *Sclerachne punctata*, *Vernonia cinerea* and especially *Abutilon indicum* were characteristic for this grassland. The grassland was floristically classified as a *Abutilon indicum-Acacia nilotica* grassland.

The living and dead biomass (airdry) of 10 plots (1 x 1 m) for the herb layer was 15 g/m^2 and 65 g/m^2 respectively.

At Kramat, two different preliminary SPOT-image units were recognized on the SPOT-image (see Figure 6). Although these areas are very pronounced, there was only limited similarity with the field situation; it is possible that the darker preliminary SPOT-image units used to be the *Vernonia cinerea*-dominated area while the lighter units were the more open grazed areas, but boundaries between these areas changed considerably.

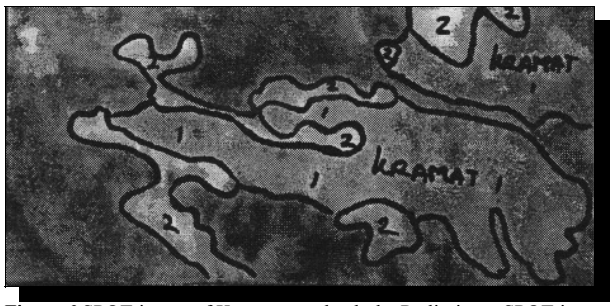


Figure 6 SPOT-image of Kramat grassland; the Preliminary SPOT-image units for this grassland have been delineated

The most pronounced area (Kramat 1) was dominated by dried remnants of *Vernonia cinerea* (up to about 1.70 m; average height 1.40 m), mixed with *Dichanthium caricosum* and *Eulalia amaure*. Also some *Acacia nilotica* shrubs and seedlings of *Azadirachta indica* were found in this *Morinda* sp.- *Vernonia cinerea* grassland. This area seems surprisingly homogenous and

was not grazed by large herbivores. The absence of grazing on this part of the grassland was quite conspicuous, but no sound explanation for this phenomena could be given.

The average amount of air-dry biomass was 75 gr/m^2 (living) and 800 gr/m^2 (dead).

The more open areas (Kramat 2), classified as *Dichanthium caricosum-Acacia nilotica* grassland, were positioned along the borders of the grassland and were dominated by *Dichanthium caricosum*. These areas seemed to be resting places for banteng (*Bos javanicus*) and kerbau (*Bubalus bubalis*), which were often encountered during the field trips to this area, and were strongly grazed (average height of about 5 cm). Only three species were found in the dry season, i.e. *Dichanthium caricosum*, young *Acacia nilotica* seedlings and few *Azadirachta indica* trees and seedlings.

The amount of biomass on this grassland was rather small; The amount of dead biomass was 25 gr/m^2 and the living biomass weighs 40 gr/m^2.

In the southeast corner of Kramat, at the border of the grassland and the more densely forested area, an additional area, containing only *Mimosa invisa*, was defined during the field trips (Kramat 3). Yet the majority of this area had a tree cover which was greater or equaled 10%, and was therefore not included. The small area (about 5 ha) outside the tree cover was classified as *Mimosa invisa* grassland. The area was not clearly visible on the SPOT-image, partly because it is too small but also (especially in cases where it was sometimes larger than the 20 x 20 m resolution of the SPOT-image) because the reflection of this area seemed to be the same as the other grassland areas. Because of the thorny stems of *Mimosa invisa*, it was impossible to extract the biomass of a specific area, so plots to determine the biomass were not sampled.

Dadap grassland was quite homogeneous, in the field as well as on the SPOT-image (see Figure 7), and consists of an alternating pattern of individual *Acacia tomentosa* shrubs (up to 1.50 m) with high (and still green) grasses and cut and grazed grasses of 5-10 cm height. The main species of the herb layer in this area were *Eulalia amaure*, *Imperata cylindrica*, *Sida* sp. and *Sorghum nitidus*. In the grassland a small stand of *Borassus flabellifer* was found. This grassland was classified as a *Sorghum nitidus-Eulalia amaure* grassland.

During the survey the majority of this area was burned, so it was not possible to obtain an average amount of biomass. Yet it was still possible to estimate the interval in which the biomass lies by cutting two specific plots (1 x 1 m); one near an unburned *Acacia tomentosa* for the maximum biomass, and one on an unburned area with only grasses up to 20 cm for the minimum biomass. This method yielded 50-600 g/m^2 living biomass and 10-80 g/m^2 dead biomass respectively.

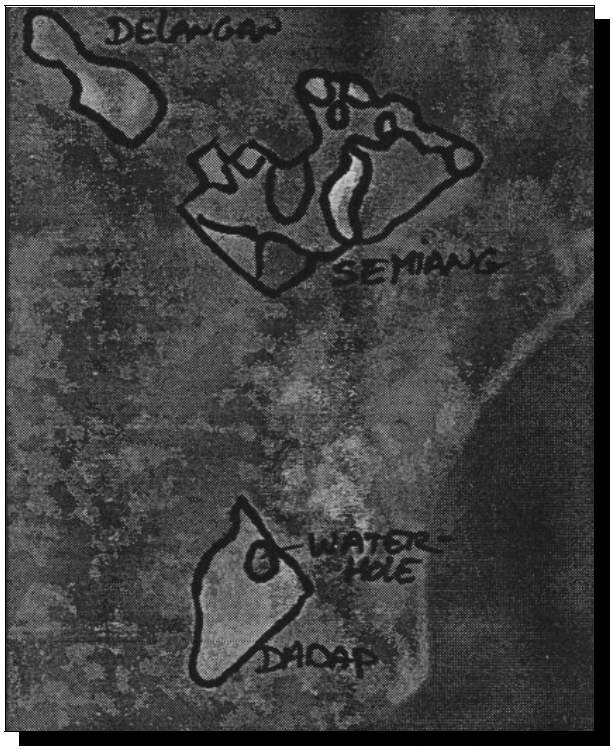


Figure 7 SPOT-image of Dadap and Semiang; the preliminary SPOT-image units of Semiang grassland have been delineated

The different areas of Semiang grassland showed strong relationship with the preliminary SPOT-image units (see Figure 7), and were covered by mainly one species each. The light areas along the borders expanded slightly, but all units were still detectable in the field.

Most species of this grassland could not be identified because of the high grazing pressure (the plants were about 3 cm high). This drawback resulted in the choice to present the data gathered on this grassland as one unit (Semiang) and not to classify this grassland floristically; only one species was identified as *Abutilon crispum*, which was quite conspicuously present at the site (it reaches up to about 1.70 m). The amount of biomass was 25 g/m^2 and 10 g/m^2 living and dead biomass respectively.

Table F Diagonal matrix of cover/abundance of plant species of several grasslands

Location	Bekol	Kramat 1	Kramat 2	Kramat 3	Dadap	Semiang
Size of surveyed area (ha)	40	105	20	5	80	100
Abutilon indicum	p r . .	. . . .	. . . .	. . . .	. . . .	. . . .
Brachiaria sp.	p r . .	. . . .	. . . .	. . . .	. . . .	. . . .
Sclerachne punctata	r p . .	. . . .	. . . .	. . . .	. . . .	. . . .
species 1	r p . .	. . . .	. . . .	. . . .	. . . .	. . . .
Calotropis giganthea	r r . .	. . . .	. . . .	. . . .	. . . .	. . . .
Flemingia lineata	r r . .	. . . .	. . . .	. . . .	. . . .	. . . .
dead grasses	3 1 . .	1 1 . .	. . . .	. . . .	. . . .	. . . .
Vernonia cinerea	a p . .	2 6 3 p	. . . .	. . . .	. . . .	. . . .
Acacia nilotica	1 4 3 1	. 1 . p	1 1 . p	. . . .	. . . .	. . . .
Eulalia amaure	p p . .	3 3 . .	. . . .	. . . .	1 2 p .	. . . .
Acacia tomentosa	r r r p	p 3 2 p	. . . .	. . . .	1 2 1 .	. . . .
Sida sp.	p r . .	. . . .	. . . .	. . . .	2 3 1 .	. . . .
Paspalum sp.	p r . .	2 2 . .	. . . .	. . . .	p 1 . .	. . . .
Dichanthium caricosum	p 1 . .	3 3 . .	3 3 . .	. . . .	. . . .	. . . .
Echinochloea colona	. r . .	. . . .	. . . .	. . . .	. . . .	. . . .
Azadirachta indica	. r . r	. r . r	r . . r	. . . p	. . . .	. . . .
Phyllanthus virgatus	. r . .	. . . .	. . . .	. . . .	r . . r	. . . .
Schleichera oleosa	. . . r	p p p 1	. . . .	. . . p	. . . .	. . . .
Ziziphus rotundifolia	. . . r	. . . .	. . . .	. . . .	. . . .	. . . .
Morinda sp.	. . . .	r r r .	. . . .	. . . .	. . . .	. . . .
Mimosa invisa	. . . .	. . . .	. . . .	1 4 . .	. . . .	. . . .
Thespesia lampas	. . . .	. . . .	. . . .	. . . .	r r . .	. . . .
Sorghum nitidus	. . . .	. . . .	. . . .	. . . .	2 3 a .	. . . .
Imperata cylindrica	. . . .	. . . .	. . . .	. . . .	1 r r .	. . . .
Alysicarpus vaginalis	. . . .	. . . .	. . . .	. . . .	. r r .	. . . .
Borassus flabellifer	. . . .	. . . .	. . . .	. . . .	r r r p	r r r r
Abutilon crispum	. . . .	. . . .	. . . .	. . . .	. . . .	p 1 2 2
species 2	. . . .	. . . .	. . . .	. . . .	. . . .	m . . .
species 3	. . . .	. . . .	. . . .	. . . .	. . . .	p . . .
species 4	. . . .	. . . .	. . . .	. . . .	. . . .	p . . .
Floristic classification	*Abutilon indicum-Acacia nilotica*	*Morinda* sp.-*Vernonia cinerea*	*Dichanthium caricosum-Acacia nilotica*	*Mimosa invisa*	*Sorghum nitidus-Eulalia amaure*	-

Cover/abundance scale: 1 - 9 = 10 - 90% cover, a = abundant, m = many, p = poor, r = rare (covers < 5%)

5 Discussion of the Results

The results of this study are discussed per objective (a semi-detailed up-to-date description of vegetation structure and flora of the whole of Baluran National Park (BNP), a general description of the present vegetation forms in BNP in the form of a tree cover map, and detailed descriptions of the four main grasslands in the park) in the following paragraphs. First of all, the results are compared with other information, then the (dis)advantages and value of the results are discussed

5.1 Semi-detailed Up-to-date Description of Vegetation Structure and Flora of Baluran National Park

The semi-detailed up-to-date description of vegetation structure and flora of the whole of BNP was based on the vegetation descriptions of the park, the SPOT-image, and ERDAS (the used geographical information system), and resulted in a preliminary vegetation structure map. Each of these factors is discussed in the sub-paragraphs below; because, in this case, the SPOT-image and ERDAS were interdependent, they will be discussed together.

5.1.1 Vegetation descriptions of Baluran National Park

Simple comparison of the species between the different periods showed some interesting points. Several species (21; highlighted in Appendix III) mentioned around 1935 were not mentioned by UNDP/FAO (1977), Partomihardjo (1992), nor by any other author in the period 1977-1987. Thus the question arose whether these species are synonyms of species mentioned in the two following periods or they disappeared from BNP, but due to a lack of time, this question could not be answered. Furthermore, a total of 77 additional species were not mentioned in the check-list of species by Partomihardjo (1992; see Appendix III). This was mainly due to the fact that Partomihardjo limited his check-list to Spermatophytes, and focussed on the grassland and the various forest vegetation structure types (VST's). Yet, Partomihardjo (1991) presents 120 species that had not been mentioned before. Quite interesting is an estimate of the total amount of species in the park. Although noone ever completely surveyed the area, a minimum amount of 604 species (the species of UNDP/FAO 1977 and Partomihardjo 1992 together) is very probable.

Although UNDP/FAO (1977) states 'exotic, introduced species ... are not appropriate in a national park and should be removed as quickly as possible', topics like 'what's an exotic/endemic species', 'how exotic are the exotic species of BNP?' were not much discussed. Considering the simple statement by Whyte (1974) that some 25 species belonging to the Gramineae may be indigenous to Java, 68 were doubtful, and 182 non-indigenous foreigners, it was clear that the term 'exotic/endemic' often is wrongly used in reference to most of these species in the park. Obviously it is very easy to refer to these species as exotics once they become a plague, but it might be possible that the arrival of they were only a consequence of a (semi) natural process of change.

Another factor barely considered was 'how, and to what costs should exotic species be removed?'. Although, for example, many schemes were proposed to reduce the area covered by *Acacia nilotica* (like herbicides and heavy machinery) the impact of these schemes were often not considered. If the removal of such a species is too costly or impossible, it should be accepted as part of BNP.

Several points have to be made with regard to the vegetation descriptions used in the survey. first of all they were from 1982-1987. And, as can be seen in Appendix II, the vegetation descriptions do not treat all VST's (nor all habitat types mentioned by UNDP/FAO 1977); the grasslands were discussed quite extensive by different authors, while coral beeches, crater bottom forest, inside crater wall, salt flats, and stony river beds were not elaborated at all. Based on the position of the plots on the preliminary vegetation structure map (see Appendix I), it was obvious that most researchers focus on sites near to the coast. Also, the different publications show quite a lot of variation in the presentation of their vegetation descriptions; each authors presents the descriptions in an individual form. Some authors did not identify all the species but use their local names, or focus on specific strata within the vegetation. This makes it quite difficult to compare the information on the vegetation descriptions with each other. A more consistent approach to inventory the vegetation of the park is the use of a standard form, for instance the ITC relevé sheet (Gils et al. 1985).

Yet, these vegetation descriptions are considered useful. Although no additional information on the vegetation and flora of the park is now available through field surveys, information that was only published in Bahasa Indonesia (and thus less accessible) can now be used in further research and surveys. Furthermore, a more complete set of

descriptions was gathered than would have been possible to survey in the field. Also, based on references made on maps and in publications, it seemed that a lot of information on the vegetation and flora of BNP from earlier research/surveys was unpublished yet. The use of the publications from 1982-1987 is also partly to encourage the spreading of this information, preferably in English.

5.1.2 Preliminary vegetation structure map

Of some importance was the variation in position of several entities in the park. The best example to explain this point is the Semiang swamp-grassland; while most authors place this grass land near Mount Montor, northeast of the Dadap grass land (Figure 8), the curent location lies at a more inland position (see Figure 7). Several factors cause variations like this. To some extend the scale of maps will influence the position of an area on a map, but more probable is, particularly in this case, misplacement on earlier maps. (Also possible is a gradual or abrupt change of the position of Semiang grassland over the years, but this was considered very unlikely since no evidence of this change was found). This variation in position created some misunderstandings during field trips, but after a long discussion with guards and researchers in BNP, the names as presented at the preliminary vegetation structure map of the park were presumed to be on the correct place.

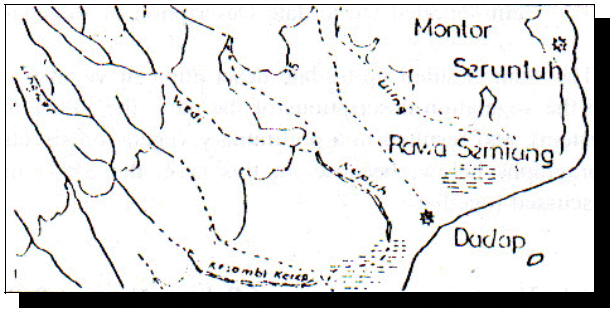


Figure 8 Position of the Semiang swamp grass land on drainage map (UNDP/FAO '77)

During the gathering of information for and processing of the preliminary vegetation structure map, several problems arise that reduced the quality of the map. The two factors which reduced the quality of the SPOT-image (a part of BNP is missing and a proportion, 3.5%, is covered by clouds and shadows) were directly visible. Due to the slowly diminishing effects of these clouds and shadows, the borders of these entities are strongly biassed and showing a large variation of VST's that were actually not present at this location; this effect was the main reason to use an abundance of representative points for some VST's to reduce their influence. This bias was slightly by reduced by reclassifying a certain area with high variance in VST's to clouds or shadow, but both drawbacks together mean that an estimated 10% of the park could not be classified for the desired VST's.

Another drawback was the strong focus on the eastern part of BNP. This means that (exact) location of entities and their boundaries more than ± 500 m from the road was mainly based on sources of information other than field trips (literature, maps, and photographs). This influence is a small one, since most entities could clearly be seen on maps and photographs, but the exact boundaries and locations could not be checked. This means that not all the information available on the SPOT-tape was used in the map, which means further reduction of quality.

Two more drawbacks were the ignorance on the use of ERDAS Version 7.4 (which will be discussed in the following sub-paragraph) and the fact that the map can hardly be compared to other maps. There were similar maps available on the park (the schematic topography map, scale 1:50,000, by UNDP/FAO 1977 and the preliminary map of landscape ecology, scale 1:50,000, by Hasanbahri year unknown), but the size of the preliminary vegetation structure map (about 1:70,000) is differing from these maps, UNDP/FAO (1977) does not clearly define the borders of the used units, and the differences with the map by Hasanbahri were too small to come to any conclusions.

Still, the preliminary vegetation structure map is useful. The map units are clearly delineated and only limited additional surveys/research is necessary to process the map to an 'up-to-date vegetation structure map'. Also, an the area covered by *Acacia nilotica*, on which no information was available, was estimated for 1990, and it can be concluded that further research/surveys in this field will show very rewarding.

5.1.3 SPOT-image and ERDAS

Although the possibilities in use of the data of a SPOT-image are quite large, determination of entities like the area that might be covered with *Acacia nilotica* (2.2, 4.1) was very simple, it has some strong disadvantages. Considering the price of a SPOT-image and the fact that the production of a tape with the information of the whole area of BNP is quite simple, it is considered quite ridiculous that these tapes are sold in standard areas; now a tape is available with

data on an area about four times the size of the park, and still a part of BNP is missing on the image. The information obtained from a SPOT-image can easily be edited on the computer, and a division into preliminary SPOT-image units based on color becomes more objective. Yet it should be kept in mind that differentiation based on colour is not necessarily meaningfull. Furthermore does the small scale of the image make differentiation between plant species only possible if the species cover(s) about 20 x 20 m or more, and detailed surveys (maps larger than 1:25,000) impossible. Another big disadvantage of the SPOT-image was caused by the unfamiliarity with the available equipment to process the image; because of the ignorance on the use of ERDAS Version 7.4, a priori information on height and additional differentiation in the form of vectors and accretions was not possible.

It seems that the SPOT-image, in combination with ERDAS, has only limited use for this survey; the SPOT-image was too small scaled and ERDAS too complicated to work with. Yet, the possibilities of a remote sensing image like the SPOT-image are so extensive, that it is assumed that only a very limited amount of the actual value of the SPOT-image was extracted. Based on these assumptions, the SPOT-image is considered very useful.

5.2 General description of the present vegetation forms in Baluran National Park

Some changes were recognized from the vegetation maps from UNDP/FAO (1977). In the period 1880-1977 the forest area decreased to make way for savanna, grass lands, and the plantations along the road increases rapidly. This decrease was caused by several factors. UNDP/FAO (1977) states: 'Undoubtedly, the most significant human influence down through the years has been fire. The incidence of large fires greatly increased in recent times, ... occurring almost every year to burn down large areas of 10,000 ha or more. Through the combination of fire and cutting of firewood, the savanna area has steadily expanded... On the other hand, fire influence at the western and southern parts of the [park, BWA] has decreased due to better fire control since the teak plantation area has increased at the expense of open savanna and natural teak-kesambi forest'. Hoogerwerf (1972) mentions that the fires would probably not change the characteristics of the park, because they already occur for tens or even hundreds of years during the dry season, but he's not willing to accept this as an accomplished fact. Based on the large areas on a map by Appelman (1937) which were covered by forest, the open savannas expanded in about 35 years at the cost of the forest formations (Hoogerwerf 1972). Additional causes in change of tree cover might be the establishment and expansion of the teak-forests at the south and west borders of BNP, and the introduction of *Acacia nilotica* as fire breaks, causing large areas of grassland to be transformed in scrubland.

Comparing the vegetation map of 1977 (Figure 4) with the tree cover map (Figure 5), it seemed that the forest areas (open woodland and woodland/forest; >40%) increased strongly in the period 1977-1990. This increase will be partly due to a difference in interpretation by the different people, but this could not be checked because it was not known what methods were used to compile these maps. It might also be possible that this relatively large area has expanded during this period, but this is not acknowledged as such here. It is far more likely that the decrease in forest cover of 1946-1977 as presented by UNDP/FAO (1977) was too drastic. In fact, since the maps of 1946 and 1991 only differ slightly it is considered well possible that the area developed from the situation in 1946 to that in 1981 without the strong decrease of forest cover as presented by UNDP/FAO (1977).

The (relatively small) differences in tree cover between 1981 and 1990 might indicate an extension of the tree cover, but were more probably caused by the different forms of interpretation. Close monitoring of the vegetation of the park in the future might shed more light on its change.

Although this map is difficult to compare with other similar maps by UNDP/FAO (1977), it is a very simple map, with a clear definition of the different units on the map. As such it is useful for further monitoring of BNP. The map was based on the only original set of aerial photographs available. This set has been intensively used and is already over 10 years old. Although the interpretation of aerial photographs is a more subjective process than the use of a SPOT-image, it is considered very useful during the preparation and execution of research/surveys and practical periods. In the field they were almost essential for orientation and considered very valuable, several new sets of photographs at the institutes involved in research on the park are therefore recommended.

5.3 Detailed descriptions of the four main grasslands in Baluran National Park

The grasslands seemed to have changed considerably over the last 7 years. In general the amount of species increased, while the amount of living biomass decreased. Yet, it was not clear if Partomihardjo (1986) only gives the

species of the herb layer, or if he included the tree and shrub layer in his research. In this study it was presumed that he did, but it is possible he only presents data on the grass species, in which case the differences in the number of species between both periods is too small to be significant.

At Bekol grassland 19 different species were found in the dry season of 1992, while 5-11 species (Table A, page 4, begin and end of dry season) were mentioned by Partomihardjo (1987/1988) in the dry season of 1985/1986. *Dichanthium caricosum* was the most important species, but *Abutilon indicum* was also often found. The average height of the herb layer of this grassland was constant (about 10 cm) and the amount of living biomass (15 g/m^2) was much lower than the 25-700 g/m^2 mentioned by Partomihardjo (1988). The species *Abutilon indicum*, *Acacia tomentosa*, *Azadirachta indica*, *Calotropis gigantea*, *Eulalia amaura*, *Flemingia lineata*, *Sida* sp., and *Ziziphus rotundifolia* were not mentioned in the vegetation descriptions of 1982-1987. The information indicates an increase in the total amount of species over the last 7 years on Bekol.

In Kramat grassland 5-10 species (begin and end of dry season) were present in 1985/1986, while 11 different species occured in 1992. *Dichanthium caricosum* was the main species of this area, but *Eulalia amaure* and *Acacia nilotica* were also important. The intervals of 5-140 cm height and 25-75 g/m^2 living biomass cover the amounts of 15 cm and 30 g/m^2 mentioned for 1985-1986. Most species were not mentioned in the descriptions of 1982-1987.

The most conspicuous grass species of Dadap grassland for the period 1985-1986 (*Imperata cylindrica*) was not very important in 1992; the important species in 1992 (*Acacia tomentosa*, *Eulalia amaura*, *Sida* sp., and *Sorghum nitidus*) were not mentioned by Partomihardjo (1987 and 1988). Again the number of species was higher than in 1985-1986 (10 versus 3-6). The given amount of living biomass by Partomihardjo lies within the interval given in paragraph 4.3 and the heights of both periods were too close to be able make further statements, but it seemed that the amount of living biomass currently was larger. This may partly be due to an increase in *Acacia nilotica*, around which most not cut/grazed grasses and herbs were found.

At Semiang grassland, *Abutilon crispum* was not mentioned by Partomihardjo (1988). The average height was lower than 1986-1985, but the amount of living biomass lies within the interval of 25-175 g/m^2.

The changes in vegetation of the different grasslands (over the year and/or per savanna) are not easy to explain. Whyte (1968) mentions that on the species covering a savanna 'a pattern can be observed in relation to three factors, altitude, distribution of rainfall and soil.' One of these factors (distribution of rainfall) may have changed in BNP during the period 1986-1992. 'East-Java..., is an area characterized by a climatic mosaic of ever-wet and seasonal... the ever-wet spots are simply caused by local topography, the southern sides of the volcanoes having an ever-wet climate due to the rain given of by the monsoon winds ascending the slopes... The influence of exceptionally dry years, which occur usually once in 5 and certainly once in 10-20 years, may be considerable because in such years the... area is subject to extensive burning.' (Whyte 1968). Yet on the changes in rainfall distribution of the park any information was available.

Several additional factors might have influenced Bekol grassland. In addition to the soil characteristics and the dry season (some species die at the end of the rainy season) as part of the rainfall distribution mentioned above, Partomihardjo (1987/1988) found on more factor, the grazing intensity (sometimes species are eaten before amphimixis takes place), that influenced the grasslands. Watling (1991) mentions that the change in species composition at Bekol grassland may be caused by change of fire regime; Arief (1991) studied the effect of fire on the vegetation of the Bekol grassland and found that burning once in the dry season of 1991 increased the production of biomass and variation of species. Also, the recent distribution of *Acacia nilotica* might be caused by the disappearance of fire from Bekol (Schuurmans 1993). Other possible causes might be recent establishment linked to import of gravel for the road, frequent vehicular traffic and presence of *Acacia nilotica* (Watling 1991), but to what extend all above-mentioned factors influence the different grasslands was unknown.

The survey of the grasslands was restricted to the dry period of 1992, through which many species could not be identified, and only four grasslands were surveyed. Both factors strongly reduced the quality of the survey and its actual value is very very limited.

5.4 Suggestions for Further Research

Based on the results, several recommendations for further research can be made. Several survey points on the vegetation and flora of BNP can be mentioned. First of all, the additional species mentioned in Appendix IV have to be checked whether these species are synonyms of other species mentioned from BNP. In addition, a more reliable estimate of the total amount of species in the park can be prepared. Also important is the publication of data on the

vegetation and flora of BNP still unpublished by Partomihardjo and additional surveys on the VST's not elaborated yet (coral beeches, crater bottom forest, inside crater wall, saltflats, and stony river beds). Another interesting point for further research are the questions 'what's an exotic/endemic species' and 'how exotic are the exotic species of BNP?'. In fact, some are considered important for a sound management plan.

Further surveys is necessary for an overall landscape ecological map; The missing part of BNP and the proportion covered by clouds and shadows will have to be inventorized. In addition to these points, additional surveys in the western part of BNP will have to executed to see how accurate the map is and refinements will have to be made by somenone more familiar with ERDAS Version 7.4.

A detailed study of the changes in surface area of grasslands versus forest land, such as started by UNDP/FAO (1977), should be initiated to get a better idea of these changes.

Year around additional surveys on the main grasslands of BNP will be necessary to get a better understanding of the changes of these grasslands. Furthermore, because not detailed information is available on the rainfall distribution and soils seems to be quite important

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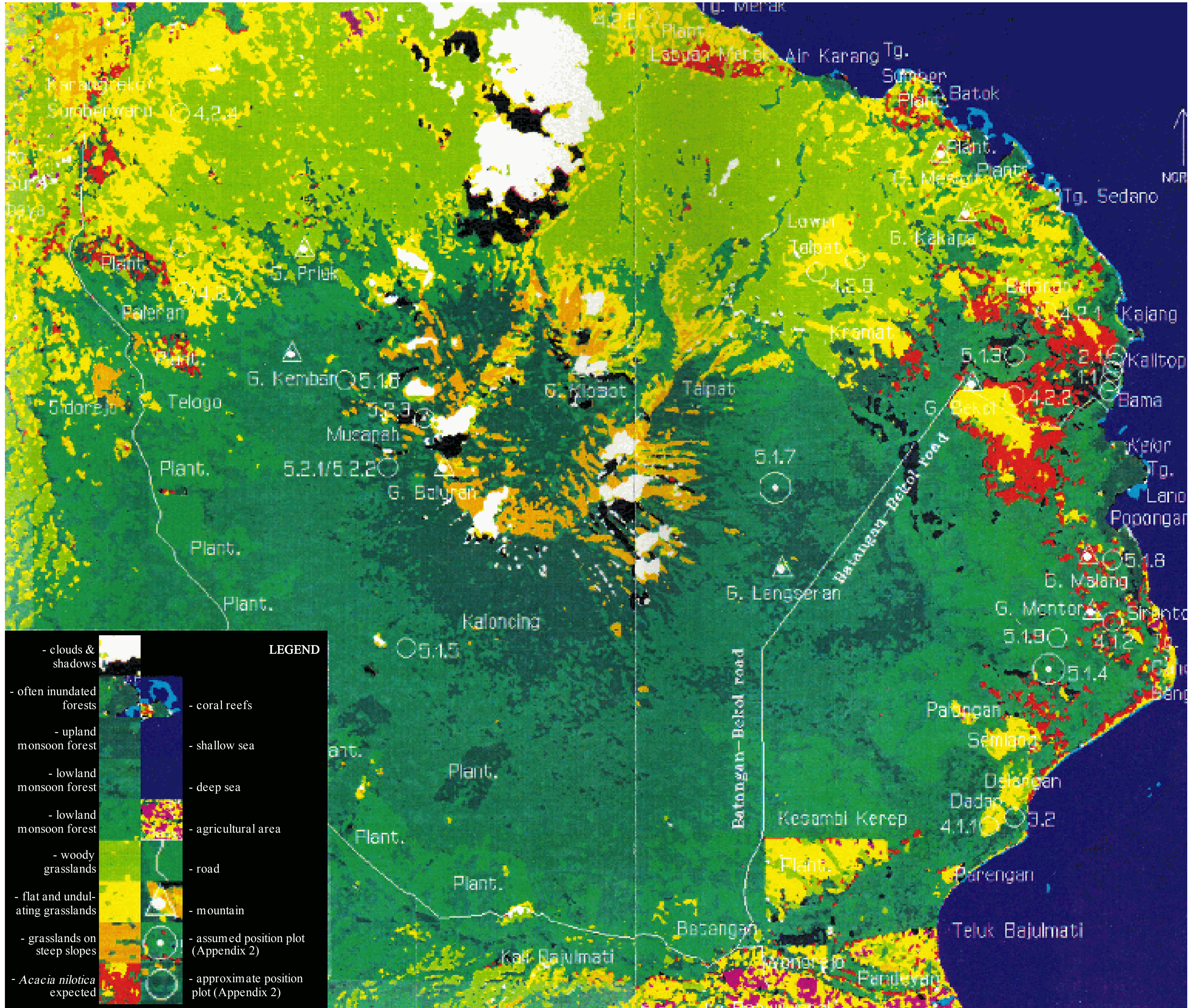
Appendix I Vegetation structure type map of Baluran National Park (1990)



Appendix II Vegetation plots surveyed around 1985

Based on a literature study, the following set of vegetation descriptons has been compiled. Because of the variation of descriptions per author a standard form to present these plots was designed. Additional remarks with this appendix are:

- The position of each described plot is marked on the preliminary formation map of Balauran National Park.
- For each plot, the plot size is given in ha, the Density (D) in individuals/ha, and height and diameter in m (a.s.l.).
- IV is the Importance Value of Curtis, defined as the sum of relative density, relative frequency, and relative dominance of a species (Mueller-Dombois 1974, Tefnai 1990).
- Unless differently mentioned, the 0.2 ha plots are 40 x 50 m areas, divided in 10 x 10 m plots for the tree stratum, one 5 x 5 m sub-plot for the poles/shrub stratum in the middle of each plot, and one 1 x 1 m sub- plot for the grass stratum in a corner of each plot.
- The original author of certain plot is mentioned in brackets behind the plot name.
- Because the formation types as presented by UNDP/FAO 1977 are used, as well because of the unclear naming of several areas, some plot names have to be adapted. Whenever necessary, the original names are added between brackets.
- Some vegetation descriptions of other periods are also included for reasons of completeness.
- For the used abbreviations in the figures, see the abbreviations below:

Ac. = Abutilon crispum
Ah, = Ardisia humilis
Al. = Acacia leucophloea
An. = Anthocephalus sp.
At. = Acacia tomentosa
At. = Atalantia trimera
Ba. = Buchanania arborescens
Bf. = Borassus flabellifer
Bm. = Bridelia monoica
Cj. = Calamus javensis
Co. = Cordia obliqua
Cs. = Canthospermum scarabaevides
Cu. = Corypha utan
Cw. = Celtis wightii
D. = Debregesia sp.
Dc. = Dichanthium caricosum
DI. = Dolichandrone spathacea
E. = Eugenia sp.
Ea. = ?
Eo. = Emblica officinalis
Ff. = ficus fistulosa
G. = Glochidion sp.
Ge. = Grewia eriocarpa
GI. = Glochidion sp.
Gr. = Glochidion rubrum
Hi. = Helicteres isora
Ht. = Homalium tomentosum
Ia. = Indigofera arecta
Kh. = Kleinhovia hospita
Lc. = Lantana camara
Ma. = Melia azedarach
Mp. = Mallotus philippinensis
Ms. = Meschocarpus sundaicus
Mt. = Morinda tinctoria
P. = Polyalthia sp.
Pa. = Palaquium amboinense
Pc. = Palaquium cuspidatum
PI. = Polyalthea lateriflora
Ra. = Rhizophora apiculata
Rs. = Randia spinosa
Rs. = Rhizophora stylosa
Sa. = Streblus asper
So. = Schleichera oleosa
So. = Schoutenia ovata
Sr. = Sapindus rarak
Ti. = Tamarindus indica
Ts. = Toona sureni
Vt. = Vitex pubescens
Zr. = Zizyphus rotundifolia

1 Beach

1.1 Bama (Tefnai 1990)

General
Position: See appendix I
Plot size: -
Height: -
Terrain: -

Tree stratum
Total number of species: 29
Density: 205
Main species: *Corypha utan* (-, IV = 55.19), *Syzygium polyanthum* (-, IV = 34.17), *Ficus superba* (-, IV = 23.52), *Buchanania arborescens* (IV = 16.74), *Schleichera oleosa* (-, IV = 15.82), *Protium javanicum* (-, IV = 13.65), *Bruguiera cylindrica* (-, IV = 11.95), and *Tamarindus indica* (-, IV = 11.10)
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: 27
Density: 120
Main species: *Corypha utan* (-; IV = 87.03), *Desmodium* sp. (-; IV = 26.45), *Streblus asper* (-; IV = 22.37), *Polygonum* sp. (-; IV = 18.60), *Bruguiera cylindrica* (-; IV = 14.65), *Ardisia humilis* (-; IV = 11.76), *Syzygium polyanthum* (-; IV = 11.47), and *Buchanania arborescens* (-; IV = 11.15)

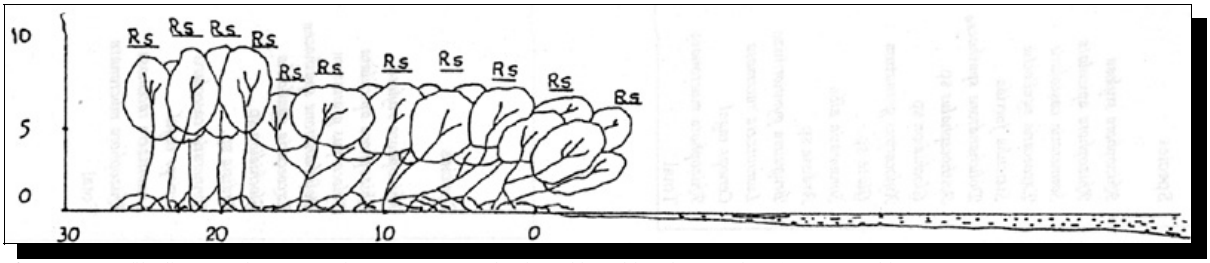


Figure II.1 Profile diagram of mangrove forest near Bama, dominated by *Rhizophora stylosa* (source Lembinas 1986)

Table II.a Basal Area (BA in m^2/ha), Density (D in individuals/ha), and Importance Value (IV) of the mangrove tree component near Bama-Kalitopo (A-E) and Bilik (Lembinas 1986)

Species	Transect A			B			C			D			E			F			
	BA	D	IV	BA	D	IV	BA	D	IV	BA	D	IV	BA	D	IV	BA	D	IV
Rhizophora stylosa	7.15	550	183.54	1.17	55	21.94	-	-	-	0.67	38	19.17	3.83	193	157.32	3.10	224	228.00
Rhizophora apiculata	2.66	200	82.44	7.90	346	133.37	7.56	381	141.28	9.95	326	200.26	-	-	-	0.44	30	30.05
Sonneratia caseolaris	1.60	25	34.02	-	-	-	5.96	56	50.71	1.51	5	11.97	-	-	-	-	-	-
Excoecaria agallocha	-	-	-	3.35	108	42.81	-	-	-	-	-	-	-	-	-	-	-	-
Sterculia foetida	-	-	-	5.79	8	29.01	-	-	-	-	-	-	-	-	-	-	-	-
Dolichandrone spathacea	-	-	-	0.75	33	22.14	-	-	-	-	-	-	-	-	-	-	-	-
Anthocephalus sp.	-	-	-	1.74	29	20.35	2.88	13	24.35	-	-	-	-	-	-	-	-	-
Glochidion sp.	-	-	-	1.78	21	16.45	0.46	31	24.03	-	-	-	-	-	-	-	-	-
Xylocarpus granatum	-	-	-	0.57	13	9.92	-	-	-	0.15	13	11.98	2.63	87	91.32	-	-	-
Gluta sp.	-	-	-	0.15	4	4.02	-	-	-	-	-	-	-	-	-	-	-	-
Sonneratia alba	-	-	-	-	-	-	3.30	106	46.06	-	-	-	-	-	-	0.41	9	17.39
Ardisia sp.	-	-	-	-	-	-	0.44	19	13.57	-	-	-	-	-	-	-	-	-
Bruguiera gymnorrhiza	-	-	-	-	-	-	-	-	-	4.92	33	56.62	-	-	-	-	-	-
Lumnitzera racemosa	-	-	-	-	-	-	-	-	-	-	-	-	0.81	46	42.69	-	-	-
Ceriops tagal	-	-	-	-	-	-	-	-	-	-	-	-	0.06	7	8.67	-	-	-
Rhizophora mucronata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.30	25	24.46
Total	11.41	775		23.60	617		20.60	606		17.20	415		7.33	333		4.25	288	

Table II.b Basal Area (BA in m^2/ha), Density (D in individuals/ha), and Importance Value (IV) of the mangrove pole/shrub component near Bama-Kalitopo (A-E) and Bilik (Lembinas 1986)

Species	Transect A			B			C			D			E			F		
	BA	D	IV	BA	D	IV	BA	D	IV	BA	D	IV	BA	D	IV	BA	D	IV
Rhizophora stylosa	2.95	800	159.17	0.70	183	59.55	-	-	-	0.99	297	78.66	1.28	320	76.39	5.16	2570	270.82
Rhizophora apiculata	2.73	600	140.83	1.65	834	179.84	2.27	625	169.62	1.47	462	159.53	0.06	107	11.03	0.13	72	11.24
Xylocarpus granatum	-	-	-	0.13	100	25.43	-	-	-	-	-	-	0.18	27	10.12	-	-	-
Dolichandrone spathacea	-	-	-	0.13	50	21.85	-	-	-	-	-	-	-	-	-	-	-	-
Excoecaria agallocha	-	-	-	0.12	33	13.33	-	-	-	-	-	-	-	-	-	-	-	-
Glochidion sp.	-	-	-	-	-	-	0.73	175	57.96	-	-	-	-	-	-	-	-	-
Ardisia sp.	-	-	-	-	-	-	0.67	250	55.38	-	-	-	-	-	-	-	-	-
Sonneratia caseolaris	-	-	-	-	-	-	0.18	50	17.04	-	-	-	-	-	-	-	-	-
Ceriops tagal	-	-	-	-	-	-	-	-	-	0.40	185	61.82	1.64	1093	123.14	-	-	-
Lumnitzera racemosa	-	-	-	-	-	-	-	-	-	-	-	-	1.53	720	79.34	-	-	-
Rhizophora mucronata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.28	97	17.94
Total	5.68	1400		2.73	1200		3.85	1100		2.86	944		4.69	2267		5.57	2739	

Herb stratum
Total number of species: -
Main species: -
Height: -

Remarks: See also Figure II.1

2 Mangrove

2.1 Bama-Kalitopo and Bilik (Budiman et al. 1984)

General
Position: See appendix I
Plot size: -
Height: 0
Terrain: flat

Tree stratum
Total number of species: 6
Density: 56
Main species: see Table II.a
Diameter: 0.02-0.20; 0.20-0.50 is reached by species like *Rhizophora apiculata*, *Rhizophora stylosa*, and *Lumnitzera racemosa*, and only seldom 0.50 diameter is reached; at the land side of the mangrove forest some *Sonneratius caseolaris* and *Bruguiera gymnorrhiza* have a diameter more than 0.50
Height and stratification: 10-25; some *Anthocephalus* sp., *Glochidion* sp. and *Rhizophora apiculata* reach 30.

Pole/shrub stratum
Total number of species: 4
Density: 1608
Main species: see Table II.b

Herb stratum
Total number of species: -
Main species: -
Height: -

Remarks: See also Figure II.1-Figure II.4. At the sea side of the mangrove forests an association of *Rhizophora apiculata* and *Rhizophora stylosa* is present, in which *Sonneratia alba* sporadically occurs. This is followed by a *Rhizophora* spp. poor mixture of species that differs due to local characteristics. Seedlings of *Rhizophora* spp. are rare, of other species seedlings are found at the land side of the mangroves near mother trees.

3 Swamp forest

3.1 Alas Malang beach - Gatal (Partomihardjo et al. 1985, Lembinas 1986, Riswan 1986)

General
Position: At the northeast boundary of Baluran National Park near the sea
Plot size: 0.2
Height: 5
Terrain: flat

Tree stratum
Total number of species: 6
Density: 520
Main species: *Ardisia humilis* (D = 275, IV = 144.48), *Glochidion rubrum* (D = 65, IV = 57.83), and *Cordia bantamensis* (D = 65, IV = 57.83), other species are *Buchanania arborescens*, *Calamus javensis* (in colonies), *Dillenia pentagina*, and *Protium javanicum*; very uniform (43% of the trees have a freq. >= 40%)

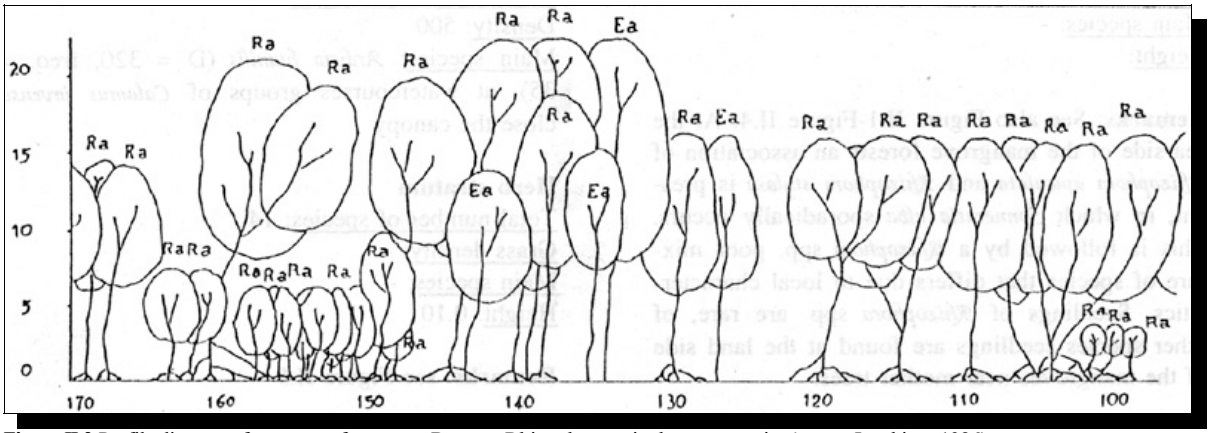


Figure II.2 Profile diagram of mangrove forest near Bama, a *Rhizophora apiculata* community (source Lembinas 1986)

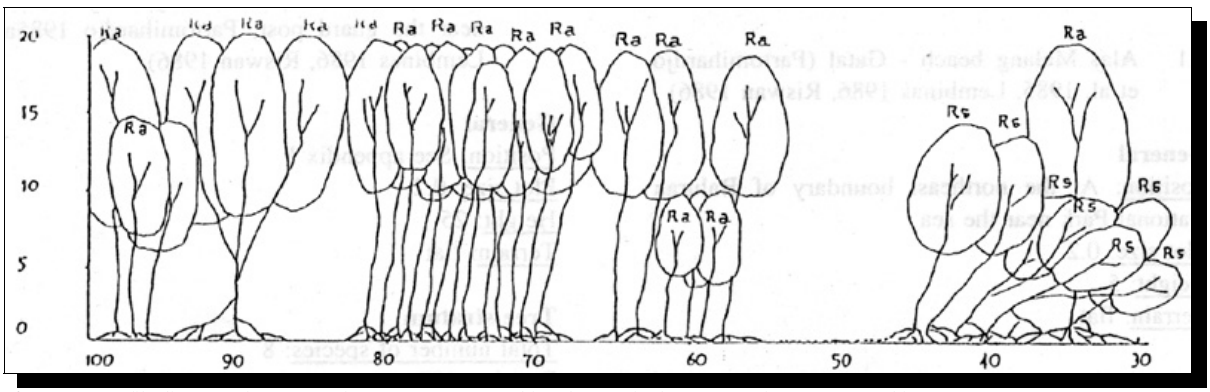


Figure II.3 Profile diagram of mangrove forest near Bama, a *Rhizophora apiculata* community (source Lembinas 1986)

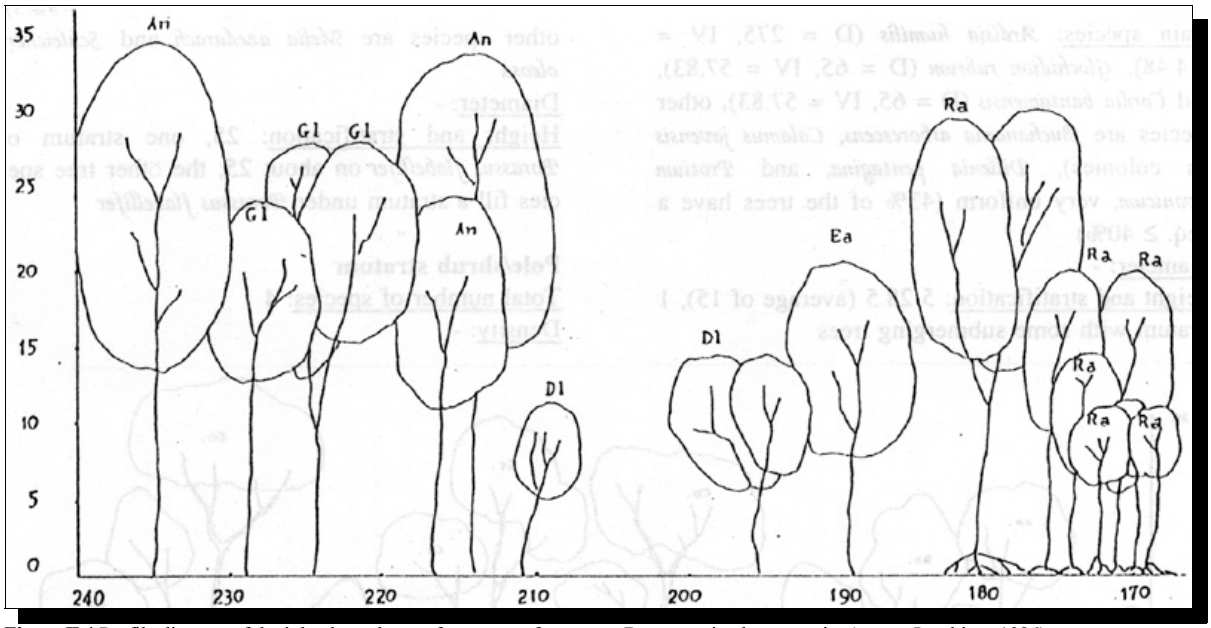


Figure II.4 Profile diagram of the inland-ward part of mangrove forest near Bama, a mixed community (source Lembinas 1986)

Diameter: -
Height and stratification: 5-28.5 (average of 15), 1 stratum with some submerging trees

Pole/shrub stratum
Total number of species: 9
Density: 500
Main species: *Ardisia humilis* (D = 320, freq. = 35), at watercourses groups of *Calamus javensis* close the canopy

Herb stratum
Total number of species: 14
Grass density: -
Main species: -
Height: 0.10

Remarks: see Figure II.5

3.2 Candi Bang-Dadap (*Borassus flabellifer* forest near the guard post; Partomihardjo 1985a, Lembinas 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 0.2
Height: 25
Terrain: flat

Tree stratum
Total number of species: 8
Density: 180
Main species: *Borassus flabellifer* (D = 65, IV = 158.7) and *Azadirachta indica* (D = 85, IV = 92.3), other species are *Melia azedarach* and *Schleichera oleosa*
Diameter: -
Height and stratification: 25, one stratum of *Borassus flabellifer* on about 25; the other tree species fill a stratum under *Borassus flabellifer*

Figure II.5 Profile diagram of swamp forest at Alas Malang beach-Gatal (source Lembinas 1986)

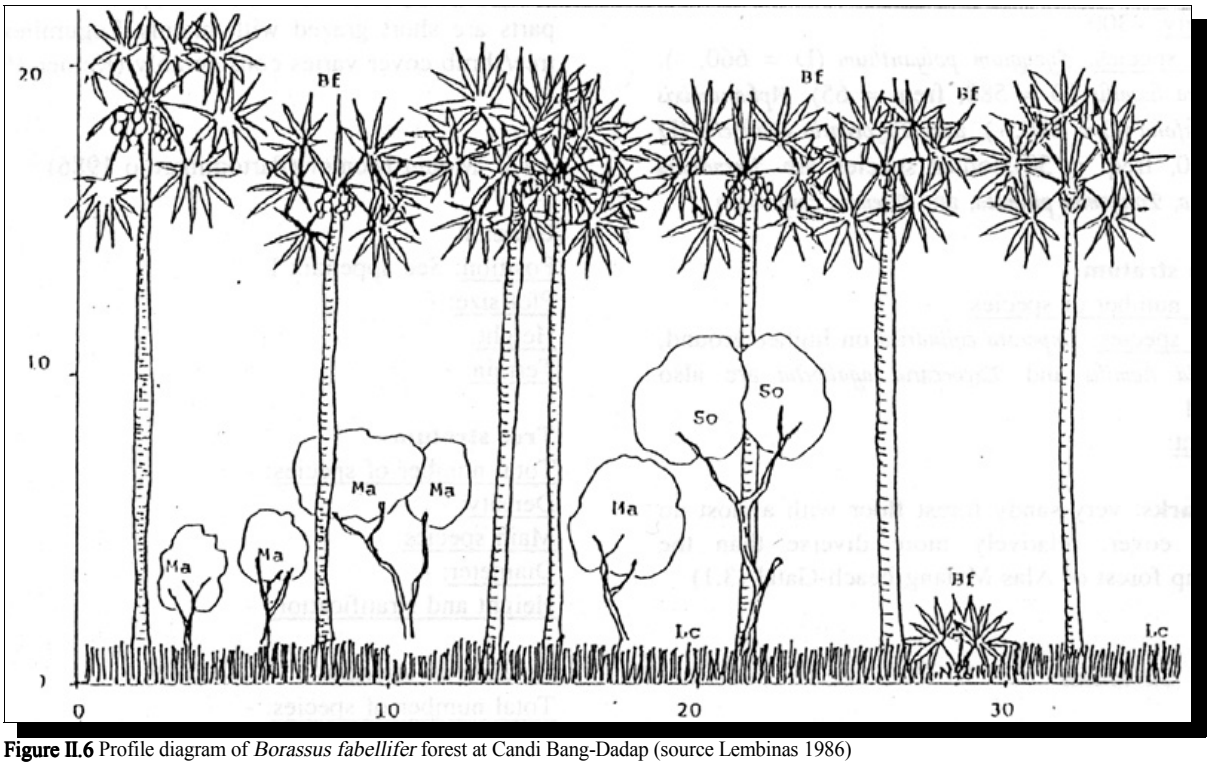


Figure II.6 Profile diagram of *Borassus fabellifer* forest at Candi Bang-Dadap (source Lembinas 1986)

Pole/shrub stratum
Total number of species: 4
Density: -
Main species: *Lantana camara* (-; IV = 86.14) and *Azadirachta indica* (-; IV = 150.27)

Table II.c Average Density (AD), Average Basal Area (ABA) and Average Importance Value (AIV) of some tree species in Dadap and surroundings (edited from Partomihardjo et al. 1985).

Species	AD (ind./ ha)	ABA	AIV (m^2/ ha)
Acacia tomentosa	21.7	0.52	79.35
Grewia eriocarpa	80.0	53.86	61.66
Acacia leucophloea	16.7	21.69	24.09
Cordia obliqua	3.3	0.04	11.97
Capparis sepiaria	1.7	0.02	10.06
Schoutenia ovata	6.7	0.33	7.27
Schleichera oleosa	1.7	0.10	6.83
Sterculia foetida	1.7	0.10	2.25
Ficus spp.	1.7	0.77	2.91
Averhoa bilimbi	1.7	0.02	1.63
Streblus asper	1.7	0.02	1.63
Total	220.9	142.15	300.00

Herb stratum
Total number of species: 25
Main species: *Apluda mutica*, *Cyperus rotundus*, *Dichantium caricosum*, and *Imperata cylindrica*
Height: 0.20

Remarks: see also Figure II.6 and Table II.c; on places where the animals don't forage the grasses might reach up to 0.50; the regeneration of *Borassus flabellifer* is very low (almost no seedlings or poles were found), this might be caused by activities of mankind; the harvest of the fruits by fishermen and other visitors, as well as the natural predation by wild pig, bring on a decrease in regeneration. *Lantana camara* is a species that seems to spread in the shadow of *Borassus flabellifer*.

3.3 Kelir-Pauli area (Partomihardjo et al. 1985, Lembinas 1986, Riswan 1986)

General
Position: Unclear, probably in the northeastern part on Baluran National Park near the sea
Plot size: 0.2
Height: 15
Terrain: -

Tree stratum
Total number of species: 14
Density: 300
Main species: *Mischocarpus sundaicus* (D = 130, IV = 99.99), *Syzygium polyanthum* (D = 35, IV = 40.81), other species are *Ardisia humilis* and *Excoecaria agallocha* (64% have a freq. <= 10%)
Diameter: 75% have a DBH of <= 0.20, several species (like *Ficus* sp., *Mischocarpus sundaicus*, *Schleichera oleosa*, *Syzygium polyanthum*) reach > 0.60
Height and stratification: 5-35.5 (average of 15), 2 strata (9-16 and 16-25); the 1st stratum consists of *Ardisia humilis*, *Buchanania arborescens*, *Mischocarpus sundaicus*, and *Protium javanicum*, the 2nd stratum of *Ficus superba*, *Mischocarpus sundaicus*, and *Syzygium polyanthum*

Pole/shrub stratum
Total number of species: 22
Density: 4300
Main species: *Syzygium polyanthum* (D = 660, -), *Ardisia humilis* (D = 580, freq. = 65), *Aphanamixis grandifolia* (D = 540, -), and *Excoecaria agallocha* (D = 520, freq. = 50), other species are *Hernandia peltata*, *Pongamia pinnata*, and *Premna corymbosa*

Herb stratum
Total number of species: -
Main species: *Imperata cylindrica* on higher ground, *Ardisia humilis* and *Excoecaria agallocha* are also found
Height: -

Remarks: very sandy forest floor with almost no grass cover, relatively more diverse than the swamp forest of Alas Malang beach-Gatal (3.1)

4 Savannas

4.1 Flat savannas

4.1.1 Dadap (Lembinas 1986, Partomihardjo & Mirmanto 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 0.2
Height: 10
Terrain: -

Tree stratum
Total number of species: -
Density: -
Main species: -
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: 1
Density: 8 ind./?
Main species: *Acacia tomentosa* (-)

Herb stratum
Total number of species: 6
Main species: *Imperata cylindrica* (rel. freq. = 33.33), *Eulalia amaura*, *Paspalum* spp., and *Sorghum nitidus*, other species are *Abutilon* spp., *Achyranthes* spp., *Alysicarpus vaginalis*, *Fimbristylis dichotoma*, *Ipomoea* spp., *Sida* spp., and *Zoysia matrella*
Height: 0.15-1

Remarks: See also Table II.c; grazed by wild
The floristic composition shows great variability at short distances; sites with *Imperata cylindrica*; there are parts with high herbs (*Vernonia* spp., *Thespesia* spp., *Eleutheranthera* spp., etc.); other parts are short grazed with mainly Leguminosae; tree/shrub cover varies considerably (Ketner 1991)

4.1.2 Mount Montor (Partomihardjo 1986)

General
Position: See appendix I
Plot size: -
Height: -
Terrain: -

Tree stratum
Total number of species: -
Density: -
Main species: -
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: -
Density: -
Main species: -

Herb stratum
Total number of species: -
Main species: *Apluda mutica*, *Desmodium* spp., *Eragrostis* spp., and *Eulalia amaura*, under cover of trees and shrubs species like *Abutilon* spp., *Acacia tomentosa*, *Elatostema* spp., *Ipomoea* spp., and *Lantana camara* occur
Height: about 0.02 with external closure of ± 4%

Remarks: -

4.1.3 Semiang (Partomihardjo et al. 1986, Lembinas 1986, Riswan 1986)

General
Position: On savanna Semiang (see appendix I)
Plot size: 0.2
Height: 10
Terrain: -

Tree stratum
Total number of species: 5
Density: 75
Main species: -
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: 5
Density: 1180
Main species: *Abutilon crispum* (D = 360, freq. = 50) and *Acacia tomentosa* (D = 640, freq. = 50)

Herb stratum
Total number of species: 26
Main species: *Brachiaria mutica*, *Brachiaria reptans*, *Bothriochloa modesta*, *Dactylotenium aegyptium*, *Echinochloa colonum*, *Eulalia amaura*, *Paspalum* spp., *Eulalia amaura*, and *Sorghum nitidus*, other species are *Abutilon* spp., *Achyranthes* spp. *Ipomoea* spp., and *Sida* spp.
Height: 0.02-0.05

Remarks: very diverse composition, intense grazing because of year round water supply.
The soil is cracked in the dry season, and the area is flooded regulary by rain water as the result of poor drainage and maybe also by brackish water during extreme high tydes. This savanna might be considered 'edaphic'? Extended area with low grass cover composed of few species, scattered groups of *Coripha utan* grazed and trampled by buffalo and deer (Ketner 1991).

4.2 Flat to undulating savannas

4.2.1 Balanan savanna (Balanan-Bekol; Partomihardjo & Mirmanto 1986)

General
Position: See appendix I
Plot size: -
Height: 50
Terrain: -

Tree stratum
Total number of species: -
Density: -
Main species: -
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: -
Density: -
Main species: -

Herb stratum
Total number of species: 11
Main species: *Arundinella setosa*, *Desmodium heterophyllum*, and *Imperata cylindrica*
Height: 0.04-0.06

Remarks: Not grazed; there is some difference between areas that are burned (6 species) and areas that are not burned (11 species); on the burned areas *Imperata cylindrica* and *Desmodium heterophylla* are always found. The height of burned areas is less (± 0.035 versus ± 0.06) but the closure has the tendency to be higher (30% versus 25%; see also Karangteko and Alas Malang savannas).

4.2.2 Bekol (Bekol-Bama; Partomihardjo et al. 1985, Lembinas 1986, Partomihardjo & Mirmanto 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 0.2
Height: 30
Terrain: -

Tree stratum
Total number of species: -
Density: -
Main species: -
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: 1
Density: 220
Main species: *Acacia nilotica* (-)

Herb stratum
Total number of species: -
Density: -
Main species: *Dichantium caricosum* (rel. freq. = 15.62), *Digitaria adscendens*, *Fimbristylis dichotoma*, and *Eulalia amaura*, other species are *Brachiaria reptans*, *Echinochloa colonum*, *Ischaemum timorense*, *Paspalum* spp., *Phaseolus* spp., *Phyllanthus maderaspatensis*, and *Sclerachne punctata*
Height: 0.02-0.05 (external closure of ± 5%)

Remarks: see also Table II.e-II.g, (5.1.2/5.1.3); because of the intensive grazing of this area is the wet and dry season, the grass stays very short, therefore this savanna will not catch fire verry quickly. Here and there *Mimosa invisa* is locally found.
Most of the young species are found far away from an adult plant.
Herb/grass savanna (*Dichantium caricosum*, *Vernonia cinerea* and *Thespesia lampas*) with *Acacia nilotica*. *A. nilotica* is cut regularly and the cut branches are burned. Last cut in 1991. If not cut Bekol will develop into a dense *A. nilotica* stand. Scattered trees of *Ziziphus* spp., *Schleichera* spp. and *Acacia leucophloea*. Heavily used by buffalo, banteng and rusa. Spread of *Acacia* spp. is probably stimulated by cutting and burning, and by wildlife through spreading of seeds via faeces (Ketner 1991).

4.2.3 Gatal-Kandang (Partomihardjo et al. 1985, Lembinas 1986, Partomihardjo & Mirmanto 1986, Riswan 1986)

General
Position: Unknown, probably at the northeastern part of Baluran National Park near the sea
Plot size: 0.2
Height: 30
Terrain: flat

Tree stratum
Total number of species: 3
Density: 20
Main species: *Morinda tomentosa* (-), *Tamarindus*

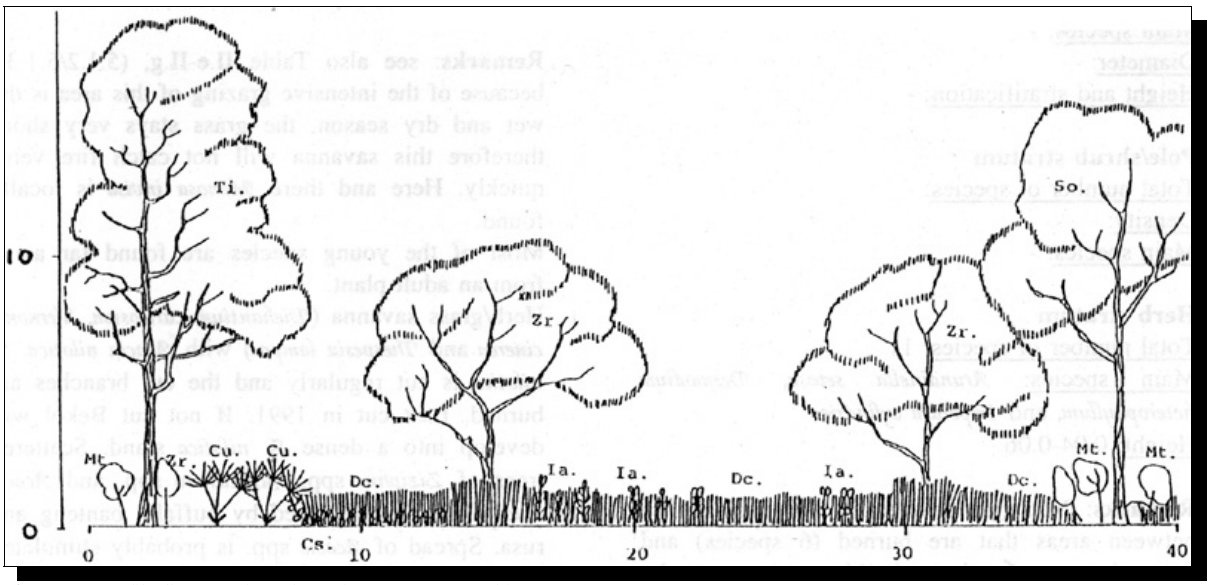


Figure II.7 Profile diagram of Gatal-Kandang savanna (Lembinas 1986)

indica (-), and *Ziziphus rotundifolia* (-), *Schleichera oleosa* is also found
Diameter: a *Tamarindus indica* reaches a DBH of 0.50
Height and stratification: -

Pole/shrub stratum
Total number of species: 4
Density: 120
Main species: *Acacia leucophloea* (-), *Morinda tomentosa* (-), *Schleichera oleosa* (-), and *Ziziphus rotundifolia* (-), another species is *Corypha utan*

Herb stratum
Total number of species: 7
Main species: *Arundinella setosa* (sometimes), *Brachiaria reptans*, *Dichantium caricosum*, and *Thelepogon elegans*, also found *Canthospermum scarabaeoides*, *Euphorbia prunifolia*, *Indigofera arrecta* and *Indigofera glandulosa*
Height: 0.50

Remarks: see Figure II.7, less grazed by animals, low fire hazard because of low development

4.2.4 Gentong-Karangteko (Partomihardjo et al. 1985, Lembinas 1986, Partomihardjo & Mirmanto 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 0.2
Height: 30
Terrain: -

Tree stratum
Total number of species: 2
Density: 25
Main species: -
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: -
Density: -
Main species: -

Herb stratum
Total number of species: 19
Main species: *Dichantium caricosum* (rel. freq. = 15.49), other species are *Diplachne fusca*, *Panicum repens*, *Eulalia amaura*, and *Sclerachne punctata*
Height: 0.05

Remarks: see also Table II.d; strongly grazed by animals, unofficial grazing ground of the local husbandry, according to Budiman et al. (1984). Karangteko mainly consists of *Themeda arguens*.
Almost all of the savanna (up till Labuan Merak) was burned in the dry season of 1985. There is clear difference between the burned areas and the areas not burned. The areas not burned have more species (18 versus 11 species), less coverage (15% versus 20%), and less (grass) biomass weight (± 100 gram/m^2 versus ± 125 gram/m^2).
Medium tall grass savanna with *Heteropogon contortus*, *Eulalia amaura*, *Themeda triandra* as main species, with scatered trees of *Ziziphus rotundifolia*, and *Schleichera oleosa*. From west to east there is a gradient of grazing by cattle. Grass cutting by local people takes place (scale of which not known). Official cattle is not allowed to graze here and areas are burned illegally; nothing is known about fire frequency/timing or intensity.

Table II.d Average Density (AD), Average Basal Area (ABA) and Average Importance Value (AIV) of some tree species in Karangteko and surroundings (edited from Partomihardjo et al. 1985)

Species	AD (ind./ ha)	ABA (m^2/ ha)	AIV
Aegle marmelos	2.50	0.09	32.06
Ardisia humilis	68.75	69.35	31.72
Tamarindus indica	1.25	0.31	28.53
Morinda spp.	2.50	0.09	28.31
Acacia leucophloea	2.50	0.39	26.56
Eugenia jamboloides	28.75	55.26	25.29
Ziziphus rotundifolia	1.25	0.03	18.16
Albizia procera	1.25	0.03	16.39
Cordia obliqua	16.25	16.29	14.46
Streblus asper	15.00	2.68	11.28
Protium javanicum	2.50	1.21	3.35
Dillenia pentagyna	3.75	0.30	2.88
Ficus spp.	1.25	0.68	2.00
Grewia eriocarpa	2.50	0.17	1.81
Schoutenia ovata	1.25	0.03	1.66
Buchanania arborescens	1.25	0.06	1.27
Pongamia pinnata	1.25	0.06	1.26
Emblica officinalis	1.25	0.03	1.11
BOGEM	16.25	16.37	20.74
KOPI[2]-AN	10.00	2.77	7.78
MANGGIS[2]-AN	5.00	1.07	4.43
RENG	1.25	0.89	2.17
TEKE'AN	2.50	0.08	2.15
AMPERI	1.25	0.61	1.96
JERUB?	1.25	0.49	1.84
SALSIHAN	2.50	0.08	1.63
BELENG	1.25	0.21	1.51
JENGLOT	1.25	0.13	1.38
KESAMBI[2]-AN	1.25	0.02	1.09
LAMBIBING	1.25	-.-	1.03
Total	205.00	171.433	300.00

tree species found on the savanna

4.2.5 Kramat (Partomihardjo et al. 1985, Partomihardjo & Mirmanto 1986)

General
Position: At Kramat (see appendix I)

Plot size: 0.2
Height: 35
Terrain: -

Tree stratum
Total number of species: -
Density: -
Main species: *Acacia leucophloea* (-), *Acacia tomentosa* (-), *Morinda tomentosa* (-), and *Schleichera oleosa* (-)
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: -
Density: -
Main species: -

Herb stratum
Total number of species: 12 species/0.002 ha
Density: -
Main species: *Dichantium caricosum* (rel. freq. = 29.10) and *Sclerachne punctata*
Height: 0.06-0.07

Remarks: strongly grazed

4.2.6 Labuan Merak

General
Position: See appendix I
Plot size: 0.2
Height: 20
Terrain: -

Tree stratum
Total number of species: -
Density: -
Main species: *Azadirachta indica* (-), *Schleichera oleosa* (-), and *Ziziphus rotundifolia* (-)
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: -
Density: -
Main species: -

Herb stratum
Total number of species: 12
Main species: *Bothriochloa modesta*, and *Dichantium caricosum*, other species *Aeschynomene indica*, *Alysicarpus vaginalis*, *Brachiaria reptans*, *Digitaria adnascens*, *Dioda samentosa*, *Setaria palmifolia*, and *Uraria lagopodioides*
Height: -

Remarks: The *Sesbania grandiflora* stands are of good quality; the fire hazard is high because the savanna is not grazed

4.2.7 Paleran (Partomihardjo et al. 1985, Lembinas 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 0.2
Height: 50
Terrain: -

Tree stratum
Total number of species: 3
Density: 25
Main species: *Acacia leucophloea* (-), *Aegle marmelos* (-), and *Albizia procera* (-)
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: 9
Density: 1200
Main species: *Aegle marmelos* (D = 580, freq. = 55) and *Grewia acuminata* (D = 580, freq. = 55)

Herb stratum
Total number of species: 19
Main species: *Bothriochloa modesta*, and *Dichantium caricosum*, sometimes interrupted by *Setaria palmifolia* and *Sorghum nitidus*
Height: 0.50

Remarks: many traces of grass cutting

4.2.8 Sumberwaru village roadside (1 km from the northern guard post; Riswan et al. 1984)

General
Position: See appendix I
Plot size: -
Height: -
Terrain: -

Tree stratum
Total number of species: -
Density: -
Main species: *Acacia leucophloea* (-), *Schleichera oleosa* (-), *Melia azedarach* (-), *Schoutenia ovata* (-), and *Aegle marmelos* (-), other species are *Acacia spinosa* and two species of *Desmodium* spp., which are not further defined
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: -
Density: -
Main species: *Helicteres* spp. (-), *Hyptis* spp. (-), *Lantana camara* (-), and *Leucas* spp. (-)

Herb stratum
Total number of species: -
Main species: *Heteropogon contortus*, *Themeda arguens*, *Setaria* spp., and *Panicum maximum*
Height: -

Remarks: the vegetation looks like savanna, stony, hilly, open and very dry. The trees are widely dispersed over the area.

4.2.9 (Lower) Talpat (Partomihardjo & Mirmanto 1986)

General
Position: See appendix I
Plot size: -
Height: 260
Terrain: -

Tree stratum
Total number of species: -
Density: -
Main species: -

Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: -
Density: -
Main species: -

Herb stratum
Total number of species: -
Main species: *Heteropogon contortus*
Height: -

Remarks: not grazed

5 Monsoon forest

5.1 Lowland monsoon forests

5.1.1 Batangan-Bekol road (Pratama 1989)

General
Position: See appendix I
Plot size: 4 plots of 3.000 x 200
Height: -
Terrain: -

Tree stratum
Total number of species: 27, 30, 28, 32 (resp. plot 1 to 4)
Density: -
Main species: *Acacia leucophloea*, *A. tomentosa*, *Bridelia monoica*, *Cordia bantamensis*, *Erythrina eudophylla*, *Flacourtia indica*, *Grewia eriocarpa*, *Kleinhovia hospita*, *Mallotus moritzianus*, *Microcos tomentosa*, *Premna foetida*, *Schleichera oleosa*, *Schoutenia ovata*, *Streblus asper*, *Tamarindus indica*, *Vitex pubescens*, and *Ziziphus rotundifolia* (see Table II.e).
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: -
Density: -
Main species: -

Herb stratum
Total number of species: -
Main species: -
Height: -

Remarks: -

Table II.e Importance Value of the main tree species per block (IV >= 10 in at least one block) along the Batangan-Bekol road lowland monsoon forest (edited from Pratama 1989)

	Blok				
Species	1	2	3	4	AIV
Schoutenia ovata	79.67	38.49	72.43	10.21	50.20
Premna foetida	2.34	10.92	13.59	8.34	35.19
Grewia eriocarpa	8.84	37.00	63.10	28.55	34.37
Schleichera oleosa	24.36	30.42	23.81	11.50	22.52
Acacia tomentosa	30.28	21.05	-.-	31.44	20.69
Tamarindus indica	18.71	7.92	6.47	42.81	18.98
Streblus asper	2.06	2.77	4.94	50.97	15.19
Erythrina variegata	49.48	1.96	-.-	6.66	14.53
Microcos tomentosa	2.81	29.71	20.43	3.43	14.10
Cordia obliqua	11.87	22.32	6.08	9.73	12.50
Vitex pubescens	8.54	22.25	16.05	-.-	11.71
Flacourtia indica	11.22	6.34	9.74	2.71	7.50
Kleinhovia hospita	-.-	2.06	3.76	23.09	7.23
Acacia leucophloea	18.05	1.02	-.-	5.57	6.16
Bridellia monoica	3.98	-.-	12.14	5.06	5.30
Mallotus moritianus	2.81	11.33	3.79	1.67	4.90
Ziziphus rotundifolia	-.-	1.45	-.-	12.56	3.53

5.1.2 Bekol I (seasonal forest; Sugardjito & Partomihardjo 1985)

General
Position: Unclear, near Mount Bekol
Plot size: 20 x 40 (parallel to the savanna)
Height: -
Terrain: -

Tree stratum
Total number of species: 5
Density: 278
Main species: *Acacia tomentosa* (D = 65, -), see Table I.a
Diameter: > 50% has a DBH <= 0.20
Height and stratification: -

Pole/shrub stratum
Total number of species: -
Density: -
Main species: *Abutilon crispum* (-), other species *Acacia nilotica*, *Acacia tomentosa*, *Atalantia trimera*, *Lantana camara*, and *Randia* sp. (see Table I.a)

Herb stratum
Total number of species: -
Main species: -
Height: -

Remarks: See also Figure II.8; some seedlings of *Acacia nilotica* and *Atalantia trimera* are found, very high grazing intensity

Table II.f Composition and Basal Area of a 0.8 ha plot in lowland monsoon forest in Bekol area (edited from Sugardjito & Partomihardjo 1985)

Species	Density (ind./ha)	Basal Area (m^2/ha)
Tree layer		
Acacia tomentosa	125	42.755
Acacia nilotica	50	0.237
Cordia obliqua	25	0.105
Grewia eriocarpa	25	0.084
Ziziphus ovalifolius	13	0.034
Pole/shrub layer		
Abutilon crispum	5.0	eaten
Lantana camara	0.2	not eaten
Atlantia trimera	0.2	not eaten
Randia sp.	0.1	eaten

5.1.3 Bekol II (evergreen forest; Partomihardjo et al. 1985, Lembinas 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 0.2
Height: 20
Terrain: flat

Tree stratum
Total number of species: 11
Density: 540
Main species: *Streblus asper* (D = 325, IV = 147.22) and *Kleinhovia ovata* (D = 160, IV = 112.41), other species are *Grewia eriocarpa*, *Polyalthia rumpfii*, and *Schoutenia ovata* (81% of the trees have a freq. <= 10%; *Kleinhovia ovata* and *Streblus asper* have a

freq. > 80%)
Diameter: 67% has a DBH <= 0.20, a *Streblus asper* reaches > 0.30 and a *Kleinhovia hospita* > 0.50
Height and stratification: 5-26.5 (average of 16.5), 2 strata (10-17.5 and 17.5-22); 27% of the trees grows under these strata, 17% in the 1st stratum, 46% in the 2nd stratum, and 27% grows above these strata

Table II.g Average Density (AD), Average Basal Area (ABA) and Average Importance Value (AIV) of some tree species at Bekol and surroundings (edited from Partomihardjo et al. 1985)

Species	AD (ind./ha)	ABA (m^2/ha)	AIV
Streblus asper	110.0	194.42	50.51
Grewia eriocarpa	36.7	10.80	39.32
Kleinhovia hospita	53.3	196.16	37.47
Acacia tomentosa	26.7	5.34	28.44
Schoutenia ovata	38.3	18.03	26.82
Homalium tomentosum	7.0	3.59	10.39
Tamarindus indica	5.0	1.40	8.82
Cissus trifolia	5.0	0.37	5.92
Azadirachta indica	3.3	0.13	4.35
Cordia obliqua	5.0	0.47	4.08
Vitex pubescens	3.3	0.42	3.59
Poliostigma malabaricum	3.3	0.05	2.58
Schleichera oleosa	1.7	0.38	1.71
KANDRI	8.3	0.47	6.22
DELIMO'AN	5.7	0.23	4.71
SANEK	3.3	0.11	2.88
JEBAU	3.3	0.09	2.17
Total	390.1	440.72	300.00

Pole/shrub stratum
Total number of species: 13
Density: 2220
Main species: *Polyalthia rumpfii* (D = 1240, freq. = 95), other species are *Atalantia trimera*, *Capparis micracantha*, *C. sepiaria*, *Randia longiflora*, and *R. spinosa*

Herb stratum
Total number of species: 15
Density: -
Main species: -
Height: 0.05

Remarks: see Figure II.8 and Table II.g; almost no herb stratum because of the evergreen character of the forest and the density of the tree and pole/shrub strata

5.1.4 Dadap-Mount Montor (seasonal forest; Partomihardjo et al. 1985, Lembinas 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 0.2
Height: 40

Terrain: undulating

Tree stratum
Total number of species: 6
Density: 325
Main species: *Grewia eriocarpa* (-; IV = 180.22) and *Acacia leucophloea* (-; IV = 72.28), other species are *Microcos tomentosa*, *Protium javanicum*, and *Schoutenia ovata* (59% of the tree species have a freq. <= 20%)
Diameter: 70% has a DBH <= 0.20, a *Acacia leucophloea* reaches > 0.40
Height and stratification: 6.5-26 (average of 16), 1 stratum

Pole/shrub stratum
Total number of species: 14
Density: 1420

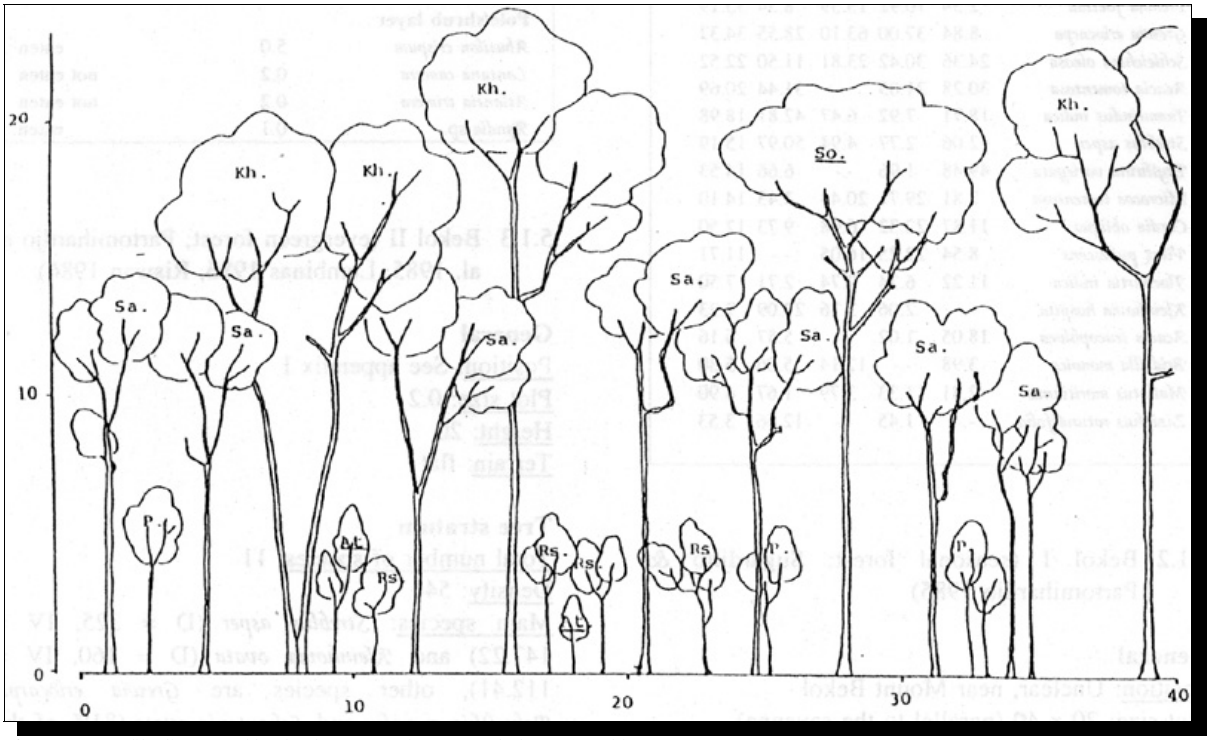


Figure II.8 Profile diagram of lowland monsoon forest at Bekol area (Lembinas 1986)

Main species: *Randia spinosa* (D = 540, freq. = 55), *Grewia eriocarpa* (D = 320, freq. = 60), and *Strychnos lucida* (D = 120, freq. = 20)

Herb stratum
Total number of species: 29
Main species: *Acacia leucophloea*, *Grewia eriocarpa*, and *Lantana camara*
Height: 0.15

Remarks: see Figure II.9 and Table II.c, most trees are leafless in the dry period

5.1.5 Kaloncing (mountain forest; Partomihardjo et al. 1985, Lembinas 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 0.2
Height: 355
Terrain: -

Tree stratum
Total number of species: 18
Density: 345
Main species: *Syzygium racemosum* (D = 115, IV = 101.14), *Streblus asper* (D = 60, IV = 45.10), and *Mallotus philipensis* (D = 40, IV = 31.13), very varied (72% of the trees have a freq. <= 10%)
Diameter: 61% has a DBH <= 0.20, a *Syzygium racemosum* reaches up to 0.77 and a *Ficus* sp. 0.83
Height and stratification: 6.5-32 (average of 18.5), 2 main strata (10-19 and 19-25)

Pole/shrub stratum
Total number of species: 27
Density: 1500
Main species: *Streblus asper* (D = 260, freq. = 40), *Pterospermum diversifolium* (D = 200, freq. = 40), and *Polyalthia lateriflora* (D = 120, freq. = 25), very varied (> 50% of the individuals has a freq. <= 20%)

Herb stratum
Total number of species: 35 (mainly grasses and seedlings)
Density: -
Main species: -
Height: 0.15

Remarks: many traces of wood, Bambu, and Rattan extraction; this seems to be a transition zone between lowland and upland monsoon forest

5.1.6 Mount Kembar area (Partomihardjo 1985b, Lembinas 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 0.2
Height: 160
Terrain: -

Tree stratum
Total number of species: 7
Density: 90
Main species: *Schoutenia ovata* (D = 40, IV = 123.37) and *Emblica officinalis* (D = 10, IV = 44.84), other species are *Grewia acuminata*, *Schleichera oleosa*, and *Grewia eriocarpa*
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: 7
Density:-
Main species: *Schoutenia ovata* (-) and *Glochidion rubrum* (-)

Herb stratum
Total number of species: 20 (in a plot of 20 m^2)
Main species: *Dichantium caricosum* and *Heteropogon insignes*
Height: > 1

Remarks: The composition of the pole/shrub stratum is almost the same as the tree stratum and is mainly found in the shadow of the trees; the soil is abundantly covered by grasses

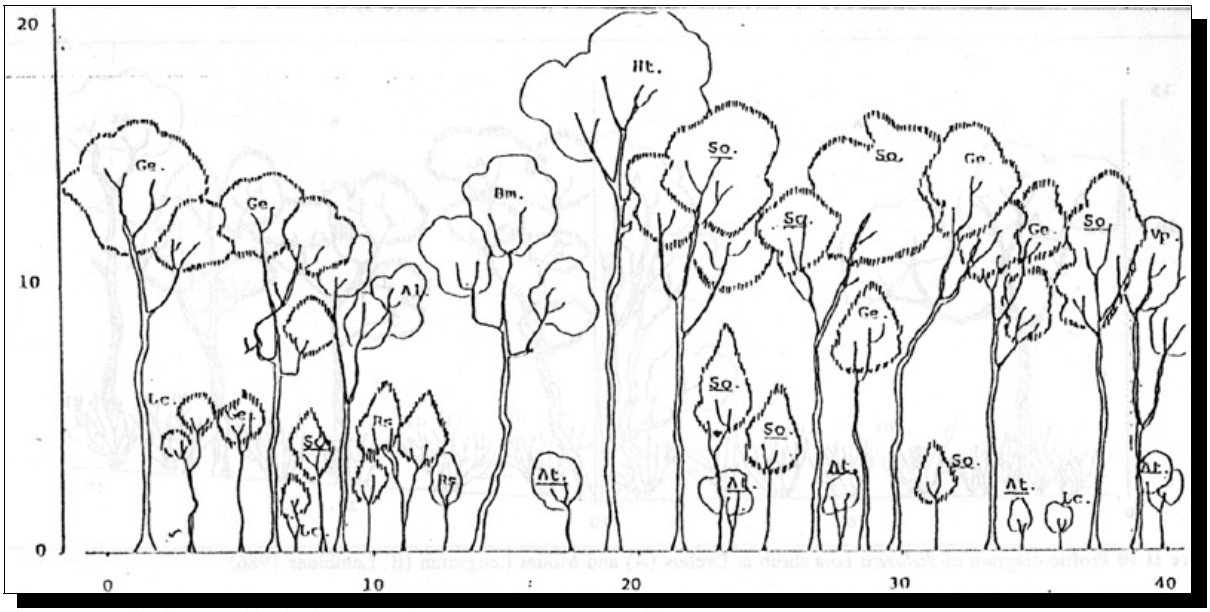


Figure II.9 Profile diagram of lowland monsoon forest at Mount Montor (Lembinas 1986)

5.1.7 Mount Lengseran-Talpat (seasonal forest; Partomihardjo et al. 1985, Lembinas 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 0.2
Height: 30
Terrain: -

Tree stratum
Total number of species: 14
Density: 405
Main species: *Schoutenia ovata* (D = 115, IV = 80.47), *Bridelia stipularis* (D = 75, IV = 44.66), *Grewia eriocarpa* (D = 50, IV = 38.47), and *Homalium tomentosum* (D = 35, IV = 31.16), other species are *Microcos tomentosa*, *Piliostigma malabaricum*, *Schoutenia ovata*, and *Sterculia foetida* (50% have a freq. <= 15%)
Diameter: 76% has a DBH <= 0.45, a *Vitex pubescens* reaches > 0.45
Height and stratification: 6-30 (average of 15), -

Pole/shrub stratum
Total number of species: 22
Density: 2700
Main species: *Schoutenia ovata* (D = 640, freq. = 50) and *Randia spinosa* (D = 240, freq. = 45)

Herb stratum
Total number of species: 24
Density: -
Main species: *Dicliptera canescens* and *Eleutheranthera ruderalis*
Height: 0.04

Remarks: See also Figure II.10; the diversity is not as high as at the lowland monsoon forest of Mount Montor area (5.1.9).

5.1.8 Mount Malang-Siruntuh (Partomihardjo 1985b)

General
Position: See appendix I
Plot size: 400 m^2
Height: -
Terrain: -

Tree stratum
Total number of species: 6
Density: 900
Main species: *Streblus asper* and *Microcos tomentosa* (see also Table II.h)
Diameter: 90% have a diameter < 0.20; a tree species that is much bigger (diameter > 1.00) is *Sterculia foetida*
Height and stratification: -, there is almost no stratification in the vegetation

Pole/shrub stratum
Total number of species: 7
Density: 1275
Main species: *Capparis micracantha* and *Randia spinosa* (see also Table I.a)

Herb stratum
Total number of species: -
Main species: -
Height: -

Remarks: -

Table II.h Composition and structure of trees and poles/ shrubs at Mount Malang-Siruntuh (in a valley) with an areal of 400 m^2 (edited from Partomihardjo 1985b)

Species	Density (ind./ha)	Basal Area (m^2/ha)
Trees		
Streblus asper	750	16.25
Microcos tomentosa	50	0.50
Sterculia foetida	25	21.50
Schleichera oleosa	25	1.00
Grewia eriocarpa	25	0.25
Glochidion spp.	25	0.25
Total	900	39.75
Poles/shrubs		
Capparis micracantha	400	0.23
Randia spinosa	275	0.07
Euphorbia spp.	250	0.05
Streblus asper	175	0.20
Strychnos lucida	100	0.01
Glochidion spp.	50	0.04
Atlantia trimera	25	0.02
Total	1275	0.62

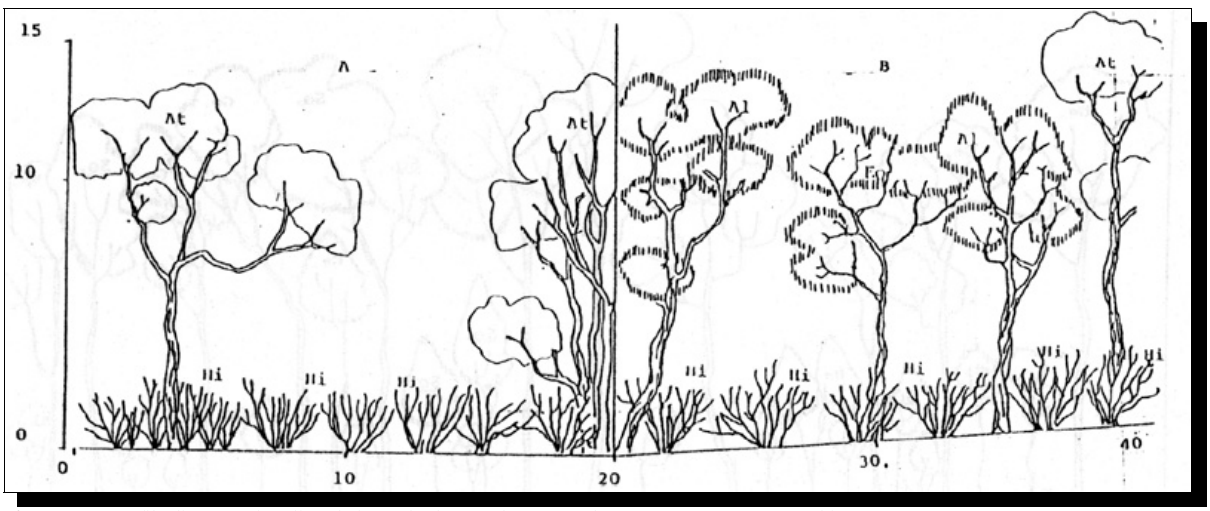


Figure II.10 Profile diagram of *Helicteris isora* shrub at Drebus (A) and Mount Lengseran (B; Lembinas 1986)

5.1.9 Mount Montor area (seasonal forest; Partomihardjo et al. 1985, Lembinas 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 0.2
Height: 20
Terrain: flat

Tree stratum
Total number of species: 10
Density: 285
Main species: *Acacia tomentosa* (D = 80, IV = 85.33), *Grewia eriocarpa* (D = 60, IV = 79.48), other species are *Acacia leucophloea* and *Schleichera oleosa* (> 50% freq. <= 15%, so we can say this is a Acacia - Grewia community)
Diameter: 79% has a DBH < 0.20, an *Acacia leucophloea* reaches > 0.40 and a *Tamarindus indica* reaches 0.45 DBH
Height and stratification: 6 - 20 (average of 14), one stratum that is occassionally open, 18% of the trees are pronounced (>= 17) and 34% consist of smaller trees in shady areas (<= 11)

Pole/shrub stratum
Total number of species: 12
Density: 1200
Main species: *Atalantia trimera* (D = 200, freq. = 50) *Grewia eriocarpa* (-), *Lantana camara* (D = 200, freq. = 35), and *Strychnos lucida* (-)

Herb stratum
Total number of species: 30
Main species: *Abutilon crispum*, *Bidens biternata*, *Cleome viscosa*, and *Rottboellia exaltata*
Height: 0.10

Remarks: see Figure II.11, many crooked stems and peeling bark; the area is very inaccessible because of the dense undergrowth.

5.2 Upland monsoon forest

5.2.1 Mount Baluran-Musapah (mountain forest; Partomihardjo 1985b, Lembinas 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 20 x 50 (0.1 ha)
Height: 600
Terrain: slope facing West

Tree stratum
Total number of species: 24
Density: 640
Main species: *Pterospermum diversifolium* (D = 90, IV = 54.84), *Polyalthia lateriflora* (D = 50, IV = 19.21), and *Streblus asper* (D = 50, IV = 15.24), 54 % of the trees have a freq. <= 5%
Diameter: 70% of the trees have a DBH <= 0.20, a *Ficus* sp. reaches 0.66
Height and stratification: 6-35 (average of 20), two strata, the 19-25 one being dominated by *Streblus asper* and the 19-25 by *Polyalthia lateriflora*, with *Pterospermum diversifolium* rising above these strata

Pole/shrub stratum
Total number of species: 18
Density: 1240
Main species: *Streblus asper* (-) and *Sumbaviopsis albicans* (-)

Herb stratum
Total number of species: -
Main species: -
Height: -

Remarks: The composition of the pole/shrub stratum doesn't differ much from that of the tree stratum, on places where rattan grows, however, the poles of tree species are less common; There are almost no grasses on the forest floor, probably because of the density of the crowns of trees, poles, and shrubs (see Figure II.12); In this area many harvest traces of bambu, *Parameria laevigata*, and *Aleurites molluccana* are found. At some places rattan is also harvested. Although there are many leftovers of the harvest of *Parameria laevigata* (only the epidermis of the plant is used for the production of traditional medicines), it is very difficult to find any living plants. The plant belongs to the Apocynaceae and is a kind of tree

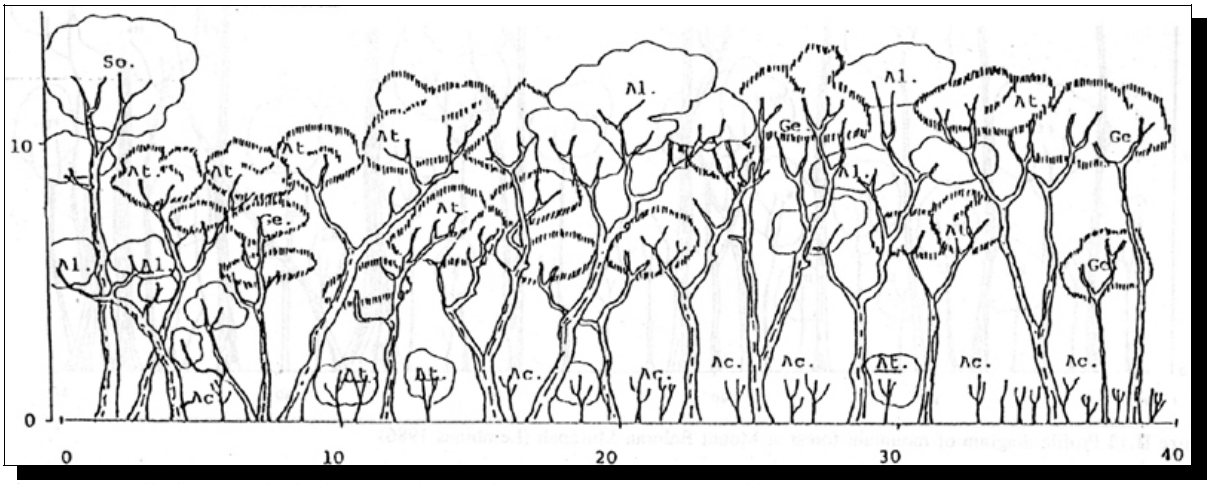


Figure II.11 Profile diagram of lowland monsoon forest at the foot of Mount Montor (Lembinas 1986)

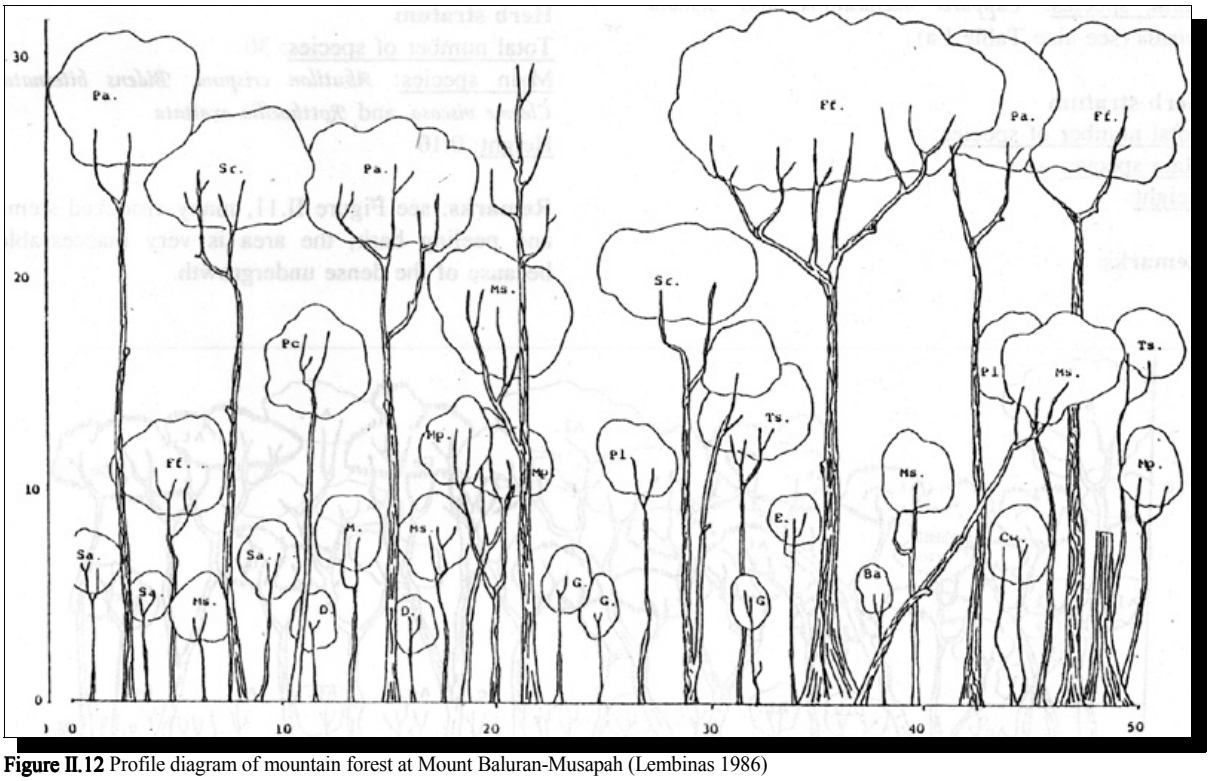


Figure II.12 Profile diagram of mountain forest at Mount Baluran-Musapah (Lembinas 1986)

climber (pemanjat).

5.2.2 Kaloncing-Musapah (Partomihardjo 1985b, Lembinas 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 20 x 50 (0.1 ha)
Height: 600
Terrain: -

Tree stratum
Total number of species: 17
Density: 540
Main species: *Polyalthia lateriflora* (D = 100, IV = 146.90), *Antidesma heterophyllum* (D = 50, IV = 166.66), and *Buchanania arborescens* (D = 30, IV = 165.53), other species are *Celtis wightii*, *Debregeasa* sp., *Ficus fistulosa*, *Glochidion* sp., *Mallotus philipensis*, *Mischocarpus sundaicus*, *Palaquium amboinense*, *Palaquium cuspidatum*, *Sapindus rarak*, *Syzygium* sp., *Toona sureni*
Diameter: 72% has a diameter >= 0.20; maximum diameter = 0.66
Height and stratification: 8-40 (average not known), three strata (9-19, 20-25, and 26-35)

Pole/shrub stratum
Total number of species: 21
Density: -
Main species: *Drypetes ovalis* (D = 140, -) and *Buchanania arborescens* (D = 100, -)

Herb stratum
Total number of species: -
Main species: -
Height: -

Remarks: The density of the poles is relatively low, this might be caused by the density of the tree crowns; not much vegetation on the forest floor, only some seedlings, shadow resistent grasses and ferns (paku[2]-an); many traces of *Parameria laevigata* harvest (often found on the more steeper slopes), but very difficult to find any living plants.

5.2.3 Pondok Sikesah (Partomihardjo 1985b, Lembinas 1986, Riswan 1986)

General
Position: See appendix I
Plot size: 0.2
Height: 760
Terrain: -

Tree stratum
Total number of species: 26
Density: 445
Main species: *Eugenia jamboiloides* (D = 55, IV = 40.06), *Parinari corymbosum* (D = 45, IV = 32.40), *Mallotus philippensis* (D = 45, IV = 22.93), and *Streblus asper* (D = 35, IV = 18.74)
Diameter: > 50% has a diameter >= 0.20), a *Pterospermum diversifolium* has a diameter of 1.40
Height and stratification: 6-40 (average of 19), three strata (9-19, 19-25, and 25-30)

Pole/shrub stratum
Total number of species: 32
Density: 5525
Main species: *Polyalthia lateriflora* (D = 680, -), *Pterospermum diversifolium* (D = 180, -), and *Capparis micracantha* (D = 180, -)

Herb stratum
Total number of species: -
Main species: -
Height: -

Remarks: The forest floor mainly consists of shadow

resistant tree seedlings and fern species (paku[2]-an); area of *Aleurites molluccana* harvest; still many old resting places of people that come there to harvest. In a plot of 40 x 50 (0.2 ha) 5 trees (25) with a diameter more than 0.60 are found; looks like groupwise dispersal (freq. = 15%).

6 Teak plantations

6.1 Place unknown (Budiman et al. 1984, Partomihardjo 1986)

General
Position: Place unknown
Plot size: 500 m^2
Height: -
Terrain: -

Tree stratum
Total number of species: 8
Density: -
Main species: *Tectona grandis* (-; 240 trees/ha), other species are *Albizia procera*, *Piliostigma malabricum*, *Butea monosperma*, *Dillenia pentagyna*, *Mallotus* spp., and *Schleichera oleosa*
Diameter: about 0.20, bigger trees found are *Schleichera oleosa* (0.68), *Piliostigma malabricum* (0.50), and *Butea monosperma* (0.43)
Height and stratification: -

Pole/shrub stratum
Total number of species: 9
Density: -
Main species: *Tectona grandis* (-; 280 poles/ha)

Herb stratum
Total number of species: -
Main species: -
Height: -

Remarks: -
Diameter: -
Height and stratification: -

Pole/shrub stratum
Total number of species: -
Density: -
Main species: -

Herb stratum
Total number of species: 6
Main species: *Zoysia matrella* and *Fimbristylis dichotoma*
Height: 1 (undisturbed vegetations)

Remarks: Game makes great use of this area because there are some water sources in this area

7 Other formations

7.1 Delangan alang[2] field (Candi Bang-Dadap, near the guard post; Partomihardjo 1985a, Lembinas 1986, Riswan 1986)

General
Position: At the border of Delangan savanna (see appendix I)
Plot size: 0.005
Height: 25
Terrain: -

Tree stratum
Total number of species: 8
Density: 36
Main species: *Acacia tomentosa* (-)

Appendix III Concept check-list of plant species of Baluran National Park, East Java (edited from Partomihardjo 1992)

Field surveys were conducted by Mr Partomihardjo in Baluran National Park, East Java during 1985 and 1989 as a part of Natural Resources Investigation. The main purpose of these surveys was to clarify the seasonal vegetation dynamic and wild animal status during a year. The results of 1985 studies were compiled in a general report of National Biological Institute, Bogor (Kadarsan et al. 1986). Part of these field surveys was the compilation of a plant collection. His collection was restricted to Spermatophytes only. The identification of the specimens was primarily carried out by means of comparison to the herbarium collection. Reexamination was done through the use of vegetation maps and books like Flora of Java volume I, II and III (Backer 1963). The plant collection was carried out more intensive on the formation types savanna, deciduous forest, evergreen forest and mountain forest than on mangrove community (Partomihardjo 1993).

The following pages are an edited version of the preliminary check-list of plant species occurring in Baluran National Park published in 1993 by Mr Partomihardjo, based on the herbarium specimens that have been collected mainly during observations in 1985 and 1989 by him. In this list, species are arranged in alphabetical order according to family. Local names are given for some plants and the bullet ( ) marks exotic species (26). The **highlighted** species (120) are mentioned by Partomihardjo 1992 only, the underlined species (26) are selected for monitoring by Watling 1990 (wherever only the family name is underlined, no further differentiation was given).

Cl = climber (total of 24)
Gr = grass (56)
He = herb (129)
Ln = liana (32)
Pa = parasite (14)
Sh = Shrub (104)
Tr = tree (168)

Be = beach
Ef = evergreen forest
Mg = mangroves
Ms = monsoon forest
Mt = mountain forest
Se = sea
Sf = saltflat
Sv = savanna
Sw = swamp forest

ACANTHACEAE			
Sh	*Acanthus ilicifolius* L	Mg	DARUJU
He	*Asystasia nemorum* Nees	Ms	DAUN MORETA
He	***Barleria prionitis*** L	Ms	LANTEPAN
He	*Dicliptera canescens* Nees	Ms	LANTEPAN
Sh	*Pseuderanthemum diversifolium* (Bl) Radlk	Ms	SAYUR KAMBING
He	*Sericocalyx crispus* (L) Bremek Bl	Ms	KEJI BELING
Sh	*Strophacanthus membranifolius* (Miq) Bremek	Ms	-
He	*Thunbergia fragrans* Roxb	-	-
AGAVACEAE			
Sh	***Cordylin fruticosa*** (L) A Chev	Mt	HANJUANG
AMARANTHACEAE			
He	*Achyranthes aspera* L	Ms?, Sv	RENDETAN
He	*Amaranthus spinosus* L f	Sv, Ms	BAYEM ERI
He	***Cyathula prostrata*** Bl	Be	ADAS[2]-AN
Sh	*Deeringia amaranthoides* (Lmk) Herr	Ms	BAYEM POHON
AMARYLIDACEAE			
He	*Crinum asiaticum* L	Be	BAKUNG
ANACARDIACEAE			
Tr	*Buchanania arborescens* (Bl) Bl	Be, Ef, Sw?	POPOHAN
Tr	***Mangifera longipes*** Griff	Ef, Mt	KAWANG
Tr	*Spondias cytherea* Sonnerat	Mt	KEDONDONG
Tr	*Spondias pinnata* (L f) Kurz	Ms?, Sv	KEDONDONG ALAS
ANNONACEAE			
Ln	*Anomianthus dulcis* (Dun) J Sincl	Ms	KALAK MATANG
Sh	*Desmos chinensis* Lour	Ms	SALUR, KALAK
Tr	***Mitrephora polypyrena*** (Bl) Miq	Mt	-
Tr	***Polyalthia lateriflora*** (Bl) King	Ef	-
Tr	***Polyalthia longipes*** (Miq) K&V	Ef	-
APOCYNACEAE			
Tr	*Alstonia spectabilis* R Br	Ef	ILAT[2]
Sh	***Ervatamia floribunda*** (Bl) Pichon	Be	SETANEN
Ln	*Parameria laevigata* (Juss) Moldenke	Ms, Mt	ALIT[2]-AN
Sh	*Rauvolfia serpentina* (L) Bth ex Kurz	Be, Ms?	PULE PANDAK
Sh	*Rauvolfia spectabilis* (Miq) Boerl	Be, Ef	SETANEN

Sh	*Thevetia peruviana* (Pers) K Schum	Be	GINJE
Sh	*Voacanga grandiflora* (Miq) Rolfe	Be, Ms	CEMPERIT
ARACEAE			
He	*Aglaonema simplex* Bl	Mt	-
He	***Homalomena cordata*** Schott	Mt	-
He	*Pistia stratiotes* L	Sw	EMPON[2]
He	*Rhaphidophora pinnata* (L f) Schott	Mt	-
He	***Typhonium trilobatum*** (L) Schott	Sv	-
ARALIACEAE			
Pa	***Schefflera elliptica*** (Bl) Harms	Mt	-
ARECACEAE			
Tr	*Arenga pinnata* (Wurmb) Merr	Mt	AREN
Tr	*Borassus flabellifer* L	Be	SIWALAN
Cl	*Calamus* sp.[1]	Mt	ROTAN
Cl	*Calamus viminalis* Willd	Be, Mt	ROTAN
Tr	*Caryota mitis* Lour	Mt	GENDURU
Tr	*Corypha utan* Lamk	Sv	GEBANG
Ln	***Daemonorops melanochaete*** Bl	Ef, Mt	ROTAN
Tr	*Pinanga coronata* (Bl ex Mart) Bl	Ef	-
ASCLEPIADACEAE			
Sh	*Calotropis gigantea* (Willd) Dryand ex WR Ait	Be, Sv	WIDURI
Pa	***Dischidia angustifolia*** Miq	Mt	-
Pa	***Dischidia punctatoides*** Bakh f	Mt	-
Pa	*Dregea volubilis* (L f) Bth ex Hook f	Mt	-
Cl	***Hoya multiflora*** Bl	Mt	-
Sh	***Marsdenia crocea*** (Zipp ex Span) Hook f ex Boerl	Ms	-
Cl	*Tylophora tenuis* Bl	Ms	RESEP
ASTERACEAE			
He	***Ageratum conyzoides*** L	Sv	BANDOTAN
He	*Bidens biternata* (Lour) Merr & Sherff ex Sherff	Sv	BUH[2]-AN
He	***Bidens pilosa*** L	Sv	KETUL
He	***Blumea lacera*** (Bur f) DC	Sv	LUNTAS
He	*Blumea riparia* (Bl) DC	Sv	-
He	*Crassocephalum crepidioides* (Benth) S Moore	-	-
He	***Eclipta prostrata*** (L) L	Sv	-
He	***Elephantopus scaber*** L	Ms	TAPAK LIMAN
He	*Eleutheranthera ruderalis* (Sw) Sch-Bip	Sv	TELEP
He	*Erechtites valerianifolia* (Wolf) DC	Sv	LINGKO
Sh	***Eupatorium odoratum*** L f	Ms	KIRINYU
Cl	*Mikania cordata* (Burm f) BL Robinson	Ms	BRAJA WENGI
Sh	*Pluchea indica* (L) Less	Be	BELUNTAS
He	***Sonchus arvensis*** L	Sv	TEMPUYUNG
He	***Sphaeranthus indicus*** L	Be	-
He	***Tridax procumbens*** L	Sv	-
He	*Vernonia cinerea* (L) Less	Sv	NYAWON
He	*Vernonia patula* (Dryand) Merr	Sv	-
He	*Wedelia biflora* (L) DC	Be	SERUNI
He	*Wedelia montana* Boerl	-	-
BEGONIACEAE			
He	*Begonia tenuifolia* Dryand	Mt	BEGONIA
BIGNONIACEAE			
Tr	*Dolichandrone spathacea* (L f) K Schum	Be	KAYU PELOK
Tr	*Millingtonia hortensis* L f	Ms	KELOR HUTAN
BOMBACACEAE			
Tr	*Salmalia valetonii* (Hochr) Corner	Ms	RANDU ALAS
BORAGINACEAE			
Tr	*Cordia bantamensis* Bl	Ms	KENDAL
Tr	***Cordia dichotoma*** Forst f	Ms	KENDAL
Tr	*Cordia monoica* Roxb	Ms	KENDAL
Tr	***Cordia subcordata*** Lamk	Ms	KENDAL
He	*Heliotropium marifolium* Retz	Ms	-

BUDDLEJACEAE			
Sh	*Buddleja asiatica* Lour	Ef	SEMBUNG ALAS
BURSERACEAE			
Tr	***Canarium hirsutum*** Willd	Ef	KENARI HUTAN
Tr	*Garuga floribunda* Decne	Ef	WIYU
Tr	*Protium javanicum* Burm f	Ef, Ms, Sv?	TRENGGULUN
CACTACEAE			
Sh	*Opuntia elatior* Mill	Be	KAKTUS PANTAI
CAPPARIDACEAE			
Sh	*Capparis micracantha* DC	Ms	KENCURAN
Sh	*Capparis sepiaria* L	Ms	-
He	*Cleome viscosa* L	Ms, Sv	TEMBEKING
Tr	*Crataeva nurvala* Buch - Ham	Sv	SAMPAL WADAK
CELASTRACEAE			
Sh	*Celastrus paniculatus* Willd	Ms	SILA
Tr	***Euonymus javanicus*** Bl	Ef	-
CLUSIACEAE			
Tr	*Calophyllum inophyllum* L	Be	NYAMPLUNG
Tr	*Garcinia balica* Miq	Mt	ROPOH
Tr	***Garcinia parvifolia*** (Miq) Miq	Ms	-
COMBRETACEAE			
Sh	*Lumnitzera racemosa* Willd	Mg, Sw?	TRUNTUM
Tr	*Terminalia cattapa* L	Be	KETAPANG
COMMELINACEAE			
He	***Commelina auriculata*** Bl	Ef	-
He	*Commelina diffusa* Burm f	Sv	GROGOS
He	*Commelina paleata* Hassk	Ms	GEWORAN
He	***Cyanotis ciliata*** (Bl) Bakh f	Ef	-
He	*Cyanotis cristata* (L) D Don	Ef, Ms?	-
He	*Forrestia mollissima* (Bl) Kds	Ef	MUKSOR HUTAN
CONVOLVULVACEAE			
He	*Evolvulvus alsinoides* (L) L	Sv	-
He	*Ipomoea eriocarpa* R Br	Sv	-
Sh	*Ipomoea fistulosa* Mart ex Choisy	Sv	KANGKUNGAN
Ln	*Ipomoea maxima* (L f) G Don ex Sweet	Ms	KACUPING
He	*Ipomoea obscura* (L) Ker-Gawl	Ms	MALINGAN
Ln	*Ipomoea pes-caprae* (L) R Br	Be	KANGKUNG LAUT
Ln	*Ipomoea pes-trigidis* L	Ms	GAMET
Ln	*Ipomoea plebeia* R Br	Ms	-
Ln	*Ipomoea polymorpha* R&S	Sv	-
Ln	*Ipomoea trichosperma* Bl	Ms	-
Ln	***Ipomoea triloba*** L	Ms	RAJUTAN
Ln	*Meremia gemella* (Burm f) Hallier f	Ms	-
Ln	*Porana volubilis* Burm f	Ms	WIDASARI
CUCURBITACEAE			
He	*Benincasa hispida* (Thunb) Cogn	Ms	BALIGO
Ln	*Coccinia cordiflora* (L) Cogn	Ms	BOLU TEKEK
Ln	*Melothria maderaspantana* (L) Cogn	Ms	-
CYPERACEAE			
He	*Carex baccans* Nees	Ef	EMPRITAN
He	*Carex rafflesiana* Boott	Ef	TEKIK
He	*Cyperus iria* L	Be	TEKI
He	*Cyperus javanicus* Houtt	Be	BELATAN
He	*Cyperus rotundus* L	Sv	TEKI
He	*Fimbristylis dichotoma* (L) Vahl	Sv	REBA KOMIS
He	*Fimbristylis ovata* (Burm f) Kern	Sv	-
DILLENIACEAE			
Tr	*Dillenia obovata* (Bl) Hoogl	Ms	JUNTI
Tr	*Dillenia pentagyna* Roxb	Ms	SEMPU
Ln	***Tetracera* sp**. -	Ef, Ms	-

DIOSCOREACEAE			
Cl	*Dioscorea hispida* Dennst	Ms	GADUNG
EBENACEAE			
Tr	*Diospyros maritima* Bl	Be	BUDENG
Tr	*Diospyros montana* Roxb	Mt	-
EUPHORBIACEAE			
Sh	*Acalypha indica* L	Ms	SANGKEP
Sh	*Acalypha paniculata* Miq	Ms	KI MANGSI
Sh	*Acalypha wilkesiana* MA	Ms	KI MANGSI
Sh	*Alchornea rugosa* (Lour) MA	Mt	MENTULAN
Tr	*Aleurites moluccana* (L) Willd	Ef?, Mt	KEMIRI
Sh	*Andrachne australis* Z&M	Mt	-
Tr	*Antidesma bunius* (L) Spreng	Ef?, Ms	WUNI
Tr	*Antidesma ghaesembilla* Gaertn	Ef?, Ms	WUNI SEPET
Sh	*Breynia cernua* (Poir) MA	Be, Ms	IMER
Sh	*Bridelia ovata* Decne	Ms	-
Sh	*Bridelia stipularis* (L) Bl	Ms	TAKOTO
Tr	***Claoxylon polot*** (Burm f) Herr	Mt	SENOH
Tr	*Cleidion javanicum* Bl	Ms	BERASAN
Tr	*Drypetes ovalis* (JJS) Pax & R Hoffm	Ef	BERASAN, PANCAL KIJANG
Tr	*Emblica officinalis* Gaertn[2]	Ms	KEMLOKO
He	*Euphorbia hirta* L	Sv	PATIKAN
He	*Euphorbia prunifolia* Jacq	Ms	-
Tr	*Excoecaria agallocha* L	Ms, Sw?	MENENGAN
Tr	*Glochidion* sp.	-	-
Tr	*Glochidion rubrum* Bl	Ms	LAMER
Tr	*Glochidion zeylanicum* A Juss	Ms	CABUK
Sh	*Jatropha curcas* L	Ms	JARAK GUNDUL
Sh	*Jatropha gossypifolia* L	Ms	JARAK LANDI
Tr	*Macaranga tanarius* (L) MA	Mt	KARAHAN
Tr	*Mallotus philippensis* (Lmk) MA	Mt	PANCAL KIDANG
He	*Phyllanthus maderaspatensis* L	Sv	GUNDO DARAT
He	*Phyllanthus niruri* L	Sv	MENIRAN
He	*Phyllanthus reticulatus* Poir	Sv	CONGKONG BELUT
He	***Phyllanthus urinaria*** L	Sv	MENIRAN
He	*Phyllanthus virgatus* Forst f	Sv	-
Sh	*Ricinus communis* L	Ms	JARAK KEPYAR
Sh	***Sumbaviopsis albicans*** (Bl) JJS	Ef	-
FABACEAE			
Cl	*Abrus precatorius* L	Ms	SAGA MANIS
He	***Aeschynomene americana*** L	Sv	-
Tr	*Albizia lebbeck* (DC) Bth	Ms, Sv?	TEKIK
Tr	*Albizia procera* (Roxb) Bth	Ms, Sv	WANGKAL
He	*Alysicarpus rugosus* (Willd) DC	Sv	CEMARAN
He	*Alysicarpus vaginalis* (L) DC	Sv	BROBOS
He	***Atylosia scarabaeoides*** (L) Bth	Sv	SALURPUMA
Tr	*Bauhinia hirsuta* Weinm	Ms	KENDAYAKAN
Tr	*Butea monosperma* (Lmk) Taub	Ms	PLOSO
Ln	*Caesalpinia crista* L	Ms	KUTUK
Ln	*Caesalpinia digyna* Roth	Sv	-
Sh	*Cassia alata* L	Ms	KETEPENG KEBO
Tr	*Cassia fistula* L	Ms?, Sv	TENGGULI
He	*Christia obcordata* (Poir) Bakh f	Sv	-
Cl	*Clitoria ternatea* L	Ms	KEMBANG TELENG
He	*Crotalaria calycina* Schrank	Sv	OROK[2]
He	*Crotalaria juncea* L	Ms, Sv	OROK[2]
He	***Crotalaria mucronata*** Desv	Sv	OROK[2]
He	*Crotalaria mysorensis* Roth	Ms, Sv	OROK[2]
He	*Crotalaria prostrata* Rottb ex Willd	Sv	OROK[2]
Tr	*Delonix regia* (Bojer ex Hook) Rafin	Ms	FLAMBOYAN
Cl	***Derris elliptica*** (Roxb) Bth	Ms	TUBA
He	*Desmodium dichotomum* (Willd) DC	Sv	DELE[2]-AN
He	*Desmodium gangeticum* (L) DC	Sv	WALIKETUPA
He	*Desmodium heterophyllum* (Willd) DC	Sv	SUKET JAREMAN
He	*Desmodium laxiflorum* DC	Sv	-
He	*Desmodium motorium* (Houtt) Merr	Sv	-
Sh	*Desmodium pulchellum* (L) Bth	Ms, Sv	PICISAN
Sh	*Desmodium umbellatum* (L) DC	Be	GUDEAN
He	*Desmodium zonatum* Miq	Ms	-

Sh	*Dichrostachys cinerea* (L) W&A	Ms	-
Cl	*Entada phaseoloides* (L) Herr	Mt	BENTOH
Tr	*Erythrina eudophylla* Hassk ex Back	Ms, Mt	DADAP (BIRU), KELOR WONO
Tr	***Erythrina fusca*** Lour	Ms	CANGKRING
Tr	*Erythrina orientalis* (L) Murr	Be	DADAP LAUT
He	*Indigofera colutea* (Burmf) Lmk	Sv	-
He	*Indigofera glandulosa* Willd	Sv	TARUM
He	*Indigofera hirsuta* L	Sv	TOMTOMAN
He	*Indigofera linifolia* (L f) Retz	Sv	DEDEKAN
He	*Indigofera trifoliata* L	Sv	-
He	*Indigofera trita* L f	Sv	-
Sh	***Lysiphyllum binatum*** (Blanco) De Wit	Be	-
Ln	***Mezoneuron culcullatum*** (Roxb) W & A	Ms	SALUR DURI
Sh	*Moghania nacrophylla* (Willd) OK	Sv	-
Cl	*Mucuna gigantea* (Willd) DC	Be	BENGUK PANTAI
Cl	***Mucuna pruriens*** (L) DC var pruriens	Ms, Sv	KRAWE
Tr	***Ormocarpum suberosum*** T&B	Sv	SARAP
He	*Phaseolus lathyroides* L	Sv	KATOK
He	*Phaseolus trilobus* (L) WT Ait	Sv	KACANG[2]-AN
He	*Phaseolus vulgaris* L	Sv	KACANG JOGO
Tr	*Piliostigma malabaricum* (Roxb) Bth (var. *acidum*)	Be	BENCULUK
Tr	*Pongamia pinnata* (L) Pierre	Be	KEPRIK
Tr	*Sesbania grandiflora* (L) Pers	Sv	TURI
Sh	*Sesbania sericea* (Willd) Lmk	Sv	JANTI
He	*Stylosanthes sundaica* Taub	Sv	-
Tr	*Tamarindus indica* L	Ms, Sv	ASEM
Sh	*Uraria crinita* (L) Desv ex DC	Sv	BUTUT BAJING
Cl	***Uraria lagopodioides*** (L) Desv ex DC	Sv	DELE[2]-AN
He	*Zornia diphylla* (L) Pers	Sv	-
FAGACEAE			
Tr	*Lithocarpus dolicarpus* (V Seem) Rehd	Mt	-
Tr	*Lithocarpus sundaicus* (Bl) Rehd	Mt	-
FLACOURTIACEAE			
Tr	***Casearia flavovirens*** Bl	Mt	BUDENGAN
Tr	*Flacourtia indica* (Burm f) Merr	Ms	RUKEM, SARABAN
Tr	*Homalium tomentosum* (Vent) Bth	Ms	GELINGSEM
FLAGELLARIACEAE			
Cl	*Flagellaria indica* L	Be, Sv	WOWO
GNETACEAE			
Cl	***Gnetum latifolium*** Bl	Ef	-
GOODENIACEAE			
Sh	*Scaevola taccada* (Gaertn) Roxb	Be	WUDULAN
HERNANDIACEAE			
Tr	*Hernandia peltata* Meissn	Be	BRENDALA
HIPPOCRATEACEAE			
Ln	*Salacia macrophylla* Bl	Ef	KACIPOT
HYDROCHARITACEAE			
He	*Ottelia alismoides* (L) Pers	Be	COWEHAN
ICACINACEAE			
He	*Cardiopteris javanica* Bl	Ms	-
LAMIACEAE			
He	*Elsholtzia pubescens* Bth	Sv	-
He	*Gomphostemma javanicum* (Bl) Bth	Ms	GLIMPUNG
He	*Leucas javanica* Bth	Sv	LENG[2]-AN
He	*Leucas zeylanica* (L) R Br	Sv	LENG[2]-AN
He	*Ocimum americanum* L	Ms	SELASIH
He	*Ocimum sanctum* L	Sv	LEMPES
He	*Salvia riparia* HBK	Ms	-

LAURACEAE			
Tr	***Beilschmiedia gemmiflora*** (Bl) Kosterm	Mt	-
Tr	*Cassyta filiformis* L	Be	TALI PUTRI
Tr	***Persea rimosa*** (Bl) Kosterm	Mt	-
LECYTHIDACEAE			
Tr	*Barringtonia racemosa* (L) Spreng	Be	SONGGOM
LEEACEAE			
Sh	*Leea angulata* Korth ex Miq	Mt	LENGKI
Sh	*Leea rubra* Bl	Ms	-
Sh	***Leea sambucina*** (L) Willd	Ef	GIRANG
LENTIBULARIACEAE			
He	*Utricularia aurea* Lour	Be (Sw)	-
LILIACEAE			
Cl	*Asparagus racemosus* Willd	Be	SONGGOLANGIT
He	*Dianella ensifolia* (L) DC	Ms	JAJAMBEAN
Cl	***Disporum chinense*** (Ker-Gawl) OK	Be (Sw)	-
Cl	*Gloriosa superba* L	Sw	DONGKELSUNGSANG
LOGANIACEAE			
Sh	*Strychnos lucida* R Br	Ms	WIDORO GUNUNG
LORANTHACEAE			
Tr	*Dendrophthoë falcata* (L f) Ettingsh	Ms	KEMADEAN
Tr	***Macrosolen teragonus*** (Bl) Miq	Ms	KEMADEAN
Tr	***Scurrula parasitica*** L	Ms	KEMADEAN
Tr	***Viscum articulatum*** Burm f	Ms	CEMARAAN
LYTHRACEAE			
Sh	*Pemphis acidula* JR&G Forst	Be?, Mg	CANTIGI
Sh	***Woodfordia fruticosa*** (L) Kurz	Ms	-
MALPHIGIACEAE			
Tr	***Hyptage benghalensis*** (L) Kurz	Ms	-
Sh	*Ryssopteris tiliaefolia* (Vent) A Juss	Ms	-
MALVACEAE			
Sh	*Abelmoschus ficulneus* (L) W&A ex Wight	Sv	KAPASAN
Sh	*Abelmoschus moschatus* Medic	Ms, Sv	CEMPLAK
Sh	*Abutilon crispum* (L) Medic	Sv	KUCEMPLAK
Sh	*Abutilon indicum* (L) Sweet	Ms, Sv	KUCEMPLAK
Sh	*Hibiscus penduriformis* Burm f	Ms	CEMPLAK
Tr	*Hibiscus tiliaceus* L	Be	WARU LAUT
Sh	*Sida acuta* Burm f	Ms, Sv	SIDAGURI
Sh	*Sida cordifolia* L	Be	SIDAGURI
Sh	***Sida rhombifolia*** L	Ms, Sv	SIDAGURI
Sh	*Thespesia lampas* (Cav) Dalz & Gibs	Ms?, Sv	KAPASAN
Tr	*Thespesia populnea* (L) Soland ex Correa	Be	WARU LOT
Sh	*Urena lobata* L	Ms, Sv	PULUTAN
MARANTHACEAE			
He	*Alpina* sp.	-	BAMBAN
He	*Halopegia blumei* (Koern) K Schum	Ef	JELANTIR
He	***Phrynium placentarium*** (Lour) Merr	Ef	BAMBAN
MELASTOMATACEAE			
Sh	*Melastoma affine* D Don	Ms	SENGGANI
Sh	*Melastoma malabathricum* L	Ms	HARENDONG
Tr	***Memecylon myrsinoides*** Bl	Mt	-
MELIACEAE			
Tr	*Aglaia argentea* Bl	Be, Mt	DURENAN
Tr	*Aglaia odoratissima* Bl	Be, Mt	PANCAL KIDANG
Tr	*Amoora grandiflora* (Bl) Walp	Be, Mt	PANCAL KIDANG
Tr	*Azadirachta indica* A Juss	Sv	MIMBO
Tr	***Dysoxylum caulostachyum*** Miq	Mt	-
Tr	*Melia azedarach* L	Ef, Ms?	MINDI
Tr	*Toona sureni* (Bl) Merr	Mt	SUREN

Tr	*Xylocarpus granatum* Koen	Be	NYIRIH AGUNG
Tr	*Xylocarpus moluccensis* (Lamk) Koen	Be	NYIRIH GUNDUK
	MENISPERMACEAE		
Sh	*Stephania japonica* (Thunb ex Murr) Miers	Ms	-
	MIMOSACEAE		
Tr	*Acacia leucophloea* (Roxb) Willd	Ms, Sv	PERENG, PILANG
Tr	*Acacia nilotica* (L) Willd ex Del	Sv	AKASIA, LAMTORO
Tr	*Acacia tomentosa* (Roxb) Willd	Ms, Sv	KELAMPIS, LOGHAJ
Tr	*Adenanthera microsperma* R&B	Ms, Sv	SEGAWE
Tr	*Adenanthera pavonina* L	Ms	SEGAWE SABRING
Tr	*Leucaena leucocephala* (Lmk) De Wit	Sv	LAMTORO, PETE CINA?
He	*Mimosa invisa* Mart ex Colla	Sv	RIUTAN
He	***Mimosa pudica*** L	Sv	SIKEJUT
Tr	***Parkia roxburghii*** G Don	Mt	KEDAWUNG
Tr	*Pithecellobium clypearia* (Jack) Bth	Be	SENGON
Tr	*Pithecellobium umbellatum* (Vahl) Bth	Be	ASEM LANDA
	MOLLUGINACEAE		
He	*Glinus lotoides* L	Be	RAYAPAN
He	***Mollugo pentaphylla*** L	Be	-
	MORACEAE		
Tr	***Ficus benjamina*** L	Ef, Sv?	BERINGIN
Tr	***Ficus callosa*** Willd	Ms	KAYU SANTEN
Tr	***Ficus drupacea*** Thunb	Ms	-
Tr	*Ficus fistulosa* Reinw ex Bl	Ef	LO GUNUNG
Tr	***Ficus fulva*** Reinw ex Bl	Ms	-
Tr	***Ficus hispida*** L f	Be	LHO
Tr	*Ficus microcarpa* L f	Ms	WERINGIN
Tr	*Ficus montana* Burm f	Ef	AWAR[2]
Tr	*Ficus racemosa* L	Ms	ALLO
Tr	*Ficus septica* Burm f	Ms	AWAR[2]
Tr	*Ficus superba* Miq	Ms, Sv?	KRASAK
Tr	*Ficus variegata* Bl	Ef	GONDANG
Tr	*Streblus asper* Lour	Ef	SERUT
	MYRSINACEAE		
Sh	*Aegiceras corniculatum* (L) Blanco	Ln	TRUNTUNG
Sh	*Aegiceras floridum* R&S	Mg	-
Sh	*Ardisia humilis* Vahl	Be	LAMPENI
Sh	***Ligustrum glomeratum*** Bl	Mt	-
Sh	***Myrsine avenis*** (Bl) DC	Mt	-
	MYRTACEAE		
Tr	***Syzygium lineatum*** (DC) Merr & Perry	Mt	JAMBU ALAS
Tr	*Syzygium polyanthum* (Wight) Walf	Be, Sw?	MANTING
Tr	***Syzygium pycnanthum*** Merr & Perry	Mt	JAMBU ALAS
Tr	*Syzygium racemosum* (Bl) DC	Mt, Ms	RESEP
Tr	*Syzygium samarangense* (Bl) Merr & Perry	Ef	JAMBU ALAS
	OLACACEAE		
Sh	***Linociera nitens*** (K&V) Kds	Ef	-
Sh	*Olax scandens* Roxb	Ms	WANGON
Sh	*Ximenia americana* L	Be	BIDARA LAUT
	OLEACEAE		
Sh	*Jasminum funale* Decne	Ms	MELATI HUTAN
	ORCHIDACEAE		
Pa	***Appendicula cornuta*** Bl	Mt	ANGGREK
He	*Calanthe ceciliae* Rchb f	Mt	KALANTE UNGU
Pa	***Dendrobium angulatum*** (Bl) Lindl	Mt	-
Pa	***Dendrobium tenellum*** (Bl) Lindl	Mt	-
Pa	***Eria annulata*** (Bl) Bl	Mt	-
Pa	***Eria multiflora*** (Bl) Lindl	Mt	-
Pa	***Eria oblotterrata*** (Bl) Rchb f	Mt	-
He	*Peristylus goodyeroides* (D Don) Lindl	Mt	-
He	***Phaius flavus*** (Bl) Lindl	Mt	-
He	***Phaius pauciflorus*** (Bl) Lindl	Mt	-
He	*Planthathera susannae* (L) Lindl	Mt	-

Pa	*Taeniophyllum javanum* JJS	Mt	-
He	*Tropidia angulosa* Bl	Ms	UWAR
Pa	*Vanda limbata* Bl	Ms	VANDA COKLAT
	OXALIDACEAE		
He	*Biophytum petersianum* Klotzsch	Ms	-
	PANDANACEAE		
Tr	*Pandanus tectorius* Soland ex Park	Be	PANDAN PANTAI
	PASSIFLORACEAE		
Cl	*Adenia heterophylla* (Bl) Kds	Ms	-
Cl	*Passiflora foetida* L	Ms, Sv	CEPLUKAN
Cl	***Passiflora horsfieldii*** Bl	Ms	-
	PIPERACEAE		
Pa	***Peperomia laevifolia*** (Bl) Miq	Mt	-
Pa	***Peperomia tetraphylla*** (Forst f) Hook & Arn	Mt	-
Cl	*Piper* sp.	Mt	-
Cl	***Piper abbreviatum*** Opiz	Mt	-
Sh	***Piper sulcatum*** Bl	Mt	-
Sh	*Pothomorphe subpeltata* (Willd) Miq	Mt	UCENG²-AN
	PITTOSPORACEAE		
Tr	*Pittosporum ferrugineum* W Ait	Ef	-
	PLUMBAGINACEAE		
Ln	*Plumbago zeylanica* L	Ms	GODONG ENCOK
	POACEAE		
Gr	*Apluda mutica* L	Sv	KELITIKAN
Gr	*Arundinella setosa* Trin	Sv	LAMURAN
Gr	*Bambusa vulgaris* Schrad	Ms	PRING AMPEL
Gr	*Bothriochloa modesta* (Back) Back & Henr	Sv	GAJI²-AN
Gr	*Brachiaria mutica* (Forsk) Stapf	Sv	KOLONJONO
Gr	*Brachiaria ramosa* (L) Stapf	Sv	PAITAN
Gr	*Brachiaria reptans* (L) Gardn & Hubb	Sv	RAYAPAN
Gr	*Brachiaria subquadripara* (Trin) Hitchc	Sv	KOLONJONO
Gr	*Chloris barbata* (L) Swartz	Sv	SUKET CAKAR AYAM
Gr	*Chloris dolichostachya* Lagasca	Sv	PUTIHAN
Gr	*Cynodon arcuatus* Presl	-	SUKET GRINTING
Gr	***Cynodon dactylon*** (L) Pers	Sv	GRINTING
Gr	*Cyrtococcum patens* (L) A Camus	Sv	-
Gr	*Dactylotenium aegyptium* (L) Richt	Sv	SUKET KATELAN
Gr	*Dichanthium caricosum* (L) A Camus	Sv	LAMURAN PUTIH
Gr	*Digitaria adscendens* (HBK) Henr	Sv	JELEPARAN
Gr	*Digitaria remota* Henr	Sv	KELITIKAN
Ln	*Dinochloa scandens* (Blume ex Nees) DK	Mt	PRING KADALAN
Gr	*Diplachne fusca* (L) Beauv	Sv	-
Gr	*Echinochloa colona* (L) Lmk	Sv	TUTON
Gr	***Echinochloa crus-gali*** (L) Beauv	Sv	PULUTAN
Gr	*Eleusine indica* (L) Gaertn	Sv	LULANGAN
Gr	*Eragrostis amabilis* OK	Sv	PEKINGAN
Gr	***Eragrostis chariis*** (Schult) Hitchc	Sv	-
Gr	***Eragrostis unioloides*** (Retz) Nees ex Steud	Sv	-
Gr	***Eriochloa prosera*** (Retz) CE Hubb	Sv	-
Gr	*Eulalia amaura* (Buese) Ohwi	Sv	LAMURAN ALUS
Ln	***Gigantochloa apus*** (Bl ex Schult f) Kurz	Mt	PRING TALI
Tr	***Gigantochloa verticillata*** (Willd) Munro	Mt	PRING GOMBONG
Gr	*Hackelochloa granularis* (L) OR	Sv	LAMURAN ALUS
Gr	*Heteropogon contortus* (L) Beauv ex R&S	Sv	MERAKAN
Gr	*Imperata cylindrica* (L) Raeusch	Sv	ALANG²
Gr	*Ischaemum barbatum* Retz	Sw	-
Gr	*Ischaemum muticum* L	Be	RESAP
Gr	*Ischaemum timorense* Kunth	Ef	PRING²-AN
Gr	*Leptaspis banksii* R Br	Sv	-
Gr	***Leptochloa chinensis*** (L) Nees	Sv	LANCURAN
Gr	*Oplismenus burmanii* (Retz) Beauv	Sv	BEBESAN
Gr	*Oryza granulata* Nees & Arn ex Watt	Ms	PADI²-AN
Gr	*Panicum luzonense* Presl	Sv	-
Gr	*Panicum repens* L	Sv	LEMPUYANGAN
Gr	*Panicum sumatrense* Roth ex R& S	Sv	-

Gr	*Paspalidium flavidum* (Retz) A Camus	Sv	SUKA
Gr	*Pogonatherum paniceum* (Lamk) Hack	Sv	DELINGAN
Gr	*Rottboellia exaltata* L f	Sv	BRANJANGAN
Sh	*Saccharum spontaneum* L	Be	GLAGAH
Gr	*Schima nervosum* (Rottl) Stapf	Sv	LAMURAN PUTIH
Gr	*Schizachyrium fragile* (R Br) A Camus	Ms	RETAK
Sh	***Schizostachyum blumii*** Nees	Mt	PRING WULUH
Gr	*Setaria adhaerens* (Forsk) Chiov	Ms	PULUTAN
Gr	*Setaria palmifolia* (Willd) Stapf	Ms	LULUWAN
Gr	*Sorghum nitidus* (Vahl) Pers	Sv	PADI[2]-AN
Gr	*Sorghum propinquum* (Runth) Hitchc	Sv	-
Gr	*Spinifex littoreus* (Burm f) Merr	Be	LARI[2]-AN
Gr	*Sporobolus humilis* Presl	Sv	TIKUSAN
Gr	*Thelepogon elegans* Roth ex R&S	Sv	RAYAPAN KASAR
Gr	*Themeda arguens* (L) Hack	Sv	MERAKAN
Gr	*Themeda giganthea* (Cav) Hack	Sv	MERAKAN GAJAH
Gr	*Themeda triandra* Forsk	Sv	MERAKAN LANANG
Gr	***Thysanolaena maxima*** (Roxb) OK	Mt	-
Gr	*Zoysia matrella* (L) Merr	Sv	RUMPUT JEPANG
POLYGONACEAE			
Cl	*Antigonon leptopus* Hook & Arn	Mt	AIR MATA, PENGANTIN
He	*Polygonum barbatum* L	Ef	SOLOH NYOWO
He	***Polygonum chinense*** L	Mt	-
Sh	*Xanthophyllum excelsum* (Bl) Hiq	Mt	SANEK
RANUNCULACEAE			
Ln	*Clematis javana* DC	Ef?, Ms, Mt?, Sv	-
Ln	*Clematis vitalba* L	Ms	-
RHAMNACEAE			
Sh	*Colubrina asiatica* (L) Brongn	Be	PARIA LAUT
Tr	***Ziziphus oenoplia*** (L) Mill	Ms	WIDORO GUNUNG
Tr	*Ziziphus rotundifolia* Lamk	Sv	WIDORO BEKOL
RHIZOPHORACEAE			
Tr	*Bruguiera cylindrica* (L) Bl	Mg	-
Tr	*Bruguiera gymnorrhiza* (L) Lmk	Mg	-
Tr	*Ceriops decandra* (Griff) Ding Hou	Mg	TINGI
Tr	*Ceriops tagal* (Perr) CB Robins	Mg	TINGI
Tr	*Rhizophora apiculata* Bl	Mg	BAKO RAYAP
Tr	***Rhizophora stylosa*** Griff	Mg	BAKO[2]
ROSACAE			
Tr	*Parinari corymbosum* (Bl) Miq	Ms	WULUH
Sh	*Rubus rosaefolius* JE Smith	Ms, Mt	KAWAR HUTAN
RUBIACEAE			
He	***Borreria brachystema*** (R Br ex Bth) Valet	Ms	-
He	*Borreria setidens* (Hiq) Bold	Ms	-
Tr	*Guettarda speciosa* L	Be	KETEPENG KETEK
He	***Hedyotis corymbosa*** (L) Lamk	Sv	-
Tr	*Morinda citrifolia* L	Ms	MENGKUDU
Tr	*Morinda tomentosa* Roth	Sv	MENGKUDU HUTAN
Tr	*Neonauchlea calycina* (Bartl ex DC) Merr	Mt	GEMPOL KETEK
Tr	*Neonauchlea obtusa* (Bl) Merr	Ef	GEMPOL
He	***Paveta montana*** Reinu ex Bl	Mt	-
Sh	***Psychotria curviflora*** Wall	Ef	KI KORESWUNGU
Sh	*Psychotria extensa* Miq	Ef	-
Sh	*Randia* sp.	Sv	-
Ln	*Randia longiflora* Lamk	Ef	DLIMOAN
Sh	*Randia miquellii* K&V	Ms	-
Sh	***Randia patula*** (Horsf ex R&S) Miq	Ms	ENTUP TAWON
Ln	***Randia wallichii*** Hook f emend R&V	Ef	KUNIRAN
RUTACEAE			
Tr	*Aegle marmelos* (L) Corr	Ms?, Sv	BILA, MOJO
Sh	*Atalantia trimera* Oliv	Ms, Sv	JERUK[2]-AN
Tr	***Euodia glabra*** (Bl) Bl	Mt	-
Tr	*Limonia acidissima* L	Sv	KAWISTA
Sh	***Lunasia amara*** Blanco	Ms	-

Tr	*Micromelum minutum* (Forster f) W&A	Ef	TELAWAS
Tr	*Murraya paniculata* (L) Jack	Ms	KEMUNING
	SALVADORACEAE		
Sh	*Azima sarmentosa* (Bl) B&H	Be	SOK DOY
	SANTALACEAE		
Tr	*Exocarpus latifolius* R Br	Ms	CENDANA SEMUT
	SAPINDACEAE		
Sh	*Allophylus cobbe* (L) Raesch	Be	CUKILAN
Tr	***Arytera litoralis*** Bl	Mt	KOPI[2]-AN
Ln	*Cardiospermum halicacabum* L	Ef	PARENAN
Sh	***Dodonaea viscosa*** Jack	Mt	-
Tr	***Elatosttachys verrucosa*** (Bl) Radlk	Mt	SOLOH
Tr	*Erioglossum rubiginosum* (Roxb) Bl	Ms	KALAYU
Tr	*Ganophyllum falcatum* Bl	Ms	MANGIR
Tr	*Mischocarpus sundaicus* Bl	Be, Mt	PANCAL KIDANG
Tr	*Sapindus rarak* DC	Mt	LERAK
Tr	*Schleichera oleosa* (Lour) Oken	Ms?, Sv	KESAMBI
	SAPOTACEAE		
Tr	*Palaquium amboinense* Burck	Mt	NYATO
	SIMARUBACEAE		
Tr	***Brucea javanica*** (L) Merr	Ms	POHAN
	SOLANACEAE		
He	*Physalis angulata* L	Sv	CEPLUKAN
He	*Physalis minima* L	Sv	CEPLUKAN
He	*Solanum junghuhnii* Miq	Ms	-
Sh	*Solanum verbascifolium* L	Ms	TETER
	SONNERATIACEAE		
Tr	*Sonneratia alba* JE Smith	Mg	KAPIDADA
Tr	*Sonneratia caseolaris* (L) Engl	Mg	PREPAT
	STERCULIACEAE		
Sh	*Helicteres isora* L	Ms, Sv	ULES
Tr	***Heritiera littoralis*** Dryand ex W Ait	Be	-
Tr	*Kleinhovia hospita* L	Ms	TIMONGO
Sh	*Melochia umbellata* (Houtt) Stapf	Mt	WISNU
He	*Pentapetes phoenicea* L	Ef	BUNGA TENGAH HARI
Tr	*Pterocymbium tinctorium* (Blanco) Merr	Ms	SRIWILKUTIL
Tr	*Pterospermum diversifolium* Bl	Mt	BELENG
Tr	***Pterospermum javanicum*** Jungh	Ef	BAYUR
Tr	*Sterculia foetida* L	Ef?, Ms	KEPUH
	TACCACEAE		
He	*Tacca leontopetaloides* (L) OK	Ms	ILES[2]
	TILIACEAE		
He	*Corchorus aestuans* L	Be	JENGGOTAN
He	*Corchorus olitorius* L	Ms	GANJA HUTAN
Tr	*Grewia acuminata* Juss	Mt	TALOK
Tr	*Grewia eriocarpa* Juss	Ms	TALOK
Tr	*Grewia glabra* Bl	Ms	DELUWAK
Tr	*Grewia retusifolia* Kurz	Sv	TALOK
Sh	*Microcos tomentosa* JE Smith	Ms	DELUWAK
Tr	*Schoutenia ovata* Korth	Ms	WALIKUKUN
Sh	*Triumfetta suffruticosa* Bl	Ms	PULUTAN
	ULMACEAE		
Sh	*Aphananthe cuspidata* (Bl) Planch	Mt	SOLOH
Tr	***Celtis tetandra*** Roxb	Ef	CENDANA SEMUT
Tr	*Celtis wightii* Planch	Ms	CENDANA SEMUT
Tr	***Gironiera subaequalis*** Planch	Ms	WULUNGAN
	URTICACEAE		
Sh	***Boehmeria nivea*** (L) Gaud	Ef	-
Sh	*Boehmeria zollingeriana* Wedd	Ef	-
Sh	*Debregeasia longifolia* (Burm f) Wedd	Ef	-

He	*Elatostema rostratum* (Reinw ex Bl) Hassk	Ef	-
Tr	*Pipturus argenteus* (Forst f) Webb	Ef	TUTUP AWU
	VERBENACEAE		
Tr	*Avicennia alba* Bl	Mg, Sw?	API[2]
Tr	*Avicennia marina* (Forsk) Vierh	Mg, Sw?	API[2]
Sh	*Clerodendrum inerme* (L) Gaertn	Be, Ms	KEMBANGBUGANG
Sh	*Clerodendrum serratum* (L) Moon	Ms	SENGGUNGGU
Sh	*Clerodendrum speciosissimum* Van Geert	Ms	-
Sh	*Lantana camara* L	Ms	TEMBELEKAN
Sh	***Premna corymbosa*** (Burm f) Rottl & Willd	Be	-
Tr	*Premna oblongata* Miq	Sv	JEBAU
Sh	*Stachytarpheta jamaicensis* Vahl	Sv	JARONG
Tr	*Tectona grandis* L f	Ms	JATI
Tr	*Vitex pubescens* Vahl	Ef, Ms	LABAN
	VIOLACEAE		
He	*Hybanthus suffruticosus* (L) Baill	Sv	-
	VITACEAE		
Ln	*Cayratia trifolia* (L) Domin	Ms	GALING
Ln	*Cissus diffusa* (Miq) Amsh	Ms	-
Ln	*Cissus discolour* Bl	Ms	DERES
Ln	*Cissus quadrangula* L	Ms	TIKELBALUNG
Ln	*Tetrastigma lanceolarium* (Roxb) Planch	Ms	-
	ZINGIBERACEAE		
He	***Alpinia javanica*** Bl	Ms	KAPULAGA
He	*Curcuma zedoaria* (Berg) Roscoe	Ef	TEMU IRENG
He	*Zingiber americans* Bl non auct plur	Ms	LEMPUYANG PAIT
He	*Zingiber zerumbet* (L) JE Smith	Ms	LEMPUYANG PAIT

Appendix IV Additional check-list of plant species (Clason 1933, UNDP/FAO 1977, Lembaga Penelitian IPB 1985)

Several authors mentioned additional species to Appendix III. The information is often incomplete due to lack of time, but for reasons of completeness these species are mentioned in this additional check-list.

Family unknown			
-	*Canthospermum scavabaevides*	-	-
-	*Feronia elephantum*	-	-
-	*Wendlandia* spp.	-	-
Aizoaceae			
He	*Sesuvium portulacastrum* L	-	GELANG LAUT
Annonaceae			
Tr	*Polyalthia rumpfii* (Bl ex Hensch)	-	-
Apocynaceae			
Sh	*Rauvolfia verticillata* (Lour) Burkill	-	-
Araceae			
-	*Amorphophalis paeoniifolius* (Dennst) Nicolson	-	ILES[2]
Arecaceae			
Cl	*Calamus javensis*	-	-
Asclepiadaceae			
Pa	*Hoya diversifolia* Bl	-	KAPALAN
Sh	*Marsdenia stenocentra* Bakh f	-	-
Chenopodiaceae			
He	*Arthrocnemum indicum* (Willd) Moq	Mg	-
Commelinaceae			
He	*Cyanotis phlonoides* Bth	-	-
Euphorbiaceae			
Tr	*Glochidion glabrum* J Smith	-	KALANGMAIN
-	*Mallotus moritzianus* MA	-	-
Tr	*Omalanthus populneus* (Geisel) Pax	-	TATAP
Fabaceae			
-	*Butea frondusa*	-	-
Fagaceae			
Tr	*Quercus* spp.	Ef	PASANG
Flacourtiaceae			
-	*Flacourtia rukam*	-	-
Tr	*Homalium foetidum* Benth	-	GELINGSEM
Hydrocharitaceae			
Gr	*Thalassia* spp.	Be/Se[3]	-
Lamiaceae			
-	*Gomphostemma phlomoides* Bth	Ms	-
He	*Hyptis* spp.	-	-
Leeaceae			
Tr	*Leea indica* Meer	-	GIRANG
Loranthaceae			
Tr	*Scurrula montana* Dans	-	CEMARA GUNUNG
Meliaceae			
Tr	*Aphanamixis grandifolia* Bl	-	PANCAL KIDANG
-	*Dysoxyllum amooroides*	-	-
Mimosaceae			
Tr	*Acacia spinosa*	-	-
Tr	*Samanea saman*	_	TREMBESI

Moraceae			
-	*Artocarpus elasticus*	-	-
-	*Ficus glomerata*	-	-
Musaceae			
-	*Musa acuminata*	-	-
Myrtaceae			
-	*Eugenia densiflora*	-	-
-	*Eugenia jamboloides*	-	-
Ophioglossaceae			
Pa	*Ophioglossum recticulatum* L	Ms	JUKUT SIRARU
Orchidaceae			
-	*Nervilia* sp.	-	-
Pa	*Tropidia graminea* Bl	-	-
Piperaceae			
Cl	*Piper betle* L	-	SIRIH
Pittosporaceae			
Sh	*Pittosporum moluccanum* (Lmk) Miq	-	KECOMBRANGAN
Poaceae (Gramineae)			
Gr	*Cappilipedium parviflorum* (R Br) Stapf	Sv	-
Gr	*Chrysopogon aciculatus* (Retz) Trin	Sv	-
Gr	*Chrysopogon subtilis* Steud	Sv	-
Gr	*Dendrocalamus* sp.	-	-
Gr	*Eragrostis tenella* (L) Beauv ex R&S	Sv	EMPRIT[2]-AN
Gr	*Heteropogon insignis* Thw	-	BAJANGAN
Gr	*Heteropogon triticeus* (R Br) Stapf	Sv	-
Gr	*Ophiuros tongcalingii* (Elm) Henr	Sv	-
Gr	*Panicum sisbaense* Hayata	-	-
Gr	*Paspalum* spp.	Sv	-
Gr	*Polytoca bracteata* R Br	Sv	-
Gr	*Pseudosorghum zollingeri* (Steud) A Camus	Sv	-
Gr	*Sclerachne punctata* R Br	Sv	-
Gr	*Themeda bracteata*	-	-
Gr	*Themeda frondosa*	Sv	-
Polypodiaceae			
Fe	*Arthropteris obliterata* JSM	Ef	-
Fe	*Asplenium nidus L*	-	PAKU PANDAN
Fe	*Doodia dives Kunze*	*Ef*	-
Fe	*Doodia samentosa*		
Fe	*Dryopteris rufuscens C Chr*	*Ef*	-
Fe	*Microlepia speluncae Moore*	-	-
Fe	*Nephrolepis hirsutula Presl*	-	PAKIS CINA
Fe	*Polystichum aristatum Presl*	-	-
Fe	*Pteridium aqualinum Kuhn*	-	-
Fe	*Pteris sp.*	-	-
Fe	*Pteris excelsia Gaud*	-	-
Fe	*Pteris longipes*	*Ef*	-
Fe	*Pteris pellucens Agardh*	-	-
Fe	*Pteris quadriaurita Retz*	-	-
Fe	*Scyphularia pentaphylla Fee*	-	-
Rhizophoraceae			
Tr	*Rhizophora conjugata*	-	-
Tr	*Rhizophora mucronata*	-	-
Rosaceae			
Tr	*Parinari griffithianum*	-	-
Rubiaceae			
-	*Anthocephalus sp.*	-	-
Tr	*Randia oppositifolia (Roxb) Kds*	-	KUNIRAN
Sh	*Randia spinosa (L f) Poer*	-	-
Rutaceae			
Tr	*Aegle procera*	-	-

Sapotaceae			
Tr	*Manilkara kauki (L) Dubard*	-	SAWO KECIK
-	*Palaquium cupsidatum*	-	-
-	*Palaquium javanense*	-	-
Simarubaceae			
-	*Harrisonia paucijuga*	-	-
-	*Harrisonia perforata (Lour) Merr*	*Ms*	-
Ulmaceae			
Tr	*Gironniera cupsidata Krz*	-	WULUNGAN
Verbenaceae			
Tr	*Avicennia officinalis*	-	-
Tr	*Gmelina arborea Roxb*	-	WARENG
Zingiberaceae			
-	*Kaemferia rotunda*	-	-

1. might be *Calamus javensis* Bl

2. is the same as *Phyllanthus emblica* L

3. found in the intertidal zone