Forestland: Its dynamics, disorganised uses and planning in South Kalimantan, Indonesia

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FOREWORD

Completing my PhD study has been a long process. It started when the former Minister of Forestry decided in 1992 to provide the necessary funds for several hundreds of employees of Ministry of Forestry to study in Indonesia or abroad for MSc and PhD degrees for 5 years. The selection was organised by the regional Forestry offices in the whole country to find qualified candidates. I thought this was a good chance to increase my knowledge, experience and ability, and to contribute something beneficial to the Forestry. So I applied for it, and passed the selection.

During my service with the Ministry of Forestry since 1975, my duties were related to project monitoring and project evaluation, forest inventory, remote sensing and GIS. Later on, I was stationed in the region for four years, dealing with operational work and problems in forest inventory and forestland use planning.

In the field, I encountered and became aware of the real problems. Whereas the problems in forest inventory and remote sensing activities were mostly technical, the problems in forestland use were much more challenging, and much broader than just technical. Many other aspects and actors were involved in the problems. At that time, I realised that the Forestry is alone in its mission to preserve the forests. Meanwhile, I also realised that the interest in forestland use planning was very limited. Then an idea came into my mind; why not do something about forestland use planning? Something scientific, but at the same time standing on solid ground, in the sense that it would be operational.

Since I wanted to study both forestland use planning and its results, the combination of science and practice could, in my opinion, lie in interpreting remote sensing data along a historical time axis and advance analysis methods. After long discussions this idea led to drawing up a project proposal that would be acceptable as the basis for a PhD study at a Dutch university.

However, although my plans were interesting to the University of Wageningen, the International Institute for Aerospace Survey and Earth Sciences (ITC) in Enschede and authorities in Indonesia, they came to nothing and the project was abandoned. People involved took on other responsibilities and the funding of my studies was discontinued.

Some years later, though, I was very surprised to be offered a one-year fellowship to finish my PhD study and take my doctoral examination. The project was set back on the rail again and I would be supervised in the Netherlands. And then there was a place for me in an Indonesia-Wageningen project, related to the same educational programme started by Ministry of Forestry in 1992, Hutan Lestari International (1996). In English this means “Sustainable Forests International”. I am proud of having been in a position to contribute to this programme.

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I would also like to express my gratitude to the Minister of Forestry, who granted me permission to pursue my PhD. study. I thank the former Head (and Director General) of Forestland use Planning Agency, i.e. the late Ir. Armana Darsidi, Ir Sunarsan Sastrosemito and Ir. Sumohadi MBA for their encouragement. During my study, I was attached to the Centre for Forestry Education and Training. I thank Ir. E. Kosasih, the Heads of the Centre and the previous Heads of the Centre for giving me their attention. There are many others in the Ministry of Forestry, who, in one way or another, supported and encouraged me. I thank them all.

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In terms of financial support, several institutions and persons were involved. In the beginning, my study was financed by the Ministry of Forestry and later by Forest Inventory and Land use Planning Agency. The extension of my study was financed by EU-FIMP (European Union-Forest Inventory and Monitoring Project) through Dr. Yves Laumonier. Much to my surprise, the staff of the National Forest Inventory Project also contributed to my study. Finally, The Gibbon Foundation, through Dr. Ir. W.T.M. Smits, who came into my life in an unexpected way, provided a fellowship for the final year. To all of them, I offer my sincere thanks. Without their contribution, my study would never have been completed.

Many people in the ITC Enschede should be thanked for their contributions. I thank Dr. M. Weir and Dr. Y. Hussin for their professional advice on remote sensing and GIS. I will not forget to thank former staff members of Forest Survey Division, ITC, who introduced me to many aspects of forest survey and remote sensing in the past. Many other staff members of ITC also contributed to the completion of my study. Unfortunately, I cannot name them all, but I appreciate their support.

At Wageningen University, Dr. D. Hoekman was very helpful to me in various matters. Mr. C.M.M. van Heijst is thanked for arranging administrative matters before and during my stay, and for trying hard to find accommodation for me. I also thank Ir. Martin Vissers for administrating my fellowship and other logistic support. Mr. E de Bruijn is thanked for the technical support.

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The way Prof. Oldeman treated me was exceptional. He taught me how to treat people nicely and politely. He reminded me of someone who once told me that “the way in which we treat people shows how we respect them”. I feel a deep sense of gratitude to him for his unconditional support and I am honoured to have him as my promotor. I would like to thank Mrs. W. Oldeman-Helder for her keen interest in me, my family and my work whenever met.

I am really indebted to my family and relatives, who I cannot all mention here. Their support and attention have really encouraged and motivated me to finish my work. I am very grateful to them. I also thank Drs. Supratno MBA for his special advice.

Finally, I dedicate this book to my mother and my wife, the two excellent women in my life, who really care about me. My heartfelt thanks to both of them.

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1. GENERAL INTRODUCTION

1.1. Major issues in forestland uses

1.1.1 Disorganisation of forestland use

Problems in using land have a close relationship to human needs. According to the FAO (1989), basic human needs must be met from the land, and land is in limited supply, which causes conflicts since demands for arable land, forestry and other purposes are greater than the available land resources. On the other hand, using the limited land is a matter of efficiency, as the land resource base in the developing world is large enough to meet the needs for biological products of its future population, if it is used efficiently (Bonte-Friedheim and Kassam, 1993). For this reason, to obtain the maximum benefits from land for the majority of the people, land must be well managed.

On the increasing needs of land, Donner (1987) stated that forests have always acted as land reserves for growing populations; and the tropical forests belong to the last remaining reserves of unused land in the world and are becoming the main targets of 'development'. For this reason, converting tropical moist forest to other land use will be unavoidable as long as the number of people rises faster than the agricultural productivity of farmland (Ecmuller and Van Maaren, 1984 in Hummel ed.).

At the local level, using forestland frequently causes competition between local community use and forest use, e.g. when the land is declared protection forest, but settlements exist in the area, or local use versus the development of timber estate. At the higher level, there can be competition between the Forestry and other Agencies regarding land use, such as the development of crop estates in a productive natural forest. Since the land area is firm, competing and overlapping uses are becoming significant, i.e. when the number of people and their aspirations increase, the infrastructure is improved, and private investments as well as development funds become available.

Deforestation and *decreasing areas of forestland* are among the outcomes of competing use of forestland, most of them caused by human activities (FAO, 1989, Fresco, 1993, Turner and Meyer, 1994, Turner et al., 1995, Sunderlin and Resosudarmo, 1996, Contreras-Hermosilla, 2000, Cleuren, 2001). These can be illegal and uncontrolled cutting, burning, institutionalised deforestation, on purpose, i.e. converting forested areas of forestland into non-forest use. Another cause is the uncoordinated planning of land use. In this situation, conversion of forestland to other uses goes beyond the forestry domains, e.g. within biophysical, social, economic, cultural, institutional and political contexts. Therefore, the conversion should be looked at in an integrated and comprehensive way (De Gier, 1995).

However, currently, the awareness of the dangers of deforestation and forest degradation is increasing, and the problem has become a global issue and of international concern, such as mentioned in Agenda 21 on Combating Deforestation (WRM, 1990, UNCED, 1992, Bandung Initiative, 1993). Nevertheless, the awareness will not in itself solve the problems

1.1.2 The legal status of forestland and forestland use planning

Disorganisation of uses of forestry and non-forestry is also possible when the forestland is not properly defined and *planned*. In this respect, Wyatt-Smith (1987) states that improper land management can happen, either if the law and regulations are lacking, or if these are laid down and implemented without co-ordination and synchronisation.

In natural forest, where the boundaries between forestland and non-forestland are not always clear, e.g. in relation with the land tenure, and currently with customary rights, competing and overlapping use of forestland can easily happen. Forestland can physically be alienated from non-forestland by demarcation. Socially and culturally, however, it is hardly possible to separate them. This is simply because for ages, the native people have been living in the forests and these forests are part of their living environment.

National lands are divided into hierarchic administrative units, namely province, regency, district, subdistrict and village. As part of the national land, forestland can not be exclusively separated from the administrative boundaries. This confuses the demarcation activities to obtain the *legal status* of forestland. Accordingly, the legal status of forestland cannot be properly defined in terms of *a 'clear and clean'* forestland area, and defended. This situation complicates tropical forest management for different types of use, since every type of use, i.e. conservation, protection and utilisation, needs of different treatment. Moreover, different interests of the various land users usually exist and compete with forestry interests. For this reason, well-accepted land-use plan that serves different aspects of forest use is important.

Towards a sustainable use of land, an appropriate plan should be developed in an integrated way by considering all aspects of land use, e.g. the utilisation and protection functions, and the current and future needs of land. In this respect, Conyers et al. (1984) stated that land use planning is increasingly expected to contribute to an integrated approach to planning the use and management of land resources among socio-economic, environmental and biophysical components. Moreover, the need for an integrated approach to the planning and management of land resources towards sustainable land use plan is globally recognised (see, ITTO, 1990, UNCED, 1992).

1.1.3. Lack of complete, recent and reliable data

The availability of complete, recent and reliable data and information is a significant factor in establishing plans, and, therefore, in managing the land properly. However, the current situation shows that in most cases the databases are defective. Even when laws and regulations are properly formulated and applied, land use problems remain unsolved if reliable data on the land are not available. A lack of data is also an important issue, since the availability of recent, complete and reliable data is crucial to sound planning, managing and monitoring of land use, including forestland use.

This situation is most likely to occur in countries that have to make do with inaccurate data, incomplete data coverage, obsolete data or unavailable spatial data, for instance when satellite-based photonic scanning of the land is hampered by permanent clouds.

1.2. Objectives and arrangement of the thesis

1.2.1. Objectives of the study

The study deals with ongoing land cover changes and land use processes, their underlying causal factors, and the design of an approach to solving the problem of disorganised use of forestland towards a proper use. To define the objectives of the study, the three major issues mentioned before were investigated by the following questions:

- In the situation where complete, reliable and recent spatial data are lacking, what is the proper way to optimally use the available spatial data?
- What are the underlying processes of land cover and land use changes? Do settlement patterns indicate the crucial role of population dynamics as a driving force behind the ongoing processes? What other forces contribute to the way in which forestland is used?
- Regarding the strategic factors of forestland use planning, is the improvement of forestland allocation helpful to decision-makers in solving their problems?
- What is (are) the appropriate way (s) to solve the forestland use problems?

Based on the above-mentioned questions, the *objectives* of the study were set up as follows:

1. To analyse land cover changes and land use processes, in terms of
    - Deforestation rates and patterns
    - Relationships between patterns and dispersions of settlements, and land cover changes
    - Role of the dynamics of rural people and other driving forces behind land use processes.
2. Regarding the implementation of two existing forestland allocation plans, to analyse
    - The continuing decrease in forestland and its possible effects on forest management
    - The decreasing role of the Forestry Agency in planning forestland uses.
3. To develop an approach to support decision-making in solving problems due to disorganised forestland use by means of
    - Land reallocation in the problem area
    - Strategic factors in the Forestland use plan
    - Forestland use re-classification.

To achieve the above mentioned objectives, the following data and information have been made available:

- Remote sensing images of various types were collected at various dates and resolution, and used in the present study.
- Topographical maps and other maps were used as base and reference documents.
- Statistical data concerning South Kalimantan and time series of statistical data on Riam Kanan were also provided.

- By interviewing local people in selected villages, socio-economic data and information about the perception by various actors of protection and environment issues and their aspirations in this field were collected.

1.2.2. Approach and framework

To achieve the objectives of the study, the following approaches were followed.

- Analyses of remote sensing data combined with some statistical calculation were undertaken to study the existing land cover and land use types, and to discover land cover changes, e.g. deforestation, settlement' patterns. Together with other supporting data, such as statistical data and interview data, this led to analysing the land use processes and their driving forces, which exist in the studied Riam Kanan river basin area.
- Two different plans related to the forestland were evaluated and compared. This led to an analysis of the continuing decrease and breaking up of forestland, and the decreasing role of the Forestry in planning land use. Analysing strategic factors, as part of the SWOT analyses was a means to understand the strengths and weaknesses of the plans in the case of South Kalimantan.
- To improve forestland use, an appropriate method of a system to support decision-makers was applied in the study area to the re-allocation of protection forest and agriculture. At the provincial level, a conceptual model to define forest functions was made, including socio-economic factors.

Based on the existing conditions, the ongoing processes and the goal to be achieved, the framework of the study is as in Figure 1.1.

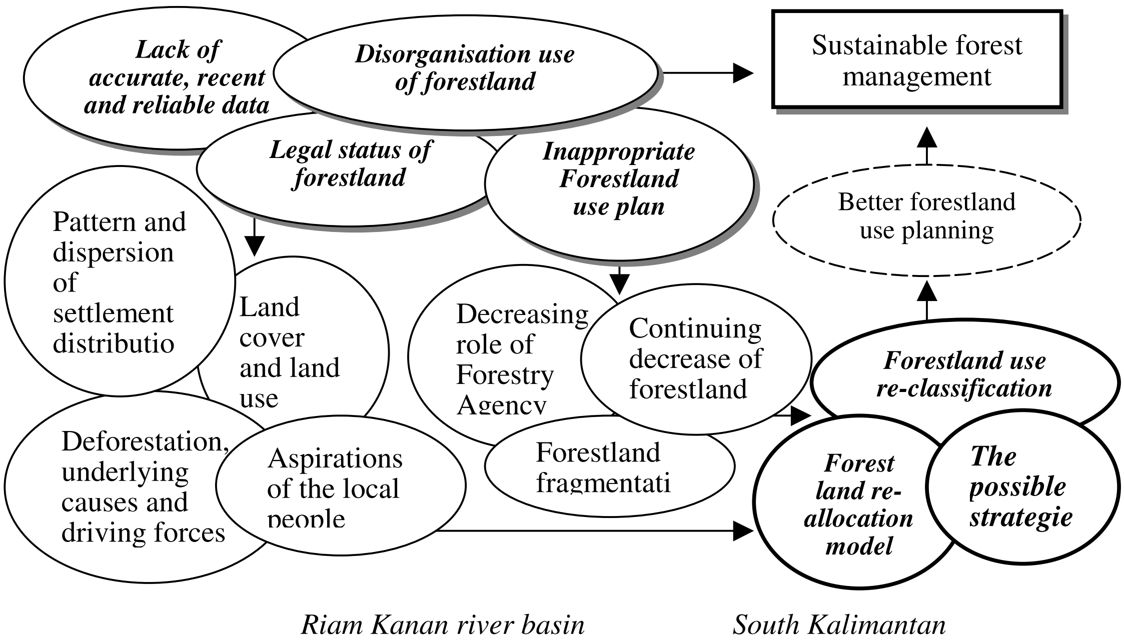

Figure 1.1. Framework of the study.

major issues · *analysis* · *impact* · *objective* · *result* · *goal*

1.2.3. Arrangement of the present book

In *Chapter1*, *General Introduction*, the interrelated three major issues from the background of the study, i.e. disorganisation of forestland use, legal status of forestland and lack of accurate data and information, are discussed. The objectives and the framework of the study are also described in this chapter, as are the considerations to select South Kalimantan as study area. The basic terms and the underlying theories related to this study are the subject of this chapter.

In *Chapter 2, Land cover changes and land use processes*, the problem of disorganised forestland use for protection and for agricultural purposes was studied, using a critical river basin, namely Riam Kanan as study area. Land cover and land use changes were analysed using different types of remote sensing data obtained at different dates. Settlement patterns and dispersion, the population dynamics as well as other possible driving forces behind the changes are also discussed. The results of interviews with local people as to their aspirations and appreciation concerning forest protection are also discussed. The resulting assessments covered rate and patterns of deforestation; land cover, land use and settlement dynamics; and the driving forces behind them. An alternative use of forestland for protection and utilisation in a river basin area was defined by means of land reallocation.

In *Chapter 3 Planning and allocation of forestland,* two plans regarding forestland allocation are discussed and compared. These plans are the older forestland use by consensus plan made by the Forestry Agency, and the newer provincial spatial management plan as the product of the Provincial authority. To some extent, these two plans have a different base, e.g. the classification system and the area, and their implementation, therefore, will affect the existence of forestland and forest management to a vastly different extent.

To answer some critical questions regarding the establishment of the newer plan, its strategic factors, e.g. strengths and the weaknesses of the older plan are analysed. The changing of forestland use, the trend towards continuing decrease in forestland due to the implementation of the both plans, as well as the decreasing role of the Forestry Agency in forest land use planning are also studied in this chapter. A concept on classifying forestland use is proposed in this chapter.

Chapter 4, General discussions and conclusions, contains an overview of the whole study.

1.3. Considerations in selecting the study area

Among the main forested islands in Indonesia, Kalimantan, the Indonesian part of the island of Borneo, is the most important one. This is not only because of its vast forest area, timber quality, the extensive logging activities, and consequently the damages these are causing, but also because of the challenge to manage the forestland properly and to guarantee the existence of the tropical forest. Due to improvement of the infrastructure and the availability of investment funds, land development is becoming more interesting. Unquestionably, environmental and conservation problems will follow. Figure 1.2 shows the location of South Kalimantan in the Indonesian archipelago.

Figure 1.2. South Kalimantan.

Table 1.1 shows the unique land use in South Kalimantan. Although it is the smallest of the four provinces in Kalimantan, it has high population density.

Table 1.1. Area and population of the provinces in Kalimantan (1990). Source: MoPW (1992).

Province	Area		Population		Population density,%
	10^3 ha	%	number	%	
West Kalimantan	14,680.7	26.74	3,234,366	34.40	22.0
Central Kalimantan	15,380.0	28.01	1,395,861	14.85	9.1
East Kalimantan	21,144.1	38.51	1,875,032	19.94	8.9
South Kalimantan	3,698.6	6.74	2,896,647	30.81	78.3
Kalimantan	54,903.4	100	9,401,906	100	17.1

Although in terms of area, South Kalimantan covers only 6.7% of Kalimantan, its population (1990) was the second largest, and consequently it was the most densely populated area in Kalimantan, much more densely than the other three provinces. In terms of land use, the annual increasing use of land for agriculture was 2.9% and for crop estates 5.6% (Prop. Kalsel, 1990a). The situation also implies a more extensive use of the land, although it is not comparable with more advanced islands in Indonesia, such as Java.

Table 1.2 shows that compared with other provinces in Kalimantan and with the national level, the percentage of Permanent Forest land in South Kalimantan is not low. However, the figure for Convertible Production Forest, i.e. the forest area reserved for non-forestry activities, was low.

Table 1.2. Forestland distribution in Kalimantan.
The Permanent forestland includes Protection Forest, Conservation Area, Limited Production Forest and Permanent Production Forest. Convertible Production Forest is reserved for non-forestry uses. Source: Dephut (1986).

Province	Area, x10^3 ha	Permanent Forest		Convertible Production Forest	
		x10^3 ha	%	x10^3 ha	%
West Kalimantan	14,680.7	7.695	52.41	1,508	10.27
Central Kalimantan	15,380.0	10,997	71.87	3,000	19.50
East Kalimantan	21,144.1	15,951	76.43	3,500	16.55
South Kalimantan	3,698.6	2,029	54.84	284	7.68
Kalimantan	54,903.4	36,672	66.79	8,292	15.10
Indonesia	193.071.0	113,433	58.75	30,537	15.82

In general, the infrastructure of South Kalimantan gives a relatively better access to the land in comparison with other provinces in Kalimantan. This is pushing the economic growth on the one hand, but it has affected the existing forestland on the other hand. The existence of various natural resources, the geographic position and its infrastructure has encouraged investments in timber estates (see Hatta, 1999), mining and plantation, which mostly are demanding large land areas. In this situation, im-balanced use of forestland can be predicted, especially because recent and accurate land information is lacking.

The above mentioned conditions indicate that the lack of available land for large-scale non-forestry activities in South Kalimantan is becoming acute, and therefore, sound land management is crucial.

1.4. Terms and Theory

1.4.1. Land cover, land use and their dynamics

Land, land cover, land use, and their changes

Land can be used for different purposes in different ways; therefore, it is important to select the way most suited to a particular piece of land that best serves the interests of those concerned (Fresco et al., 1992). *Land cover* is conceptualised as the layer of soil and biomass, belonging to a particular vegetation that covers the land surface (Fresco, 1994). This may also include physical structures built by human beings, biotic phenomena, and any types of development. *Land use* is a term used for any form of using land (FAO, 1989), the function of land being determined by both natural conditions and human intervention (Purnell, 1984).

The relationship between land cover and land use varies. A single type of land use may correspond to a single cover class, such as grassland, or to several distinct cover classes, such as a farming system. Hence, a single land cover class may support multiple uses of land, for instance different forest uses. Turner and Meyer (1994) defined two linked components of land transformation; namely land cover and land use changes. *Land cover changes* include two ideal types, i.e. conversion and modification. The term land use denotes human employment of the land; therefore, *land use changes* always involve shifts to other uses or to a different intensity of the existing use. Land use change is likely to alter the land cover class, but land cover may also change under unchanged land use.

Referring to Turner et al. (1995), land use affects land cover with various implications, and the use-cover relationship is complex, as illustrated in Figure 1.3.

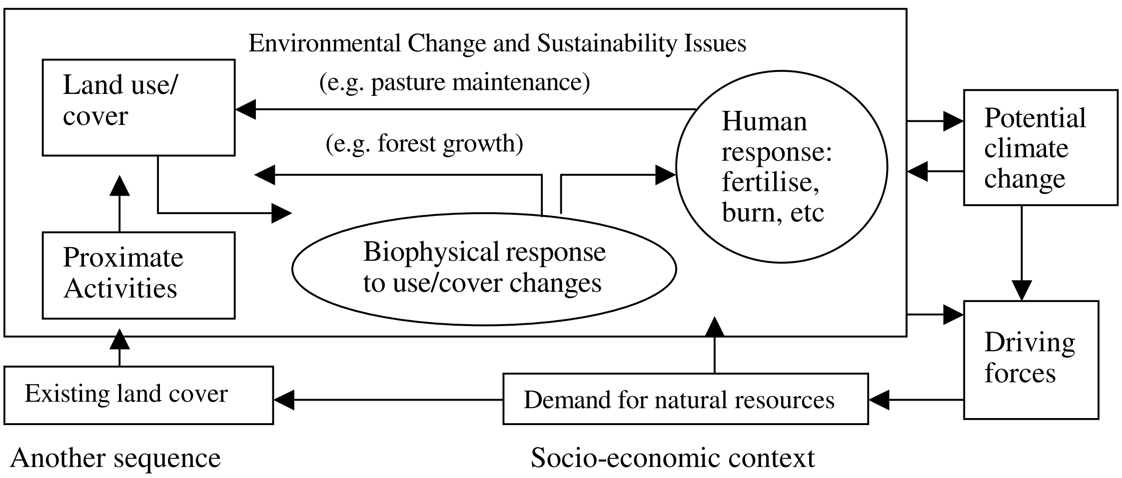

Figure 1.3 Land use and land cover dynamics (after Turner et al., 1995).

Information level of different remote sensing images

Each of the remote sensing images has its own specification, fits to a specific purpose and has certain limitation in information content. Therefore, depending on the sensor system and image resolution, dissimilar level of details can be obtained from different remote sensing products that are usable for different purposes, as shown in Table 1.3.

Table 1.3. Level of information in various remote sensing data.
Instead of scale, the term spatial resolution is often used, e.g. Landsat MSS image has a 80 m spatial resolution. Source: Avery (1971), Lillesand and Kiefer (1994)

Level of information	Representative format	Approximate range of scale
National level	NOAA, Landsat MSS	1:500,000 - 1:3,000,000
Provincial level	Small scale aerial photograph, Landsat TM	1: 60,000 - 1: 80,000
Regional or district level	Medium scale aerial photo, SPOT image	1: 20,000 - 1: 60,000
Local or management level	Large scale aerial photograph	1: 8,000 - 1: 20,000

In land cover analyses, there are two approaches in combining different remote sensing images, namely by 1) geo-referencing images based on the same reference grid, analysing different images individually, and comparing the results, and 2) fusion of images (see Chaves, 1987, Grasso, 1993, Pohl, 1996, Aspinal and Hill, 1997, Dimyati et al., 1996). In case of small-scale aerial photographs, enlargement can be done three to four times to obtain appropriate results without degrading their visual resolution (Reutebuch and Carson, 1994), but the information content usually does not increase as much as the enlargement factor.

When visually interpreting remote sensing images, the smallest size of a single land cover unit that can be defined and observed is important. It depends, e.g. on the scale and spatial resolution of the original image and the final scale of the land use/land cover map (Avery, 1971, Lillesand and Kiefer, 1994). The minimum area of a single land cover unit that can be delineated on aerial photographs is 0.5 cm^2, and the width limit on the maps is 0.2 cm to 0.5 cm (Tomar and Maslekar, 1974, Avery, 1971). Moreover, object areas less than the pixel size will not be represented as a single pixel, while the single pixel is influenced by the eight surrounding pixels.

Land cover and land use classification

Land and vegetation classification can be done on two interrelated bases. These are environmental factors (such as topography and soil), and actual land cover classes (Tomar and Maslekar, 1974). Various schemes of land cover and land use classification have been developed over the years (Valkenberg et al., 1952, Anderson et al., 1967, Paludan, 1976 in Van Gils et al., 1991), but most of the classifications did not separate land use and land cover. Land use and land cover classification systems for use with remote sensing data have been broadly discussed (Anderson et al., 1976, Schoch, 1982, Fresco, pm, Fresco et al., pm and Huising, 1993). Van Gils et al. (1991) developed a land use and land cover classification system starting from aerial photographs or satellite images. In this classification, land use is differentiated from land cover and the relationship between land use and land cover is included.

There are three basic natural elements of land cover, i.e. water, soil and vegetation, which may influence the optical characteristics of a landscape in tropical areas. Alone or in combination in various proportions, they give to a tract of land its particular image characteristics. Thus, any approach to identify a land cover unit has to rely on prior knowledge of the spatial and spectral characteristics of the individual image forming elements. The land use is then interpreted from this preliminary identification process. However, neither an ideal classification nor a single classification system of land cover/land use, which serves the purpose of all users of land use data, or would be applicable in all geographical areas, all scales and types of imagery can be developed (Nunally, 1974, Malingreau, pm).

Forest as a form of land use

Compared with agriculture and grazing, forest as a form of land use has some distinctive features and it ensures multiple functions (Longman and Jenik, 1990). Indeed, forest displays a long period from planting to harvesting, has multiple uses and values, covers a wide range of management intensities, has a conservation function whatever the direct aim of the forest maybe, and needs to be planned in space and time so as to obtain a due to sustained output flow (FAO, 1989).

On the other hand, forest tends to show some serious disadvantages, e.g. by un-quantifiable benefits of the service functions and a longer time to produce an investment return (Van Maaren, 1984). Sharma (1992) stated that, forests are undervalued since many of their non-commercial products, environmental goods and services, are not taken into account. Moreover, the environmental benefits from forests and the environmental cost associated with destructive deforestation are often ignored. Many of these statements are due to the fact that sound ways of forest management that avoid such complications are forgotten because of the profits from wood (Oldeman, 1991). According to De Gier (1995), unlike many agricultural land-uses, forests, particularly natural forests, should in principle be considered permanent in both time and space, thus complicating shifts between land use alternatives.

Driving forces in land use processes

Land cover changes often indicate the changes in land use, and the changes are driven by different *forces.* These are population (P), level of affluence (A), technology (T), political economy, political structure, and attitudes and values. According to Turner, Moss and Skole (1993), the relationship between P, A and T are linked to environmental change, as Impact = f (P, A, T). McNeill et al. (1994) defined the driving forces as 1) political, i.e. decision-making process and state capacity, 2) economic, i.e. vulnerability to external pressure, market allocation, technology and division of wealth, 3) demographic by population pressure on land, and 4) and environmental, due to the quality of natural resources.

Among various driving forces behind land use changes, *human population* and their activities is the most obvious (FAO, 1989, Fresco, 1993, Turner and Meyer, 1994, Turner et al., 1995). However, relating human driving forces of land use directly to land cover changes is difficult because of the complexity of the interactions between human and environmental factors (Turner, Moss and Skole, 1993). For this reason, a multi-sectoral approach in an integrated and comprehensive way is needed to solve the problem (Vanclay, 1993, De Gier, 1995).

Hugo et al. (1987) described the typology of population movement, which covers movements within a local community and movements outside a community. And their causes and effects can be approached from *macro* and *micro determinants*. This scaled approach has points in common with Oldeman (1992,1993), who links products and services to various scales, from small plants through trees to forest parcels and landscapes.

Settlement, its pattern and location

In human geography, a *settlement* covers all forms of grouping of human habitations (Stamp, 1966, Stamp and Clark, eds., 1979, Mayhew and Penny, 1992). As nodes, a settlement can be classified based on morphological criteria, namely urban and rural settlements, population size, i.e. clusters, and functional features, namely central and non-central place (Hagget, et al., 1977).

Based on the similarities and differences regarding their characteristics, a *settlement pattern* can be seen as a distribution pattern of population clusters or settlements of varying sizes (Johnston, ed. 1981, Mayhew and Penny, 1992, The Oxford Guide, 1985, Johnston, 1981, Cox, 1972, Hudson and Fowler, 1966 in Rogers, 1974, and Unwin, 1981). Assuming that in a spatial environment objects are treated as *points,* there are three different basic patterns, namely a linear pattern, a cluster pattern and a uniform pattern (Harris and Ullman, in Garner, 1968). But the more widely used terms are uniform or regular spacing, random spacing and clustered or clumped spacing. See Figure 1.4.

Related to the degree of dispersion, the patterns can be placed in a continuum, ranging from the perfectly clustered to the perfectly uniform, with the random pattern in between (Cox, 1972). From a statistical point of view, these patterns are following binomial, Poisson and negative binomial distributions, respectively.

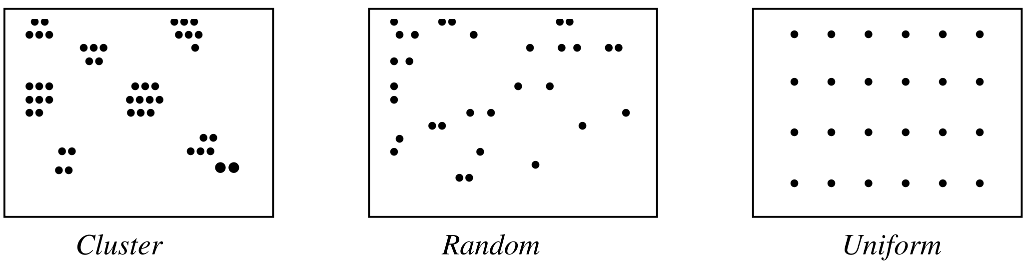

Figure 1.4. The basic patterns and dispersion of objects.
In reality, the pattern and dispersion of objects are not always as perfect as the above figures, e.g. the settlement distribution in Riam Kanan rivern basin.

To understand how far the real situation departs from the basic pattern, Green's index (Ludwig and Reynolds, 1988) and the nearest-neighbour index can be used to understand the *dispersion* (ILWIS, 1993) to characterise the observed pattern as compared with those generated by the independent random process. Different parametric and non-parametric tests can be applied to characterise the observed pattern and dispersion such as the Student's t-test and Chi-square test (see e.g. Hayslett, 1981, Bender et al., 1989, Snedecor and Cochran, 1989).

Understanding the difficulty in finding the centre of the settlements, Toyne and Newby (1971) suggest using the obvious object, e.g. by defining the centre of the settlement as the location of the church or mosque or by the point indicating halfway the main road through the settlement. As a matter of scale, the points are related to the minimum area.

Other approaches to analyse patterns and distributions of settlements are based on the characteristics of the function, such as the degree of permanence, socio-economic function and structure, geo-topology, size and form, and on the development of the settlement origin and development form (Lienau, 1972). In conclusion, Vincent et al. (1976) stated that the pattern is a complex phenomenon and no single parameter is ever likely to be able to describe the pattern successfully. This is confirmed by the architectural analysis of living systems (Oldeman, 1991), that can only be expressed mathematically by very complex simulations.

When selecting the site of the first settlement, people had incomplete knowledge of the suitability of the land. Since they had to exist in a self-sufficient manner, the availability of possibly arable land, nearby water supply and the proximity of building material and fuel is important (Everson and FitzGerald, 1973). Garner (1968) describes the premises of a settlement's location. There is a tendency for human activities to agglomerate and to take advantage of the economy of scale, where locational decisions are taken to minimise the fractional effects of distance (law of minimum effort, Lösch, 1954).

The spatial distribution of human activities reflects an ordered adjustment to the distance, by which some locations are more accessible than others. Harvey (1968) states that distance is a relative measure. He considered that in rural areas, some factors such as accessibility and topographic conditions affect the time required to go from one place to another. Effort is qualifying the geometrical distance. Indeed, in mountainous regions like the Alps in Europe, rural distances are not expressed in kilometres but in hours' walking (Oldeman, pers. comm., 2002)

1.4.2. Land use planning and decision-making

Land Use Planning

Planning is defined as a continuous process that involves decisions or choices about alternative ways of using available resources to achieve particular goals at one time in the future; it also means to make decisions concerning future actions and to create blueprints of the future (Conyers and Hill, 1984). Planning is hierarchical; requires an integrative and holistic perspective; the process and rationale used in planning decisions must be clear; and the plans are responsive to change (Derting, 1985).

Land use planning is a man's systematic way of changing land cover (Fresco, 1994). This is valuating options toward selecting combinations of land and land use, aimed to make an efficient use of land to achieve production and protection objectives, and to make the land-use decision process open and visible (Derting, 1985). It usually involves the government at one level or another, and concerns with reconciling the goals and objectives of individuals and groups in society (Mather, 1986).

Land use planning can be seen as a process or as a means. As a *process*, it leads to the selection of kinds of land use best suited to achieve specified objectives, together with the courses of action needed to achieve these objectives (Young, 1993). Therefore, it should be rational, flexible, require teamwork and be multi-functional (Von Nelson, 1984 in Derting, 1985). As *means*, land use planning can help decision-makers to decide how to use land systematically; to make the best use of land; and to identify sustainable alternative uses to solve land allocation problems by assessing the present and future needs (FAO, 1989, Dent, in Fresco, 1992). Although, assessing the future needs is always a gamble, where history shows that extrapolation of trends is an untrustworthy method (Oldeman, pers. com., 2002).

An example of a proper land use planning process (Dent and Ridgway, 1986 in FAO, 1989) is given in Figure 1.5.

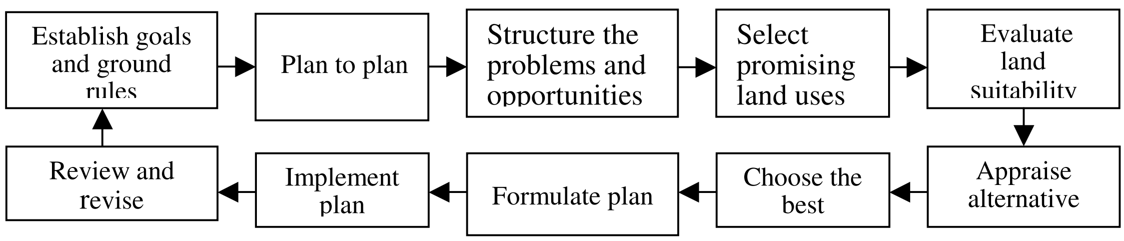

Figure 1.5. Scheme of Land use planning process (after FAO, 1989).
The important thing of that scheme is its *spiral mode*, in which the plan should always be *reviewed* and *revised* periodically, adjusted to new aspirations and needs, and new methods should be integrated in the plan.

Although it has often to be implemented by sectoral agencies, land use planning is non-sectoral (FAO,1989). However, sectoral approach land use planning is commonly encountered, as various level institutions operate on a sectoral basis (such as in its responsibility and organisation). Lack of co-ordination, and rivalry between various agencies in such cases are indicated as major obstacles to a more integrated approach (Ceccarelli, 1997). Meanwhile, the compartmentalised, sector-orientated and mono-disciplinary structure is a major weakness of government bureaucracy in the present situation (FAO 1995b).

Land use planning is increasingly expected to contribute to the integrated planning of economic, social and environmental forces of both operational (small scale, short-term) and strategic (large scale, long-term) level, after Conyers et al. (1984). A biophysical resource component must be included in all cases (UNCED, 1992). Indeed, an integrated approach to planning the use and the management of land resources between *socio-economic factors, environment and biophysical resource components* is a crucial point (Oldeman, 1990, UNCED, 1992).

However, attempts at any kind of integrated planning are most commonly frustrated by insufficient and ill-defined responsibilities for the co-ordination of sectoral activities and regional administrations; inadequate co-operation with executive agencies, national and regional authorities; and by an inadequate use of data (FAO, 1989).

In land use planning, *flexibility,* that is the ability to tolerate unexpected disturbances or changes in circumstances and to produce new or amended plans quickly when needed, is important. However, flexibility has possible risks, e.g. an over-flexible plan endangers a consistent and powerful development, and the earlier plan may be too easily rejected. And the quality of plans may decline because not all useful information can be collected and there is not enough time for thorough consideration (Virtanen, 1992). Over-flexibility can result in the destruction of valuable objects, such as buildings or “natural monuments” such as waterfalls, mountains and rare plants and animals.

Forest policy and forestland use planning

According to Wyatt-Smith (1987), most tropical forest countries have a *forest policy*, but its implementation is not effective, since an overall integrated land use policy that surrounds and supports forest policy is often lacking. This omission can be disastrous to forestry, which, in contrast to agriculture, is a long-term activity requiring stability and confidence both for the necessary investments and for the survival of the ecosystems.

Ecmuller and Van Maaren (1984) indeed confirmed that policy decisions on the future of tropical forest should be taken within the framework of a general land use policy. Van Maaren (1984) describes the major task of forest policy, namely to settle the priorities and a right balance between long-term objectives and between measures to satisfy various uses. Moreover, a coherent land use policy provides a sensible basis for defining the relationships between forest policy and sector policies involving land in general. Further, he states that forest policy not only interfaces with other land use policies, but a country’s economic, social and environmental policies influence and are influenced by forest policy in a web of complicated and sometimes unclear interactions.

According to Young (1993), *Forestland use planning* is the application of land use planning procedures to objectives in the forestry sector. It includes the allocation of land to forestry and non-forest uses, choice of the type of forestry system and methods of management, and always requires consideration of three main aspects, namely the

- *Environmental aspect:* Will the proposed land use conserve natural resources? Will it be sustainable, or in other words, who sustains conservation?
- *Social aspect:* Does the proposed use meet the material and immaterial needs of the local people, so that they are willing to sustain it? What is the impact on particular sections of the community, e.g. poor or minority people?
- *Economic aspect:* Does the use meet the defined criteria of economic acceptability, or who is going to sustain payment of the cost?

Strategic factors and generating strategies

The implementation of the strategies is aimed at accomplishing the missions and objectives of the organisation. In a Strategic Decision Making Process (Wheelen and Hunger, 1989), a strategy is formulated as in Figure 1.6 starting from the evaluation of the current performance up to generating and selecting the best strategy to counter the problems. The strategic factors consist of internal factors, i.e. *strengths* and *weaknesses* and external or environmental factors, i.e. *threats* and *opportunities.*

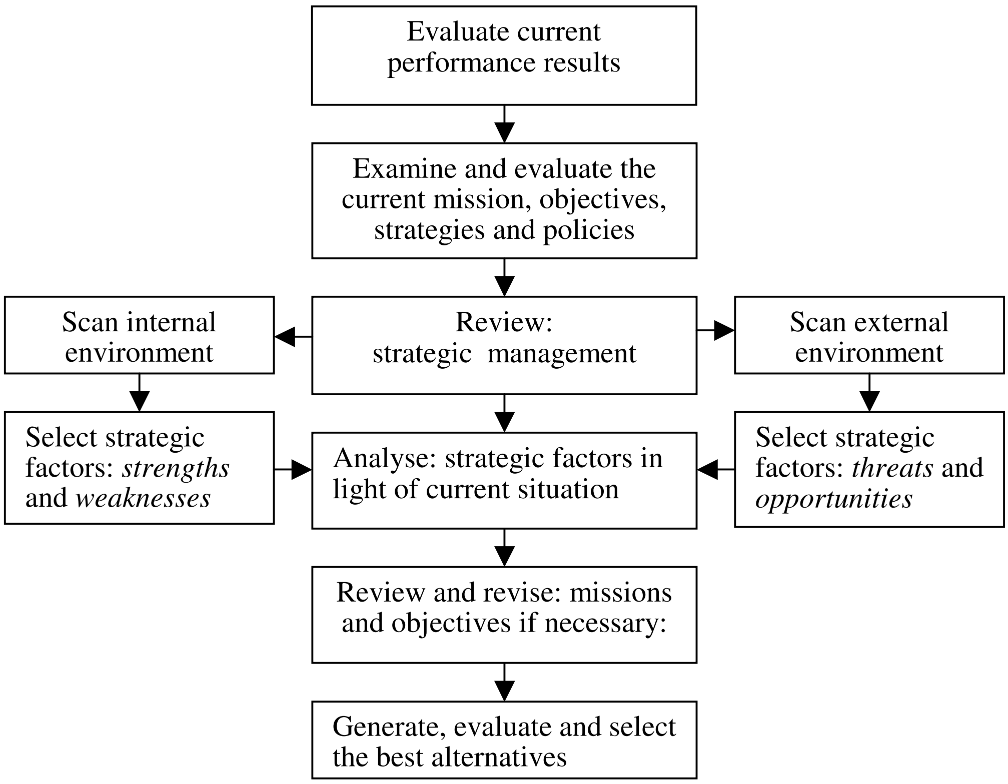

Figure 1.6. Strategy formulation in a strategic decision-making process (after Wheelen and Hunger, 1989).

To be able to analyse and to address the overall situation, the major issues faced will be isolated by describing and evaluating the strategic factors. The next step is the formulation of the strategy. This approach attempts to balance the internal strengths and weaknesses against the opportunities and threats that the external environment presents. The information collected and analysed in the strategic factors may suggest that changes be made either in the mission, objectives, policies or strategies (Bosman and Phatak, 1989).

According to Pierce II and Robinson (1991), the best implemented strategy could be selected by matching internal and external strategic factors as in Figure 1.7.

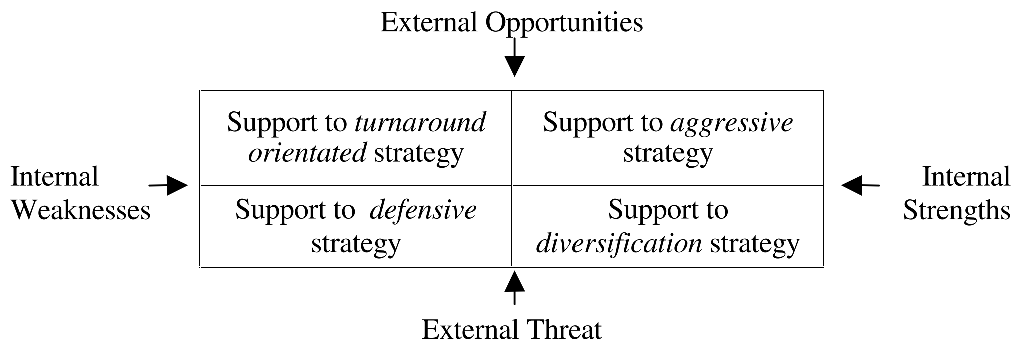

Figure 1.7. Types of possible strategies (after Pierce II and Robinson, 1991).
Please note that a combination of two strategies may be needed to get the optimum result, e.g. turnaround orientated and aggressive strategies, when threat can not be avoided. The term environmental is sometimes used instead of external.

Problem structure, decision making process and system to support decision making

Basically, decision problems lie between *structured* or *well-structured,* and *unstructured* decision problems (Simon, 1960). According to Malczewsky (2000), structured decisions, or programmed tasks, occur when the decision-making problems can be structured either by the decision-maker on the basis of his expertise, or on the basis of a relevant theory. An appropriate computer-based procedure can solve these known and well-understood problems. On the other hand, unstructured decisions, occur when the people involved in the decision-making process are unable or unwilling to structure the problem, and when the problem can not be structured on the basis of a relevant theory. This kind of decision must be solved by a decision-maker making use of *his own heart and brain*. Figure 1.8 shows the degree of a problem structure.

This is a general principle in the evolution of living species, the structured response being ruled by Mendelian genetics and the unstructured one being the adaptive response (Rossignol et al., 1998). Without structured response the species dies (becomes extinct), without unstructured adaptation it also dies (can not adapt to environmental change).

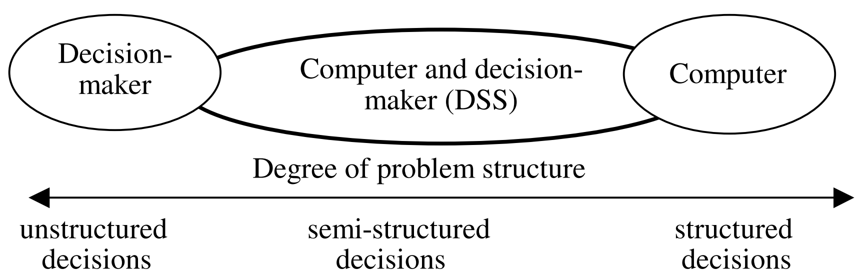

Figure 1.8. Degree of a decision problem structure (after Malczewsky, 2000).
Unstructured problems known as non-programmable tasks, while structured problems are known as programmable tasks. The boundaries between these three problem structures are not always clear.

The characteristics of well-structured and semi or ill-structured problems are described in Table 1.4.

Table 1.4. The characteristics of well-structured and semi/ill-structured problems.
* based on Sol (1982), in Schaik (1988)

Well structured problems *	Semi or ill-structured problems
• Are relatively easy to be identified and measured • The set of alternative actions or solutions is finite and limited • The solutions are consistently derived from an empirical model that shows a good correspondence • The outcome of the courses of action can be numerically evaluated or mapped.	• Occur when the problem, the objective or both cannot be fully and coherently specified (Geoffrion, 1984) • They are usually complex, of a fuzzy nature and require value judgements (Gorry and Morton, Alter, Hoopkins in Densham and Goodchild, 1989) • May be caused through a lack of data or knowledge, unquantified (non-numerical or un-measurable) variables or too great a complexity (Guariso and Werthner, 1989) • Human intervention is needed (Guarisso and Werthner, 1989) • Addressed by selecting viable solutions among a set of alternatives (Densham, 1989).

Decision-making is the final phase of problem solving. It involves the process of a number of phases (consists of sets of activities), starting with identification of the present diagnosis of dissatisfaction and ending with the solution (Schaik, 1988). Simon (1960), cited by Schaik (1988) distinguishes *three* phases in the *decision making process*. These are *intelligence* involves scanning the environment for situations demanding a decision, *design* deals with generating, developing and analysing possible alternative courses of action, and *choice* phase, i.e. selecting one of the alternative courses of action. In a strict sense, these three phases described by Oldeman (2002) as diagnosis, prognosis and prescription, respectively. This relationship is pictured by Bosman (1977) as in Figure 1.9.

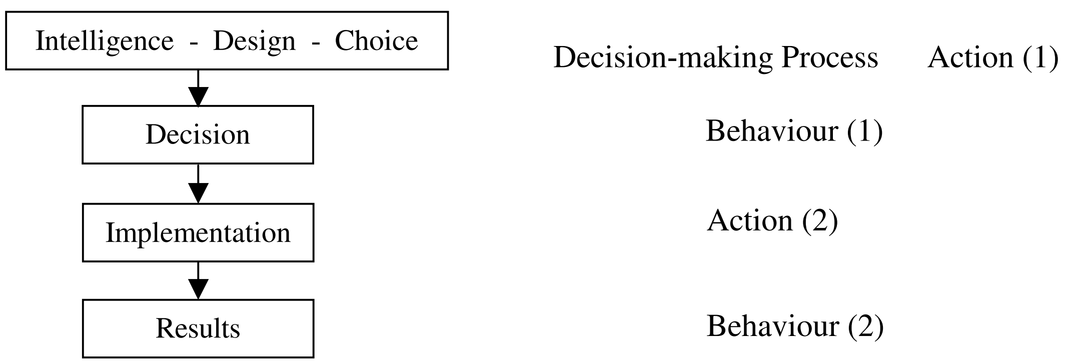

Figure 1.9. Relationship between action and behaviour (after Bosman, 1977).
The intelligent phase is the information gathering phase, and design phase is the brainstorming phase, before the selection of the alternative.

Ill-structured problems require more emphasis on the intelligence and design phases of the decision-making process, as illustrated by Oldeman's title (2002) "Diagnosis of complex ecosystems". *Well-structured problems* require more emphasis on the choice phase (Simon, 1960). A decision-making process applied to ill-structured spatial problems must reflect the inherent difficulties and inter-personal differences (Densham and Goodchild, 1989). Such processes often display multiple, conflicting objectives, and the solution must reconcile these conflicting goals. For this, a variety of analytical techniques have been developed to help the decision-maker solve the problems with multiple criteria (Densham, 1991).

Decision is a choice between alternatives based on some criteria, which may be courses of action, hypothesis, land allocations, etc. (Eastman, 1993). Resource allocation decisions can be made at different levels. The techniques require some special qualities, but the outcome should be understandable by the lay person. Land use decisions involve a multiplicity of factors, i.e. the objectives of various land users, the process or means by which a decision is reached, and the background factors that influence the decisions. Decision-makers are consciously or un-consciously influenced by background factors. These include the intrinsic personal and psychological factors and the external influences arising from the nature of the land unit concerned and its wider setting, e.g. environmental perception or culture (Mather, 1986).

When solving land use problems, there will often be no single solution. When external factors, such as socio-economic data, should be added to provide some alternatives, human expertise is needed to improve the decision making in the participatory decision-making process (Eastman, 1990).

In a complex spatial problem, a flexible problem solving environment, i.e. *Spatial Decision Support System* (SDSS) is useful to help the decision-maker solve ill or semi-structured problems. The goal of a SDSS is to help the decision-maker to generate and evaluate alternative solutions through an *iterative*, i.e. following an iteration process, *integrative*, i.e. integration of various data and information, and *participative*, i.e. an active role of the decision-maker in the decision making process (Densham and Goodchild, 1989).

In using land different users may be competing for the same piece of land for different objectives. In this case, more than one objective (or multiple objectives) are concerned, such as the objectives of a protection forest, to use land for agriculture or different other kinds of utilisation such as estates or cattle farms. The multiple objectives can be *complementary*, i.e. land may satisfy more than one objective; therefore, desirable areas will serve these objectives together in a specific manner, or they can be *conflicting,* i.e. they compete for the available land that can be used for only one purpose. The common solution is a compromise to allocate land that maximises or minimises a certain objective function, subject to a series of constraints (Eastman, et al., 1993). This means, at a more comprehensive scale, that parts of landscapes are allocated to one function each, in a multiple use landscape mosaic built by single user units (Oldeman and Kuper, 1996).

The relationship between Decision-making and Decision support system (FAO, 1989) is given in Figure 1.10.

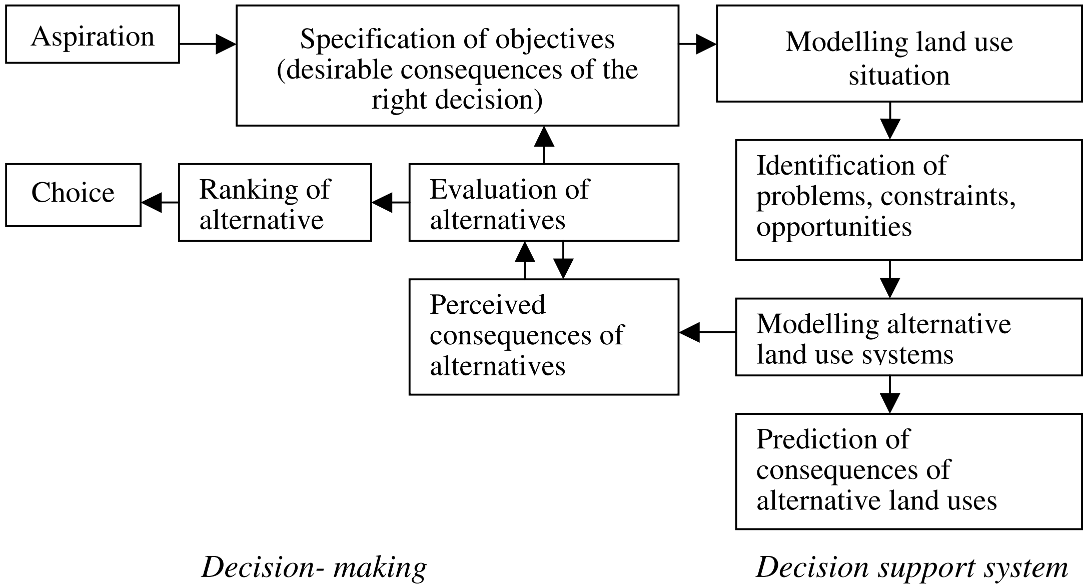

Figure 1.10. Schematic representation of decision-making (FAO, 1989).
Please note that the problems, constraints and opportunities here are similar to the strategic factors as mentioned by Wheelen and Hunger (1989) in Figure 1.6.

2. LAND COVER AND LAND USE PROCESSES

2.1. Scope of the study

The analyses in this chapter concern land cover and land use dynamics, including settlement patterns, dispersions and their dynamics; deforestation; and the driving forces of land use changes; as well as the aspirations of the local people as to conservation aspects. This chapter covers the Riam Kanan river basin as study site.

The use of remote sensing images to manage natural resources is among the current issues most countries are concerned about. Unfortunately, for different reasons good quality data, e.g. accurate, recent, comprehensive, cloud-free and proper scales are sometimes hardly available, and various "whatever" available data then have to be used. In this study, different types, scales and dates of remote sensing images, i.e. large-scale and small-scale aerial photographs, Landsat MSS images, and Landsat TM images were available, as well as topographic maps. Aerial photo interpretation and digital image analysis are used to analyse land cover changes and deforestation.

Measuring point patterns based on density and distances has been extensively used in different fields, such as in human or settlement geography and in plant ecology (see among others Garner, 1968, Harvey, 1968, Unwin, 1981, Ludwig and Reynolds, 1988). This method was applied to analyse patterns and dispersion of the settlement locations.

However, a descriptive evaluative study was done to analyse the socio-economic data, collected from local statistics and from interviewing local people in the six selected villages in the subdistrict Aranio.

The last part of this chapter deals with the design of a spatial model for land re-allocation of the study area, using GIS and spatial decision support systems as tools.

2.2. Riam Kanan river basin, the study area

2.2.1. Administrative and land status

Administratively, the larger part of Riam Kanan river basin lies in the subdistrict Aranio, district of Banjar. The approximate geographical position of the subdistrict Aranio is between 2°45' to 3°45' southern latitude and between 14°45' to 115°30' eastern longitude. It covers around 116,000 ha area and consists of 12 villages. The study area is part of the watershed, which is surrounded by the Meratus and Babaris mountains.

A dam was constructed in 1970 in the river Riam Kanan to create a 9,200 ha reservoir to supply water for hydropower generation, irrigation and drinking. Some villages had to be moved uphill to avoid the inundated area. To protect the reservoir and the continuation of water supply, in 1975 the Minister of Agriculture declared the river basin area protection forestland. The effect of this status is that no significant activity is allowed in this area, although some settlements existed already before the enactment of the decree. The construction of the dam and the establishment of the electric generator were an important benchmark in the land use processes in the study area. That significant moment is a meaningful study subject, especially when comparing the situations before and after the dam construction and the establishment of the Riam Kanan reservoir.

On the other side, the existence of the villages is ensured by the issuance of a higher level regulation, i.e. Government Regulation no. 43 (1968). The presence of the settlements inside the river basin area was even strengthened by the issuance of the Government Regulation (1985), which defines a more independent subdistrict Aranio. These two different regulations applied to the same land are confusing, especially in terms of land tenure; whether the local people are entitled to the definite land rights is unclear. Therefore, two objectives, i.e. the establishment of protection forest and the development of the villages based on different regulations are conflicting.

The Riam Kanan river basin is of great importance by the existence of a reservoir providing water for various uses. Therefore, through a Joint Ministerial Decree from the Minister of Interior, the Minister of Forestry and the Minister of Public Works in 1984, the area was defined as one of the top priority river basins and its rehabilitation is therefore urgent.

2.2.2. Physical condition

The whole Riam Kanan river basin area measures 127,833 ha, consisting of 6 tributaries, namely: Hajawa, Tanjungan, Kalaan, Riam Kanan Tengah, Sungai Besar and Riam Kanan Hilir. The catchment area surrounding Riam Kanan reservoir covers three sub-river basins, namely Hajawa, Tanjungan and Kalaan (BRLKT, 1987), covering 109,105 ha area, ranging from low hills to around 1,200 m peaks. The main rivers in the upper part of the watershed are of Pa'au, Hajawa, Tabatan, Tuyub, Kalaan, Puliin and Malino (ProLH 1992).

The watershed area is dominated by a podzolic-latosol complex (ultisols, inceptisols, oxisols) with medium textures of loamy and silty clays. Most of the podsolic (ultisols) soils were poor in nutrients. The stability of the soil structure was low, due to the low organic matter content. The soil types (based on Dudal and Supraptohardjo, 1961) and USDA Soil Taxonomy Classification (1994) in the river basin area are represented in Table 2.1.

Table 2.1. The soil types in the subdistrict Aranio.
* older classification types, based on Dudal and Supraptohardjo, 1961, ** new classification, based on USDA, 1994. Source: ProLH SK (1992).

Soil types*	Order**	Area	
		ha	%
Latosol	Inceptisol, oxisols	74,905	68.7
Red-yellow podsolic	Ultisols, inceptisols	11,700	10.7
Complex of red-yellow podsolic, litosol and latosol	Ultisol, inceptisols, entisols (lithic),oxisols	11,700	10.7
Latosol	Entisols (lithic subgroup)	10,800	9.9
Total area		109,105	100

In 1989, 60% of the whole river basin area was eroded, 51% of which was in the forest area and 10% outside the forest area (MoPW, 1992). The erosions are mainly surface and gully erosions, ranging from 9.6 ton/ha/year in the Tuyub tributary to 83.1 ton/ha/year in the Puli'in tributary. The actual sedimentation ranged from 1.1 ton/ha/year in the Hajawa tributary to 11.7 ton/ha/year in the Puli'in tributary (ProLH SK, 1992).

2.2.3. Forest resource

Rain forest is the natural vegetation in the region, and currently it covers the mountainous parts, approximately one-third of the basin. Lalang grass (*Imperata cylindrica* (L.) Beauv.) spreads out mainly in the lower areas in the centre part of the watershed. According to the forestland use plan (1982), the forestland in the Riam Kanan river basin is Protection Forest, located around the reservoir; Conservation Area in the Southern part of the reservoir; and Permanent Production Forests in the Northern and Eastern parts. Later on, based on Presidential Decree no. 52 (1989), the whole river basin area was declared Grand Forest Park 'Sultan Adam', covering 106,400 ha (previously defined 112,000 ha, and then revised to 104,300 ha), covering the following areas.

Figure 2.1 and Plates 1to10 gives an impression of this study site.

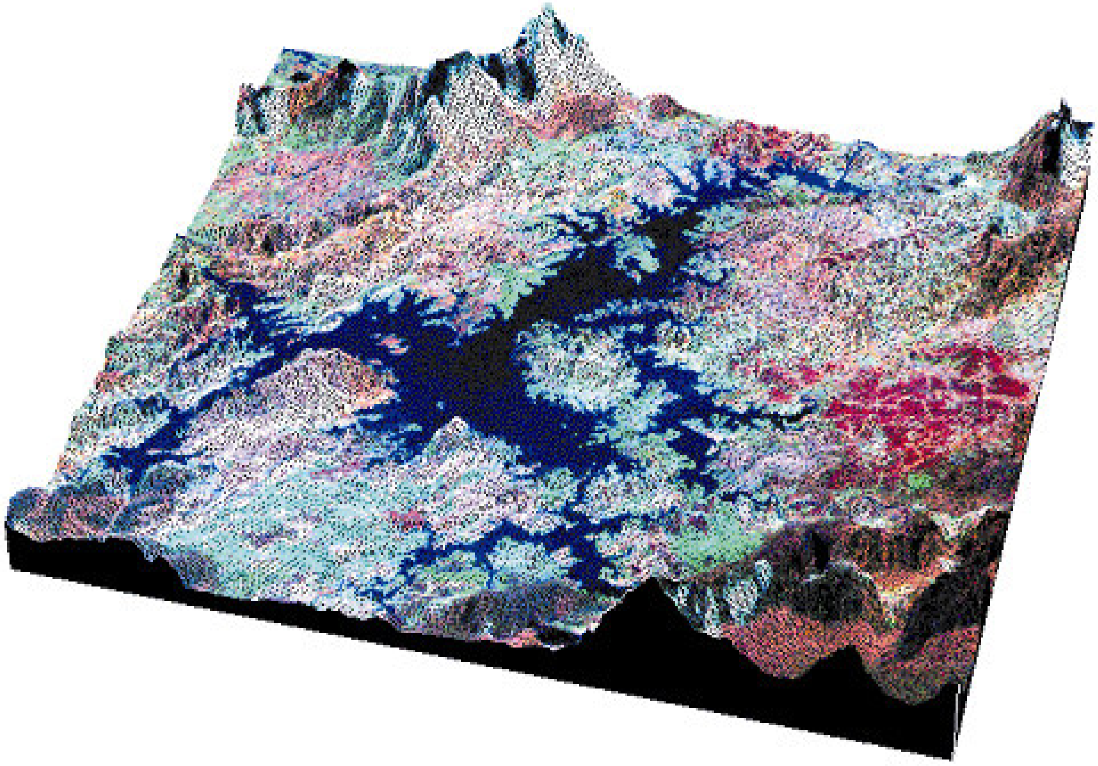

Figure 2.1. The central part of the Riam Kanan river basin.
This 3D image was created using a 1994 Landsat TM image with 30 m spatial resolution. The black and dark blue areas are water, mainly the reservoir; the dark red areas are natural forests; the lighter red areas are plantation forests, the green and light blue are open areas, which can be farm land or abandoned land.

The following plates show the situation of the Riam Kanan area.

Plate 1.1.

Burned grassland to get new grass shoots. It covers a large area, which often intrudes into the reforested area.

Plate 1.2.

Decreasing water level of the reservoir. Note the appearance of the trunks, which will be under water in the rainy season.

Plate 1.3.

Cattle on grassland in the dry season. The cattle are left free on the large area, close to the reservoir. The areas are sometimes fenced.

Plate 1.4.

Successful reforestation area using *Acacia mangium* trees. The forested area is surrounded by grassland and abandoned land.

(Plates 1.5 to 1.10 are on pages 38-39)

Table 2.2. The coverage of the Grand Forest Park "Sultan Adam".
GG stands for Governor General, the highest authority in Indonesia in the past.

Location	Forest function	Legal basis, year	Area, ha
Kinain Buak	Protection	GG of Nederland Indie 1926	13,000
Riam Kanan	Protection	MoA Decree no. 10, 1975	55,000
Riam Kanan	Education	Governor Decree no 144, 1980	2,000
Pleihari Martapura	Wildlife conservation	MoA Decree no 65, 1974	36,400
	Total area		106,400

Reforestation programmes have been carried out since 1973, but not very successfully, mostly due to long droughts, forest fires and by burning 'lalang' grass to get young grass leaves for cattle (see Plate 1.1). The reforestation figure is given in Table 2.3. During the dry seasons, the water level in the lake drops tremendously, causing problems in the electricity supply (see Plate 1.2). Based on MoPW (1989), 61,744 ha of the river basin area was in a critical condition, 51,617 ha in the forest area and 10,127 ha outside the forest area.

Table 2.3. Reforestation figure, Riam Kanan river basin (1974 - 1991).
*Source: * SK Forest Service(1982) ** ProLH SK (1992).*

Period	Target, ha	Successful, ha, %	Burned, ha, %
1974-1982*	25,858	13,381 (46.36%)	>5,0000 (>17.33%)
1983-1991*	12,100	4,287 (35.43%)	7,813 (64.57%)

Box 1.

The Manager of the Riam Kanan Water-energy Electrical Centre states: 'The continuing decreases in the water level in the Riam Kanan reservoir in this long dry period have approached the critical point. If within the next two weeks there will be no rainfall, all turbines, which produce electric energy for this area will have to be stopped' (*Suara Pembaruan Daily News, October 16, 1997).*

Currently, almost all of the watershed area in South Kalimantan is in a critical condition, even starts to dry out. Since the rivers flow to the irrigated land, this influences the water supply to the rice fields. The Riam Kanan river basin is the largest and in a bad condition, which causes environmental destruction, followed by uncontrolled logging by timber concession holders and by illegal cutters. Encroachment for coal and gold mining and other activities are suspected to worsen the environmental condition (*Kompas Daily News, August 4, 2001*).

A group of local people from the Aranio subdistrict, district of Banjar, tried to meet President Megawati to complain about the disfunctioning of the Riam Kanan reservoir. They have sacrificed their land for the irrigation project, but they still have difficulties in getting sufficient water and they are not able to use the reservoir *(Kompas Daily News, February 9, 2002)*

Half of the 320 families in the Riam Kanan transmigration resettlement unit, district of Banjar have left the location, because their agricultural activities since 1995 did not have any results. Meanwhile, their houses and 0.5 ha house yards have been sold to citizens of Banjarmasin.

2.2.4. Socio-economic conditions

In 1993 the total population in Aranio was 7,666 people, spread over 12 villages. The number of people per village ranged from 472 to 1193, and the number of families was 1,803, making the population density between 3 to 59 people per km2. On average, a family consisted of 4 people (SD Aranio Statistics, 1993). Approximately 80% of the people have been educated only in the elementary school or basic Islamic school (*madrasah*; Ind.).

In 1988 the local people (*Banjarese*) consisted of farmers and farm labourers (81.9%), officials (7.9%), and local miners (5%) (SDA, 1988). Most farmers are involved in subsistence agriculture and fishing, and some in doing cattle husbandry. Most villagers grow rice and other vegetables in small plots. In 1993 there were 388,6 ha irrigated rice-fields, 1,378 ha non- irrigated rice-fields and 1,296 ha annual crops (SD Aranio Statistics, 1993).

Grazing land occupies a larger portion than arable land, while cattle are left free on the grassland. Grasslands are periodically burnt to produce young shoots for cattle, leaving some areas seriously overgrazed. Unfortunately, the grazing areas were not recorded properly and could not be identified clearly. From 1988 to1994, the number of cow increased from 1851 to 2860, and the number of water buffalo increased from 175 to 267 (SD Aranio Statistics, 1993). For most villages in the subdistrict, the reservoir and the rivers are the main way of transportation for everyday life, and for the transport of goods and agriculture products from and to the market.

Plate 1.5.

Land clearing on the steep slope, very close to the settlement site.

Plate 1.6.

Surrounding the electricity generator. This area is covered by dense vegetation.

Plate 1.7.

Uncovered land caused by quarrying, close to the land with dense vegetation.

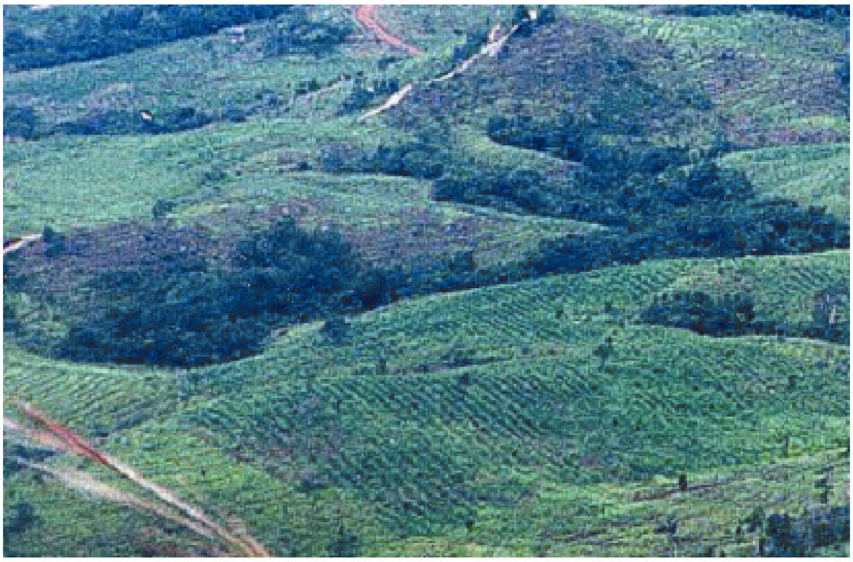

Plate 1.8.

Reforestation on gentle slope area, using mechanical equipment. Note the rows of new plants.

Plate 1.9.

Cattle in the young reforested area on the steep slope land. The darker tones indicate that the area was just burned.

Plate 1.10.

Farming on the steep slopes, close to the reservoir. The eroded soil goes directly into the reservoir.

2.3. Land cover and land use and dynamics

2.3.1. Pattern and distribution of land cover and land use types

By analysing remote sensing images at different dates and field observations, the main land cover types in this area can be detected. These are mainly water body, forest and shrubs, grassland, arable land and settlement. Their related land use types are reservoir, protection forest, annual crops, farms, rice fields, pastures, abandoned land, and villages. Their patterns and distributions are given in Table 2.4.

Table 2.4. Pattern and distribution of land cover and land use types. The information on land cover types achieved from various remote sensing images and field observation

Land cover types	Main Land use	Pattern	Distribution
Water body	Reservoir	Large single area, minor changes in its shape due to water level changes.	In the centre lower part of the basin
	Multipurpose river	Narrow line, snaky form	From the upper part basin downward to the reservoir
Forest and shrub	Protection forest	Compact large areas of forest mosaic, mainly composed of high eco-units, few shrubby and open units	In the upper part and along the creeks or small rivers, i.e. natural forest, and in the lower parts and small islands, i.e. reforestation
		Small patches of forest mosaic, mainly composed of large low successful plantation eco-units and small, old eco-units	Young reforestation in the lower parts surrounding the reservoir, which can be confusingly interpreted as grassland and shrubs
		Small patches degraded forest mosaic, composed of small, low, irregular eco units	Among dense forests in the hilly or lower areas, at the edge of the dense parts of the old natural forests and along the creeks
Arable land	Annual crops, farms and rice fields	Agro-mosaic, with large and smaller areas with regular forms and clear boundaries	In the lower parts of the watershed area. Close to or surrounding the villages and along the rivers
Grassland	Pasture and abandoned grass land	Large areas, sometimes fenced, irregular forms.	On the steep slopes and in hilly areas. It is not possible to distinguish pastures and abandoned grassland. Burned grassland, in the upper part
Bare land	Abandoned land	Small patches or larger areas	At the tips of the reservoir, temporarily in the dry season when the water level had dropped
Settlement	Village, single houses	Large area, regular forms. In small scale aerial photographs seen as housing lines	In the tip of reservoir or close to the rivers. In satellite images, indicated by a clump densely vegetated land close to the water; in lower part of the area, close to the water

To attain a more accurate interpretation, field checking, observations and knowledge of the target area are important, since different land cover types may have deceivingly similar appearances in the same remote sensing images as well as in different images.

Based on the existing images, a more detailed interpretation is less useful, since all information should be compared at the same integration level. In this case, information from large-scale aerial photographs were downscaled to small-scale aerial photographs and Landsat TM levels as the common bases, while information from Landsat MSS images was up-scaled to the same level of comparison.

From the existing land cover types, the water body, especially the reservoir is clearest. Dense forest is also clear, but sometimes it is mixed with low-density forest and shrubs in a mosaic of quite heterogeneous eco-units. Arable land is indicated by the water content in the soil, seen as a bluish surface on the Landsat images, while on aerial photographs it looks like a smooth object without much texture, with darker tones than grassland. On aerial photographs, the very dark tone with fine texture represents burned grassland. Please, note that the date of the data taken is important information, needed to understand seasonal patterns. It is difficult to differentiate abandoned land from arable land in the images, if the arable land is still in the clearing, ploughing or sowing stage.

Discussion

Each of the remote sensing images has its own specification, fits to a specific purpose and has certain limitations in information. Therefore, depending on the sensor system and image resolution, dissimilar levels of details can be read from different remote sensing products. Each level is usable for different purposes (Avery, 1971, Lillesand and Kiefer, 1994). When classifying different remote sensing images, i.e. types, scales and dates used to analyse land cover types, confusion and inconsistency is possible because of variations in characteristics, scales and information. The great time differences in the dates of the images, i.e. 5 to 10 years, only allow general analyses.

Comparing the land cover types and their areas with the situation in the past, namely with the 1946 topographic map, it can be seen that the grasslands existed much earlier, when the number of people and their activities was much less than today. Moreover, grassland as well as bare land and shrubs can be considered temporary land cover types, which by human responses such as soil conservation, fertilising and reforestation can be changed into more stable land cover types like forest or arable land (see Turner et al., 1995).

2.3.2. Land cover and land use changes

Land cover changes

By comparing the situations in 1963, 1973, 1981, 1991 and 1996 as seen on Landsat MSS and TM, aerial photographs and by field observation, land cover changes in Riam Kanan can be described as follows.

1. Major changes, the transfer of forest, shrubs, grassland, arable land and (old) settlement to the water body, i.e. reservoir happened only once, in the 1970's, when the reservoir filled up. The process is considered permanent and irreversible.
2. However, the process leading from bare land to arable land, and then to a water body, to some extent was minor, cyclic and temporary. This always happened in the dry season when the water level dropped, especially on the piece of land at the tip of the reservoir. Grassland most likely did not become established in this relatively short period.
3. Small-scale deforestation by illegal cutting and land clearing changed forest into arable land. The area will subsequently become grassland when abandoned. These processes are one-way degradation processes.
4. The minor process from arable land to grassland, passing through bare-land, can be considered a continuous, temporary and reversible process. If bare land is cultivated, it becomes arable land; and if it is left fallow for some reasons, especially when there is no water for crop cultivation, it changes back into bare land and then into grassland.
5. Reforestation, intended to change non-forested areas into forested areas, is not always successful. If it fails, a reforested area turns back to grassland or is cultivated as arable land.
6. To a lesser extent, settlements, i.e. villages, as a land cover type, also change, either because of development or by the reservoir filling up. The changes include extinction of old settlements, moving of existing settlements, and the establishment of new settlements.

The above-mentioned is schematically presented in Figure 2.2.

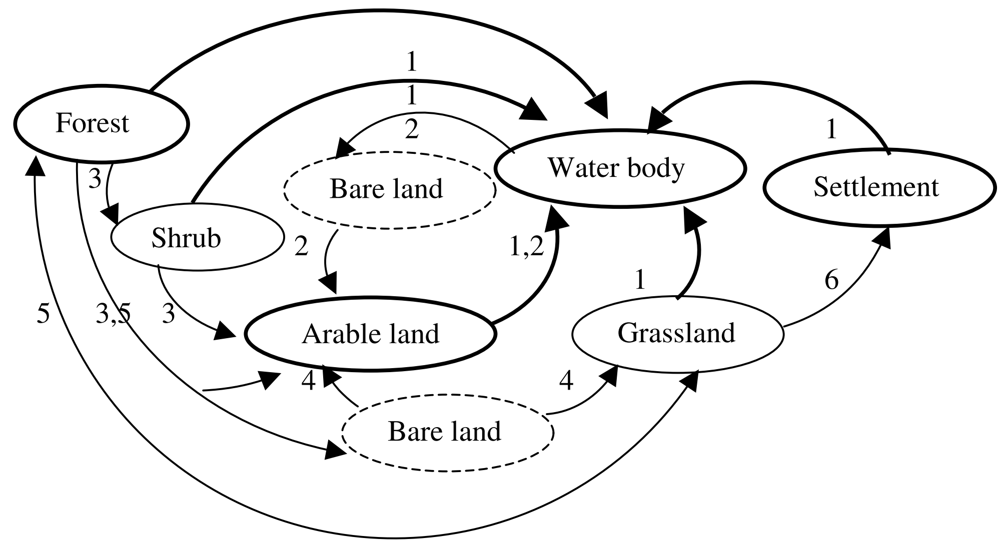

Figure 2.2. Flow diagram of land covers changes.
settled land cover types, intermediate cover types, reversible process, one way process, process in established reservoir, other process. For number, see text.

Land use changes

The term land use denotes human employment of the land. Therefore, it includes human activities involved in land use changes. Land use in the study area is not very complex, because except for reforestation, no large-scale land use activities, such as transmigration or crop estate are allowed in this area, due to its status as protection forest. Land use changes in this area are summarised as follows:

1. Changes of forest, old rubber plantations, farmland, pastures and settlements being inundated by the reservoir were the major changes in this area in the past. They were irreversible and occurred only once when the reservoir was established. All forest stands, fields and villages in the lower part were flooded. The tree trunks can be seen, when the water level is low.
2. Changes of forest to farmland by illegal cutting mostly show up as small patches in the fringes of the forested area.
3. Periodical changes from farmland to pasture or abandoned land, and back to farm land.
4. Changes of pasture and abandoned land to forest by means of reforestation, and vice versa, back to pasture when reforestation failed.
5. Establishment of new settlements in the non-settlement area.
6. Establishment of new, small-scale perennial crop plantations, e.g. rubber trees and clove trees, on the abandoned land and pasture, which may remain invisible in remote sensing images as long as they are new and small-scale.

Schematically, the major land use changes are presented in Figure 2.3.

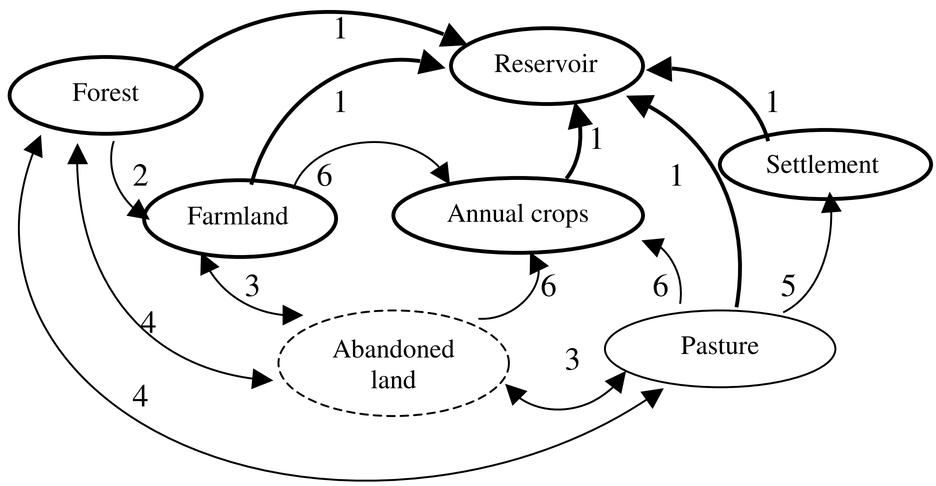

Figure 2.3. Flow diagram of land use dynamics.
For number, see text, settled land use types, intermediate land use types, reversible process, one way process, process of establishing reservoir, other process.

2.3.3. Settlement dynamics

The names of the villages identified and indicated on 1946, 1974/77 and 1990 topographic maps, and statistical reports are shown in Table 2.5.

Table 2.5. List of the villages indicated on the topographic maps, subdistrict Aranio. Villages typed in italics, were present throughout the period of this study. Those typed in bold are administrative villages. Source: Topographic Maps (1946, 1974/77, 1990), SDA Statistics (1990)

No	1946	1974	1982/1990
1	**Artain**	**Artain**	Artain
2	*Bunglai*	*(Bunglai)*	**Bunglai**
3	*Kalaan*	**Kalaan**	**Kalaan**
4	*Manunggul*	**(Manunggul)**	Manunggul
5	*Rantau Bujur*	*Rantau Bujur*	***Rantau Bujur***
6	*Rantau Balai*	*Rantau Balai*	***Rantau Balai***
7	**Tiwingan**	**Tiwingan**	*Tiwingan*
8	Ampalawan	Alimpung	Alimpung
9	Maliano	Aranio	*Anawit*
10	Mangkualo	Belangian	*Apuai*
11	Rantau Layung	Benua Anyar	*Aranio*
12		Benua Riam	*Belangian*
13		Bukit Batas	*Benua Riam*
14		Kalaan Baru	Binjai
15		Mangkualo	Jungur
16		Teluk Dalam	Kalaan baru
17		Sumber Batu	*Pa'au*
18			**Tiwingan Baru**
19			**Tiwingan Lama**
20			Tuhin
21			Sungai Luar

From Table 2.5. it is clear that the village dynamics were as follows:

- Out of 11 villages identified in 1946, only 7 villages still exist today;
- Four villages identified on the 1946 map do not exist any more. They are now at the bottom of the reservoir. These were Maliano, Mangkualo, Rantau Layung and Ampalawan;
- Eight villages, which did not exist on the 1946 map, were identified on the 1974/1977 map.
- Some 14 new villages were established during the period from 1946 to 1990;
- Several villages were split into more than one village or in hamlets, namely Kalaan into Kalaan and Kalaan Baru, and Tiwingan into Tiwingan Lama and Tiwingan Baru.

By comparing the position of the villages in 1946 and 1981 as seen on the1990 topographic map with the distance calculation, only two villages have moved considerably away from their original sites, i.e. Manunggul and Tiwingan, while the others have moved to adjacent locations. By using a nearest neighbour distance calculation, the mean distance and the expected distance can be determined. The mean distance between the villages before and after the dam construction are 2421.5 m, and 2668.4 m, respectively; while their expected distance is 2440 m and 3272 m, respectively. It indicates that the villages that had to be moved because of the construction of the reservoir were relocated not far away from their original positions.

Settlement pattern and topographic position

Physically, the Riam Kanan watershed is between two mountain ranges, isolating the basin area in the centre part. By combining the information about village locations, slopes and altitudes, it is clear that:

- The villages were located in the lower part of the basin along the rivers, mainly the river Riam Kanan. Currently, most of them are positioned along the reservoir banks. This points to the importance attached to access to water;
- Most of the villages were established at altitudes of less than 125 m above sea level;
- Relatively flat and gentle areas are obviously locations preferred for establishing the villages. Closeness to the 'outside world' is regarded as less important.

Figure 2.4 shows the height of the settlements' site.

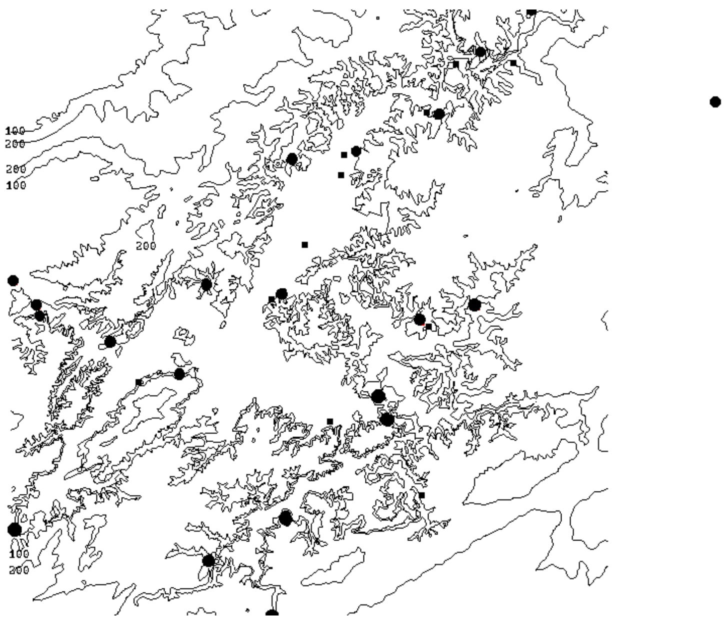

Figure 2.4. Settlement locations and contour lines.
The circle dots indicate the position of new settlements, while the squared dots indicate the position of the old settlements. The numbers, i.e. 100, 200, are the contour lines, indicating the height above sea level. The scale of the original topographic map was 1:50,000.

Socio-economic function and the village structure

More than 80% of the labour force in the Aranio subdistrict, especially in the villages located around the reservoir, work in agriculture, and almost 5% work in some small local mining fields (gold and gemstone). An exception to this is the inland village of Aranio, capital of the subdistrict, where part of the inhabitants work in the state electrical company and offices of the subdistrict. Based on these types of occupation, the villages in this area can be classified as *primary sector* or *agricultural settlements*, where the primary occupation is directed towards the exploitation of plant and animal life, and the majority of the population is working in the settlement itself (Lienau, 1972).

Distribution and supply centres

The *central place* functions play a role as distribution and supply centre to a surrounding area (Chorley and Hagget, 1967, Everson and FitzGerald, 1973). They are marked by special facilities. Distribution and supply centres in the river basin are analysed by identifying their function as central places. In the study area, the central place functions are found at three different levels as shown in Figure 2.5.

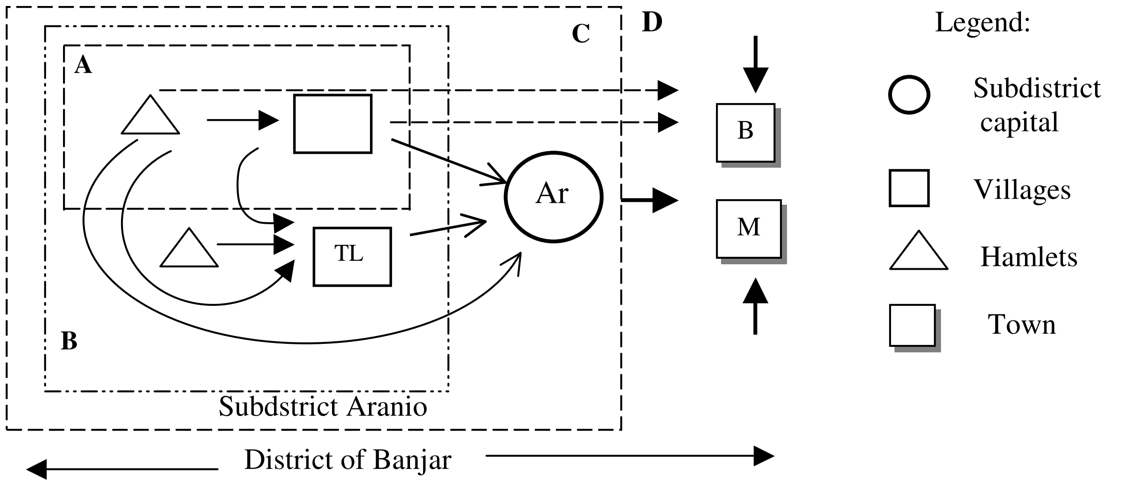

Figure 2.5. The hierarchy of central place functions in and above subdistrict Aranio.
A: Partial sub-centre, **B**: Lowest order central place, **C**: Low to medium central place,**D**: Medium central place, Ar: Aranio, TL: Tiwingan Lama, B: Banjarbaru (the closest town to Aranio), M: Martapura (the capital town of district of Banjar), arrows indicate the service seeking flow.

These *central place* functions are:

A. *Partial sub-centre:* Several villages consist of one or more hamlets or occupy more than one site, e.g. by inclusion of a village into another village. In a limited way, such villages are *partial sub-centres* mainly in terms of limited administrative services.
B. *Lowest order centre:* Tiwingan Lama (TL), where a small market exists, serves the basic needs of the people from surrounding or neighbouring villages. Therefore, this village can be considered a *lowest order centre,* or central place that meets the daily and short-term demands.
C. *Low to medium order central place:* Aranio (Ar) as the site capital of the subdistrict, where the only junior high school, market, health centre and post office in the subdistrict are located, provides public services. For this reason, this village has the importance of *low to medium order central place*. It meets the increasing and longer-term demands of other villages.

The position of the village Tiwingan Lama is unique because of its geographic location. It lies at the entrance of the reservoir and the lower bed of the river Riam

Kanan. It is also the starting point of roads to places outside, so the people from other villages and hamlets normally have to pass this point e.g. to go to the town. In this situation, Tiwingan Lama serves other villages, except Aranio, that have the same hierarchical level as a central place that meets the daily and short-term demands by the existence of a small market. At the same time, Tiwingan Lama and the other villages are served by Aranio, capital of the subdistrict, in terms of the public services mentioned.

One level higher than the subdsitrict level, i.e. in the district of Banjar, the central place function is held either by Banjarbaru, a town located close to Aranio, or by Martapura, the capital of the district of Banjar, which is located somewhat further than Banjarbaru.

2.3.4. Discussion

Land cover and land use changes

Two linked components of land transformation determine land cover changes, i.e. conversion and modification, and land use changes, i.e. shifts to other use and intensification of the existing use (Turner and Meyer, 1994). Some examples are conversion of forest cover into arable land, along with the shifts from protection forest use towards perennial or annual farm use, respectively. The conversion, and consequently the shifting of use, can be major, permanent and irreversible, such as the establishment of a reservoir. It can also be a minor, temporary and reversible change, as in the case of seasonal changes.

Land use affects land cover with various implications. Land use change is likely to alter land cover class, but land cover may also change even if the use is not changing (Turner et al., 1995). A first year reforestation programme on abandoned land will not change the land cover type, since the physical activities will only cover land clearing and planting seedlings. A single type of land use, such as pasture corresponds to a single land cover type, which is grassland. But a single type of land use, like farmland may correspond to several distinct cover classes, namely different stages of the planting system or different contrasted crop species such as rice and cassava. In the study area, all kinds of transformation had occurred (see Figure 2.6.).

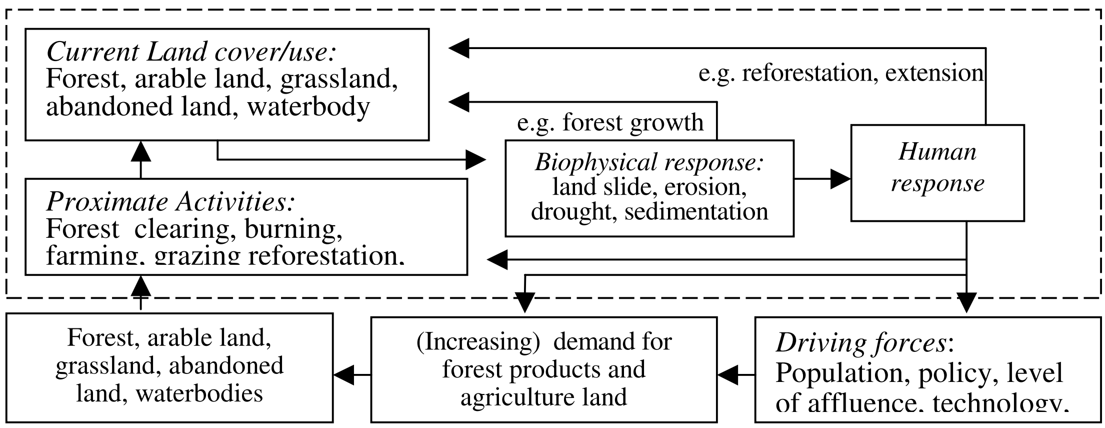

Figure 2.6. Land use and Land cover relationship (adapted from Turner et al., 1995)

The village dynamics

Village characteristics are defined following the classification scheme for rural settlement establishment (Lienau, 1972) covering *functional aspects, development aspects*, and *topographic aspects.*

Degree of permanency means the duration and regularity of habitation in one place. In the study area, most of the houses in the villages are permanent and continuously used. Outside the permanent village sites, some temporary houses are built for seasonal use, mostly for periodic but regular usage during planting and harvesting seasons, especially when the agricultural fields are far from their permanent houses. Temporary houses are usually small huts in the form of a cabin. During these seasons, people stay in those huts to guard their plants and they come back to the main village every week. The situation in Tiwingan and Aranio is slightly different, since part of the inhabitants of these villages are not traditional farmers, and most of their agricultural land is close to their permanent houses. Therefore, temporary settlements are not significant here.

Based on its *residential and employment function*, all the villages in this area are considered *residential settlements* or settlements with an absolute or predominant residential function. This function is characterised by the surplus of residences and lack of places of employment. Since more than 80% of the people are working in the agricultural fields, the settlements are classified based on *types of employment* as *primary sector* or *agricultural settlements*. This is because the primary occupation of the inhabitants is directed towards the exploitation of plant and animal life and the majority of the population are working in the settlement itself.

Based on the *relationship of the residents to agriculture and soil*, most of the settlements in Riam Kanan can be considered *settlements with an agricultural population.* Indeed, the majority of the active population is occupied independently and full-time in agriculture and related activities. Excluded from this general situation, the settlement of the village of Aranio is considered a *settlement with a land-related population*. This because part of the active population is active in agriculture and the other part is active as officials in government offices and as workers in the state electrical company.

Based on the *economic and social community*, most of the settlements, especially in the basin area, are considered *co-operative settlements* rather than private or collective settlements. Although their individual sphere is maintained and land cultivation is done individually, the settlers are bound by common interests and tasks. Although the majority of the settlements are bound to certain locations, some individual settlements exist in isolation from the main group in the main settlement site.

Central places marked by their special facilities (Chorley and Hagget, 1967, Lienau, 1972, Everson and FitzGerald, 1973) not only play a role as distribution and supply centres in terms of commodities to the surrounding area, but also show a flow of information and administrative services. Except for the administrative services, such as the application for ID and any kind of legal certificates, the people in the 'sub-ordinate' or lower level settlement are able to bypass the direct central place and go to the higher central place. This happens, especially when distance and time are no constraints.

As stated by Clarke (1972), steep slopes, exposure and ruggedness of the terrain play an important role in restricting human access, habitation and cultivation. Therefore, topographic relief is often used as the basic consideration in establishing a village. For those reasons, most of the existing permanent villages in the study area are considered established according to the *topographic relief*, in gently undulating areas, and with *access to water,* namely rivers and the reservoir. From an ecological point of view, the climate and vegetation certainly were not the main selection criteria for settlement sites.

Roads to connect the villages are not always available. Therefore, rivers and reservoirs are the main *means of transportation* for the daily needs. Rivers have been used as means of transportation for times immemorial, long before the construction of the dam and reservoir.

The usual parameter of the *size of settlement* is the number of houses. Assuming that each family lives in its own house, the administrative villages can be grouped into: small size settlements, i.e. Apua'i, Pa'au, Artain and Belangian, with less than 100 families, and the other eight villages as small to medium size settlements, with 100 to 300 families.

Concerning their *originality,* the settlements may have emerged spontaneously in the past in a *less-regulated* way, i.e. not regulated by external regulations, or *less-organised* way, i.e. a spontaneous village may have an organisation but have no administration. Later on they have developed into their present-day form. The regulations originated either in the villages themselves, such as through periodic village meetings, or came from outside, from the local and central government in the form of declared regulations, administration, extensions and village demarcation.

Since the existing settlements are not primary or original any more, their pattern has become a secondary or *developed form*, which step by step evolved from the original. The changes either originated in settlement expansion, e.g. an increasing number of houses due to an increasing population density, or in partial abandonment. Due to the construction of dam and reservoir, tertiary or new forms of settlement came into being. This happened by splitting one village into more than one, e.g. Tiwingan and Kalaan; or by moving the village from the original site to a new place due to flooding of the old one, e.g. Manunggul and Tiwingan. The original or secondary settlement also disappeared by the filling up of the reservoir, e.g. Maliano, Mangkualo and Ampalawan.

Before and after the dam construction, the nearest neighbour distance indices show that the village distribution was close to random/Poisson distribution (Rn = 1), although slightly departing from the randomness towards a clustered pattern (Rn = 0). Before constructing the dam, its departure from randomness towards the clustered pattern was more pronounced than after the dam construction, i.e. 0.82 and 0.79 compared to 0.92. This is because there were no villages located far from the main river, unlike the situation after the dam construction. A reservoir indeed has many more random contours than a river.

2.4. Local people: conditions and aspirations

2.4.1. Introduction

Six villages, namely Anawit, Artain, Apuai, Pa'u, Belangian and Bunglai were selected randomly for interviewing. From each selected village, 10 to 12 people were chosen as respondents, 62 respondents in total. The questionnaires covered various aspects, such as social status, occupations, land tenure, land uses, income and opinion about conservation and forest protection as well as their willingness to move to other places (see appendix 1).

The interviews took place in the planting season, when most of the men had left their villages and stayed in the field in the temporary huts, to guard their cultivated land against wild boar and other pests. They were available only on Friday morning till afternoon, when they came home for Friday prayers, collecting some logistic materials and community gathering, and then went back to the field in the afternoon. On this day, the official announcements from the head of the villages, visits and extension from the Government officials and other services were took place.

The interviews were done using the Indonesian language, although some people are limited in understanding '*bahasa'*. For them, the questions needed to be translated into the local language, and their answers translated back into Indonesian. The results of the interviews are summarised below.

2.4.2. Socio-economic conditions

The social status, occupation, education level and housing permanency

All respondents were male. Most of them were ordinary men (87.1%), and the rest were formal leaders and non-formal leaders (6.5% each). Almost all respondents were married and acted as head of the family (95.2%); 48.4% respondents had more than 5 family members, while 17 respondents (27.4%) had more than 5 children.

In terms of their main *occupation*, 59 respondents (95.2%) were farmers. The sources of additional income included gathering gemstones, small commerce, animal husbandry, boat operating, fishing and gathering rattan.

Out of 62 respondents, 24.2% were *local migrants.* Most came from neighbouring villages in the same subdistrict. The distances from their original villages to the new villages varied from 10 km to 200 km. The farthest was located in another district. Their former occupations were farmer (73.3%), tailor and gemstone digger. The reasons for moving were economic (46.7%) and other reasons such as to join their wives. Twelve migrants (80%) said that their economic condition was better than before, and that adaptation to the new place was no problem.

Most respondents (91.9%) had attended an elementary school, one had attended Junior High School, and two respondents were at a Senior High school. The highest education levels among their family members were Elementary school (80.6%), Junior High school (10.9%), Senior High school (5.4%) and Polytechnic (3.2%).

Of the respondents, 41.9% lived in a permanent house, 51.6% in semi-permanent housing and the rest in temporary house. In terms of their *level of affluence,* only 5 respondents (8.1%) considered their material conditions to be relatively good. Electricity, house appliances (TV, radio, etc.), glass windows, bricks and wooden-walled houses are some indications of permanent housing and wealth.

Land tenure and land occupation

About *land tenure,* 48 respondents (77.4%) considered their occupied land to be unregistered, while the remaining 14 respondents did not give any clear response.

Related to *land occupation*, 30.7% of the respondents occupied 2 ha of land or more, 17.7% of them occupied 1.5 ha, 29.0% of them occupied 1 ha of land, and the rest occupied less than 1 ha. However, for some reason or other, not all occupied lands were cultivated. Among the respondents, 50% only cultivated up to 1 ha of land, and the remaining respondents currently cultivate 1.5 ha to 2 ha.

Agriculture in general

Out of the 59 farmer respondents, 96.6% managed rice fields and 2 respondents managed small-scale coffee plantations. Most of their farms were relatively close to their settlement (77.7%), while 91.5% of the respondents said that their farms had been managed less intensively, e.g. without terracing, and without or with only a small amount of fertiliser. Rice - partly saved for subsistence uses - and peanuts (*Arachis hypogaea*) were sold locally (72.9%), while coffee was sold at the district market outside the village. Rice, peanut and recently rubber trees were the most preferred plants. Only 27% of the respondents earned an annual income of more than Rp 1 million from farming activities and the others less than that. The exchange rate at the end of 1994 was 1 US$ for Rp 3,150.

Only 19 out of the 62 respondents (30.6%) had cattle, i.e. cows and water buffaloes, where most of them (57.9%) had 3 or less, 1 respondent had 4, one had 5, and 6 respondents had 6 cattle (31.6%). Cattle were not sold every year. Therefore, the income from animal husbandry was not recorded. The cattle were left free in extended grasslands, sometimes equipped with a simple fence, together with cattle belonging to other villagers. Each group consisted of cattle belonging to several people/villagers, up to 30 owners, which were not necessarily people from the Aranio subdistrict. The grassland areas used were not well recorded.

Not all respondents practised fishing. Of them, 20 respondents used nets and lures, and 4 respondents used *karamba,* a kind of fish cage put into the water. They caught 1 to 3 kg fish per day, partly used for daily consumption. The income from fishing ranged from Rp 1,000,- to Rp. 5 000,- per day, depending on the situation.

2.4.3. The aspirations

Appreciation of conservation and environment

Among the respondents, 33.9% practised *slash-and-burn*, including burning the grassland to get young shoots for their cattle activities, mainly because it is easy and cheap to clear land (52.4%), and also out of habit. The remaining 66.1% respondents did not practise slash-and-burn, because they worked on permanent farms. Of the respondents, 8.1% said that slash-and-burn activities do not destroy the forest, since they practise it outside forested areas, while 1 respondent said that slash and burn does no harm, since the rotation cycle is 3 years.

Only 36.0% of the farmer respondents practised *soil conservation,* such as terracing. The reasons for not practising soil conservation were that, they did not understand how to do it (59.5%), that their land was flat (29.7%), that it was difficult to practise (8%), or that they cultivated former re-greening areas.

All 62 respondents used *firewood* for cooking. Most of them collected fuel wood from around their village (51.6%), around their house yard (33.9%), from the ex-reforestation area (*Acacia sp.*), and from ex-rubber plantations, currently sunk in the reservoir. Only 5 people (8.1%) said that they partly bought firewood.

About the *decreasing water supply* in the dry season, 30.6% of the respondents said that this situation was disturbing, others did not understand the problem (19.4%), even a few people (4.8%) did not care. Regarding the *erosion/sedimentation* balance in the reservoir and rivers, some said that it was disturbing (14.5%), especially for transportation. Logging activities by concession holders in the upper part of the neighbouring area were blamed for it (4.8%). Of the respondents 19.5% believed that erosion and sedimentation could be avoided by cultivating flat land and applying soil conservation.

About the *forest fires*, 40.3% of the respondents said that they were involved in helping to stop the fires, while 17.7% respondents claimed that they did not burn any forest and 9.7% respondents felt disturbed by fires. As to *forest destruction*, 24.2% respondents did not cut trees in the forest, 9.7% respondents felt disturbed, and 21% respondents did not care.

Most respondents (40.3%) had no idea about *the loss of bio-diversity* or did not understand it and 9.7% respondents did not care. Some people understood that cutting trees in the forest causes bare land and grassland to appear (29.0%), and that forest degradation was disturbing life in the village (11.3%). The rest did not respond to this question.

Future life

About *efforts for a better life,* all respondents wanted to have a better life, but the majority did not know how to achieve it (40.3%) and 29.0% of the respondents preferred to work harder for a better life. Some other answers included increasing land productivity (6.5%), and asking for government aid in terms of loans to improve their agriculture and animal husbandry (8.1%).

About the *future of the children*, simple answers were recorded. They hoped that their children would have a better life than their parents, whatever way they chose. They would like to send their children to school and special courses (43.5%); some had the same ideas but hampered by their economic condition (8.0%), while 6.4% of the respondents did not care too much about their children's future.

About the condition of the land in the future, most respondents did not comment or did not understand (43.3%). Some answers were: there will be no significant changes in the future (11.3%), natural forests will go and sources of livelihood will decrease (9.7%), slash and burn will still be practised (6.4%) and there will be more bare land if shifting cultivation does not stop (6.4%). Optimistic respondents said that in the future grassland would decrease and forest would increase (9.7%).

In comparing *land coverage in the present situation and in the past,* most of the young people did not know of the situation in the past (27.1%). The older generation's opinions were divided as follows:

- The current situation is the same as in the past (30.5%)
- The current situation is worse (30.5%), indicated, e.g. by decreasing forest products, decreasing water quality, droughts in the dry season, warmer temperature, fewer plants and less forest.
- The current situation is better than in the past (11.9%), as formerly the land was dominantly covered by grass.

What should the government do to improve life?

To this question, every respondent gave more than one possibility, 92 opinions in total. To increase their standard of living, the government should support them by improving the infrastructure, i.e. roads, bridges and electricity (27.2%). Other requirements were: the government should provide education (17.4%), capital (15.2%), animal husbandry (12%), seedlings, preferably of rubber-tree, coconut, chocolate and fertilisers (10.9%), agricultural extension (9.8%), reforestation and re-greening for local people (4.3%), and establish co-operatives (3.3%).

Moving to a new place, worth to be considered?

About the possibility of moving to another place, their opinions differed.

- Most of them (46.7%) had no objection to moving under some conditions, such as housing and agricultural land provided by the government. Other conditions were: better replacement for their business (23.3%), not too far from the original places (11.7%), with access to collecting forest products.
- Others wanted to stay (38.3%), mainly for historical reasons; already having a stable business (30.0%), and having difficulty in adapting to the new situation.
- Other respondents (15%) never planned or even thought about moving to other places.

2.4.4. Discussion

Socio-economic issues

Only 5 out of 62 respondents considered themselves relatively wealthy, based on their housing conditions, house appliances and their business, e.g. most of them had a small electric generator, and a boat to let. But, considering that less than 50% of the respondents live in permanent houses, it can be said that, in general they were not yet in good economic conditions. The size of the land they occupied did not have a direct relationship with their wealth, since for different reasons, not all of the land was productive and regularly utilised. The reasons were: a lack of manpower and capital, weather conditions, and a marginal soil quality.

It is normal that every respondent wanted to a have better life in the future. But this was hampered by their lack of knowledge, i.e. 40.3% did not know how to improve it, while the realistic answer was to work harder (29%), without really knowing how to work harder. More than 50% of the respondents wanted a better education for their children. The underlying factor to this answer is the fact that the education level of the older generation is low. Meanwhile, asking the government to help them improve their life is a pragmatic answer, although it is only given by 8.1 % of the respondents.

Government involvement in improving the infrastructure, education, capital and animal husbandry is the main wish. It is a realistic way of thinking that improving the infrastructure, such as bridges, roads and electricity will, in turn, trigger various social and economic activities. Better road networks and bridges for examples, will reduce transportation cost and the required time to go to other places. A higher level of education is undoubtedly also very important to receive new information and technology and compete with people from outside the area. Asking for capital, i.e. credits to increase their businesses or farming activities is also logical due to their limited economic sources. Government involvement in developing cattle husbandry is based on the fact that grassland and cattle are closely related to their lives.

Protection and environmental issues

Slash-and-burn activities are commonly practised in South Kalimantan. The reasons as mentioned by the respondents are that they are easy, fast, cheap and traditional. The interesting opinion is that slash-and-burned does not destroy the forest, since they practise it on non-forested areas, while slash-and-burn does not harm if the cycle is 3 years. The related question then is: if they do not practise it in the forest, then where do they do it? The answer is burning the grassland to get the young shoots for their cattle where the fires easily go to the forest.

The majority of the respondents (60.1%) said that there was no improvement in the land cover since the old times, in the sense that grasslands have already existed since the beginning. Only 11.9% said that the current situation is better than before. It is also understood that reforestation sometimes takes place on grassland in the lower part of the area, which people also use for their cattle husbandry. This statement can be related to the failure of reforestation programme.

The failure of reforestation programmes may have a relationship with the statement that people do not see any advantage of the timber estates, especially of *Acacia mangium*, a fast growing species mostly used for reforestation programmes. For them, fruit trees for the people are much better. People only joined reforestation programmes to get an additional income as the project workers (see also Unlam 1986, 1987).

Undoubtedly, decreasing water levels in the dry seasons cause problems for the local people, especially for farming and transportation. When the water level drops, some villages in the upper part cannot be reached by boat, and the people have to walk to get to the lower part deep enough for the boat. More intelligent opinions were that:

- The decreasing water level in the reservoir is not due to forest degradation, but to less rainfall in the past years, and the dry season becoming longer.
- Some even said that the lower water level was the result of an increasing energy production by the electrical company.

Erosion and sedimentation may be of no consequence for the local people, but for the electric supply it is a big problem. As to this, 19.4% of the respondents said that erosion and sedimentation may be avoided by cultivating flat land and applying soil conservation. They said that a forest concession holding company on the neighbouring site was to blame for it.

Regarding the awareness of protection and conservation, it seems that this is a matter of understanding rather than appreciation. This can be concluded from the number of respondents answering and not answering the related questions properly, and the quality of the answers given by the respondents. Moreover, it can be explained by the fact that most of the respondents (91.9%) only attended elementary school. Another possibility is that the respondents did not care about environmental conditions due to their limited economic situation.

Land status and Government policy

As to the land status and land tenure, most respondents fully understood that they were living in the protection forestland. For that reason, they knew that they were not entitled to a formal right of ownership on the land they occupied. Consequently, they could not sell the land they occupied when they wanted to move to another place.

Concerning the possibility to move to other places, the larger part of the respondents said that they had no objection to moving under some conditions. However, in total, those who wanted to move (46.7%) were fewer than the remaining part (53.3%) who did not want to move The conditions they asked for, such a house and farmland, seemed normal and not exaggerated. On the other hand, those who refused to move also had logical reasons, such as a historical reason and the fact that they already had an established business.

From the Government's point of view, several possibilities to solve the problem in the river basin area can be considered, namely (a) moving the people from the river basin, (b) changing the status of the protection forest, and (c) a compromise between the two options.

By law, the first option is possible (see Ministry of Interior Instruction no 15, 1989 which includes three possibilities to move the local people in the protection forest land to outside areas), although some consequences should be faced. Some consequences are that the government has to find large-scale land, establish new settlements and farming land, which is costly. Moreover, the local people have to face social and cultural impacts in the new area. Not all of the people are willing to move due to historical reasons, even when houses and farmlands are provided.

Changing the status of the protection forest will also create some problems, especially for the safety and life-time of reservoir and dam, related with the continuous water supply for irrigated rice fields in the down stream area, drinking water and a shortage of electrical energy. This is also related to sedimentation and erosion in the upper rivers, forest and grassland fires.

The third possibility, namely the compromise option by reclassifying, re-allocation, land use zoning and agricultural intensification seems to be an alternative worth to be considered, although there are still risks, such as illegal cutting of natural forest.

2.5. Deforestation and its driving forces[1]

2.5.1. Introduction

This study covers part of a river basin in South Kalimantan Indonesia, where a dam was constructed, creating a reservoir to supply water for electricity generation, irrigation and drinking water production, mostly for the outside areas (Banjarmasin and its surrounding areas). For this purpose, several villages had to be relocated to higher sites. To protect the watershed, the area was declared Protection Forest. As a consequence, no land-use activity affecting the protection function is allowed, although some villages inside the watershed still exist. As, however, another government regulation supports holding the villages, the land status and land tenure is unclear. This results in a competition between forest protection and agriculture. This has led to illegal cutting of natural forest, failure of reforestation and ultimately land degradation (as indicated by the high rates of erosion and sedimentation).

This study seeks to identify and evaluate the driving forces behind deforestation (as the land-use/land cover change), by relating population dynamics (i.e. growth, migration), village distribution pattern and socio-economic indicators with spatial aspects of land cover changes.

Study Area

Part of the Riam Kanan watershed area in South Kalimantan, Indonesia was selected as a study area. The approximate geographical position of the area is 2°45’ - 3°45’ S and 114°45’ -115°30’ E. Administratively it falls under the Aranio subdistrict, district of Banjar.

The reservoir, completed in 1972, and located in the central part of the basin, was designed to cover 9200 ha. Rivers and the reservoir are the main ways to transport daily goods and agricultural products from and to the villages.

The soil types were dominated by the Podzolic-Latosol complex (Ultisols, Oxisols) with medium textured loamy and silty clays. Most of the Podsolic (Ultisols) soils were poor in nutrients. The stability of the soil structure was low, due to the low organic matter content. Sheet and gully erosion varied from 9.6 to 83.1 ton, ha-1, y-1, causing 1.1 to 11.7 ton, ha-1, y-1 sediments to accumulate on the river beds (SK, 1992).

In 1988, the local people (Banjarese) consisted of 81.9% farmers and farm labourers, 7.9% officials, and 5% local miners (SDA, 1988). Most farmers practised subsistence agriculture and fishing, and some were involved in cattle husbandry. Grazing land occupies a larger portion than cropland, while cattle are left free on the grassland. Grasslands were periodically burnt to produce young shoots for cattle, leaving some areas seriously overgrazed. The number of cows and water buffaloes increased from 1851 and 175 in 1988 to 2860 and 267 in 1994, respectively. The education level of

[1] The original version was published in Journal of Land Degradation and Development 9, 311-322 (1998) as: ‘Deforestation and its driving forces: a case study of Riam Kanan watershed, Indonesia’

the villagers was mostly low, i.e. elementary school (SDA, 1988-1994).

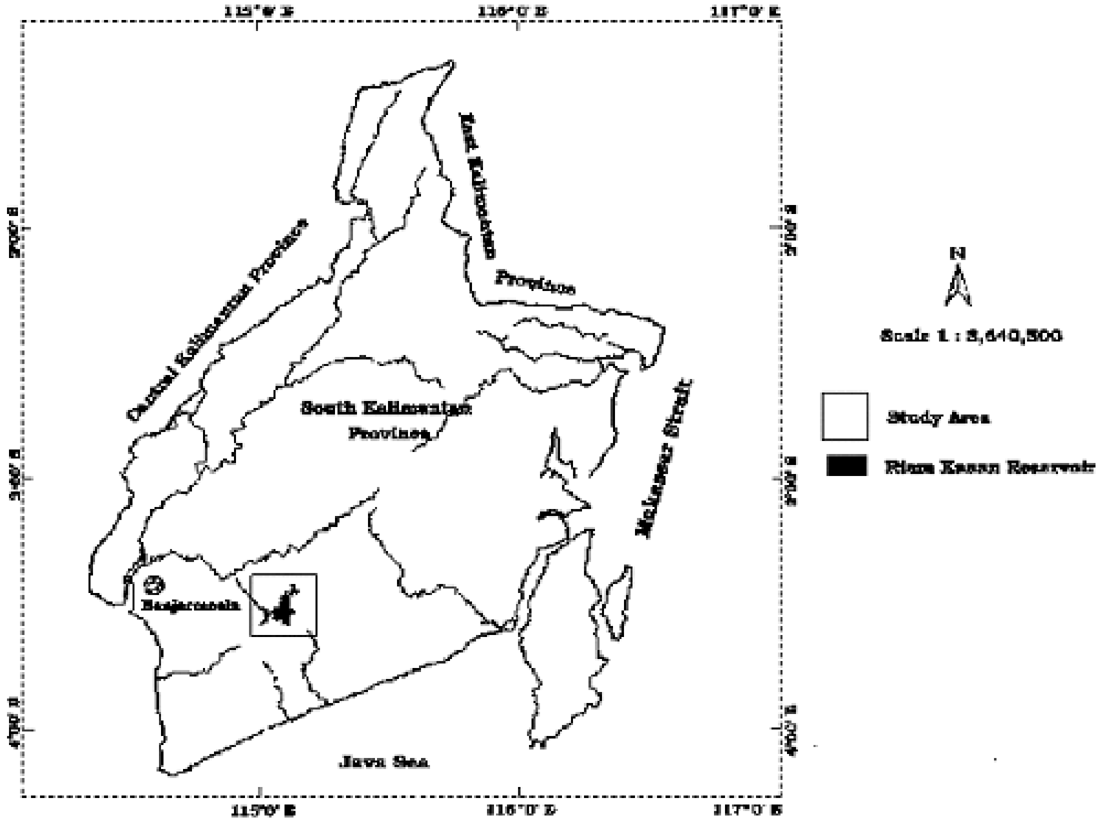

Figure 2.7. Location of the Study Area.

In 1989, 60% of the whole watershed area was eroded, of which 51% was in the forest area and 10 per cent outside the forest area (MoPW, 1992). During the dry season, the water level in the lake often dropped drastically, causing a problem in the electricity supply. A reforestation programme, carried out since 1974 had not been very successful, mostly due to uncontrolled cattle intrusion, forest fires, and burning of grasslands, especially in the long, dry season.

2.5.2. Materials and Methods

Analysing Land cover Changes

Land cover was studied on the basis of panchromatic aerial photographs of 1:12,600 (June 1963) and 1:100,000 (August 1981), and digital data of Landsat MSS (October 1973) and TM (June 1991). Topographic maps of 1:100,000 scale (1946) and of 1:50,000 scale (1974 and 1990) were also available; the latter was made based on the 1:100,000 scale aerial photographs from 1981. To analyse the remote sensing data, ILWIS 1.4 software was used (ITC, 1993).

Colour composites were made for Landsat MSS and TM data. A digital orthophoto was created for the small-scale aerial photographs (Bargagli, 1991). Visual interpretation, followed by screen digitising was applied to obtain digital data. The area of each land cover type was calculated for each data set. Then, the individual results were integrated to calculate the rates of change, emphasising the forest cover changes.

In this study, deforestation refers to both permanent and temporary removals of forest cover (Sunderlin and Resosudarmo, 1996). The deforestation rate for a given land area was calculated as follows (Veldkamp, et al., 1992):

$$\text{Deforestation rate } (\%, y^{-1}) = \frac{\left[\dfrac{F_1 - F_2}{F_1}\right]}{N} \times 100$$

Where,

F_1 = Forest area at the beginning of reference period
F_2 = Forest area at the end of reference period
N = number of years in reference period
y = year

Defining village pattern, dispersion and dynamics

The village was taken as subject for the demographic studies, because it is from the village that the rural people engage in the activities that lead to land-use changes. The number of villages shown on the 1946 and 1990 topographic maps were 11 and 21, respectively.

The null hypothesis was that the villages were randomly distributed. The quadrates count method (Rogers, 1974, Unwin, 1981) was used to measure pattern (i.e. a zero-dimensional characteristic of a spatial arrangement which describes the spacing of a set of objects with respect to one another (Hudson and Fowler, in Rogers, ed., 1974) of the village distribution, where the village sites were represented by points at approximately the centre of each village. A grid, consisting of 10 x 12 equally sized quadrates, was overlaid over the study area on the topographic map. Each quadrate measured 2041 m x 2041 m.

The points falling into each quadrate were counted, and their mean (μ), variance (σ^2) and variance to mean ratio were calculated. Theoretically, patterns can be random ($\sigma^2=\mu$), clustered ($\sigma^2>\mu$), and uniformly spaced ($\sigma^2<\mu$). Student's t-test was used to test the observed pattern against those generated by an independent random process (Toyne and Newby, 1971, Unwin, 1981). As a continuum, the point pattern ranged from maximum uniformity to maximum clustered with random distribution in between.

As a measure of *dispersion* (i.e. one-dimensional characteristics of a spatial arrangement which measures the spacing of set of objects in relation to one particular shape of a given area, Mc Connell in Rogers, 1974), the Green's index (Ludwig and Reynolds, 1988) was applied on the village distribution. The Green's index (GI) was calculated as follows:

$$GI = \frac{(\sigma^2/\mu) - 1}{(n-1)}$$

Where n = number of points (representing villages). GI can range from -n+1 (maximum uniformity) to 1 (maximum clustering), while 0 means that the dispersion is completely random.

The mean distance between the villages was calculated using the Nannal program and ILWIS. The patterns and dispersions before and after the dam construction were compared. Village dynamics include the establishment of new villages, splitting of the original villages, disappearance of villages that existed before, and moving of villages from their original places.

Analysing Human Population Dynamics

Population characteristics (Clarke, 1972) embrace absolute population numbers, physical and socio-economic characteristics and population dynamics (mortality, fertility and migration).

Human population statistics at the district level existed for the period of 1987-1993. Information obtained by interviewing selected local people was an additional source of knowledge to understand the population dynamics. Five villages were selected randomly, and from each village, 10 respondents were chosen randomly, resulting in a total of 50 respondents.

2.5.3. Results

Land-cover types and Distribution

Differences in geometry, resolutions or scales, image characteristics and the minimum area of interpretation (see, e.g. Burnside, 1985, Lillesand and Kiefer, 1994, Pohl, 1996) affected the quality and accuracy of the analysis of RS data (e.g. accuracy of the interpreted shrub and arable land). These problems are not addressed in this study.

The most clearly distinguishable land cover types were forest and water bodies; they were clearly identifiable in all images, either through its false colour or dark-grey tone. The grasslands were also clear in Landsat MSS and TM images, but on the small-scale aerial photographs they could not be separated from the arable land. Shrub was the intermediate cover type between forest and grassland; therefore its class boundary was not quite distinct.

The arable land was clear in Landsat MSS and TM data as light-green to light-blue colours, but it was not easily identifiable in aerial photographs. The 1963 data were not used to calculate the deforestation rate due to an incomplete coverage of the existing photographs as compared to the later data.

The main land cover types in different years are given in Figure 2.8 and Table 2.6. The 1946 topographic map showed that in the past, forest and grassland dominated the area, especially in the central part. More recently, the land in the lower central part surrounding the reservoir was converted to arable land and low-density vegetation.

Table 2.6. Changes area of the main land cover types, in ha.

Cover types	1973		1981		1991	
	ha	%	ha	%	ha	%
Forest	8,061	22.41	7,251	20.16	6,259	17.40
Shrub	2,094	5.82	699	1.94	5,447	15.14
Grassland	11,064	30.76	20,970	58.30	6,175	17.17
Arable land	8,458	23.51	106	0.29	12,927	35.94
Reservoir	6,295	17.50	6,946	19.31	5,164	14.35
Total	35,972	100	35,972	100	35,972	100

The natural forests were located mainly in the hilly and mountainous parts of the watershed, while most of the villages were surrounded by small patches of densely or less densely vegetated area, i.e. cash crops. In the 1991 image, some reforested areas were seen to be located mostly on the lower parts of the watershed.

Often the shrubs and the grasslands are intermingled, creating problems in separating these two land cover types in images. Most of the grasslands (which could also be abandoned agricultural land) were located in the gently undulating parts of the watershed area. Sometimes it was mixed with shrubs or young forest plantations. To some extent, grassland and arable land were interchangeable in the sense that at certain times arable land could be left fallow and become grassland. In general, the arable land was cultivated once a year, except if water was available for a longer period, then twice-a-year cultivation was possible. In the small-scale aerial photographs, the patches of rice fields along the small rivers were too small to be delineated.

Although the reservoir was designed to cover an area of 9200 ha, in the observation dates (dry seasons), this area fluctuated between 5164 ha (1991) to 6946 ha (1981). In 1963, the area to be covered by the reservoir was mostly grassland.

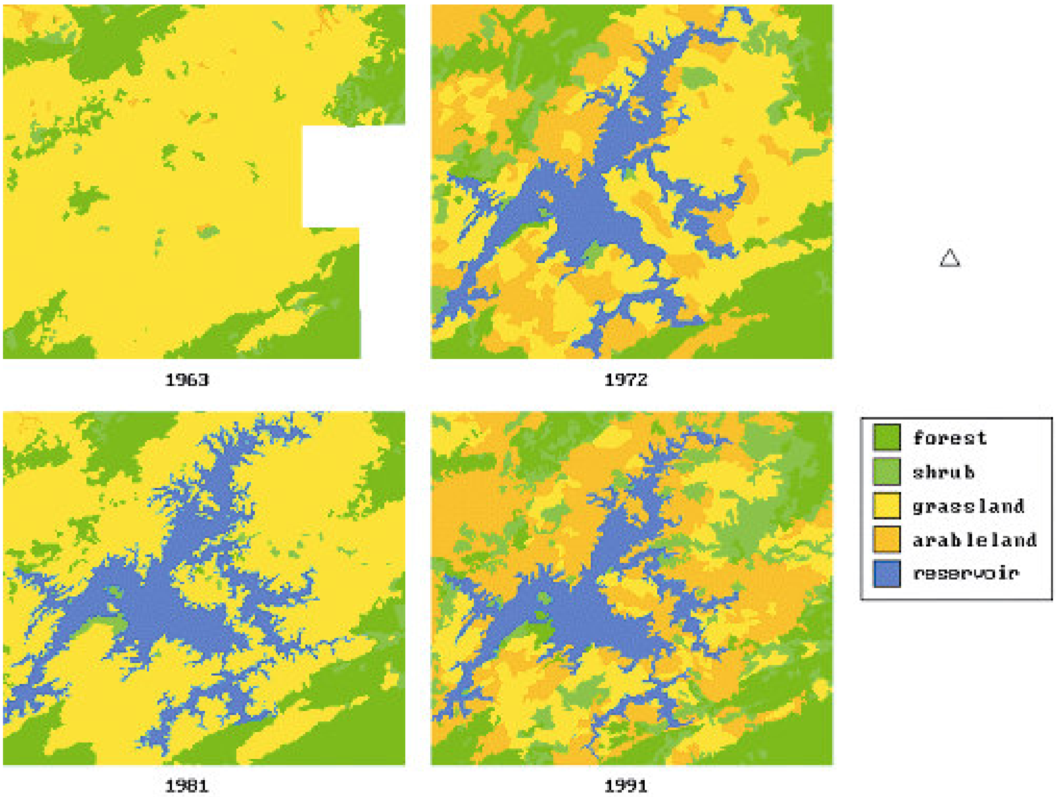

Figure 2.8. Land cover types in different years.

Deforestation and reforestation

From Table 2.6, it was calculated that the annual deforestation rate from 1973 to 1991 was 1.24%, while from 1973 to 1981 was .26% and from 1981 to 1991, it was 1.37%. There was an increasing rate of deforestation from 1981-1991 compared with the 1973-1981 period. Considering the areas that have been reforested, the real forest encroachment during 1981-1991 could be larger than the calculated rate.

The individual deforestation sites were small, irregular and scattered on the fringes of the forest areas. This spatial pattern of the deforestation was closely related to the village's distribution pattern (i.e. clustering in the lower centre area), the location of the forest areas (i.e. at the outskirts of the watershed), and the short distance from the villages to the forest.

The conversion of the forest started from the most accessible area (i.e. close to the villages), either by extending the arable land located in the centre of the forested area outwards, or initiated from the different places outside the forested area inwards. The horizontal distance from the rivers (currently a reservoir), where the villages are located, to the forest area is shown in Figure 2.9. This figure shows that the distance was relatively short (each distance unit is 1 km), which for the local people is within walking distance.

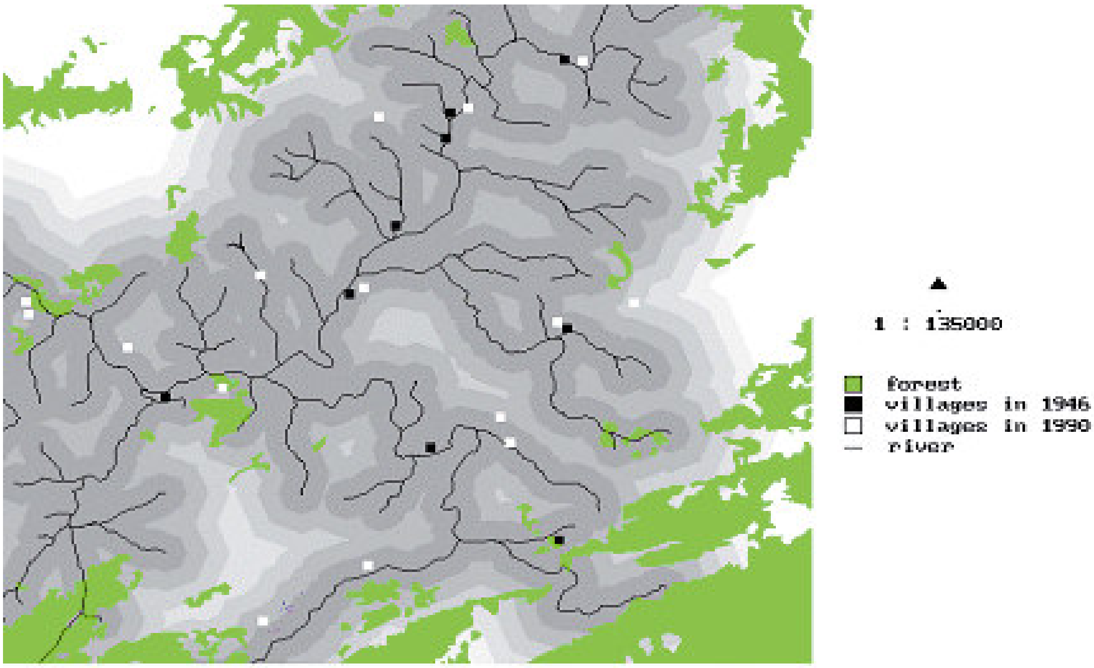

Figure 2.9.Distance from the river to the forest area.

Table 2.7. Reforestation in the Riam Kanan river basin, 1983 – 1992.
Source: SK Statistics, 1994

Source of Funding, Year	Planted, ha	Burned, ha	Second burned, ha	Remaining (1996), ha	%
Inpres, 1983 - 1992	11,600	5,182	1,170	5,247	45
OECF, 1990 - 1992	10,674	2,535	0	8,138	76
Total, 1983 - 1992	22,274	7,717	1,170	13,385	60

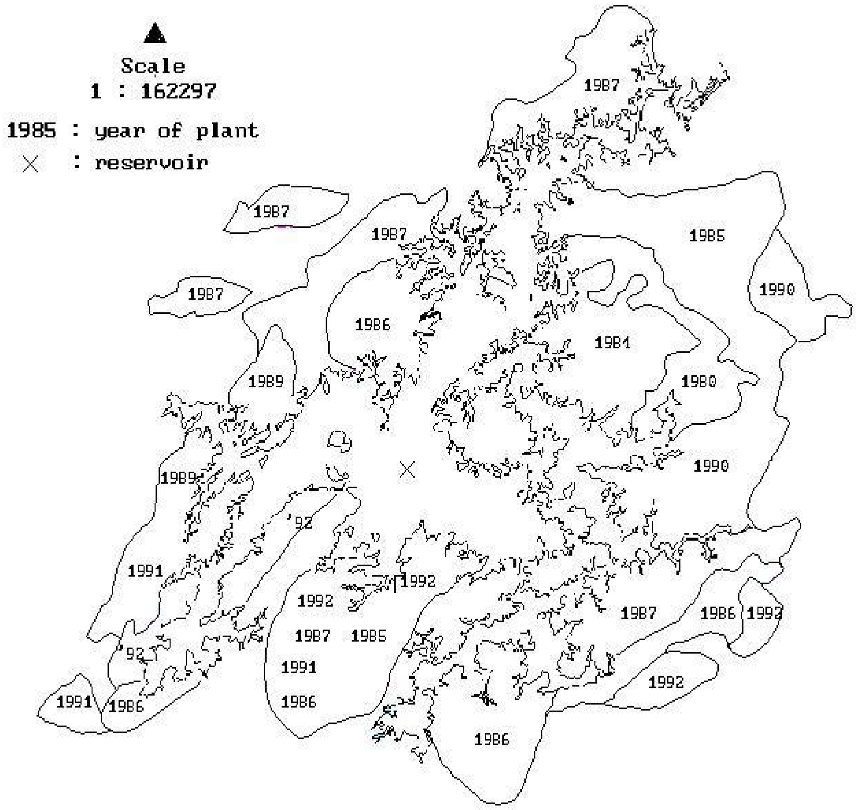

Figure 2.10. Reforestation areas (source: BRLKT).

The reforestation activities before 1983 were not significant in the area and since then, most of the area had to be replanted (Figure 2.10.). Table 2.7. shows that only 60% of the reforested area remained in 1996. Given this number, it is clear that the future of these plantations is far from certain.

The Dynamics, Pattern and Dispersion of the Village Distribution

The village dynamics

Out of 11 villages identified in 1946, 4 villages did not exist anymore in 1974, because of the lake formation. Some 14 new villages developed during the 1946-1990 period, including 8 new villages already indicated on the 1974 map, and 2 split villages as indicated in 1990. Two villages from the inundated area were re-established relatively far away from their original sites, while the others were displaced to adjacent locations. Instead of horizontal displacement closer to resources or infrastructure, the displacement was directed up-hill, because of the inundation by the rising water level in the reservoir.

The mean distances between the villages in 1946 and 1990 respectively, were not so different (i.e. 2.4 km and 2.7 km) indicating that on average the displacements were not far from their initial positions. It is likely that this is because sites suitable for village establishment were confined to the gently sloping areas, surrounding the reservoir.

The village pattern and dispersion

The 1946 data were used to represent the village distribution before the dam construction, and the 1990 data represented the situation after the dam construction. The approximate positions of the villages in 1946 and 1990 are shown in Figure 2.11.

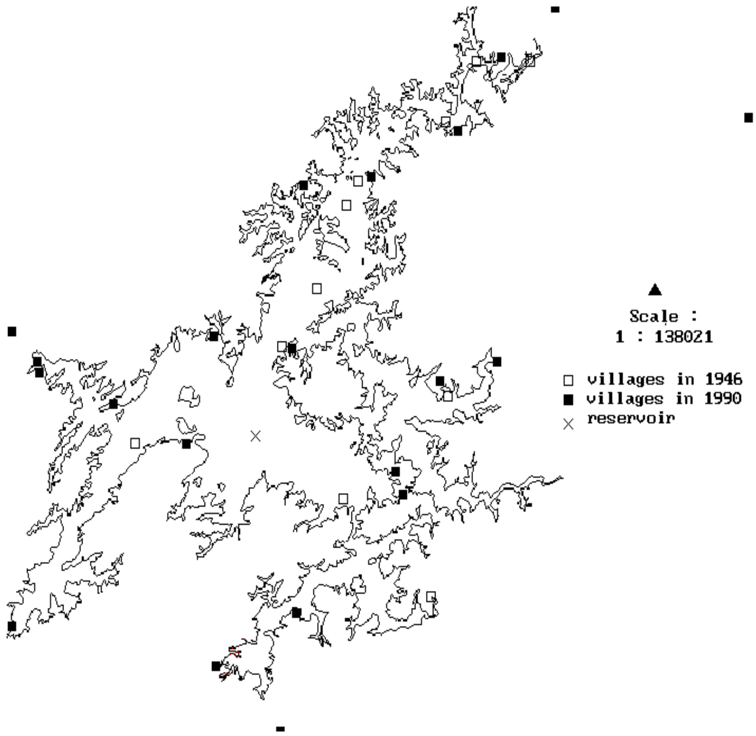

Figure 2.11. Location of villages in 1946 and 1990.

Table 2.8. Pattern, goodness of fit and dispersion of the village distributions (1946 and 1990)

Items	Random Value	1946	1990
Pattern: Variance/mean	$\sigma^2 = \mu$	0.101>0.092	0.196>0.175
Goodness of fit: Student's t test	$t_{calc} < t_{tab}$	0.766<1.98	0.926<1.98
Dispersion: Green's Index	0	0.01	0.06

Table 2.8 shows that in both the 1946 and 1990 observations, the variance to mean ratio (σ^2/μ) indicated a clustered pattern, i.e. $\sigma^2>\mu$. It meant that the dam construction in the 1970's had no effect on the village pattern. The reason seems to be that in 1946 all the villages were built along the main river in the centre of the watershed area, and only 2 out of 21 villages (1990) were located far from other villages in the lower part surrounding the reservoir, while the rest were close to each other, creating groups of three or more villages.

The Student's t-test showed similar results for the 1946 and 1990 observations, i.e. $t_{calc} < t_{tab}$, indicating that there was no significant difference and the null hypothesis of randomness appears acceptable for both situations.

The Green Index for dispersion that was used to check the degree of clustering of the village distribution patterns before and after the dam construction showed similar results (i.e. 0.01 and 0.06), meaning that the degree of clustering is low.

Human Population Distribution and Population Dynamics

The number of people per village in the sub-district varied from 167 to 1156 in 1987 and from 327 to 1193 in 1993. The population density in the *desa* (the lowest administrative unit of the rural area, consisting of a built-up area, i.e. village and other areas such as agricultural areas) ranged from 1.7 to 57.6 people per km2 in 1987 and from 2.7 to 58.6 people per km2 in 1993.

Table 2.9 shows the total population and population dynamics of the subdistrict Aranio from 1987 to 1993.

Table 2.9. The total population and population dynamics, subdistrict Aranio.
* interpolated from 1989 and 1991 data. Source: Subdistrict Aranio

Items	1987	1988	1989	1991	1992	1993
Total population	7117	7342	7465	7564	7621	7666
Natural Increment	-	0.51%	0.78%	0.13%	0.42%	0.38%
Net migration	-	0.59%	2.34%	0.15%	0.33%	0.22%
Growth rate	-	3.16%	1.67%	0.66%*	0.75%	0.59%

From Table 2.9. it is clear that in general, both the natural increment (i.e. crude birth rate -crude death rate) and the net-migration (i.e. in migration – out migration) in the subdistrict had low rates and decreasing trends. The positive net-migration means that the in-migration was larger than the out-migration. The migration in the sub-district consists of internal and regional types. The in-migrants came either from the neighbouring villages, e.g. by marriage, or from other districts within the same province.

The population growth determined by net-migration and natural increment. Even though the number of people increased, the trend of the population growth in the sub-district decreased from 1987-1993.

As to the population density and population growth, more than 80% of the '*desa*' had low population densities and low population growths in 1987 and 1993. Exceptions were Aranio and Tiwingan Lama (both are located close to the road network going outside), because although their population growth was low, the population density was high.

Local Land use and Agriculture Products

The interviews showed that most respondents used 1 to 3 ha land, of which between 0.5 and 2 ha were cultivated for subsistence purposes, partly for rice production (mostly as non- irrigated rice fields or '*ladang'*) and partly for other crops. The remaining areas were left fallow or used as grasslands. The most popular other crops were peanut, cassava and maize. In some places, banana plants, young rubber trees and young clove trees were seen. The land was prepared manually by the land user, often with the help of other villagers. Sometimes, mixed cropping was practised, mainly vegetable crops. Inter-cropping was done only if water was available for a longer period (e.g. rice and cassava or maize and cassava).

The area and land productivity for some agriculture crops is given in Table 2.10.

Table 2.10. The area and land productivity for agriculture crops, subdistrict Aranio. Sources: Statistical Data (1990, 1991, 1992, 1993), District of Banjar

Year	rice (ladang)	rice (sawah)	maize	cassava	peanut
1990	1179 ha, 1.6 ton,ha^{-1}	58 ha, 1.65 ton,ha^{-1}	43 ha, 0.88 ton,ha^{-1}	64 ha, 6.89 ton,ha^{-1}	1017 ha, 0.96 ton,ha^{-1}
1991	179 ha, 2.12 on,ha^{-1}	313 ha, 1.86 ton,ha^{-1}	20 ha, 0.95 ton,ha^{-1}	21 ha, 7 ton,ha^{-1}	272 ha, 1.02 ton,ha^{-1}
1992	828 ha, 2.89 ton,ha^{-1}	73 ha, 1.52 ton,ha^{-1}	50 ha, 0.96 ton,ha^{-1}	15 ha, 9.1 ton,ha^{-1}	1572 ha, 0.58 ton,ha^{-1}
1993	748 ha, 2.34 ton,ha^{1}	27 ha, 3.3 ton,ha^{-1}	73 ha, 0.95 ton,ha^{-1}	26 ha, 5.27 ton,ha^{-1}	1058 ha, 0.59 ton,ha^{-1}

From table 2.10, it can be seen that from 1990-1993, the sizes of areas for all crops fluctuated considerably. Except for irrigated rice fields (*sawah*) in 1993, there was no indication of increasing land productivity during that period. In terms of cash crops, no rubber was produced. Some farmers had a few heads of cattle, which would be sold after 3 years of husbandry. The large number of cattle observed in the fields belonged to people from outside, whereas local people were employed to look after them. The cattle were left free on the large grassland areas; the manure was therefore unintentionally used to fertilise the arable land.

2.5.4. Discussion and Conclusions

Combined Use of Remote-sensing data

The dissimilarities encountered between the different remote-sensing images (i.e. dates, geometry, image characteristics, resolutions or scales, and minimum area of interpretation) influenced the accuracy of the classification, especially when applying visual interpretation. This was reflected, for example, in differentiating forest and shrub (where the fuzziness of the land cover objects was concerned), or in differentiating similar grey tones of grassland and arable land in the small-scale aerial photographs.

Deforestation

Due to the land status of the area as Protection Forest, no extensive land use activities (such as a forest concession holding or a large-scale estate) were allowed in this area. For this reason, the causes of forest encroachment could be linked to illegal cutting and extending agricultural land.

Two different causes contributed to deforestation, namely (a) the conversion of forest into non-forest land, and (b) the failure of reforestation. The first was usually done by slash-and-burns, and the second was caused mostly by fire and cattle intrusions. Participation of the local people in reforestation activities was limited to income generation and the possibility of cultivating the reforestation area using the taungya system, i.e. by planting the food crops between the rows of the reforestation seedlings (Unlam, 1986, 1987). For most of them, reforestation was not very useful because they were not allowed to harvest the trees.

Comparing the deforestation in the study area with other tropical countries (Veldkamp et al., 1992, Colchester, 1993a and 1993b, Monbiot, 1993, Witte, 1993, Lohmann, 1993, Leonen, 1993, Osemeobo, 1990) the following differences can be described. Unlike some other tropical countries, there was no large-scale physical activity in the study area (such as logging, estates, or mining that caused large-scale deforestation); the small-scale deforestation areas, therefore, did not follow logging or estate roads. The dam that was constructed in 1970s covered areas of grassland, villages, agriculture land, and a small area of forest (which was not completely clear-felled before inundation).

The situation here was similar to that in the Brazilian Amazon area: the settlements in the study area were limited to areas along the major rivers (which had recently become a reservoir) and no extensive permanent road was available (Alves, 1994). Nevertheless, the difference here was that, in the past, grassland dominated the area and land clearing was not intended to build a large-scale settlement or estate, but mainly to extend little by little the arable land area. Skole and Tucker (1993) found that in Brazilian rainforests, the deforestation had a strong tendency towards spatial concentration, while the undisturbed forests tended to be sizeable.

Driving Forces to Deforestation

The pace of population dynamics between 1987 and 1993 in the study area was shown to be low, judged by the following factors:

- The increase in the number of people showed a slow pace, from 7117 to 7666 people, and most villages had a low population growth and population density.
- Both the natural increases and the net migration were low, the population growth rate decreased from 3.16% to 0.59%, and their trends decreased.

The low in-migration level could be related to the fact that no significant economic activity triggered migration into the study area. Moreover, the available infrastructure was scarce, and the land status as Protection Forest was considered a limitation. The out-migration was also low, most likely because of the low education level of the people, who could not compete with higher skilled people in the town. People movements among the villages around the reservoir were mostly due to inter-village marriages. For that reason, most of the migration must have occurred in Aranio (the district capital) and the Tiwingan villages due to more economic activities (e.g. market, offices, and the presence of a road network), and a larger number of people (e.g. officials and employees of the electrical company). In this sense, the study area differed considerably from more dynamic areas such as the Amazon area.

Relating low population dynamics with deforestation, we may argue that the forestland clearing (annual deforestation rate of 1.24 per cent) had no direct relationship with the low population dynamics (i.e. low growth rate).

Whereas the pattern of the village distribution before and after the dam construction showed a clustering pattern, their dispersions showed a low degree of clustering. This meant, that apart from the low soil quality, the available arable land area for each village was large enough to be cultivated. Although the number of villages increased, most were located in the central lower part of the area, bounded by less steep land and close to rivers and reservoir. Water availability for daily life, for transportation and for agriculture were the main considerations when developing the settlements (which also explained the unchanging village pattern before and after the dam construction).

It can, therefore, be reasoned that the deforestation was most likely to have been caused by individual activities, rather than by large-scale organised clearing of the hilly natural forest areas to create extensive agriculture land. This argument was supported by the fact that in general, the size and patterns of the deforested areas were small and irregular.

The attitude related to the level of education and level of affluence. The low educational level of most local people explained the difficulty in understanding the relationship between clearing the hill forest, cultivating steep slope land without soil conservation and high levels of erosion and sedimentation. It also meant that they did not grasp how to manage the land properly in order to achieve a better production. The drop in the water level in the reservoir is considered by local people to be due to less rainfall (personal communication).

The level of affluence was indicated by the following facts:

- The largest occupational groups were farmers and farm labourers (81.9 per cent in 1988).
- The soil quality in the area was marginal, i.e. podsolic (ultisols) soils, poor in nutrients, and with high erosion and sedimentation levels.
- Except for cattle husbandry, most of the agriculture products were for subsistence.

These facts may have contributed to the low input given to increasing land productivity. Additional income was mainly achieved by fishing, converting forest areas on the hills, and at the same time, by selling firewood.

The level of technology was reflected in the slash-and-burn activities and the lack of soil conservation practices (e.g. by not terracing the land on steep slopes). The use of fire, used to clear land and to get young grass for cattle, also underlines the lack of technological progress compared to many other areas of Indonesia. This suggests, as elsewhere, that it was certainly the lack of intensification of land use (shown by insignificant increases of land productivity, see Table 2.10) that explained the particular continuing deforestation. The slow advancement of farming practices was also shown by extensive grazing and simple methods used in cattle husbandry.

The land status as Protection Forest and the existence of settlements (both were supported by their own regulations) created conflicts on land use and uncertainty to the actors involved in their physical development. As a result, the local people could not have a formal land-right. This led to conflicts on the reforested land, since the local people assumed that reforestation was done on land that they owned; now they consider it a competitive activity.

The aforementioned shows that humans and their activities are obvious driving forces (see FAO, 1989, Fresco, 1993, Turner and Meyer, 1994, Turner et al., 1995). However, relating these forces to land cover changes is difficult because of the complexity of the interactions between human and environmental factors (Turner et al., 1993). For this reason, Vanclay (1993) and De Gier (1995) state that a multi-sectoral approach in an integrated and comprehensive way is needed to solve the problem.

Conclusions

The spatial pattern of the deforestation in the study area (i.e. irregular, small-sized, scattered on the fringes of the forest area), is related to the pattern of the village distribution (i.e. both are clustered in the lower area). Subsistence agriculture is dominant and there is no estate-like development in the area. Therefore, the deforestation in the study area must have been caused by illegal cutting and extending the agricultural land on an individual farmer basis. In this respect, the spatial pattern of the deforestation differs from other areas like in the Brazilian rainforests, where the deforestation has a strong tendency towards spatial concentration (Skole and Tucker, 1993, Mahar, 1990).

The dam construction had no effect on the pattern and dispersion of village distribution (i.e. low degree of clustering), while the mean distances of the villages before and after the dam construction were not so different.

The population dynamics explained the deforestation only partly. But, other aspects related to the human population (i.e. the low level of education, affluence and technology) also contributed to the deforestation process in the study area. This is in line with statements that human population and their activities are the most important driving force in land-use changes, in a complex interaction (FAO, 1989, Fresco, 1993, Turner et al., 1993, Turner and Meyer, 1994, Turner et al., 1995).

Uncertainty about the formal land status led to conflicts between the forestry institution and the local population concerning the use of land. Local people did not perceive deforestation as an illegal act. The lack of success of the reforestation efforts can also be attributed to the same problem of conflicting land use. The government 's decision on formalising the land status may thus be regarded as a political driving force to the problem of deforestation, and the limited success of reforestation.

2.6. Towards solving the problem, reallocation of the Riam Kanan area

2.6.1. Introduction

The Riam Kanan has become a more important river basin since the establishment of a reservoir, aimed at providing water for the generation of electricity, provision of drinking water and irrigation. To protect the river basin, the area was declared protection forestland. On the other hand, some settlements existed in the area long before, the inhabitants practising agricultural activities and husbandry. Different laws and regulations support the establishment of both protection forest and settlements. These regulations are conflicting.

The impact of the existing settlements on the steep slopes around the watershed area was small-scale deforestation, mainly caused by agricultural land and land clearing for subsistence agriculture. In most cases, proper soil conservation practices were lacking, leading to erosion and sedimentation. The reforestation programme mostly failed, either because of fires or because of the intrusion of cattle into the young reforested area. Most cattle are left free on the grasslands, and the grass is often burned to stimulate the production of young shoots. Both, deforestation and the failure of reforestation threaten the continuity of water supply, water flows and are decreasing the lifetime of the reservoir and generators (see plates 1.2, 1.3 and 1.5).

Studies made by Unlam and KLH (1986 and 1987) show that local people do not always consider reforestation activities to be beneficial. The only short-term benefit for some local people is the additional income as reforestation workers. Moreover, reforestation often takes place on the shallow slopes of the area surrounding the reservoir (plate 1.7), which are also used for agriculture and grazing.

A study by the local government shows that all of the 12 settled villages in the area meet the criteria to be moved (Bappeda Kalsel, 1998). From a viewpoint of regulation, moving settlements out of this area is possible in different ways (Inmendagri no. 15/1989). Moving local people out, however, may cause serious troubles and have dire consequences, since the people are strongly bound to their land. Human attachment to agricultural settlements is usually strong, and the results of the interviews show this to be the case here, too (see Section 2.3 and 2.4). On the other hand, not all parts of the river basin have steep slopes. Some parts surrounding the reservoir, currently used for agriculture, are relatively flat or gently sloping. Therefore, these spaces indeed lend themselves to careful agricultural activities.

Using the same area for different objectives may cause problems of mutually exclusive and/or overlapping uses. In turn, this raises sustainability issues for the ways in which to use the land resources. There are many ways and different approaches to solve land use problems, especially in terms of land allocation processes. Like other problems in land allocation with multiple objectives, the problem in this area can be considered an ill-structured or a semi-structured problem (see Chapter 1 for definition). In the present study, land *reallocation* is proposed. The results will be alternative uses of the newly allocated land for protection or agriculture, to be selected by decision-makers.

2.6.2. Structure of the model

a. The basis

In the present study, an approach to solve the problem involving the active role of decision-makers in a participatory decision-making process is applied. The decision-maker is the one who makes the final choice between some alternatives. Decision-makers can make decisions individually or group-wise. Members of a decision-making group work together as a team, discussing the problems, the objectives, constraints and the limiting factors involved. They then reach a consensus in a step-wise, participatory decision making process and establishing a *model*, i.e. a representation of the real world, sometimes on a smaller scale. In this approach, no single solution is provided. The results of the model give several options to select from, each alternative having its own risks and benefits.

The model is a *spatial model*, in which *spatial data* are analysed, so as to find a solution. All data and information used in the process hence are presented in the form of geographically referenced data. In other words, the required data are translated into superposable maps, as map layers.

In this respect, there are some basic principles that should be kept in mind. These are:

- The principles of generalisation and simplification are used to represent the real world in the model; it should be communicative and informative, i.e. easy to understand.
- The number of the *evaluation criteria* should be defined in such a way that the model describes the problem situation as closely as possible; the more evaluation criteria are used to establish the model, the more complicated the model.
- The evaluation criteria should be *comprehensive, measurable, complete, operational, decomposable, non-redundant and minimal* (Malczewski, 2000).

b. The framework

The framework of the land allocation model is represented in Figure 2.12.

A decision is a choice between alternatives. A decision-making process begins when the decision-maker(s) recognise and define the *decision problem* as a perceived difference or a gap between the desired and the existing states of a system (Eastman, 1997). Hence there is a need to evaluate these states before taking a decision.

Evaluation criteria in the first place involve *objectives,* i.e. statements about the desired state of the geographical or other system under consideration, statements that reflect all concerns relevant to the decision problems. It then involves *attributes* or *criteria,* i.e. some basic items for a decision that can be measured and evaluated. The evaluation criteria are associated in the present case with *geographical entities* and their *relationships.* Therefore, they can be represented in the form of *maps*. Thus, an *evaluation criterion map* or *data layer* is a unique geographical attribute.

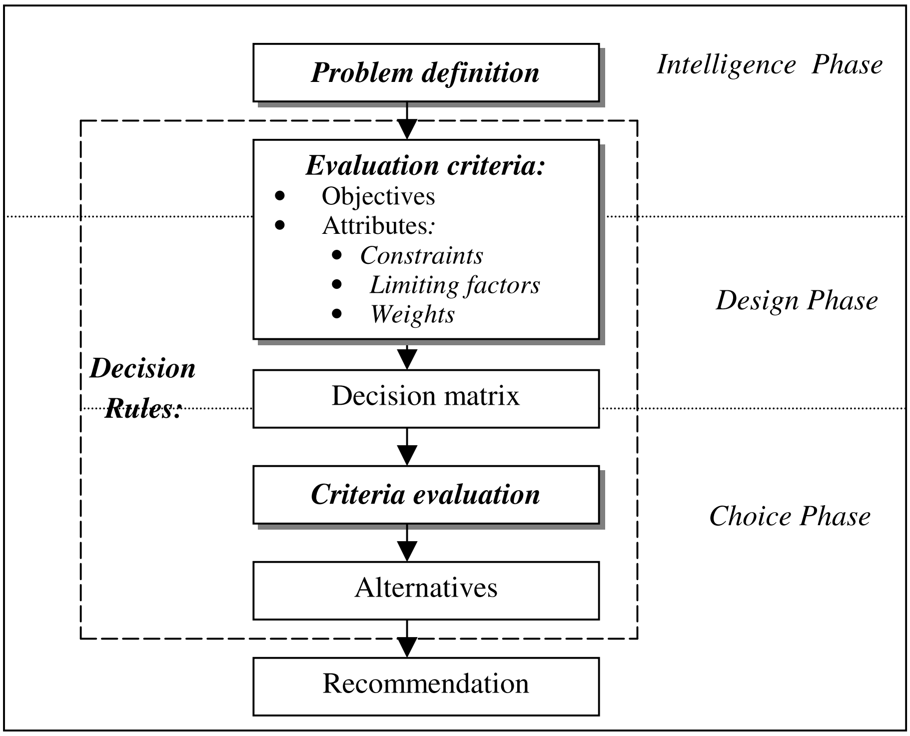

Figure 2.12. Framework for the land allocation model (adapted from Eastman, 1997).

According to Eastman (1997), an *attribute* (or *criterion)* consists of *constraints* and *factors. Constraints* are restrictions imposed by nature or by human beings, and restrict the movement within the *decision* and select the set of *feasible alternatives.* They block certain actions necessary to implement one or more decisions out of the set of decision alternatives (Keeney, 1980). Eastman (1997) defines *factors* as criteria that enhance or detract from the suitability of the specific alternative for a considered activity. According to Oldeman (pers. comm, 2002), in biology or ecology, a factor is a specific cause, acting by determining a development, e.g. soil fertility, rainfall. In Latin, 'factor' means literally 'maker'. Factors, therefore, can not be criteria in themselves, although there may be, and are, limiting factors, such as poor soils or droughts.

In this sense, during the construction and before the model is implemented, the factors are considered as virtual factors, which will become real factors as soon as the model is implemented. In this study, the 'factors' (Eastman, 1997) will be termed *'limiting factors'*.

With respect to the *evaluation criteria,* the decision-maker's *preferences* are incorporated into the decision model. The preferences are typically expressed in terms of the *weights of relative importance* assigned to the evaluation criteria. These are called *criterion weights*

In the present case, the Analytic Hierarchy Process (AHP) method by means of pairwise comparison (Saaty, 1980, Eastman, 1997, Jankowski, 2000) is used. Following Saaty, a *decision matrix* is a square reciprocal matrix of pair-wise comparison between *limiting factors.* The comparisons concern the relative importance between two limiting factors being compared in determining suitability.

The weight of each factor derived by taking the principal eigenvector of this reciprocal matrix.

Decision rules define a procedure for *ordering alternatives* (Starr and Zelleny, 1977), selecting and combining criteria (Eastman, et al.,1993) so as to compare evaluations in order to chose a particular evaluation. It dictates how best to *rank alternatives*, or to decide which *alternative* is *preferred* to another (Eastman, 1997). The actual process of applying decision rules to planning and design is called *evaluation*. The end result of a decision-making process is a *recommendation* for future action, based on the *ranking of alternatives.*

From the above it is clear that, based on the desirable objectives, all consequences of each alternative land use were analysed and theoretically predicted. Based on the theoretical consequences, decision-makers evaluate and rank the available alternatives, and finally, decide upon the best one.

b. Recognising a decision problem

See Introduction (Section 2.6.1.) for explanation. Now, the *decision problem* is how to reallocate the land to satisfy the needs of both sides, i.e. the need to protect the river basin and the need to establish settlements with their agricultural activities.

c. Defining and Standardising Evaluation Criteria

The Objectives

The *overall objective* is to reallocate the river basin area to agricultural land on the one hand, and protection forest on the other hand, following a precise set of *constraints* and *limiting factors*, so that the reservoir can function well and the continuation of water supply is assured. In the meantime, local people still must earn their living in the same area, practising subsistence agriculture in a sustainable way (for a sustained African example, see Kippie, 2002).

Therefore, the *specific objective is* to localise the land able to sustain agriculture. The *first specific objective* is to select suitable land for subsistence agriculture. The standard land surface allocated to each family in the transmigration scheme is 2 hectares. Following this standard, in this model, 2 hectares of land is allocated to each family. The number of families in the Aranio subdistrict was 1788 in 1998. So, the total land needed for subsistence agriculture is 3576 ha.

Since cattle husbandry is also the main activity of the people, some areas should be provided for the grassland. Hence, the *second specific objective* is to allocate suitable land for cattle husbandry. In this case, 3 hectares of land for each family is considered sufficient. Thus, 5364 hectares of land should be allocated for grassing purposes. This land should be used as common land or group land. Besides, certain areas should be reserved for infrastructure and replacement, in case the allocated subsistence land is not suitable (e.g. often inundated by reservoir or rivers). Assumed is that 60 ha land is adequate for reserve. Therefore, in total, 9000 hectares of land is needed. Accordingly, the *third specific objective* is to allocate part of the area to be maintained as protection forest, namely the remaining parts of the river basin area.

Constraints and constraint maps

There are four *constraints* to the re-allocation process. These obstacles define properties of unsuitable areas, which will be excluded from the target or candidate areas for the first specific objective, that is agricultural land use. Areas with obstacles are the following ones.

(1) Areas covered by forest and surrounding generator turbines

The forested areas cover the remaining natural forests and the successfully reforested areas. The natural forests are mostly located in the upper parts of the river basin, whereas, reforested areas can also be found in the lower parts. The forested area should always be conserved as forestland in order to maintain its protection function of the river basin.

The electricity generator is located at the mouth of the reservoir, close to the village of Tiwingan Lama. The turbine/generator can not be observed by remote sensing, but dense forests, which surround its location, can be found back.

(2) Areas covered by water bodies

Although water can not be cleared like land, reservoir and rivers are among the objects to be protected. They can be utilised in a sustainable way, especially for fishing and transportation. Neither activity causes harm to the stability of the water level and water supply. Rivers and the reservoir also define areas unsuitable to meet the specific objective, i.e. agricultural land.

Cultivating land close to water bodies may cause sedimentation. Therefore, to protect these parts, a wide strip of land along the water bodies is excluded from cultivation. The planning authority set this width at 100 m from the tip of rivers or reservoir. However, in reality, most of the existing arable lands are located exactly in the strip along rivers and reservoir. In this situation, the distance limit in this model is reduced to 50 m from the water bodies. No agricultural activities will be allowed within this strip.

(3) Areas with a slope of more than 30%

The steeper the slope, the riskier land clearing in the area. Once such areas are cleared, especially without proper soil conservation measures, negative impacts will follow. The effects upon the reservoir are clear, namely erosion and sedimentation, and unstable water supply, i.e. excess supply in the rainy season and scarce supply in the dry season. In turn, this reduces the quality and quantity of the electricity supply and the life span of the generator. These areas, hence, are to remain part of the protection forests.

(4) The maximum area to be allocated to agriculture

As the *target* of the first and second specific objectives, the total amount of the river basin area allocated to agriculture is set at 9000 hectares, a surface that may not be exceeded. Therefore, this amount delimits the allocation process and hence is considered a constraint for agricultural expansion.

Except for the fourth constraint, i.e. the geographically arbitrary, but socially determined maximum allocated area for agriculture, all other constraint maps are treated as Boolean maps. The boundaries between the constraint areas and their surroundings are given as clear or crisp boundaries. Gradient transitions are unsuitable for delimiting land use areas because of their fuzzy character. Indeed, planning limits are established to allow orderly human activities, in which land allotted to neighbours must have sharp limits so as to avoid human conflicts. Boolean maps are raster maps, built by digitising topographic maps and classifying Landsat images.

As in Boolean maps, all values of constraint raster maps are converted either to 1 or to 0. The area to be excluded from the target or candidate area for agricultural use, i.e. the forested area and the water bodies are given a value of 0, and other areas that will be part of the target area are given a value of 1. The constraint maps are used as masks to the area of the river basin.

Limiting factors and limiting factor maps

The *limiting factors* are measured at different scales. Therefore, it is important to standardise them before they can be combined into a single suitability map. Its can be done by weighting each limiting factor.

Following the standardisation level of the *byte* scaling, the limiting factor maps are standardised using value ranges from 0 to 255. Considering that continuous boundaries are more frequent in limiting factor maps than crisp boundaries, fuzzy membership functions are applied The last limiting factor, namely the land cover type is of course an exception. Five elements are selected and used as *limiting factors,* as follows.

(1) Proximity to the slope gradient

The steeper the slope, the more prone it is to erosion, sedimentation and land cover disruption. The land with flat and shallow slopes, therefore, is protected and may be used for agricultural land, while the land with steeper slopes will remain under protection forest.

Lands with slopes below 30% are suitable and most cost-effective for agriculture, and lands with slopes above 30% are not suitable for agricultural practices. A steep slope is a constraint. Therefore, the value of 30% slope gradient is used as threshold. Meanwhile, lands with slope gradients ranging from 0 to 10% are considered having one and the same suitability level, the highest. Hence, a 10% slope is the first critical control point, showing maximum suitability, and a 30% slope is the second critical control point, delimiting areas unsuitable for agriculture**.**

A reversed J-shape function with a *monotonically decreasing curve* is used to re-scale this factor map into the range of values between 0 and 255. For this, a contour lines map was established by digitising the contour lines of the area seen on the 1:50,000 scale topographic map. From the contour lines map, a slope map was derived, showing the slopes of the watershed area.

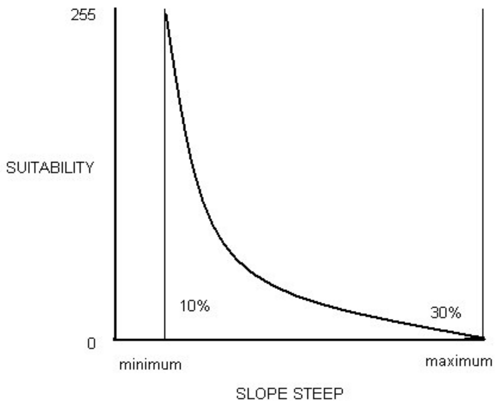

Figure 2.13.a. Non-linear suitability curve for slope gradients.
The10% slope used as the first control point, showing maximum suitability, and the 30% slope is the second control point, delimiting unsuitable areas for agriculture**.**

(2) Proximity to the forested area

Dense vegetation coverage, i.e. forest, is the best protection for the river basin, whereas experience shows that establishing forest is quite difficult. Reforestation programmes do not always succeed (see e.g. Table 2.7). For the safety of the existing forested area, the land preferred for agriculture lies far from the forested areas. The closer the agricultural land to the forest, the higher the threats to the forest, such as illegal cutting, cattle intrusion and forest fires.

A range of values from 0 to 255 is again used as a scale. For this second factor**,** a *linear distance decay function* using a *monotonically increasing curve* is selected to standardise this factor map. A GIS system, showing distances from the forested areas, served to establish a distance map.

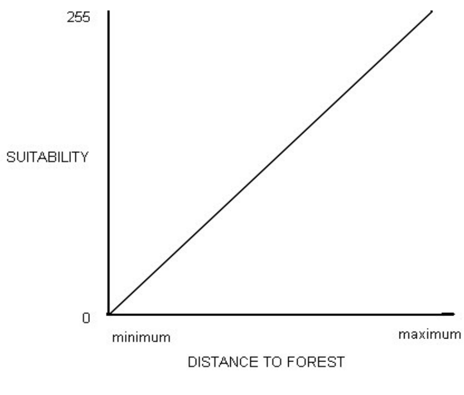

Figure 2.13.b. Linear suitability curve for proximity to forested area.
In this case, no control point is needed.

(3) Proximity to settlements

Similar to the second limiting factor, suitability is a function of distance. The distance from the settlement location to agricultural land is an important factor, especially linked to the energy and time consumed and the cost engaged, e.g. for transporting seedlings, manure or fertilisers. But, contrary to the distance to the forest area, the most suitable area for agriculture is the one closest to the settlement. The closer the agriculture area to the settlements, the easier the access it offers to the farmers.

A sigmoid function with *a monotonically decreasing curve* used to re-scale this limiting factor map to the 0 to 255 value range. A distance between 0 m to 500 m corresponds to the highest range of suitability. Therefore, the 500 m distance is used as the control point. Like for the previous factor, a distance map was established using a GIS distance analysis function.

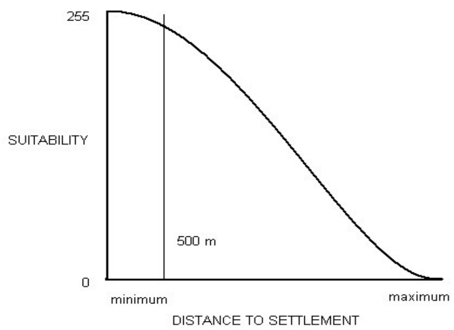

Figure 2.13.c. Non-linear suitability curve for proximity to settlements.
The 500 m is used as control point, assumed that the highest suitability lies within this distance

(4) Proximity to water bodies

Except for Tiwingan Lama, no proper direct road connecting settlements and roads leading to the outer river basin area are available. Hence, in terms of accessibility and cost, rivers and reservoir are the most important passages for transportation. The distance from the water bodies, like the distance from settlements, is non-linear and inversely proportional to the agricultural suitability of the lands.

The distance to water bodies is also a continuous factor; therefore, it is also re-scaled along the value range of 0 to 255. Here, again, a s*igmoidal monotonically decreasing function curve* is used to standardise this factor. The 50 m distance from the water bodies was chosen as the limit under which agricultural use is forbidden. In that case, the strip between 50 m to 100 m from the waterfront is considered ideal land for agricultural activities, and so has the highest suitability. From 100 m to 1000 m, the agricultural suitability decreases fast, and beyond 1000 m, the suitability is very low. Both distances are used to define the control lines for land allocation.

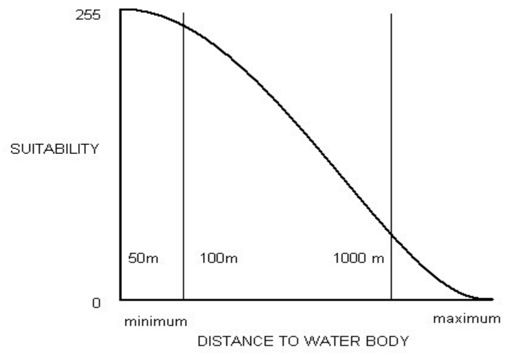

Figure 2.13.d. Non-linear suitability curve for the proximity to water bodies. The 50 m distance from the water body is considered unsuitable for agriculture land, and beyond 1000 m, the suitability is considered very low.

(5) Land cover types

Other than forest and water bodies, selected as constraints, several land cover types exist in the area. These are settlements, agricultural land, grassland, shrubs and abandoned land. Those land cover types have different suitability levels to be used in defining target areas for new agricultural land. This is, among others, based on the required efforts to convert the original land cover types into agricultural land. Except for settlements, the *rank* of the land cover types in relation to agricultural land suitability in descending mode is arable land, grassland, abandoned land and shrubs.

Unlike other factors, every land cover type is subjectively rated a different level of suitability for agriculture. Here again, the role of the decision-maker is crucial. The value range of 0 to 255 is also applied to re-scale them. The adopted suitability rates are: arable land (255), grassland (200), abandoned land (150) and shrubs (100).

To simplify the model, the soil type in the whole area is considered the same, without claiming that the soils are identical. Similarly, the rainfall for the whole watershed is considered as having the same intensity, without denying local variation. Therefore, both soil types and rainfall intensity are not considered either constraints or limiting factors.

The current settlement locations are considered the proper positions. The location of the settlements and villages is assumed to remain unchanged. Moreover, the objective of land allocation is not to reallocate settlements, but to reallocate agricultural land.

d. Estimating Criterion weight

Development of a pairwise comparison matrix

In the Analytic Hierarchy Process Method, pairwise comparison between factors allows to construct a matrix, in which both the rows and the columns represent all of the factors. The comparisons concern the relative importance of two factors being compared, especially in determining suitability.

The ratings are provided on a 9 - point continuous scale, shown in Figure 2.14.

1/9	1/7	1/5	1/3	1	3	5	7	9
extremely	very strongly	strongly	moderately	equally	moderately	strongly	very strongly	extremely

← *less important* ——————— *more important* →

Figure 2.14. Continuous rating scale (after Saaty 1980).

Computing the Criterion weights

Following Saaty (1980), the weights are derived from the principal eigenvector of a square reciprocal matrix of pairwise comparison between factors. To obtain a first idea of the weights of the limiting factors prior to the construction of the model, the weights are calculated using a simple method to get the *best fit* set of the weights.

1. Sum the rate values of the first column
2. Divide each entry of the first column by the sum of all entries in the first column
3. Repeat the same steps for the next columns
4. Then, take the average of the calculated values for each factor.

Estimating the consistency ratio

In this procedure, a test called '*consistency ratio*' checks the probability that the ratings were developed by chance. It provides a measure of departure from consistency. The procedure (Jankowski, 2000) is as follows:

1. Determine the Weighted Sum Vector, by
   - Multiplying the weight for the first limiting factor by the first column of the original pairwise comparison matrix, then the second limiting factor, and so on.
   - Sum these values over the rows.
2. Determine the Consistency Vector (CV) by
   - Dividing the Weighted Sum Vector by the criterion weights.
   - Compute λ (lambda), i.e. the average value of the consistence vector.
3. Compute the Consistency Index (CI) = $(\lambda\text{-}n)/(n\text{-}1)$, in which n is 5, i.e. number of factors.
4. Calculate the Consistency Ratio (CR) = CI/RI, where RI is the randomness index, i.e. the consistency index of a randomly generated pairwise comparison matrix.
5. If $CR<0.10$, the ratio indicates an acceptable level of consistency in the pairwise comparison; while if $CR>0.1$ there is an indication of inconsistent judgement, and the matrix should be corrected by reconsidering the relative importance of the limiting factors.

The Random Inconsistency Indices (Saaty 1980) are given in Table 2.11.

Table 2.11. Random Inconsistency Indices (RI) according to Saaty (1980). Where, n = number of limiting factors being used.

n	RI	n	RI	n	RI
1	0.00	6	1,24	11	1.51
2	0.00	7	1.32	12	1.48
3	0.58	8	1.41	13	1.56
4	0.90	9	1.45	14	1.57
5	1.12	10	1.49	15	1.59

e. Decision rules (Criteria Evaluation)

The criteria, i.e. constraints and limiting factors are combined to yield a suitability map by using the following formula:

$$S = \Sigma W_i X_i * \Pi C_j$$

in which :
S = suitability
W_i = weight of Limiting factor i
X_i = criterion score of Limiting factor i
C_j = criterion score of Constraint j (either 0 or 1)
Π = product

The criterion score (X_i) is standardised using the following linear scaling formula:

$$X_i = (R_i - R_{min}) / (R_{max} - R_{min}) * \text{standardised range}$$

in which:
R_i = raw score
Standardised range = 0 to 255

The final step of the criteria evaluation is to find the suitable land for agriculture, by ranking the possible candidate pixels of a remote sensing image or digitised map, starting from the highest suitability cell or pixel until the target area is filled. This step rests on the following choice function:

$$\text{Max } (\Sigma S_k) \text{, with the constraint that } \Sigma \text{ area } (k) = 9000 \text{ hectares}$$

in which:
S_k = suitability rating of pixel k

The remaining areas that are not selected as suitable for subsistence agricultural land and grassing area belong to the third specific objective, i.e. protection forest, together with the areas subject to two constraints, either sloping at more than a 30% gradient, or being covered by forests.

Criteria evaluation is implemented in different ways to provide several alternatives to be chosen, such as:

1. Full trade-off among all limiting factors, using Weighted Linear Combination method.
2. Low risk and no trade-offs by using the Order Weighted Average method. In this case, a new Order weight is added besides the Criterion weight.

The level of trade-off between limiting factors indicates whether the results of the criteria evaluation (i.e. in terms of suitability map) is either accepting and taking (i.e. the optimistic solution), or avoiding risk (i.e. the pessimistic solution). In the first case, the certain part of the candidate area (represented by a pixel of the limiting factor raster map) is selected to meet the specific objective, even if only *one limiting factor* is met. In the pessimistic case, the same pixel is selected only if *all limiting factors* agree with the suitability level.

By using different combinations of the order weight, the results of the criteria evaluation will fall somewhere inside the triangle of decision space or decision strategy space, as the following figure shows.

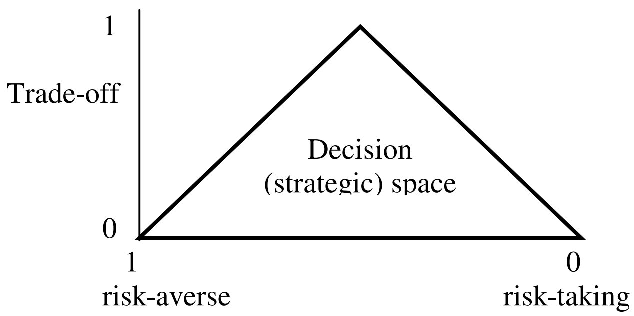

Figure 2.15. Decision strategy space (after Eastman, 1997).

2.6.3. Preparing the allocation model

a. Estimating criterion weight

Development of the pairwise comparison matrix

The rating of the limiting factors was pre-defined as Table 2.12.

Table 2.12. Pairwise comparison matrix showing the comparative relative importance among factors. In the implementation of the model, the above rating will be revised, if its consistency ratio is above 0.10.

Rating of the row factor relative to the column factor

Limiting factors	Slope gradient	Proximity to Forested area	Proximity to Settlement	Proximity to Water body	Land cover type
Slope gradient	1	2	5	4	3
Proximity to Forested area	1/2	1	3	2	2
Proximity to Settlement	1/5	1/3	1	1/2	1/2
Proximity to Water body	1/4	1/2	2	1	1
Land cover type	1/3	1/2	2	1	1

Computation of the criterion weights

The results of the criterion weights calculation are shown in Table 2.13.

Table 2.13. The approximate limiting factor' weights derived from a simple calculation.
* data taken from Table 2.12

Limiting Factor	Slope gradient	Proximity to Forest. area	Proximity to Settlement	Proximity to Water body	Land cover type	Sum	Mean
Total rate values*	2.283	4.333	13	8.50	7.5		
Slope gradient	0.438	0.462	0.384	0.470	0.400	2.154	0.431
Proximity to Forested area	0.219	0.231	0.231	0.235	0.267	1.183	0.237
Proximity to Settlement	0.088	0.077	0.077	0.059	0.067	0.368	0.074
Proximity to Water body	0.109	0.115	0.154	0.118	0.133	0.629	0.126
Land cover type	0.146	0.115	0.154	0.118	0.133	0.666	0.132

The rank order of the limiting factors based on its weights are given in Table 2.14.

Table 2.14 Rank order of limiting factors based on its approximate weights

Factor	The average Approximate Weight
Slope gradient	0.43
Proximity to Forested area	0.24
Land cover type	0.13
Proximity to Water body	0.13
Proximity to Settlement	0.07

Estimation of the consistency ratio

The calculation of the Consistency Ratio is as follows.

Table 2.15. Calculation of Weighted Sum Vector.
For each limiting factor, the weight (from Table 2.13) is multiplied by its rank (from Table 2.12) and summed; then, divided by the weight of the concerned limiting factor.

Limiting Factor	Multiplying the weight	Weighted sum vector
Slope gradient	(0.431)*1 + (0.237)*2 + (0.132)*5 + (0.126)*4 + (0.074)*3	2.291/ 0.431 = 5.3155
Proximity to Forested area	(0.431)*0.5 + (0.237)*1 + (0.132)*3 + (0.126)*2 + (0.074)*2	1.2485/ 0.237 = 5.2679
Land cover type	(0.431)*0.333 + (0.237)*0.5 + (0.132)*2 + (0.126)*1 + (0.074)*1	0.7260/ 0.132 = 5.5001
Proximity to Water body	(0.431)*0.25 + (0.237)*0.5 + (0.132)*2 + (0.126)*1 + (0.074)*1	0.6902/ 0.126 = 5.4782
Proximity to Settlement	(0.431)*0.2 + (0.237)*0.333 + (0.132)*1 + (0.126)*0.5 + (0.074)* 0.5	0.3971/ 0.074 = 5.3665
	Total	26.9282

Hence:

$\lambda = 26.9282/5 = 5.3856$

CI = $(\lambda - n)/(n-1) = (5.3856-5)/(5-1) = 0.3856/4 = 0.0964$
CR = $CI/RI = 0.0964/1.12 = 0.086<0.1$

b. Establishing Constraint maps and Limiting Factor maps

Constraint maps

An image analysis is used to find out, where the natural forests and the successfully reforested areas are. A Landsat ETM7 image of 1999/2000 is available for this purpose. This image will be classified to locate the above mentioned areas. The older Landsat TM images of 1991, 1994 and 1997 are also available to give additional information. To draw this constraint maps, the boundaries of the reservoir are digitised using topographic map as source of information.

The following Figure 2.16 shows the three Constraint maps.

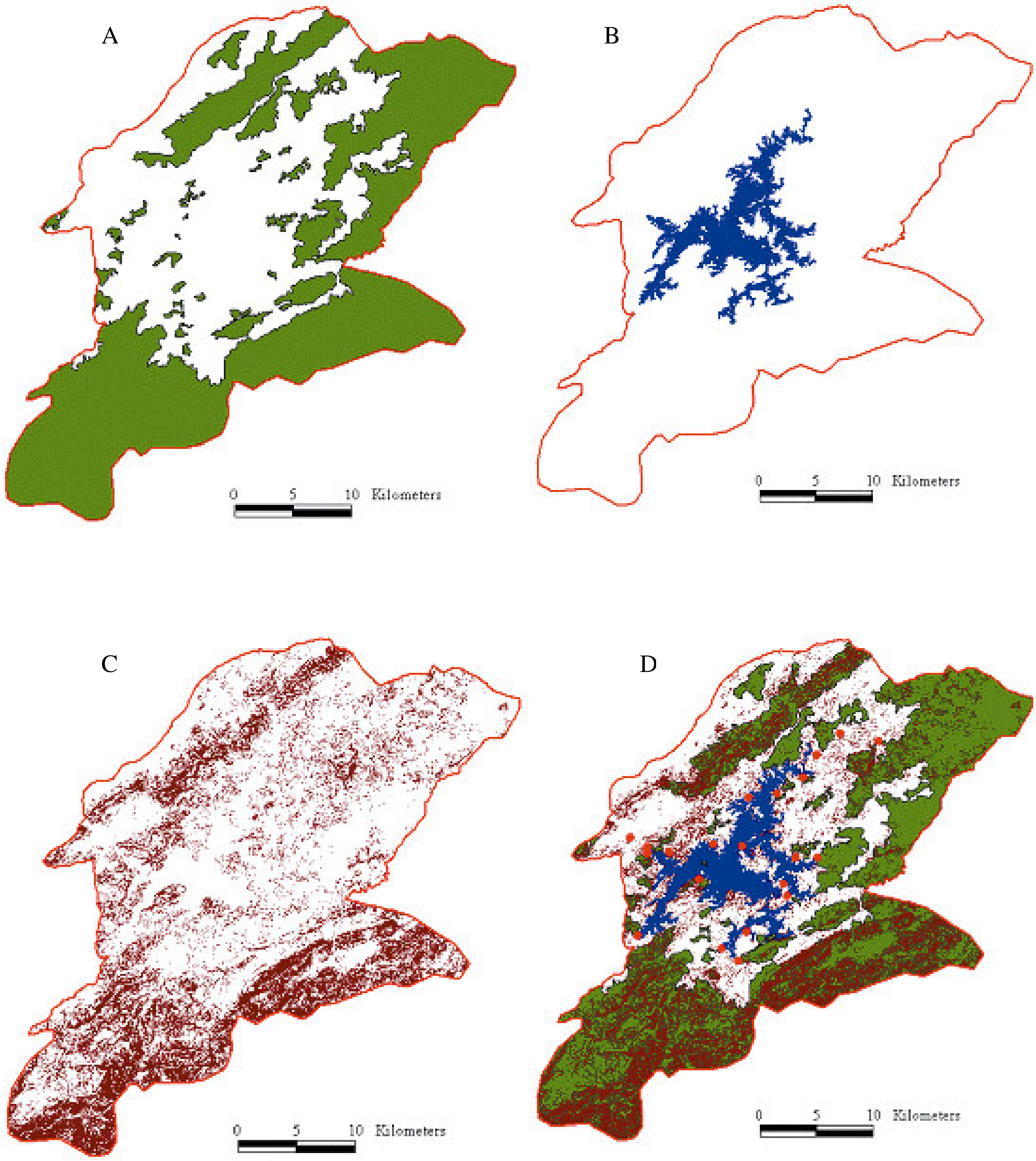

Figure 2.16. The constraint maps. A = The forested area is shown in green; B = The reservoir is indicated by light blue; C = The slope map, where the light brown colour indicates an area having more than 30% slopes; D = Combination of three constraint maps, where the red dots indicate the villages location.

Limiting Factor maps

The Limiting Factor maps are represented in Figure 2.17. Three Limiting factor maps are treated as distance maps, i.e. proximity to forested area, Proximity to water bodies and proximity to settlements. The Proximity to slope gradient map is treated as slope map. The Land cover Limiting Factor map is a raster map, derived from Landsat ETM image.

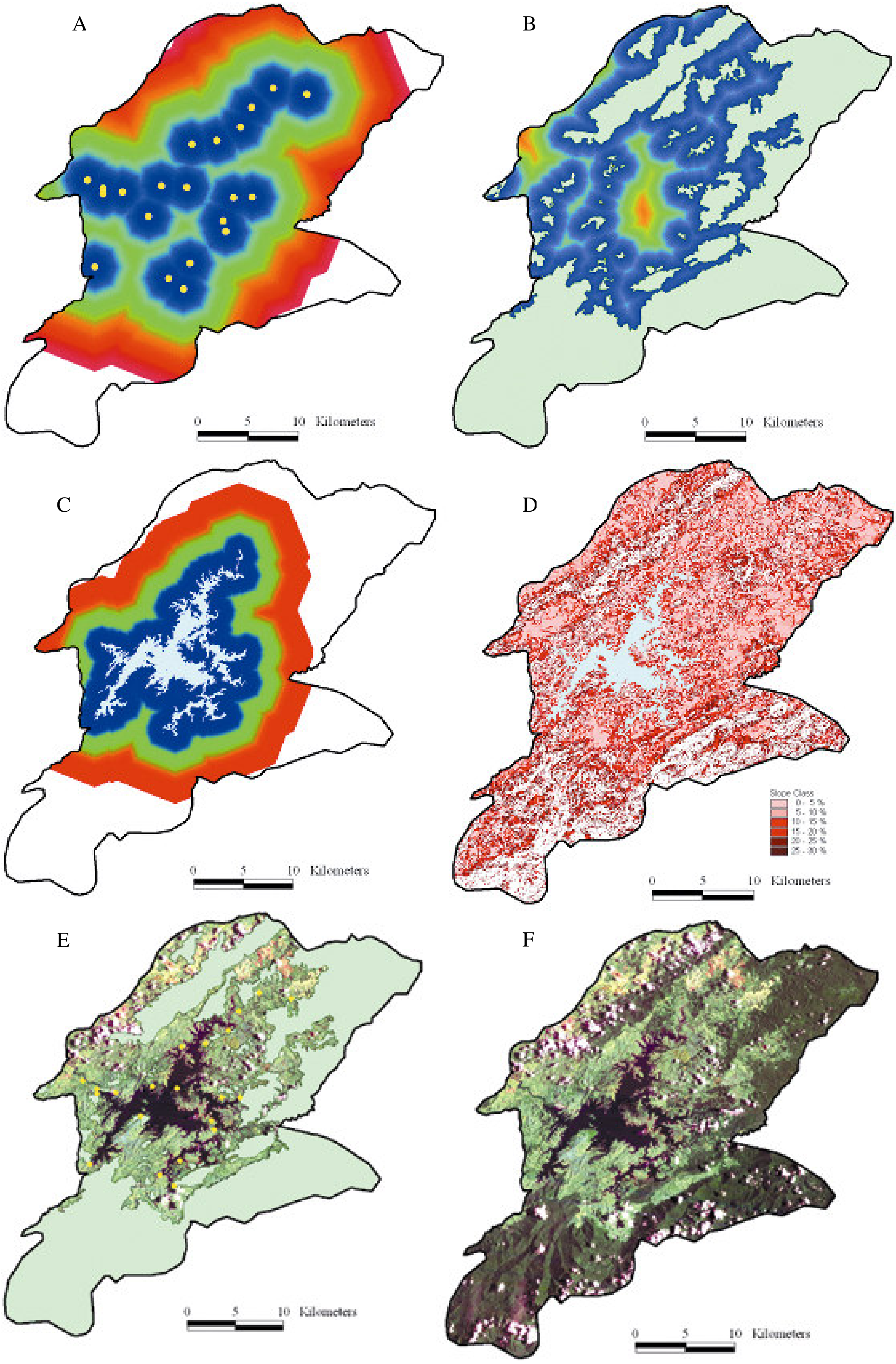
A
0 5 10 Kilometers
B
0 5 10 Kilometers
C
0 5 10 Kilometers
D
Slope Class
0 - 5 %
5 - 10 %
10 - 15 %
15 - 20 %
20 - 25 %
25 - 30 %
0 5 10 Kilometers
E
0 5 10 Kilometers
F
0 5 10 Kilometers

Figure 2.17. The Limiting Factor maps.

A = The distance from the village locations, the points indicated the village positions. B = Shows the distance from the forested areas, the green colours indicate forested areas. C = Distance to the reservoir. D = Slope map, indicating the steepness or the slope gradient, where the white colour marks the area with >=30% slope gradient. E = the arable land of the area, where the light green and black colours indicate the constraint areas. F = Landsat ETM7 image of 1999/2000 as a base; the dark green colour is dense forests; the light green colour indicates lower density vegetation, ranging from shrubs to cultivated land; the brown and yellow colours show the open and abandoned land; the black colour is reservoir; while white objects are clouds.

3. PLANNING AND ALLOCATION OF FORESTLAND

3.1. Scope of the study

The study dealt with aspects of forestland use planning and forestland allocation, using South Kalimantan, Indonesia as a study area. In Indonesia, forestland use planning covers three main activities, namely:

- Forest area gazzetting or settling the outer forest area boundaries officially, starting from designation of the forestland and arriving at gazetted forestland.
- Designing certain forest functions for each part of the forest land, based on defined criteria, and settlement of the inner forest land boundaries, e.g. protection forest land or production forest land.
- Releasing part of the forestland and allocating it for non-forestry uses, such as agricultural or crop estates, as well as granting, lending or exchanging forestland.

In this study, two land allocation plans related with forestland uses were compared and analysed by means of a retrospective and descriptive evaluative study. These are the Forestland Use Plan (1980') and the Provincial Spatial Management Plan (1990'). The first plan was made by the Forestry and related Agencies in consensus, aimed at reaching an agreement on the allocation and use of forestland, while the second was established by the provincial authority, to be used as a base for all uses of the land in the province.

Forestland dynamics, which portrayed a continuing decrease in forestland, were studied. A GIS analysis is among the methods used to specify the change-over of forestland from one forestland use class (or forest function) to the other. The decreasing role of the Forestry Agency in planning forestland uses, as one of the main actors involved in the forestland use planning process was also described.

Forestland fragmentation or break-up (a similar case termed for a natural process, see Oldeman, 1990) resulting from intersection between two different forestland allocation plans is also discussed in this chapter. Perimeter/area and fractal dimension approaches were used in this part.

The SWOT analysis was also used in this part. Strategic factors, i.e. strengths, weaknesses, opportunities and threats related to forest land use and forest land use plans were identified, and a possible strategy to counter the problems currently faced by the Forestry Agency in planning forestland uses was formulated.

At the end of this chapter forestland use classification towards a sustainable use of forestland is proposed.

3.2. South Kalimantan

3.2.1. Administration setup

The province of South Kalimantan lies in the south-eastern part of Kalimantan, covering some 3.7 million hectares of land. Geographically, it is located between 114° 19' 13" to 116° 33' 28" eastern and between 1° 21' 49" to 4° 10' 14" southern latitude (Bappeda KS, 1992). The province boundaries are Makassar Straits in the east, Central Kalimantan in the west and north, the Java Sea in the south and a small part of East Kalimantan in the north (see Figure 3.1).

Figure 3.1. South Kalimantan

South Kalimantan consists of 9 districts and the capital city of Banjarmasin. The area covered by each district is unequal. The largest district, Kotabaru is approximately three times larger than the smallest district, Hulu Sungai Tengah. The districts comprise 109 subdistricts and 2,434 villages.

3.2.2. Physical condition

The Meratus Mountains are situated approximately along the south-western part to the north-eastern part of the province, dividing the flat area into two, namely the western and the eastern parts. Morphologically, 74.3% of the land area is less than 100 m above sea level, mostly flat and undulating, and only 4.8% of the area is located over

500 m above sea level. In 13.3% of the area there are steep slopes, while almost 60% or 2.2 million hectares lie in the flat areas and are used for various human activities. Out of the total area, 26% is badly drained, as a result of permanent or temporary inundation (SK Province, 1990a).

Red-yellow podsolic soil (ultisols, inceptisols) dominates this area, covering more than 1.9 million hectares. They are relatively infertile, acidic and sensitive to erosion. Other soil types are alluvial (entisols, inceptisols), latosol (inceptisols, oxisols) and organosol (histosols). Alluvial soils cover 0.7 million hectares (19% of the area), mainly occupied by agriculture and settlements.

The annual rainfall intensity is high, ranging between 2,000 and 3,700 mm. The mean number of rainy days per year is 120 (SK Province, 1990a). Barito is the main river, mainly used for daily life as well as an alternative transportation route to the upper part of the province and to the Central Kalimantan. Several smaller rivers exist, most springing from the Meratus Mountains.

3.2.3. Natural resources

The main natural resources in South Kalimantan are forest and coal. Coal deposits are spread out almost over the whole province, and in some places they are exploited commercially. Available minor resources are oil, gold, gem stones, quartz sand, phosphate and granite. Most of them are not exploited commercially.

The forest area occupies the largest part of the province. Originally (MoA Decree, 1984), it covered some 2,314,720 hectares, i.e. 62% of the total land. Out of the 1,742,669 ha (75.3%) Production Forests, 949,731 ha or 54.5% (formerly 1,161,850 ha) are granted to be managed by 10 private concession holders and State owned company. The concession area is ranging from 44,000 ha (4.6%) to 309,000 ha (32.5%). Currently, the remaining forestland is less than 62% of the total land as formerly defined, because parts of the forestland have been excluded from the forestland category and were released for non-forestry use.

Table 3.1. Forestland allocated for non-forestry uses (1993).
*by the Governor, ** by the Minister. Source: SK Forestry statistics (1993)

Uses	Reserved, ha*	Approved, ha**	Released, ha
Crop estates	252,851	197,865	96,418
Transmigration	187,771	165,055	43,345
Mining	1,444,317	125,408	2,200
Telecommunication	-	1,622	1,622
Electricity	-	2,060	2,060
Total	1,884,939	498,354	145,645

The forest stand is dominated by many Dipterocarp species, e.g. Shorea sp., while ironwood (*Eusideroxylon zwagerii*) is commonly found, which yield excellent wood for building materials and roof shingles, but which is an extremely slowly growing tree species. The general condition of the forestland in 1993 is given in Table 3.2.

Table 3.2. Forest conditions in South Kalimantan (1993).
* Forestry plan 1987 (Re-evaluated version). Source: SK Forestry statistics (1993).

Forest function	Forested, ha	Non-forested, ha	Total, ha*
Conservation Area	87,251	33,938	121,189
Protection Forest	295,208	90,781	376,079
Limited Production	118,069	25,532	143,601
Permanent Production Forest	861,457	292,946	1,154,403
Convertible Production Forest	87,184	260,198	347,381
Total area	1,449,168	693,395	2,142,653

Comparing Table 3.2 with Table 1.2, the differences in area are caused by re-evaluation of the forest land after demarcations, exclusion of other property rights, e.g. village area, and releasing part of the forest land for other uses, e.g. estates, transmigration.

3.2.4. Socio-economic condition

In 1992, the population of the province was 2,629 million people, consisting of 61.3 % adults and 38.7 % children, with a 2.3 % annual increment rate. The population density was 71 people/km^2, ranging from 24 to 6,723 people/km^2. Distribution of the population is uneven, 18 % of the total population living in Banjarmasin, the provincial capital. The rest live in lowland patches in the relatively flat area to the north-east and along the south-eastern part. The annual migration rate to the provincial capital was high, i.e. 4.5% as compared to the migration rate to other urban centres, such as Hulu Sungai, which was only 0.9 % (SK Province, 1990a).

Agriculture is the base of the economy, although its role in the Gross Regional Domestic Product decreases every year. It is followed by manufacturing, trading and service sectors. In the last five years, the annual economic growth has been 5.2% (MoPW, 1992).

In 1992, among some crops, rubber (121,905 ha) and coconut (56,799 ha) were the most frequent, followed by sugar cane (11,591 ha), coffee (8,422 ha) and cloves (8,196 ha) cultivated by local people and large companies (SK Statistics, 1993). The area of subsistence agriculture in the province in 1992 was 434,124 ha of rice fields, 19,719 ha of maize, and 11,421 ha of cassava (SK Statistics, 1993).

3.3. The major law and regulations concerning forest land uses

3.3.1. Historical perspective

The primary law in land regulation, the Act on the Basic Principles of Land Management *(Undang-undangPokok Agraria, UUPA, Ind.)* was enacted in 1962. It authorises the Government to plan, regulate and manage the country's land. Unfortunately, there was no awareness at that time that establishing a land use plan was a mission implicit in this act. This explains why there was a strong tendency to claim that the absence of land use planning was the main cause of recent complications and problems in land use in Indonesia (Sandy, 1986).

In 1967, the government's authority in administering the forests was strengthened by the Act on the Basic Principles of Forest Management *(Undang-undang Pokok Kehutanan, UUPK, Ind.).* By this authority, the Forestry Agency was able to act not only as a *forestland user,* but also as the *forestland manager*, which made its position even stronger. These roles were different compared with other Agencies related to land use. A new Forestry Act was enacted in 1999 to replace the former one; but there was no significant change or improvement in the forestland use planning part.

The Acts on Foreign Investment (1967) and Domestic Investment (1968) encouraged and triggered abundant investments in large-scale land use, including forest use, namely by forest concession holders. To anticipate the rapidly increasing number of land-based activities, a forestland, confirmed permanently in terms of its status, area and boundaries, therefore, was urgently needed.

In the past, there was no confirmation of the exact figure of forestland in the country. In 1966, for example, the forestland designated into different functions was stated as 86 million ha (Dephut, 1987b). In 1978, the forestland was stated to be 119 million ha or 62% of the total land in the country (Kartawinata, 1981). While in the Forestry Master Plan (1975 to 2000), 122 million ha forestland was affirmed (Dephut, 1986).

3.3.2. Forestry Plan: Forestland Use by Consensus

In the absence of an overall land use plan, the Forestry Agency initiated a Forestland Use Plan *(Rencana Pengukuhan dan Penatagunaan Hutan, RPPH, Ind.)* at the provincial level in 1981. In fact, the *RPPH* consists of two different plans, namely 1) the Forestland Gazzetting Plan, i.e. concerning the forestland boundaries or outer boundaries, and 2) the Forestland Allocation Plan, i.e. concerning the division of forestland into different forestland use classes (i.e. based on its main functions) and its inner boundaries. Ideally, the first plan should be implemented before the implementation of the second plan; but, in reality, those two plans should have been implemented concurrently.

Since available accurate data on land were very limited, and understanding that the different Agencies were concerned with land use, all land-related agencies in the province were involved in establishing a forestland use plan in *a consensus* way. Therefore, the *RPPH* plan is also referred to as the Forestland Use by Consensus Plan

(Tata Guna Hutan Kesepakatan, TGHK, Ind.), which only concerned the forestland in the province and leaving the non-forestland blank. This plan was enacted as a ministerial decree, from the Ministry of Agriculture, where the Directorate General of Forestry was attached to. As an indicative plan, it was intended as a basis 1) to confirm the area and status of forestland, 2) to designate forestland use classes, and 3) to allocate forestland to various uses, including non-forestry uses.

To obtain the legal status of forestland, *the gazetting process* is followed by excluding non-forestry property rights, such as settlement and crop estates from the forestland. A Forest Boundary Marking Committee is established and is involved in the gazetting process. The committee consists of all land-related agencies in the district and is headed by the Regent. In the fields, the agreed boundary lines were physically marked. Gazetting is a continuous process, covering physical and administrative activities that will take several years to complete. After the completion of the process, the Minister of Forestry issued a ministerial decree on the legalisation of forestland. Similarly, the conversion process from forestland into non-forestland is also a long-term process.

Designation of forestland according to different forest functions is done internally by the Forestry Agency without the involvement of the Forest Boundary Marking Committee. Every part of the forestland is given a specific function, as in the following classification.

1) Nature Conservation Area, consists of:
   - *Nature and Wildlife Conservation Areas*
   - *Recreation Forest*
   - *Hunting Park*
   - *Educational Forest*
2) Protection Forest
3) Production Forest, consists of:
   - *Limited Production Forest*
   - *Permanent Production Forest*
   - *Convertible Production Forest.*

Except for the Convertible Production Forest, reserved for gradual conversion to various non-forestry developments, all other forestland is considered permanent forests.

A Nature Conservation Area (for reasons of simplification, this will be called *Conservation Area*), is determined according to its bio-diversity, such as the richness of special flora and fauna, rather than to its physical conditions. The main factor to determine Protection and Production Forests is their *susceptibility to erosion*, depending on three physical factors, namely, steep slope, soil type and rainfall intensity. Each criterion is divided into five classes. For the relative importance of each criterion, a weight of 20, 15 or 10 is given. A forest area is determined as Protection Forest if the total index value of the three criteria is >175, or if the slope is >45%, or if it is located >2000 m above sea level, or, if the Minister so decides. For Limited Production Forest, the total score is 125 to 174, and for Permanent Production Forest, the score is <124. There is no specific value for Convertible Production Forest.

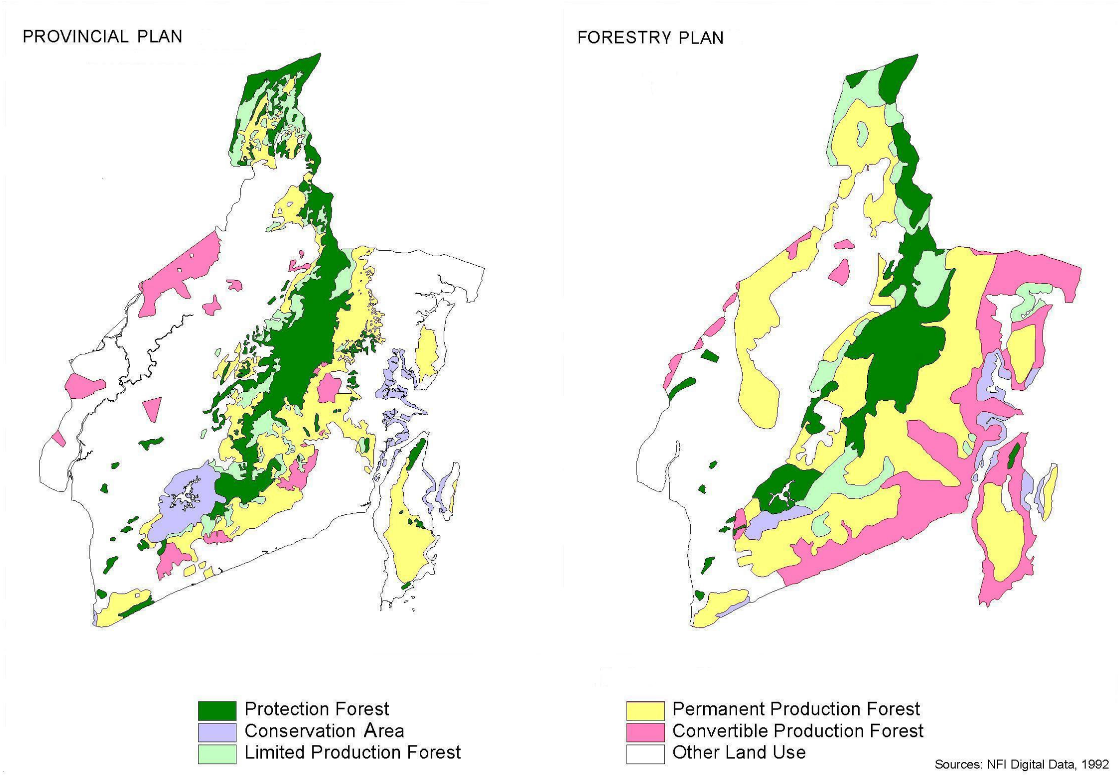

Figure 3.2. Provincial plan (1993) and Forestry plan (1987) of South Kalimantan Province. The original scale of the provincial plan is 1:250,000, while that of the Forestry plan is 1:500,000. The non-forest land use classes in the Provincial plan are not included in the figure.

Although socio-economic considerations should be taken into account as mentioned in the regulation, in reality, no specific criteria were laid down and applied to determine forest functions.

The Production Forest can be 1) granted to private and state-owned companies as forest concession holders, 2) lent for specific uses, like mining or running a power plant, or 3) released for other uses, like transmigration or estate crops. The released forestland is mostly Convertible Production Forest. However, releasing Permanent Production Forest is also possible, namely through area exchange, in such a way that the total *permanent forest* will not decrease.

Based on the national *RPPH* or *TGHK*, the forestland was stated to cover 144 million ha. It consists of 114 million ha permanent forest and 30 million ha Convertible Production Forest. The permanent forest covers 19 million ha of Conservation Area, 30 million ha of Protection Forest, 31 million ha of Limited Production Forest and 33 million ha of Permanent Production Forest (MoF, 1993). This area is given as a gross figure, from which some areas still have to be subtracted to obtain the net forestland area in the gazzetting process.

In the remaining part of this book, the TGHK plan will be mentioned as the ***Forestry plan.***

3.3.3. Provincial Plan: Provincial Spatial Management Plan

The Act on Spatial Management was enacted in 1992. It aimed at the development of three land allocation plans as the basic reference on land use, namely at the national, provincial and district levels. At the provincial level, a Provincial Spatial Management Plan (*Rencana Tata Ruang Wilayah Propinsi, RTRWP, Ind.*) was formulated by the Provincial government. All agencies in the province related to land, including the Forestry Agency, were consulted. However, they were only considered as *land users*. In 1993, the Governor of the province legalised the plan as a provincial regulation (*Peraturan Daerah, Ind.*). The provincial authority considered that the enactment of RTRWP invalidated the *Forestry plan* as to define, gazette and allocate forestland.

In *RTRWP*, the Province land is first differentiated into two main groups, namely Protection Area and Utilisation Area. The *Protection Area* covers four major land use classes, namely 1) Area protecting lands downhill, 2) Local Protection Area, 3) Nature and Culture Conservation Area, and 4) Area Sensitive to Natural Disasters. The first three major classes were broken down into 13 subclasses, including Protection Forest and Nature Conservation Forest. The *Utilisation Area* is first divided into six major classes, consisting of Production Forest and five non-forestry classes. Production Forest is further differentiated into three subclasses, namely Limited Production Forest, Permanent Production Forest and Convertible Production Forests, similar to *Forestry plan*.

At the National level, the total forestland in *RTRWP* was estimated at 121,138,888 ha, consisting of 113,054,054 ha Permanent Forest and 8,081,834 ha Convertible Production Forest. The latter comprised newly appointed areas, which sooner or later will be excluded from the forest land category. The Permanent Forest includes 33,928,375 ha of Protection Forest, 20,629,931 ha of Nature Conservation Area and 58,495,748 ha of Production Forests. Compared with the national *Forestry plan*, the total area of forestland decreased by around 22.9 million ha.

From this point in this book, the RTRWP plan will be mentioned as the ***Provincial plan.***

3.4. Forestland dynamics; the outcome of applying different laws and regulations

3.4.1. Introduction

Experiences from all over the world show that human interventions and conflicts of interests are among the significant problems related with forest land use since times immemorial (Aiken and Leigh, 1986, Madar, 1989, Osemeobo, 1990, Kio and Abu, 1992, Kiss, 1992, Auerbach, 1999). Other problems often associated with poor co-ordination, are absent or inadequate definite policies, strategies and legislation regarding the technical, socio-economic and political aspects, as well as a lack of conceptual, comprehensive and basic information (Qureshi, 1981, Khairi and Hamid, 1985, Rapera et al., 1985, Mahar, 1990, Hudakorn et al., 1991).

Problems of competing human parties using forestland frequently lead to deforestation and so cause the forestland to decrease. Meanwhile, decreasing tropical forests and sustainable tropical forest management are becoming global issues of international concern, see, e.g. Rio Declaration and Tropical Forest Action Plans (WRM, 1990, MoF, 1991, UNCED, 1992, Bandung Declaration, 1993)).

This present study aimed at identifying and analysing 1) The dynamics and the trend of the continuing decrease in forestland and 2) Implications and possible impact of the *RTRWP* on forest management.

3.4.2. Forestland dynamics

Three different figures of the allocated forestland areas in South Kalimantan were compared, showing the situation at different dates. These were the original forestry plan (1984), the re-evaluated forestry plan (1987), i.e. the estimates of the existing forestland in 1987 after some areas had been excluded based on the gazzeting process and released for non-forestry uses, and the original provincial plan (1993). The possibilities and difficulties of such comparisons were recently examined critically in Mexico by de Jong (2000, chapter 3).

The period of 1984 to 1987

By comparing the two forestry plans (1984 and1987), forestland dynamics in South Kalimantan for this period can be made visible (see Table 3.3). The re-evaluated forestry plan data show the situation in 1987, after some areas, such as settlements, transmigration, agricultural and crop estates have been excluded from the forestland in the gazetting process.

Table 3.3. Forestland dynamics (1984 to 1987).
** or forest function; ** The original plan; *** Re-evaluated plan. Source: MoA Decree no. 247 (1984), Dephut Kalsel (1993)*

Forestland use classes *	Forestry plan (1984)**		Forestry plan (1987)***		Changes	
	ha	%	ha	%	ha	%
Conservation Area	139,315	6.0	121,189	5.7	-18,126	-13.0
Protection Forest	432,736	18.7	376,079	17.5	-56,657	-13.1
Production Forest:	(1,742,669)	(75.2)	(1,645,385)	(76.8)	(-97,284)	(-5.58)
Limited Production Forest	132,975	5.7	143,601	6.7	10,626	8.0
Permanent Product. Forest	1,325,024	57.2	1,154,403	53.9	-170,621	-12.9
Convertible Product. Forest	284,670	12.3	347,381	16.2	62,711	22.0
Total forest land	2,314,720	100	2,142,653	100	-172,067	-7.4

From Table 3.3, it can be seen that in total, 172,067 ha land have been estranged from the forestland between 1984 and 1987. This was 7.4% of the forestland indicated in the *Forestry plan* (1984). The dissociated areas occurring in every forest function were observed in the real field situation in the gazetting process.

During this period, the most prominent change was the decrease in Permanent Production Forest that accounted for 170,621 ha, 12.9% of the area in 1984, or 7.4% of the total forestland. Most likely, it was converted into Convertible Production Forest and Non-forest land. The Convertible Production Forest area had increased significantly by 62,711 ha or 22.0% of the 1984 area. This can not be seen as increasing forestland, since this was not part of the *permanent forest* and sooner or later, this area is wont to be opened up by clearing the forest. Decreasing Protection Forest, most likely changed into Limited Production Forest, and the decrease in the Conservation Area shows that the concern of decision-makers for environmental issues was low.

The period of 1987 to 1993

Table 4.2 shows the forestland dynamics for the period of 1987 to 1993. In total, 303,159 ha forestland was excluded during this period, which was 14.1% of the forestland in 1987. The most prominent change was the allocation of 265,638 ha to Convertible Production Forest, which was a reclassified area, since the Convertible Production Forest in *Forestry plan* (1987) has been completely allocated. There were 47 companies recommended by the Governor of South Kalimantan to utilise 503,958 ha of land for the development of estate crops. Out of them, 20 companies applied for 326,321 ha of forestland. In reality, only 39,338 ha (7.81 %) had already been physically utilised (Dephut Kalsel, 1994). For transmigration purpose, 186,900 ha forest land was released, consisting of Permanent and Convertible Production Forests (Dephut Kalsel, 1993).

Table 3.4. Forestland dynamics (1987 to 1993).
forest function, * reallocated area. Source: MoA Decree no. 247 (1984), Dephut Kalsel (1993), Dephut Kalsel (1994)

Forestland use classes #	Forestry plan (1987)		Provincial plan (1993)		Changes	
	ha	%	ha	%	ha	%
Conservation Area	121,189	5.7	178,065	9.6	56,876	46.9
Protection Forest	376,079	17.5	552,689	30.4	176,610	47.0
Production Forest:	(1,645,385)	(76.8)	(1,108,740)	(60.2)	(-536,645)	(-32.6)
Limited Production Forest	143,601	6.7	155,268	8.4	11,667	8.1
Permanent Production For.	1,154,403	53.9	687,834	37.4	-466,569	-40.4
Convertible Production For.	347,381	16.2	265,638*	14.4	-81,743	-23.5
Total Forest land	2,142,653	100	1,839,494	100	-303,159	-14.1

Other notable changes took place in the Nature Conservation Area and Protection Forest, which increased significantly, namely by 46.9% and 47.0% of the 1987 area, respectively. Meanwhile, the Permanent Production Forest decreased substantially, namely by 40.4% of the 1987 area. These changes emphasise that environmental preservation aspects were apparently given more attention than before. However, considering that a significant, large area of newly allocated Convertible Production Forest already existed, the impression of more attention being paid, is not necessary justified.

Figure 3.2 shows the forestland in the *Provincial plan* (1993) and *Forestry plan* (1987) map of South Kalimantan. Those figures show the differences in area and boundaries, i.e. the mosaic architecture of the existing forestland.

In 1999, the Ministry of Forestry confirmed the *Provincial plan* (1993) by the enactment of MoF Decree no. 453/1999 on the Appointment of Forestland. Comparison of the Provincial plan and the MoF Decree figures are represented in Table 3.5.

Table 3.5. The Provincial plan (1993) and the confirmed forestland (MoF decree, 1999), in ha. Source: MoF Decree no. 453/1999. Note that the slight difference in areas are only in the Conservation Area and Protection Forest.

Source	Conservation Area	Protection Forest	Limited Product. Forest	Permanent Product. Forest	Permanent Forest	Convert. Product. Forest	Total Forestland
RTRWP	178,065	552,689	155,268	687,834	1,573,856	265,638	1,839,494
MoF Decree	175,565	554,139	155,268	688,884	1,573,856	265,638	1,839,494

From Table 3.5, it is clear that there are no significant differences. The slight differences between those two location plans ranged from 0.15% in Permanent Production Forest to 1.4% in Nature Conservation Area. These differences could merely be technical errors in drawing and measuring the class

The more important question is why it took so long, i.e. 6 years, before MoF finally accepted the *Provincial plan* without any significant changes, whereas the validity of this plan is 15 years, commencing in 1993. One may conclude that it shows a lack of power of the MoF in allocating forestland, which means that in this case the Central Government was less powerful than the Provincial Government.
The shifting of the forestland use class (1987 to 1993)

To get the new value of each picture element, crossing maps can be done by overlaying two or more raster maps. In the present case, the new value of a land use class shows whether or not a certain area has changed its class. By overlaying two plans as shown in Figure 3.2, the forestland remains in the same class and the forestland changing its classes can be identified. Table 3.6 shows the switching or shifting of the forestland classes at the province level from 1987 to 1993.

Table 3.6. Shifting of forestland use classes at province level (1987 to 1993), in %.
CA: Conservation Area; PF: Protection Forest; LP: Limited Production Forest; PP: Permanent Production Forest; CP: Convertible Production Forest; NF: Non Forestland.

Forestry plan (1987)	Provincial plan (1993)						
	CA	PF	LP	PP	CP	NF	Total change
CA	-	0.0	0.0	0.05	0.0	1.3	1.3
PF	1.3	-	0.9	1.8	0.25	1.8	6.2
LP	0.2	3.0	-	0.8	0.1	0.5	4.6
PP	0.3	2.9	2.0	-	1.35	10.7	17.2
CP	0.2	0.2	0.1	1.4	-	14.3	16.3
NF	0.1	0.2	0.1	0.4	0.7	-	1.5
Total	2.2	6.3	3.17	4.5	2.4	28.6	47.1

At the provincial level, 47% of the land changed class and 53% remained in the same class. Important changes happened in Permanent Production Forest (17%) and Convertible Production Forest (16%). These mostly became non-forestland, namely 10 % and 14%, respectively. Meanwhile**,** 1.5% of former non-forest land shifted into various forestland use classes in the Provincial plan. However, one can also think that this change was an error related to a lack of accurate data, considering that for matters of application, there is a low possibility to include non-forest land into forestland.

Meanwhile, out of the 53% remaining classes in the province that consists of 29% non-forest land and 24% forest land, the significant remaining forest land use classes were 6.9% Protection Forest and 13.6% Permanent Production Forest. Out of the 47% shifted area, as much as 28.6% shifted to non-forestland, that is, 10.7% came from Permanent Production Forest, and 14.3% came from Convertible Production Forest. The percentage of shifting classes within the forestland is shown in Table 3.7.

Table 3.7. Shifting of forestland use classes at forestland level (1987 to 1993), in %.
PF: Protection Forest, CA: Conservation Area, LP: Limited Production Forest, PP: Permanent Production Forest, CP: Convertible Production Forest, FL: Forestland, NF: Non-forestland (see also Table 3.6.).

Forestry plan (1987)	Provincial plan (1993)						
	CA	PF	LP	PP	CP	FL	NF
CA (6.18)	-	0.0	0.0	3.7	0.0	3.7	96.3
PF (1.34)	21.6	-	15.0	29.6	4.0	70.3	29.7
LP (4.64)	5.0	64.0	-	17.7	2.6	89.2	10.8
PP (17.23)	2.0	16.7	11.4	-	7.8	37.9	62.1
CP (16.26)	1.3	1.4	0.6	8.7	-	12.0	88.0

Note that the major shifts in Conservation Area (96%), Convertible Production Forest (88%) and Permanent Production Forest (62%) went to non-forestland. A significant shift inside the forestland happened in Limited Production Forest, where 64% of the changing area moved to Protection Forest.

3.4.3. Trend of the continuing decrease in forestland

The composition of permanent forestland use classes from 1984 to 1993 is shown in Table 3.8.

Table 3.8. The class composition of permanent forestland, in %

Year	Conservation Area	Protection Forest	Production Forest		Total Permanent Forest
			Limited Production Forest	Permanent Production Forest	
1984	6.9	21.3	6.5	65.3	100
1987	6.7	21.0	8.0	64.3	100
1993	11.2	35.2	9.9	43.7	100

The above table shows that the portion of Conservation Area and Limited Production Forest in the Permanent Forest had not significantly changed, ranging from +0.2% to + 4.5% in the Conservation Area, and +1.8% to +1.9% in the Limited Production Forest. In contrast, the portion of Protection Forest and Permanent Production Forest in the Permanent Forest has changed significantly, namely up to +14.2% in Protection Forest and down to -20.6% in Permanent Production Forest. In the meantime, the proportion of the Permanent Production Forest shows a continuing decrease.

Table 3.9. shows the percentage of each forestland class within the total land area of the province.

Table 3.9. The percentage of forestland to provincial land, in %.

The province area covers 3,763,05 ha land. The mentioned year indicated the plans being used as the basis, i.e. original Forestry plan, re-evaluated Forestry plan and Provincial plan, respectively. * the newly appointed area.

Year	Conservation Area	Protection Forest	Production Forest		*Permanent Forest*	Convertible Production Forest	Total Forest land
			Ltd.	Permanent			
1984	3.7	11.5	3.5	35.2	53.9	7.6	61.5
1987	3.2	10.0	3.8	30.7	47.7	9.2	56.9
1993	4.7	14.7	4.1	18.3	41.8	7.1*	48.9

From Table 3.9, it is clear that from 1984 to 1993, the total forestland decreased by 12.6 % of the total provincial land, or 475,226 ha. This area was 20.5 % of the forestland in 1984. The major decreasing forestland, which accounted for 16.9 % of the province land, originated from Permanent Production Forest. However, over the same period, the Protection Forest and Conservation areas in 1993 had increased by 3.2 % and 1.0 %, respectively. Similarly, the Limited Production Forest had increased by 0.6 %. Since by 1993 all of the Convertible Production Forest (1987) had been completely allocated, the area described in the Provincial plan was newly allocated area.

In terms of the *Permanent Forest*, the difference between the situation in 1984 and 1993 was 22.5 % or 12.0 % of the total provincial land. In addition, the total forest land in the *Provincial plan* is still a gross figure, meaning that in the near future settlements and rural areas too small to be represented on the map, still have to be excluded from the forest land. Because of such factors, the forestland is still continuously decreasing in the land use statistics. The trend of the decrease in forestland can be seen in Figure 3.3.

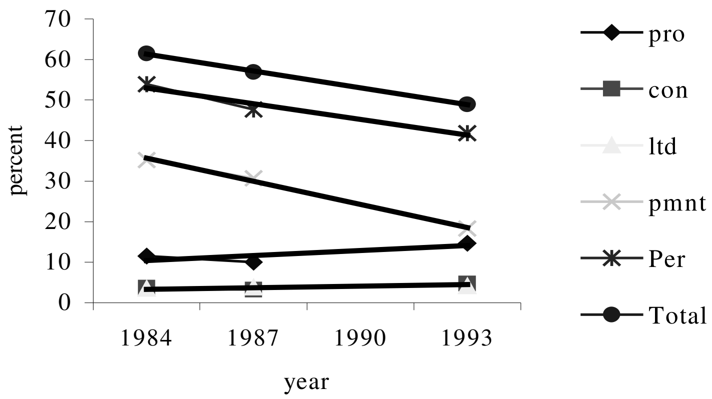

Figure 3.3. Trend of forestland dynamics from 1984 to 1993, in %.
pro: Protection Forest, con : Conservation Area, ltd: Limited Production Forest, pmnt: Permanent Production Forest, Per: Permanent forest, Total: Total forestland

From the above figure, it can be seen that the trend of a continuing decrease in total forestland and permanent forestland is significant, which is to be attributed to the substantial decline Permanent Production Forest. Exceptions to the continuously decreasing area are the barely increasing trend of the Limited Production Forest, Protection Forest and Conservation Area.

During the implementation of the Forestry plan from 1983 to 1993, the following tendencies were noticed:

- A reduction of the Protection Forest and Conservation Area accompanied by an increase in Production Forest, namely Limited Production Forest most likely was due to a claim of the forest concession holders. They distrusted the accuracy of boundary registration of Protection Forest and Conservation Area, especially regarding the application of the steep slope criterion. The reason for their distrust could be their wish to expand their working area, since part of their concession area was Protection Forest land.
- Reducing the Permanent Production Forest to increase Convertible Production Forest due to the claim of regional authorities regarding the fast development of large-scale non-forest uses, such as crop estates and transmigration.

Related to the enactment of the *Provincial plan* at a later stage, the following indications seem to be *dubious,* because there are not enough elements of full proof:

- Because of large increases in Protection Forest, Conservation Area and Limited Production Forest, against reduction of the Permanent Production Forest Area, it may be presumed that public concern as to the improvement of environmental conservation had increased.
- On the other hand, trends to attribute more land to non-forest uses also increased. This was indicated by the large-scale allocation of land to the newly appointed Convertible Production Forest to the class of "doomed" forest, which mostly was taken from Permanent Production Forest.
- In other words, Permanent Production Forest was sacrificed for two opposite reasons, namely, increasing environmental concern, and expanding large scale non-forest use.

3.4.4. The underlying factors, implication and possible impacts

Low accuracy of data

The lack of complete, accurate and recent data and information, and the low quality of data on the existing forest cover and land use became apparent when the *Forestry plan* was established. A similar situation was also faced by other Agencies dealing with land uses in the province. Long term plans of sectoral and regional development, such as crop estates, transmigration and agricultural development were not available. This made the design of the *Provincial plan* more difficult. If any plans existed at all, they were constructed using different base maps, which were not matched to each other and so caused still more inaccurate figures when combined.

Problems related to the data quality occurred in both the *Forestry plan* and *Provincial plan* maps. Neither of both plans was established based on complete and accurate data, as stated by Talkurputra, Deputy Head of National Land Agency (Republika and Suara Pembaruan daily news, October 21, 1997).

The consensus way

Because of many limitations, such as the lack of accurate data and information on land cover and land uses, a consensus was the only way to accommodate the various interests of different agencies in developing the *Forestry plan*. Later on, for certain reasons, namely the increasing needs of land for various developments, the way of consensus was considered inappropriate, and it was not considered by other agencies in the province leading to any confirmed agreement anymore. Therefore, it was not to be respected any longer.

The application of large-scale land for non-forestry uses, i.e. from Convertible Production Forest to agriculture took a long time and was not always satisfactory. For this reason, the Forestry Agency was accused of having a high *sectoral ambition*, merely because it defended the existing forestland without giving priority to the need for land of other sectors. Despite this, other sectors have also tried to reach their own development targets.

Moreover, the idea to develop the *Forestry plan* came from the Forestry Agency, which was not the highest authority in the province. The plan, therefore, met with little respect from the other Agencies in the province. However, the Boundary Marking Committee established the gazzetting process, and was actively involved in it. The Regent acted as Chairman and all related Agencies were members of the committee.

The lack of balance

From the point of view of the Regional Authorities, private companies and local communities, the ratio between forestland (62%) and non-forestland (37%) in the *Forestry plan* was considered an imbalance. Additionally, the Convertible Production Forest for various developments was only 7% and most of it had been allocated. Moreover, the non-productive forest inside the *permanent forest* that could be used for non-forest uses, was maintained by the Forestry Agency as "forestland".

Prior to the *Provincial plan*, the Provincial authority had made two land allocation plans, although neither was implemented. The first (1985) divided the provincial land into 55.35 % development land and 44.65 % forestland. The second (1989) divided the provincial land into 71.83 % utilisation area, 16.69 % non-utilisation area (including protection forest and nature conservation area) and 11.27 % buffer zone (Bappeda Kalsel, 1990, Pemda Kalsel, 1993).

The continuing decrease in forestland

The continuing decrease in forestland is a long-term problem, since the *Provincial plan* will be revised after certain periods (i.e. 15 years), and a new plan will be established meeting the new needs for land for development, which can only be filled from the remaining forest land. Now, the general impact of decreasing tropical forests is broadly discussed, and currently has become a global issue and of international concern (see, e.g. Hurst, 1990, WRM, 1990, UNCED, 1992, Vanclay, 1993, Sunderlin and Resosudarmo, 1996). Politically, this may have widespread impact.

Environmental aspects

Considering the multi-functionality of tropical forest, namely protection, conservation and production, the decreasing area of production forest will affect the protection and conservation functions of the whole forest area. This is so, simply because in the natural tropical forest, whatever the function of the forest, aspects of soil and water protection and conservation of genetic resources will always exist (Longman and Jenik, 1990).

Consequences for wood production

The possible effects of decreasing production forestland for forest management can be manifold and interrelated. Currently, these areas are managed by forest concession holders. There were 10 Forest Concession Holders, covering 1,161,850 ha area (1,037,862 ha of which located in the Production Forest) ranging from 44,000 ha to 309,000 ha. Working in the forest production activities in 1993 were 23,615 people, 2,513 in the concession holders, 3,756 in the sawmill industries, and 17,346 in the plywood mills (South Kalimantan Forestry Statistics, 1993).

Most of the forest operational jobs existed in the concession areas. Decreasing the working area will reduce the wood-based activities and affect the number of labourers, while losing their jobs undoubtedly will affect their prosperity and security. See the following Figure 3.4. for decreasing forestland in the concession areas.

Figure 3.4. Decreasing production forests area granted to concession holders.
The polygons represent the concession holder areas. The dark grey colour indicate the Limited and Permanent Production Forest areas in Provincial plan; the light grey colour represents Limited and Permanent Production Forest areas in Forestry plan.

Decreasing production will lead to fewer royalties paid to the region, which means fewer funds available to increase prosperity and to establish forests. The royalties paid by the concession holders are based on the actual log production. Based on a Government Regulation (1990), the royalties are distributed to Provincial (30%) and District authorities (15%), regional forestry development (15%), national forest rehabilitation (20%) and land tax (20%).

It also causes fewer forest products being delivered to the markets, which will raise the timber price and lead to *illegal cutting*. Significant reduction of the concession area can seriously affect the companies, and may lead to their withdrawal, particularly when the working area is too small for sustainable production.

On the other hand, reducing the forest concession areas can safeguard the natural forests, only if they are converted into Protection Forest or Nature Conservation Area. But if the concession areas are converted into non-forest Utilisation Areas, the impact on the forests will be very negative.

Legal aspects

Potentially, some terminology in the basic Forestry Act could raise problems, such as the definition of forestland that includes *non-forested areas*, and the authority of the Forestry Agency to manage forestland, which to a certain extent, overlaps the Act on the Basic Land Management (*UUPA)*. Currently, the Government's full authority, i.e. the Forestry Agency to manage the forestland is questioned by some local communities, especially when the existing '*customary rights*' are neglected.

The authority to define forestland and to designate forest functions was vested in the Minister responsible for the Forestry. Therefore, the South Kalimantan *Forestry plan* was declared by the Minister's Decree. On the other hand, the *Provincial plan* was set up in the province and legalised by the Governor as a Provincial Regional Regulation, which was a lower hierarchical level than a ministerial decree. This was a conflicting situation.

The significantly decreasing area of forestland in the *Provincial plan* as compared with the *Forestry plan* will affect the gazetting process, the legalisation of its result, the status of land in all categories, and consecutively also the forest management. When a forest function is changed, legal aspects will also be involved, such as the change of Production Forest to a non-forest Utilisation Area, especially on forestland that has been granted to third parties. An example is the legal status of an area excluded from a forest concession granted through a ministerial decree, when this area is allocated to other uses, e.g. crop estates.

In terms of boundary lines, it is clear that the *outer forestland boundaries* and *inner forest function boundaries* in those two plans are different (see Figure 3.2). As a consequence, tremendous resources, in terms of funds, manpower and time will be needed to re-mark the new boundaries. Out of the 5,847 km outer and inner boundary lines, which have already been marked in the field, only 3,236 km boundary lines will be accommodated in the *Provincial plan*. Roughly, 10 years' time was needed to settle those boundaries (Dephut Kalsel, 1993). Moreover, the boundaries between forestland and non-forestland according to the local community's property rights or customary rights, were not always clear. This created problems in the gazetting process (Dephut Kalsel, 1994).

Inconsistency in land use classification

Classification differences between the two plans were found, e.g.:

- The term '*permanent forest'* exists in the Forestry legislation, meaning that the land will be kept permanently as forest, i.e. as recommended by ITTO (ITTO, 1990), but not recognised in the *Provincial plan.*
- The criteria and measures to determine forestry-related land use classes in the *Provincial plan* were adopted from the same basis as the *Forestry plan*; therefore the results are supposed to be the same. In reality, some differences in area and classes occurred.
- Some land use classes were re-grouped and classified differently. One example is the mangrove forest, which was part of the Protection Forest, while in the *Provincial plan* this was grouped under Conservation Area. Another instance is the existence of the Grand Forest Park (*Provincial plan*). In the *Forestry plan,* this area is part of the Protection Forest and Nature Conservation Area. The Grand Forest Park class does not exist, and is considered a management unit instead of a land use class, similar e.g. the National Park.

Decreasing role of the Forestry Agency

By law, the appointment, legalisation and determination of forest functions rest with the Minister responsible for forestry. Therefore, '*de jure'*, MoF was the responsible and authorised actor in the whole planning and implementation processes of the *Forestry plan*. *'De jure'* and *'de facto'*, the *Forestry plan* draft was prepared and enacted by MoA, because at that time, the forestry activities were under the Ministry of Agriculture. It is clear that the position of the MoA, currently the MoF, in planning forestland uses in *Forestry plan* was very strong and its role was very important.

In contrast, the planning of land use under *Provincial plan,* which includes defining the location and area of forestland, rests heavily on the regional authority. The Forestry agency was not involved in the decision-making process, and acted only as a land user, similar to other agencies. In this respect, the role and the strength of the MoF in planning forestland use have diminished.

The decreasing role and strength of the MoF is also clear by the enactment of the MoF Decree (453/1999) on the designation of forestland. After six years, the MoF finally accepted the *Provincial plan* figure with only minor, insignificant changes, although long arguments and debates had taken place prior to the enactment of the MoF act.

3.4.5. Conclusions

The presence of one single, acceptable, integrated land use plan based on socio-economic, environmental and biophysical factors as a common base for land use and land allocation is beneficial to sustainable forest management (see Ecmuller and van Maaren, 1984, van Maaren, 1984, Conyers, et al., 1984, FAO, 1989, UNCED, 1992), in the sense that the existence and the status of forestland will be properly ensured and respected by non-forestry agencies. To some extent, this can eliminate problems of using forestland for non-forestry developments (see also Wyatt-Smith, 1987, Young 1993).

The implementation of the *Provincial plan,* the extinction of the *Forestry plan* and the decreasing role of the Forestry in planning forestland use are some facts that should be accepted. Elimination of forestland, as a result of increasing needs for land for various other sectoral and regional developments, which affect forest management, e.g. in legal aspects, job opportunities and illegal cutting, is among some consequences. The decrease in forestland in the *Provincial plan* proves that institutionalised deforestation occurs.

3.5. Forest land fragmentation

3.5.1. Introduction

Deforestation causes fragmentation of a single compact forest area into some smaller forest areas, resulting in smaller isolated forest patches that are more accessible. Forest fragmentation is a *process* by which large expanses of forest are increasingly divided into smaller, discontinuous blocks or units. In nature, this process is started off by the death of trees or tree groups, fragmenting the whole forest into uneven-aged eco-units forming a mosaic (Oldeman 1990). Forest fragmentation is also often caused by forest elimination for agriculture, industry (e.g. timber, mining), roads or urban and human development (BFL, 2000, Reed, Beiswenger, and Johnson-Barnard, 2002). Fragments of this second kind are not part of a forest mosaic, but are the remains of such a mosaic, scattered over the landscape. The reduction in forestland and the often-occurring increase in human population density around the forest fragments exert a growing pressure on forest resources.

A fragmented forest in the present text refers to a landscape that was formerly forested but now consists of forested tracts that are segregated and sometimes isolated in a matrix of non-forest habitat. As the degree of fragmentation progresses, a *naturally patchy forest* is transformed into *a fragmented forest*, then to a number of *forest fragments*, and finally a single *insular tract or forest patch* (Harris and Silva-Lopez, 1992).

Different aspects of forest fragmentation have been studied using different methods, such as by Hlavka and Strong, 1992, Rudel and Rooper, 1997, Fox et al.,1995, Reed, et al., 2002, Riitters, et al., 2000, and Russ, 2002.

This study analyses the impact of forestland shrinkage because of government policy, leading to a decreasing compactness and the break-up of the existing forestlands. This kind of deforestation affects the total area of forestland, and therefore leads to fragmentation of the forest itself. Spatial analysis, i.e. GIS was used to calculate some indicators, basically by measuring the area and perimeter of forest land patches on two land allocation maps, namely, the *Forestry plan* and the *Provincial plan.*

3.5.2. Materials and methods

The two maps mentioned contain locations and boundary lines of forest patches belonging to each forest function (see Figure 3.2). In the GIS analysis, these patches are treated as *polygons*. To transform the analogue data of the forestland polygons into the digital form, the maps were digitised, and polygon maps were made. Every polygon contains information about its area, its perimeter and its attributes, i.e. the forest function of the area where the polygon belongs.

The indices were calculated using a number of polygons in each forest function and two variables of the polygon, namely perimeter and area, to find the relationship between those two variables in different ways or methods. Metric units, i.e. ha for the area and hm (i.e. 100m) for the perimeter were used to calculate the indices

Perimeter/area index

Two different calculations were applied for perimeter/area indices. The first was the basic index, simply calculated by dividing the polygon area by its perimeter for each polygon. The quotients were then added up and the average taken. The second was the shape index, calculated using the following formula (Baker and Cai, 1992, FAO, 1993, Rudel and Rooper,1997) :

$$PAI = 0.282095 * \frac{Pa}{\sqrt{(A*N)}}$$

Where:
Pa = total measured perimeter
A = total area
N = number of polygon, i.e. forest patches
0.282095 = an equation constant empirically found

The first index varies within the size of a patch, even if its shape is constant, whereas, the second index varies from 0 (i.e. for a circle) to infinity (i.e. for infinity long and narrow-shaped polygon) (Baker and Cai, 1992).

Fractal dimension

A fractal is simply a graph of a different type of function, following Mandelbrot (1967) who coined the term "fractal" in 1975 from the Latin *fractus* or "break" (Jürgens et al., 1990). Lorimer et al (1994) stated that fractals are geometrical objects or constructs, which have dynamical properties. Despite many attempts, the definition of "fractal" is not definitive; and following semantic convention, if an object or process has fractal properties, it is called a fractal. Further he stated that there is an agreement that the fractal properties are: fractional dimension, scale independence, self-similarity and complexity.

Fractal geometry is a new branch of mathematics with roots in set theory, topology and the theory of measures (Lorimer et al, 1994) and rich in mathematical bases; therefore, a fractal dimension can show the complexity of shapes of landscape elements (Milne, 1991, Ricotta et al., 1998). Fractals geometry has potential applications to describe complex natural patterns and is used to develop models, such as coastlines and mountains (http://www.kcsd.k12.pa.us/~projects/fractal/), soil erosion, seismic patterns (http://archive.ncsa.uiuc.edu/Edu/Fractal/Fractal_Home.html), and measuring leaves dimension and foliage distribution (Zeide, 1998).

The dimensional index (D) is calculated using the formula (Milne, 1991, Ricotta et al., 1998):

$$D = 2*k \text{ , and}$$
$$\text{Log}_2 (l/4) = 4*\log_2 (s) + c,$$

Where:
k = slope of the area and perimeter regression
l = perimeter of each polygon
s = area of the polygon
c = intercept of the equation.

Potentially, the fractal dimensions (D) derived from area-to-perimeter regression is ranging from 1.0 to around 1.5 (O'Neill et al., 1988). To calculate the fractal index, a macro language on a GIS environment was established (example of macro language: see appendix 2).

3.5.3. Results and discussion

a. Results

Number, size and distribution of polygons

By comparing the *Forestry plan* and the *Provincial plan*, the differences in number and sizes of polygons for each forest function are summarised in Table 3.10.

Table 3.10. Number and size of polygons for each forest function.
Decimals in the last six columns are mathematical artefacts without significance in the real field situation, given only to check the calculations. F: Forestry plan, P: Provincial plan.

Forest function	No. of polygons		Polygon sizes, in ha					
			Smallest		Largest		Mean	
	F	P	F	P	F	P	F	P
Conservation Area	11	30	478	26	28,470	89,913	9,553	4,745
Protection Forest	16	61	1,032	128	285,292	334,792	74,716	7,903
Limited Prod. Forest	15	42	1,637	454	64,559	26,272	17,582	4,764
Permanent Prod. Forest	11	27	11,665	127	376,076	219,433	106,400	21,947
Convertible Prod. Forest	12	17	628	392	457,681	74,716	49,966	10,597
Total polygons	65	177						

The break-up of the forestland is clearly shown by the large increase in the total number of polygons or forestland patches, namely from 65 to 177 polygons or 1.7 times larger. The major change was contributed by Protection Forest, which increased around 2.8 times. Meanwhile, the smallest change occurred in Convertible Production Forest, i.e. only 0.4 times.

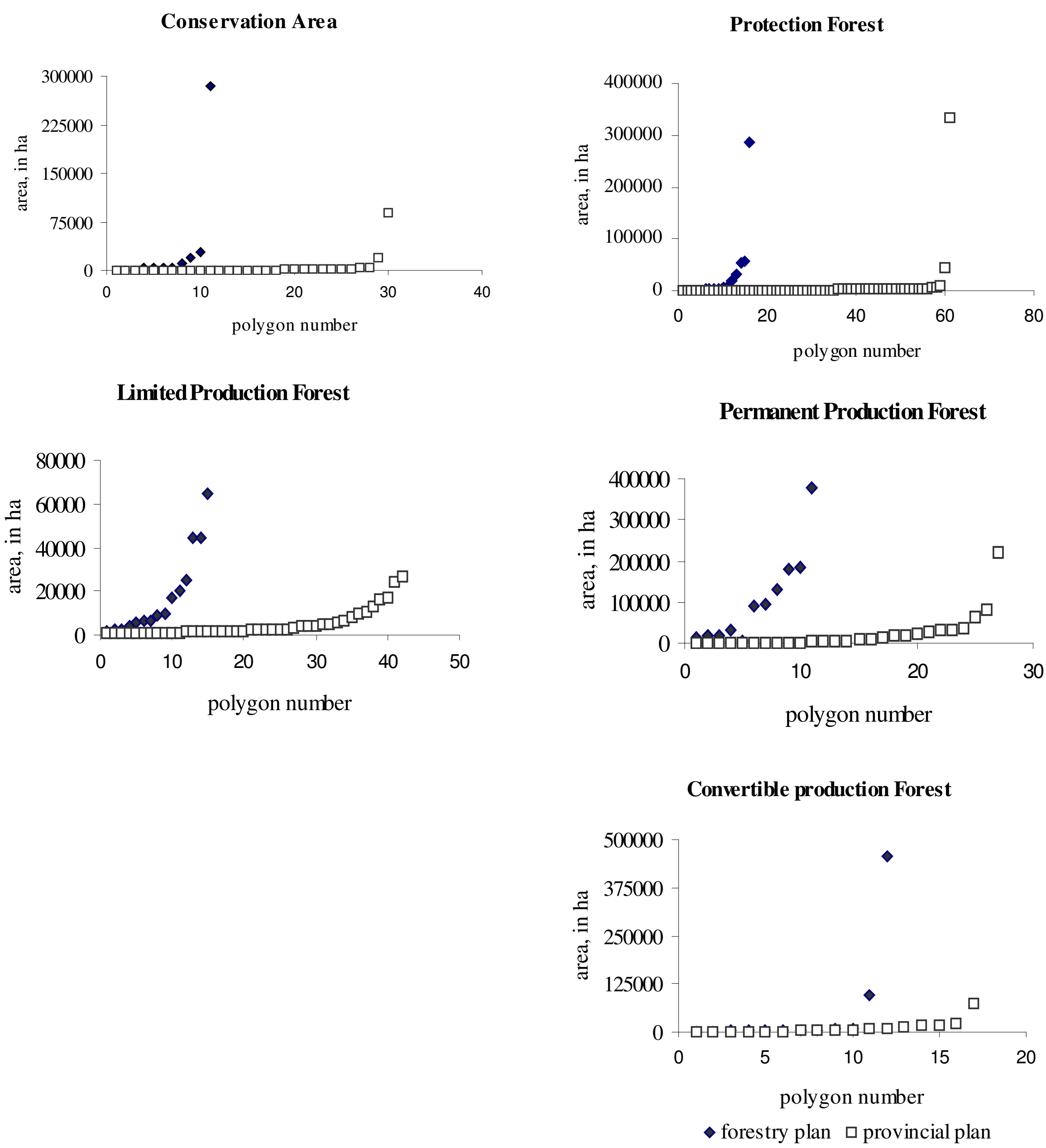

Figure 3.5. Polygon distribution for the Forestry plan and the Provincial plan. Each graph represents the polygon distribution for each forest function, i.e. Conservation Area, Protection Forest, Limited Production Forest, Permanent Production Forest and Convertible production forest. Each point represents each polygon showing its area.

Regarding the *mean size* of the polygons, all forest functions show a similar behaviour, namely decreasing the mean polygon area. In percentages, the smallest decreasing mean polygon area was in the Conservation Area, namely for 100%. For the other four forest functions, the decrease in polygon sizes ranged from 2.6 to over 3 times.

The *largest* polygon size decreased from 0.7 to over 5 times in all three-production functions. The largest size of the Protection Forest also increased. The Conservation Area, which showed a decreasing mean size and smallest sized polygons, showed a three times larger size of its largest polygon.

For the *smallest* polygon, all forest functions show a decrease in size; but both Protection Forest and Permanent Production Forest showed tremendous decreases, namely ranging from 7 times to 90 times.

Figure 3.5. shows the distribution of the polygon sizes for each forest function in the *Forestry plan* and the *Provincial plan*. The polygon sizes were ranked in an ascending mode for ease of interpretation.

Comparing the distribution of polygon sizes in the *Forestry plan* and the *Provincial plan* maps, the above figures show the general tendencies of decreasing polygon sizes and the accumulation of the polygons in the smaller size ranges on the *Provincial plan* map. The Convertible Production Forest area showed only minimal differences.

Perimeter/area index

Number and size of polygons have a relationship to the mean polygon area, and therefore, to its perimeter. The larger the perimeter, the larger the gate into the forest land and the more accessible the forestland for the outsider. This is so especially if the polygons are neighbours to non-forest land. The measured polygon perimeters of the two maps are given in Table 3.11.

Table 3.11. The perimeter of polygons for each forest function. Measures in hectometers (1 hm = 100 m). Decimals in the last 6 columns are mathematical artefacts without meaning in the real landscape, given to check calculations. F: Forestry plan, P: Provincial plan

Forest function	Polygon perimeters, in hm							
	Shortest		Longest		Mean		Total	
	F	P	F	P	F	P	F	P
Conservation Area	94	20	1,603	3,520	604	357	6,654	10,710
Protection Forest	129	55	5,542	11,409	834	448	13,354	27,356
Limited Product. Forest	152	101	1,941	2,875	700	440	10,502	18,480
Permanent Product. Forest	666	43	5,743	11,396	2,316	1,182	25,484	31,914
Convertible Product. Forest	120	85	11,387	1,838	1,574	455	18,891	7,738

For the shortest, longest and mean perimeters, different trends were found. Convertible Production Forest shows decreasing perimeters, for all, i.e. mean, shortest, longest and total perimeter. The other four functions show a decrease in the shortest perimeters only, but show some increase for the longest, mean and total perimeter. Please note that the shortest perimeter is in the Conservation Area, namely 20 hm with 26 ha in area, which is too small for a management unit, but not for an old-growth ecological unit of the type “small tree group” (Oldeman 1990).

In the total perimeter, increasing polygon perimeters can be related either to an increasing number of polygons, or to the fuzzy peripheral limits of the polygons. Figure 3.6. shows this indication.

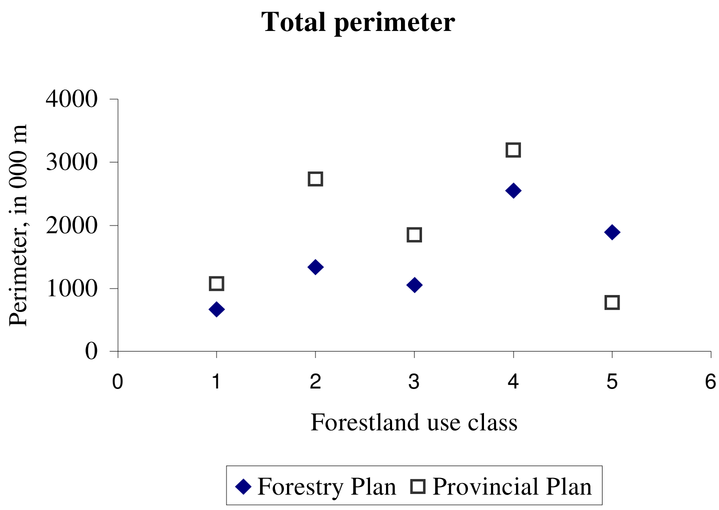

Figure 3.6. Total perimeter of polygons in the two plans, the Forestry plan and the Provincial plan. The forestland use classes are 1: Conservation Area, 2: Protection Forest, 3: Limited Production Forest, 4: Permanent Production Forest, 5: Convertible Production Forest

Two calculated indices of the polygons perimeter/area are shown in Table 3.12.

Table 3.12. Perimeter/area indices of the Forestry Plan and the Provincial Plan. The indices were calculated for each forest function, by dividing the perimeter and area of each polygon, adding up and taking the mean value. An equation constant of 0.282095 was used as a correction factor in calculating the shape index.

Forest function	Basic index		Shape index	
	Forestry plan	Provincial plan	Forestry plan	Provincial plan
Conservation Area	0.70	2.27	1.81	1.68
Protection Forest	0.45	3.46	1.57	1.65
Limited Product. Forest	0.60	3.88	1.52	1.80
Permanent Product. Forest	0.24	1.45	2.08	2.14
Convertible Product. Forest	0.38	0.73	1.87	1.46

For the perimeter/area index, except for Convertible Production Forest, other forest functions show different levels of increasing rates from *Forestry plan* to *Provincial plan*. As to the shape index, Conservation Area and Convertible Production Forest show decreasing rates and the other three functions show slightly increasing rates.

Fractal dimension

In this study, the fractal index was calculated for the forestland patches (i.e. represented by polygons), and not calculated for the forested areas. In reality, the forestland patches may and may not be forested areas. Therefore, the calculated fractal index has only a relationship with the *Forestry plan* and the *Provincial plan*, in indicating the excess of forestland fragmentation (e.g. for planning purposes), in conjunction with other indices. To be able to calculate the forest fragmentation for the whole province, some recent clear satellite images will be needed, which will be difficult to obtain due to the cloud coverage of this tropical area, which is partially permanent.

The calculated fractal dimensions of both land allocation maps are given in Table 3.13.

Table 3.13. The fractal index of the Forestry plan and the Provincial plan. The index was calculated for the forestland polygons of each forest function, using perimeter-area approach. A computer macro language was made and used to facilitate the calculation of the index.

Forest function	Fractal index	
	Forestry plan	Provincial plan
Conservation Area	1.33	1.36
Protection Forest	1.25	1.39
Limited Production Forest	1.39	1.43
Permanent Production Forest	1.27	1.35
Convertible Production Forest	1.47	1.13

The fractal dimension index, which was calculated based on the perimeter and area of the polygons shows that, except for Convertible Production Forest, the indices for the Provincial plan are higher than for the Forestry plan.

For the *Forestry plan* they lie between 1.27 and 1.47 and for the *Provincial plan* between 1.13 and 1.43. All indices are closer to 1 (i.e. the line is a mathematical line without width) than to 2 (i.e. not a line but a surface). Since the polygons were defined on small-scale maps, where their boundary lines looked smooth, the classical link between scale and fractal dimension, often illustrated by the saying that "*the length of the British coastline depends on the length of the measuring stick*", comes into play. Looking back at Figure 3.2, it can simply said that the area of the forestland as a whole and per forest function in the *Forestry plan* is more compact and less fragmented than in the *Provincial Plan*. These makes the boundary lines in the *Forestry plan* smoother, and the individual lines longer (i.e. due to larger polygon areas).

Enclaves of forestland and non-forest land islands

From Figure 3.2 (in the previous section) the occurrence of some small patches of forestlands in non-forest land in the *Provincial plan* map were indicated. Mostly, these are Protection Forestland, and the enclaves of some small patches of non-forest lands in the forestlands are indicated. Figure 3.7. shows these circumstances.

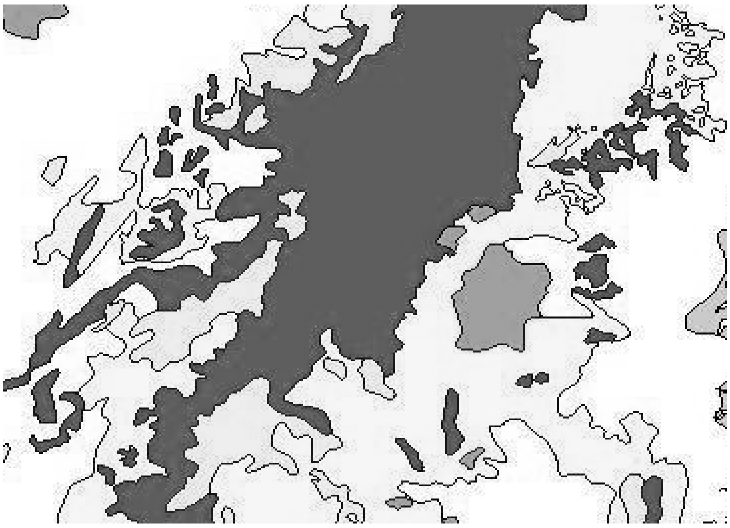

Figure 3.7. Enclaves of forestlands and non-forest lands in the Provincial plan. The original map scale is 1: 250,000, while the approximate scale of this map is around 1:1,500,000. See Figure 3.2. for the forest land use classes.

Discussion

The number of polygons is an important index in determining the degree of fragmentation. The higher the number of polygons, the more fragmented the forestland. In the study area, the most fragmented forestland in the *Provincial plan* lies in the Protection Forest and Conservation Areas. This is not a proper situation, considering that both areas are intended to safeguard untouched and undivided nature and the intact specific habitats in it. The degree of fragmentation of the production forests is less than that of the protection and conservation areas, but still for all three the numbers are high. The least increasing polygon number shows up in Convertible Production Forest. In this area, the impact of fragmentation is not as high as in other areas, because the area is reserved for non-forestry use. When it is "cleared" of forest, this happens in one operation and completely, not piecemeal, so no small fragments remain. For this reason also, the areas in the *Provincial plan* are completely different from those in the *Forestry plan*.

The size of the polygons is also an important indicator. In the given unit area, the size of a polygon is generally inversely proportional to the number of polygons. Indeed, the higher the number of polygons, the smaller the mean size of each polygon. The smaller sizes of polygons have implications. In *production forests*, small polygons require special forest management practices in planning and timber harvesting, as well as in monitoring and in controlling. In case of timber concession areas, more roads have to be constructed to reach many small patches, and some of them can only be built through the non-production forest areas and perhaps also through non-forest land. This causes other problems, since the opening up of roads in forestlands is usually followed by other human activities that affect the remaining forests (cf. Cleuren, 2001, Sunderlin and Resosudarmo, 1996, Reed et al., 1996).

In the *Provincial plan*, the smallest polygons have accumulated at the lower part of the graphs, meaning that more small than large polygons exist under the *Provincial plan*. Moreover, in areas defined for *protection and conservation* purposes, problems of safeguarding those areas and the minimum area for certain habitat types are involved. For example, maintaining the conservation function in a sustainable way for a small size area as 26 ha (i.e. the smallest existed polygon) is hardly possible.

Enclave effects for both forestland polygons inside non-forestland and non-forest land polygons inside forestland are similar. Although their status remains forestland, these isolated positions really endanger the very existence of the forest in these places. This situation worsens if the size of the forestland polygons decreases. In terms of forest management, it is also difficult to manage such mini-forests properly, no matter whether the forestland patches are having protection, conservation or production functions. The *Provincial plan* map clearly shows this tendency

Although indicating a certain degree of differences, perimeter/area indices and fractal dimensions do not show clear differences between both land allocation maps. Therefore, they do not in themselves show any clear indication of a deteriorating situation caused by the shifting from the *Forestry plan* to the *Provincial plan*. However, at least they support other indices in showing the potentially negative consequences of the implementation of the *Provincial plan* for the very existence of the forestlands.

3.5.4. Conclusions

Different indices used to compare the *Forestry plan* and *Provincial plan* maps show clear evidence of forestland fragmentation.

The clearest indication is the large and increasing number of polygons (i.e. forestland patches) in the *Provincial plan* as compared to the *Forestry plan*, and consecutively, the smaller size of these polygons. The larger the number of polygons, the larger is the sum of their perimeters. This leads to more borderline situations (transitional biotopes) in and around the forestlands, and to easier access to these forestlands.

The wide distribution of smaller-sized polygons has a great impact upon the forest management. For production forest, planning and controlling forest operations in scattered, small areas is quite problematic. For conservation and protection areas, safeguarding their functions to protect nature and habitats is also difficult. For functions linked to extended biotopes, e.g. primate territories, it becomes inherently impossible to ensure them.

The *Provincial plan* fosters the existence of enclaves, namely forest land patches inside non-forest land and non-forest land inside forested land. This is also going to create problems in forest management, the more so as the size of the enclave areas is small and their numbers are high.

3.6. Towards solving the problems

3.6.1. The strategic factors and the possible strategy

Questions to be answered

In the situation of disorganising the use of forestland, rejection of the *Forestry plan*, the continuing decrease in forestland and decreasing role of the Forestry in planning forestland use, several questions arise, which need to be answered. The questions are:

- Why is the *Forestry plan* no longer acceptable?
- Why is the *Provincial plan* needed and more acceptable?
- What can the Forestry provide or do*?*

Although the *Forestry plan* has some positive things, especially as seen from the Forestry's point of view, non-forestry agencies, local communities, provincial and local governments, see it differently.

Why is the *Forestry plan* no longer acceptable?

- It is a low quality reconnaissance plan.
- It is a land allocation/land use plan orientated to the Forestry sector.
- It contains an imbalanced and disproportional composition of forestland and non-forestland, including the Convertible Production Forest.
- It insufficiently accommodates the ever-increasing need for land for the development of various non-forestry sectors.
- It shows the very important role of the Forestry in managing the forestland, even more important than the role of Provincial authority, such as the obligation to provide an exchange area if non-forestry agencies want to use Permanent Production Forest, and in declaring the status of permanent forest.

Why is the *Provincial plan* needed?

- The plan is not sectoral, but regionally orientated
- In terms of coverage, the *Provincial plan* is a more comprehensive land allocation/land use plan
- It was established by the highest provincial authority, which treated all land-related agencies equally as land users; therefore, it is respected by all regional agencies.
- It represents the provincial authority in regulating provincial lands, especially in relation to regional *autonomous movements* that recently have come up.
- It accommodates the increasing needs of various agencies in using land for development.

To be able to answer the last question: *What can the Forestry provide or do?,* the strategic factors of the *Forestry plan* and its implementation were described and analysed.

What the Forestry Agency can do in this situation is take the following steps:

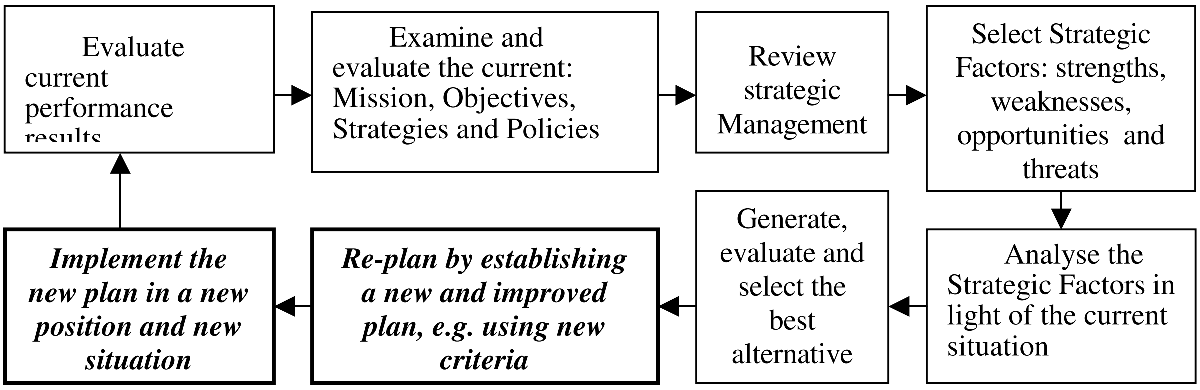

Figure 3.8. Strategy formulation Process (adapted from Whelen and Hunger, 1989)

The strategic factors

The strategic factors consist of *internal* strengths and weaknesses, and *external* opportunities and threats (Boseman and Phatak, 1989, Wheelen and Hunger, 1989, Certo and Peter, 1990, Pierce II and Robinson, 1991). The strategic factors of the *Forestry plan* will be disclosed and analysed; then new strategies towards solving forestland uses problems can be formulated. Note that to some extent, the *Provincial plan* may have the same strategic factors as the *Forestry plan*.

a. The strengths

The strengths of both the *Forestry plan* and the *Provincial plan* as land allocation plans or land use plans are obvious. Both plans aimed at conserving and preserving natural resources, e.g. through limiting the use of land in the proper place, and at the same time regulating the use of land in more realistic ways and on rational bases. This corresponds to the main aspects to be considered in forestland use planning as in all land use planning, i.e. *environmental aspects* and the *economic acceptability* in the context of sustainable forest management (Young, 1993, Ferguson, 1996).

More specifically, the *Forestry plan* was drawn up as a guide for the protection of the forests and their surrounding areas, to preserve nature, limit the use of forestland on the safe area, and at the same time to utilise it in a balanced manner. In this way, different functions of the forest have been accommodated to serve different sides.

The difference between the two plans is, that the *Forestry plan* covers only the forestland whereas the *Provincial plan* covers all the provincial land, i.e. both forestland and non-forestland. In this respect *Provincial plan* is more comprehensive and extensive than the *Forestry plan.*

Allocating forestland on the base of its proper functions is a strong point of departure to limit the risk of using land in the wrong way. It also prevents an excessive use of (forest) land, e.g. by providing Convertible Production Forest, found in both plans, and defining the condition for releasing Permanent Production Forest, i.e. by providing an appropriate exchange area. This is in line with the way in which to promote *sustainability*, i.e. by minimising the loss of productive land (FAO, 1989).

Moreover, the possible use of Permanent Production Forest for non-forest use in the *Forestry plan* shows the *flexibility* of the forestland use plan (Virtanen, 1992), which is *responsive to socio-economic changes* (Fresco and Kroonenberg, 1992). This flexibility is a property of all land use systems with proven historical sustainability (Van der Wal, 1999, W. de Jong, 1995, Kippie 2002).

The use of c*onsensus* as a road towards establishing the *Forestry plan*, and the involvement of other land-related agencies as members of the Boundary Marking Committee in the gazetting process, to some extent guarantees acceptable forms of co-ordination. In this respect, the *co-ordination* between the Forestry agency, other sectoral agencies and the regional authority was implemented by an *integrated approach* (FAO, 1989).

b. The weaknesses

In general, the *Forestry plan* and the *Provincial plan* show many weaknesses. These have different causes, such as the process used to develop the plan, the sources of supporting data and information, the criteria and classification method used to develop the plan, and indeed the different, often *hidden interests* behind them.

Although the best available data and information from different sources were used to establish the *Forestry plan*, they still had a low accuracy level. Moreover, the *Forestry plan* was presented on an overly small scale, with an overly generalised legend, and too inaccurate borders. This led to the misclassification of large pieces of forestland. However, the accuracy of the *Provincial plan* could also be questioned. In this sense, the attempts of *integrated planning* was further hampered by the use of inaccurate and incomplete data, in line with what was stated by the FAO (FAO, 1989).

The criteria used to define forest functions in the *Forestry plan* were inappropriate. They rest heavily on *physical aspects*, i.e. steep slopes, soil types and rainfall intensity, rather than on *socio-economic* considerations. Some of the criteria were qualitative, i.e. a lack of definition, and were not really specific, such as the criteria to define Convertible Production Forests and Nature Conservation Area. Most of the criteria used in *Forestry plan* were also used in the *Provincial plan*. This made that many requirements, the *social aspect*, i.e. meeting the local people's needs, or the integration of *socio-economic, environmental forces and biophysical components* (as stated by Young, 1993, Conyers et al., 1984, UNCED, 1992) were not met.

The South Kalimantan *Forestry plan* was legalised in 1984 and has never been significantly *revised*, especially not regarding the increasing needs for land for development, e.g. in terms of the criteria used to define certain forest functions, and with these, areas. The only updating was the exclusion of other property rights during the forest area gazetting process. This fact shows that the *dynamic response to changing socio-economic conditions* (Fresco and Kroonenberg, 1992) was not fully accommodated in the *Forestry plan*.

As said, the *Forestry plan* obviously is a sectoral land use plan, in which, according to Ceccarelli (1997), the sectoral approach is the most common situation encountered. And institutions and their technical agencies operate on a strongly sectoral basis in terms of responsibility and organisation, indicating a major obstacle to a more *integrated approach*. Moreover, a major weakness in the present situation is the compartmentalised, sector-orientated and mono-disciplinary structure of typical government bureaucracy (FAO, 1995, RIN, 1984).

c. The opportunities

Decreasing tropical forest areas and sustainable tropical forest management have become global issues and of international concern, see, for example, the Rio Declaration and Tropical Forest Action Plans (WRM, 1990, MoF, 1991, UNCED, 1992, and the Bandung Initiative, 1993). Forestland use planning is a strategic response to these issues. The establishment of a forest land use plan, such as the *Forestry plan* or *Provincial plan* is in line with the conditions set by the organisations involved, such as the International Organisation for sustainable forest management (ITTO, 1990).

The contribution of forestland to the socio-economic development of the country is high. For instance, it provides various forest products, job opportunities and government income, which should be long-lasting. The role of the forest in nature conservation and protection is also essential. The consequence of this meaningful position is the responsibility to manage the forest in a better way, namely by regulating forestland properly. Moreover, the achievements of the forestry missions, i.e. forestland protection, nature conservation and forest utilisation by regulating and managing forestlands, are of national and even international concern. For this reason, forests should in principle be considered permanent in time and space (De Gier, 1995).

d. The threats

The ever-increasing need for land for various regional and sectoral developments, e.g. due to the availability of investment funds, new aspirations in development and population growth has led to the conversion of forest to non-forest uses. In this sense, the forest acted as a reserve of unused land, and became the main target for development as stated by Donner (1987). This is especially so, if and when the environmental benefits from the forests and the environmental cost associated with destructive deforestation are ignored (Sharma, 1992).

The need to increase regional income and to provide more jobs for the people, was sometimes satisfied by offering facilities, such as land, made available to the investors. Often, the forest-covered area is not taken into account (Oldeman, 1992). In this respect, forests are undervalued by not taking into account their non-quantifiable benefits, or service functions (Van Maaren, 1984). And, in accordance with Sharma (1992), since the contribution of the forest sector to the economy is considered to be lower than other productive activities, the forest sector is assigned a low priority

The more established sectors, e.g. agriculture in general and other strategic development sectors, e.g. mining, and formerly also transmigration, by their influential positions can and do reduce the strength and the role of the Forestry Agency in regulating and managing the forestland. Moreover, the existence of other land management rights, such as transmigration and mining, often leads to overlapping uses with the forestland.

The Provincial plan, an opportunity or a threat?

The *Provincial plan* can be considered an opportunity. Since it is used as the main basis to allocate land for various regional and sectoral developments in the province, the inclusion of the forestland in the *Provincial plan* will make the existence of forest land clearer and more respected by all land-related agencies in the province. Therefore, a more appropriates planning of forestland uses and the implementation of forestland use plans towards a sustainable forest management in the future will be more promising.

On the other hand, the *Provincial plan,* at least the part related to the forestland allocation, can also be considered a threat to the existence of forestland and to sustainable forest management. Since the Forestry Agency is only considered to be a land user, they are no longer free to define the forestland. And so, their bargaining position is weak. Therefore, the Forestry Agency can do nothing in matters of extension and distribution of forestland, as was the experience with the *Provincial plan* and the *MoF Act, 1999*. In other words, the Forestry had lost its power.

The total forestland area, especially regarding the production forestland, had decreased significantly in the *Provincial plan.* There is no assurance for the permanency of "Permanent" Production forestland in the future; and therefore, achieving sustainable forest management has become an uncertain objective. In the words of Remmers (1998), it is *"hitting a moving target*".

The possible strategy

The best strategy could be selected by pairing the internal and external strategic factors (Pierce II and Robinson, 1991), see Figure 1.7. There are four types of possible strategies, namely:

- Using Strengths to take advantage of Opportunities to support an *aggressive* strategy,
- Overcoming Weaknesses by taking the advantage of Opportunities to support a *turn-around orientated* strategy,
- Using Strengths to avoid Threats to support a *diversification* strategy,
- Minimising Weaknesses and avoid Threats to support a *defensive* strategy.

The strategy formulation

Balancing the *advantages* of the internal and external strategic factors against the *disadvantages* is an approach towards the formulation of the strategy. A better situation can be expected if these internal and external strategic factors are in balance. This attempt is meant to ensure the future of the forestland by securing the planning process and the product, i.e. the forestland use plan and the implementation of the plan. By pairing internal and external strategic factors, there are four possible combinations, each of them leading to the strategy formulation (Pierce II and Robinson, 1991).

Since it is hardly possible to avoid the Threats, in particular the ever-increasing need for land, the most likely choices are:

- Aggressive strategy (Strengths-Opportunities approach), and
- Turn-around strategy (Weaknesses-Opportunities approach).

If the *aggressive strategy* (*Strengths-Opportunities* approach) is selected, the possible strategies are:

- To assure and secure allies and support from other government institutions, communities, and the international community by continuing publicity campaigns, extensions and training, regarding:

  - The importance of forestland to achieve Forestry missions by its significant contribution to environmental protection and socio-economic development. This can be done by keeping sufficient areas of forestland with different forest functions in a balanced conservation-protection-production pattern.
  - The importance of proper forest land use planning is based on environmental, i.e. sustainable conservation of natural resources, social, e.g. the needs of local people, impacts on the community, and economical, i.e. meeting the defined criteria for economic acceptability.
  - The global issue of decreasing tropical forest and of sustainable forest and the international concern as to sustainable forest management. This concern will imply international pressure on the country, which most possibly will affect the economic aspects, since the tropical forest is assumed to be a “world heritage” and “a treasure house of bio-diversity” or “a carbon sink” (B. de Jong, 2000).
- To call for increasing co-ordination in establishing a respected land use plan.
- To call for intensification of agricultural land uses to get more food crops and estates crop production per unit of land.

In the *turn-around strategy (Weaknesses-Opportunities* approach), the possible strategies are:

- To assess the *quantified need* for tangible and intangible forest products in a given region in Indonesia, in order to calculate how many areas of forestland should remain and in which locations.
- To arrange a *new forestland use plan*, through:

  - Assessing forest functions precisely through calculating their economic values in relationship with land use changes.
  - Reconsidering the criteria used to define forest functions, e.g. more specific, more quantitative, accommodating socio-economic aspects.
  - Increasing the quality of the required data and the product of forestland use planning, e.g. by accurate, complete, detailed and up-to-date maps.
  - Wholly new ways of forest use with much better economic properties (Oldeman, 1993, Global Forest Conference, Bandung Initiative, 1993)
- To improve the process and mechanism of the forestland allocation in relationship to the needs of non-forest users, e.g. shorter time to release forestland, period of revision, accommodation of the dynamic response to changing socio-economic conditions.
- To calls for increasing co-ordination to reduce the use of the sectoral approach.

For optimum achievements, the feasible strategies from both approaches, i.e. the aggressive and the turn-around strategies, can be combined. This combination will lead to a moderate approach from the "*outward-looking*" aggressive strategy and "*inward-looking*" turn-around orientated strategies. And it would imply the integration of the new *Forestry plan* into the new *Provincial plan*.

3.6.2. On forestland use classification

References and studies in forestland classification and forestland evaluation

Forestland can be classified in different ways. In Indonesia, it is classified based on the main functions of the forests into protection, conservation and production forest, mainly based on physical criteria (see 3.3). Forest in *Thailand* is also classified into *Protective Forests*, *Productive Forests*, *and Forestlands suitable for Agriculture* (Dulyapach, 1985, Hudakorn et al., 1991). Here, the conservation area is included in the protective forest, while *Forestlands suitable for Agriculture* is similar to convertible production forest in the Indonesian classification. In *Pakistan*, forestland is also classified based on its primary use into *Production*, *Protection* and *Aesthetic forests* (Qureshi, 1981).

Differently, forestland in *Malaysia* is classified into three main categories, i.e. *Permanent forest estates*, *State-land forest* and *Forest reserves* based on their accessibility, forest coverage and other physical criteria (Khairi and Hamid, 1985, Mok, 1986, Hasan and Rahim, 1991). In the *Philippines*, the basic forestland classification combines *natural* (i.e. natural vegetation, landform and soils), and *cultural* components, i.e. relating to designated and developed land uses (Driscoll et al., 1987). Then, the forestland is grouped into *Natural forests*, *Man-made forests*, *Watershed preservation*, and *Pasture and range lands* based on slope gradient, existing land use, economic and environmental needs, and its urgency (Rapera et al., 1985),

In Europe, in Rumania, the forests are divided into two functional groups, namely forests with special protection functions, and forests with both productive and protection functions. Only the first group is divided further into more specific sub groups, while the second main group is not (Kiss, 1992). In the Netherlands, the forest functions are divided into four categories, i.e. wood production, recreation, nature conservation, and forest as part of the landscape (Konijnendijk, 1992).

Land evaluation is the process of assessing suitability of land for alternative uses which supports land use planning by supplying alternatives for land resource use (Fresco et al., 1992). For forestry, it is defined as a process of assessing the performance of land when used for specific present of projected forms of forestry (Bennema, 1981). Some studies on land evaluation, land use planning, land utilisation types and land capability for forestland have been undertaken.

Bennema et al. (1981) reviewed the applicability of a land evaluation framework that was mainly applied to agriculture in forestry using the main principles for agriculture and forestry. Beek and Laban (1981) emphasise the need for integrated approaches in forestland evaluation, which should be assessed simultaneously for timber production and other uses by considering physiological growth, forest operations and environmental protection. Purnell (1981) outlined the main objectives, principles, features and shortcomings of the Framework for Land Evaluation as to their significance for classifying land for multipurpose forestry. Schweithelm (pm) describes the need for a land evaluation method of upper watersheds illustrated by the Riam Kanan basin, Indonesia. The need is in the context of requirements for watershed management, land use conflicts, biophysical, socio-economic and institutional characteristics. He concludes that the method must be simply applicable with available resources at the provincial level.

Andel et al. (1981) dealt with the concept of land utilisation types, and proposed to adopt it for forestry purposes. A procedure that led to a detailed description of land utilisation was outlined, illustrated by examples from Southeast Asia and north-western Europe. While Lee (1981) examined the status of land capability classification that was carried out in Indonesia. He evaluated the potential of the land development and their needs in relation to national requirements and implications on forestland management. He stated that the existing forest inventory and land capability classification does not provide adequate information to evaluate the productive potential of forestlands. Therefore, a proposal for a landscape approach to aid forestland evaluation and forest inventory is given.

Huising, B (1984) formulated a land use planning guide for watershed development based on his work in Indonesia. He proposed methods and strategies to strengthen land and water management through the application of land use planning activities within the watershed management framework. Donner (1987) completed a comprehensive study in Indonesia covering land use in the face of ecological problems in outer islands and environmental problems of non-agricultural land use. For outer islands, he stresses its precarious potential (i.e. forests, swampland and grassland) and environmental impact of development and aspects of transmigration policy.

Abell (1988) studied the current method of classifying Indonesian forests, and proposes to improve the method by linking the land system map to a potential erosion index. The possible major improvements are in the index calculation and in separation of Convertible and Normal Production Forest. In 1987, LRDC completed land suitability and land capability analyses for a physical planning programme for Transmigration covering South and Central Kalimantan. In relation, Ross (1983, 1984) developed a methodology to select agricultural land from tropical forest in Indonesia, based on the need to convert forestland for transmigration purposes. He suggested a method to classify tropical forests according to their ability to yield industrial logs, by taking into account: volume of standing stock, potential for regeneration, species, accessibility and location. Sutter (1989) dealt with land and forest classes in great detail to establish base line information on forestland and growing stock.

Sustainability in forestland use planning

Basically, forestland use planning should always consider three main aspects. These are social acceptability, environmental soundness and economical viability in an integrated approach (Conyers et al., 1984, Oldeman 1990, UNCED, 1992). The just mentioned aspects can be achieved through answering a series of questions as stated by Young (1993). The questions are: will the proposed land use conserve natural resources?, will it be sustainable?, who will sustain the conservation?, does the proposed use meet the material and immaterial needs of the local people, so that they are willing to sustain it? what is the impact on a particular community, e.g. poor or minority people?, does the use meet the defined criteria of economic acceptability or who is going to sustain payment of the cost?

The answers to the above questions should be intrinsically reflected in the *new* forestland use plan, i.e. in the process of establishing the plan, in the forestland use classes and in the criteria used to define forestland use classes. To be realistic, the plan should be based on a proper forestland evaluation (see, e.g. Bennema et al., 1981, Beek and Laban, 1981, Purnell, 1981, Abell, 1988, and Ross, 1983, 1984) which will be used as 'ground truth' (Oldeman, 2002, pers. comm.) representing the reality in the field. Nowadays, highly accurate data are available and more accessible than before (e.g. various high-resolution remote- sensing images). Besides, new methods to process the data and to assess land cover and land use types are more advanced than before. To mentioned a few: digital image analyses system, geographical information system, decision support system, and global positioning system (see further Lillesand and Kiefer, 1994, Pohl, 1996, Aronoff, 1991, Burrough, 1993, Eastman, 1993 and 1997). For the sake of a higher quality of the plan, these advanced systems should be used more intensively.

The proposed forestland use classes

Currently, forestland in Indonesia is classified based on the main forest functions into Conservation Area, Protection Forest and Production Forest. Except for Protection Forest, the main class is then differentiated further into more specific classes. Production Forest, for example, differentiated into the Permanent Production Forest, the Limited Production Forest and the Convertible Production Forest (see also section 3.3 on Major laws and regulations).

In reality, whether the designated forestland use class is for protection, conservation or production functions, the protection function is always included (see Kiss, 1992). In this respect, Production Forest also supports the protection function, whether they are Permanent Production Forest, Limited Production Forest or Convertible Production Forest. The same applies to the Conservation Area, which has a protection function.

In case of Limited Production Forest, its position is ambiguous, whether the main function is production or protection. Although a limitation (in terms of annual allowable cut and the smallest diameter of harvested trees) is set differently compared with Permanent Production Forest, it still lies in the grey area. This situation is often used by the concession holders to claim larger working areas, using the inaccuracy issue when this area was designated into the current land use class. Moreover, planning, controlling and monitoring timber harvesting in this area is also problematic. In this respect, the elimination of this class will simplify the management of production forest, especially in terms of planning and monitoring the wood production. In this regard, the area of this class should be accurately re-measured and included either in Protection Forest area or in Permanent Production Forest area.

In the immaterial sense, the existence of Convertible Production Forest as an independent class in forestland use classification is also improper. It triggered using this area without appropriate planning, while hoping to get the timber from the released area. Often, *'hit and run'* practices occurred in the field, leaving the area unmanaged after the timber had gone. In this respect, eliminating this class, and including the area into Permanent Production Forest could reduce the problems in using forestland. Moreover, parts of the Permanent Production Forest are non-forested areas, where some are physically safe to be used for non-forestry uses. In this way, the availability of forest areas for non-forest uses is hidden. In relation, a very accurate assessment is needed before releasing the production forest (e.g. only on the non-forested part, and preferably not in the centre part of the forested area which may cause an enclave area).

For the sake of the local people, access to forests to collect wood products (for non-commercial use) and non-wood products for the local community should be available. For this reason, certain areas should be provided for them to be utilised. This area, name it Community Forest area, should be close to or adjacent to the village or settlement areas, so that for the local people the distance is not a constraint. The following Figure 3.9 schematically shows the situation. The status of the Community Forest should be designated clearly, either as an independent forestland use class, or as a subclass of the Production Forest.

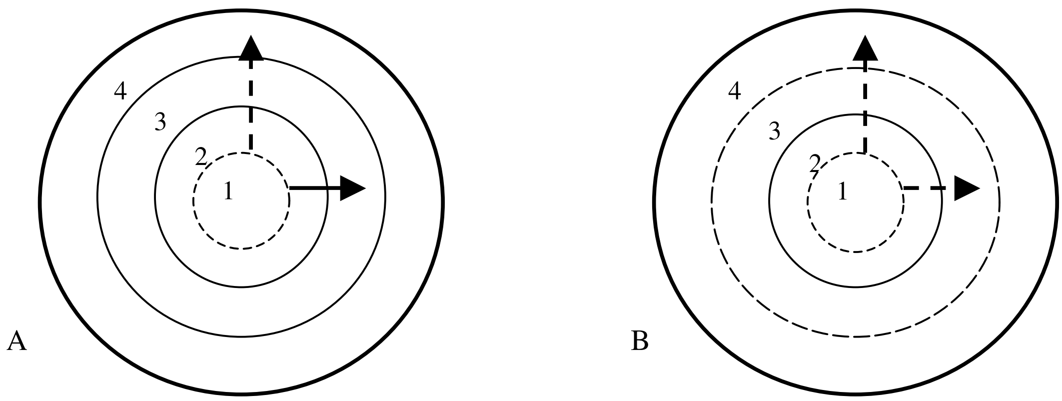

Figure 3.9. Location of the community forests in the forestland.
A. Community Forest inside or surrounding the Production Forest, B Community forest inside or surrounding the Conservation Area or Protection Forest. 1 = settlement, 2 = farm/agricultural land, 3 = community forest, 4 = other forestland, → = full access, - - -▶ = limited access.

For Community Forest adjacent to Production Forest, the access for the people should cover both wood and non-wood products, and beyond this point, i.e. inside Production Forest, the access should be limited to non-wood production. While for Community Forest located adjacent to Protection Forest and Conservation Area, access for the local people to Community Forest as well as to Protection and Conservation Area should be limited for non-wood forest product.

In conclusion, in the future forestland use classes in should consist of Conservation Area, Protection Forest, Production Forest, and Community Forest. Or, if Community

Forest is considered a subclass belonging to Production Forest, then the main forestland use classes will consist of Conservation Area, Protection Forest and Production Forest (that covers also Community Forest and Convertible Production Forest). Conservation Forest can be subdivided into more detailed subclasses as in the current classification.

In this situation, the basis for the classification is no longer the main physical function of the forests, but also covers the social aspect of forest and forestland. Further studies and extensive and accurate assessments will be needed to realise this idea.

As to meet the sustainability issue as mentioned before, the existing considerations used to define or to classify the forestland, should be revised. The three physical factors used before should still be used, and additional factors should be considered. These are, e.g.:

1. The social acceptability aspect: access to the permanent forestland for local people to collect wood and non-wood products for non-commercial use should be opened. This can be done through the establishment of an independent Community Forest located close to the settlements in sufficiently large area.
2. The environmental soundness aspect: degree of the forestland fragmentation, indicated by the existence of small-size forestland patches, should be lowered or eliminated by designating more compact forestland. And so, the existence of small-size enclaves, either as forested land patches or as non-forestland patches should also be avoided (see section 3.4. on Forestland dynamics).
3. In terms of economically viability, the forested area should still be kept as forestland, while the subclass Convertible Production Forest should be re-designated and be limited only on non-forested areas with a highly accessibility. In relation to 2, smaller patches of Production Forest should be avoided.

Improving the quality and higher accuracy of the new forestland use plan can be done in many ways. This includes the process, the input, the data processing and the results presented. The process should follow a co-ordinated and integration approach by sectorals and regional institutions. The input (in terms of data and information) should cover high-resolution and large-scale recent spatial data, such as topographic maps, remote sensing images, accurate position data as collected using GPS, as well as non-spatial data, e.g. current socio-economic data from local people, distribution of settlements, new aspirations. The processing system, which includes the analysis, should be done with advanced methods, e.g. computerised-based analysis. And the final results should be presented on more detailed and larger scale maps, as well as in digital data format. The latter will facilitate further analyses, improvement and checking. Therefore a single common format should be used among various institutions involved in the process.

The hierarchical steps to assign the classes

Considering its precarious aspect, Conservation Area is considered as at the top of the hierarchy among other forestland use classes. Once the specific flora or fauna or the natural beauty of the area diminishes or becomes extinct, the role of Conservation Area will be finished. In this case, a minimum size of the area should be carefully considered. It is useless to designate a very small Conservation Area surrounded by non-forestland. So, the first priority should be to find and designate these areas.

Protection Forest has the second position in the hierarchy, due to its main functions. Extra careful attention should be paid when selecting these areas. The topographic conditions of the areas vary largely, especially related to size. A small size flat area inside the high-elevation steep slope areas, for example, should remain Protection Area, together with its surrounding areas. As with the previous class, the issue of minimum area is applied. Designating a very small Protection Forest may not be beneficial.

Lower in the hierarchy is Production Forest. In this stage, the environmental issue is less urgent than with the other two classes. Aspects of social acceptability and economic viability are more pronounced. The social acceptability aspect will be answered by the establishment of Community Forest; will it be either an independent class or a subclass under Production Forest. Economic aspects, will be answered through considering the forest coverage, standing stock and accessibility. Further studies are needed to elaborate on these considerations.

Convertible Production Forest (which would become a subclass under Production Forest) should only cover the non-forested area in a highly accessible area (e.g. existing road, infrastructure and distance to the town, market or port), preferably close to the settlement. In such a way, the local people can benefit from and facilitate the new land use (e.g. estate crop).

4. GENERAL DISCUSSION AND CONCLUSIONS

Opening remarks

The selection of the Riam Kanan river basin and the province of South Kalimantan was based on the fact that both sites have typical problems regarding their forest lands, especially in terms of land use and land allocation. The existing problems are quite similar, namely in that they share the disorganised use of forestland. The direct driving forces may be different, but the underlying causes that were found are similar. They reside in conflicting laws and regulations.

4.1. The Riam Kanan river basin

4.1.1. Land cover and land use dynamics

Protection versus utilisation

Referring to the Act of the Basic Forest Management (UUPK 5/1967 and 41/1999), the implication of an area having acquired the 'status' of forestland is, that the Forestry Agency authorises for this area forest management in a sustainable way for the benefit of the people. The term 'authorisation' does not imply that the area belongs to the Forestry Agency. This status as forestland has no relationship with either *land rights* or *land tenure* as mentioned in the Act on Basic Land Management (UUPA 5/1962).

Regarding protection forest, no activities are allowed in such areas that adversely affect their protection function. The Act does neither clearly mean, nor explicitly mention whether or not settlement is prohibited in this area. Since the enactment of the MoA Act defining the Riam Kanan river basin as Protection Forest in 1975, there has been no regulation limiting farming activities to certain areas, or separating farmland from protection areas. Although extension services regularly distributed information on practising land conservation and on the prohibition to cut and encroach upon the forest, no law enforcement was implemented (see Plates 1.5 and 1.10, showing land clearing on steep slopes just behind a village).

The issuance of the MoI act, which declared this area a more independent subdistrict brought more complications. The local government, on the basis of its duties and responsibilities, established and developed the Riam Kanan area, e.g. by constructing an infrastructure and public facilities, such as schools. Meanwhile, the farmers felt free to cultivate the land for subsistence agriculture, sometimes occupying more land than they could physically cultivate, without bothering about the status of the land. This is especially the case for land used extensively for pastures (see Plate 1.3 and Section 2.4. Local people: condition and their aspirations).

On the other hand, the Forestry keeps trying to reforest the area, considering that the protection functions of this area should be brought to the optimum level. Unfortunately, reforestation is not always considered beneficial by local people. First, they are not allowed to obtain and use wood from the forest, and second, reforestation is considered their competitor in using land (see Unlam, 1986 and 1987). Especially where gently sloping areas are reforested, that could also be used as agricultural land (see Plate 1.8). The predictable result is the failure of reforestation, either by fire, cattle intrusion or other causes (see Plates 1.1, 1.3 and 1.9, and Hatta 1999).

Later on, the extended area of the Riam Kanan river basin was declared "Grand Forest Park 'Sultan Adam'", a land management system that allows the co-existence of different functions in the area. Unfortunately, the effectiveness of such management units has never been proven. It is unknown whether or not this system really works, benefits the parties involved, and solves the land allocation problem.

Land cover and land use dynamics

The Riam Kanan river basin is special because of the existing water storage for generating electricity, providing drinking water and irrigation. The protection function of the upper area hence must be maximised, otherwise the quantity and quality of the water supply will degrade, leading to serious problems (see Box). Table 2.6 clearly shows that, instead of covering 9200 ha as planned, the reservoir area decreased to 5164 ha in 1991. In 2000, the TM Landsat image showed that the area of the reservoir was only 7220 ha (see Section 2.6 Towards solving the problem). It shows that the reservoir was never completely full, so that the protection function of the uphill areas was far from optimum. Plate 1.2 proves this to be the case.

The components of land transformation, i.e. *conversion* and *modification* of land cover changes, *shifts to other use,* and *intensification of the existing use* (Turner and Meyer, 1994) are schematically presented in Figure 2.5. Due to the increasing demand for forest products and agricultural products, and driven by different forces, the lands are transformed through various activities, e.g. forest clearing, burning, farming, grazing, reforestation. Bio-physically, the land in the form of land cover types and land use types, reacts in different negative and positive ways such as landslides, erosion, drought, sedimentation, or forest growth. The biophysical responses lead to human responses, either in a positive way, e.g. reforestation or soil conservation, or in a negative way such as clear cutting or overgrazing. Meanwhile, human responses are linked to human activities, and therefore, implicitly to land cover and land use types.

Deforestation is caused by various factors, but compared with natural causes, human activities are the most significant ones. Among various driving forces on land use changes, human population and human activities are the most obvious (FAO, 1989, Fresco, 1993, Turner and Meyer, 1994, Turner et al., 1995). However, the interactions between human and environmental factors are complex (Turner, Moss and Skole, 1993, Oldeman 2002).

Sunderlin and Resosudarmo (1996) gave two different opinions on the causes of deforestation in Indonesia. On the one hand, smallholder producers, the growing number of such producers and civil society (i.e. non-state actors), are seen as the main causes of deforestation, acting as the lead forces in forest cover removal. On the other hand, the government and its development projects including the forest concession holdings, are said to be responsible. Relating these opinions and findings to the study area, it can be said that, at different scales, both civil society and the government policy contributed to deforestation, at least they were the hidden driving forces.

In this area, deforestation, forest degradation, and illegal cutting are found at the subsistence level, i.e. on a small scale. Small patches of deforestation mostly existed in the fringe of the natural forest on the hilly parts. This seemingly low deforestation rate is due to there being no large-scale physical activities, such as logging, estate planting, or mining that cause deforestation over large areas. This situation is different from deforestation in other areas or other tropical countries (Veldkamp et al., 1992, Colchester, 1993a and 1993b, Monbiot, 1993, Witte, 1993, Lohmann, 1993, Leonen, 1993, Cleuren, 2001).

Meanwhile, most of the failure of reforestation occurred on the lower slopes, close to the reservoir, in the area also used as agricultural or grazing land. Reforestation here is largely failing, which to some extent was triggered by the overlapping, mutually unadjusted laws and regulations regarding the status and the management of this area, particularly the inconsistency in government policy and improper planning. Such an improper plan is reforestation on the flat areas. Figure 2.7 shows that almost the whole of the river basin area was reforested once before, part of it more than once. This indicates that the rate of reforestation failure is high.

Then, the question is why attempts to reverse deforestation have failed? According to Vanclay (1993), the reason is that instead of addressing causes (e.g. overpopulation, poverty), they address symptoms (e.g. erosion, flooding, land slides, shifting cultivation). Many forms of pressure originate outside the forest, so a multi-sectoral approach is needed. In this respect, land should be considered belonging to many parties, not only to the Forestry. Therefore, every Agency dealing with lands, together with the local people, should be co-responsible for its sustained use.

On local people and their settlements

A low level of affluence and education of the local people caused the technological input into the agricultural land to remain small. Less intensive farming, slash-and-burn practice and extensive cattle grazing (e.g. by leaving cattle free on the grassland) are examples. All of these factors often lead to pinpoint the local people as the main authors of deforestation. However, our study showed their share in causing deforestation to be as insignificant as their population dynamics. Both their natural increment and the net-migration showed low rates and decreasing trends, which only diminished the pressures on land use changes (see Table 2.9.).

As a traditional agricultural community, access to water for daily life, irrigation and transportation was the first consideration of the local inhabitants when selecting the site of their settlements. Access to the 'outside world' was the second consideration. The former was and remained the major reason why they stayed close to the reservoir when the dam was constructed and the old bed of the river Riam Kanan was inundated. The short distances between the previous settlements and the new settlements are also proof of this statement.

Their settlements are distinguished as typically agricultural settlements with an agricultural population (see Section 1.4.1, especially on Settlement, their pattern and location). This also explains the *strong attachment* of the people to their land. This fits in with the results of the interviews, showing that most of the respondents, explicitly or implicitly, disagreed to be moved from their current places. However, the regulations allowed to resettle them, and a study by the local authorities showed that all villages fulfilled the conditions to be moved to other places. Still, moving the local people from the Riam Kanan river basin is not a wise decision and it cannot be successfully implemented. The strong attachment to the land is also supported by the existence of different level *central place* functions, marked by special facilities (Chorley and Hagget, 1967, Everson and FitzGerald, 1973). A central place is shown to be a well-organised and well-regulated supply and distribution centre for the surrounding area, in terms of materials, logistics and services. The very existence of central supply places proves the permanent type of the settlements.

The local people in Riam Kanan are simple people with simple aspirations and uncomplicated desires. Their wish that the government improves the infrastructure, increases the accessibility and education facilities, and provides some basic aid, are merely aimed at improving their basic standard of life. All of those 'dreams' are considered normal, not excessive. In terms of land tenure, they fully understand that they are living in so called 'protection forest land' and that they cannot claim any formal right on the land they occupy.

4.1.2. On land re-allocation

The basic idea and the model

A model is a representation of the real world. It can be built in different forms, such as a mathematical model (e.g. mathematical formulae), a maquette (miniature real three-dimensional model of a building or a living system), or a spatial model (e.g. maps, digital elevation models).

Not all details of the real object can be represented in the model. In this case, principles of *abstraction, generalisation, simplification* and *representativity* are applied. Oderwald (1990) described the simplicity of the model as the Least Degree, Fewest Parameters, Most Probable, and Easiest to Disprove. Zeide (1990) and Semevsky and Zeide (1990) stated that good models manage to combine desirable features, which constitute the quality of the model. Trade-offs between model characteristics (e.g. accuracy, generality, robustness) should not be accepted as inevitable.

Symbols and numbers are often used in mathematical models to represent parameters, variables or functions (sums, averages, quotients, products, roots, etc.). A snaky river is generalised, and represented as a curved line on a small-scale map. Compounds of houses are often simplified as small box forms on the map, or maintained as replica buildings, leaving out all details. The accuracy of the model is represented, among others things, by its scale. The smaller the model's scale (e.g. a country map $1:10^6$ or one millionth as opposed to a precise forest plot map $1:2.10^2$ or one two-hundredth), the lower the accuracy. Moreover, a map on paper does not automatically show three-dimensional features, which have to be coded. The rough, uneven surface of the earth, for example, is not visualised well on a topographic map, but only by contour lines.

Since in the present case of land-use planning the model is established to bridge the gap between the model builder (e.g. the decision-maker) and the user (e.g. local people), in other words as a tool for communication, other principles should also be kept in mind. In particular, the model should be *communicative*, *informative* and *easy to understand*. The user, usually a lay person, may not understand the process of establishing the model, but he or she should know and understand the model clearly enough to use it as a source of relevant information.

The re-allocation model being proposed in these pages is a *spatial model*. The term spatial refers to three-dimensional 'space or room'. The spatial modelling uses *spatial data*, i.e. either data with geo-reference information, or mere co-ordinates. In general, spatial data are represented in terms of points (or nodes), lines (or arcs) and areas (or polygons). The spatial data are accompanied by attribute data, i.e. information about the spatial data. The spatial data are normally analysed by *spatial analysis* methods, such as a digital image analysis system, geographical information system, or spatial decision support system (for modelling, also see Oldeman 2002).

The re-allocation model

The first aim of this re-allocation model is to effect a virtual re-allocation of the study area, based on either its suitability or its unsuitability for agriculture. The second aim is to find a 3576 ha area, to satisfy the needs of the 1788 families in the study area based on a standard of 2 ha area per family. The model can be expanded further, for example to find 3 ha land per family, suitable for grazing. The most suitable area is selected first, until the whole target area is found to the satisfaction of all people involved. The remaining area will be maintained as protection forest.

The model will not go as far as to divide the suitable area at the level of the individual farmer. It will depend on the decision-maker in the field, how to distribute the suitable area among the people. So personal problems, such as 'the farmer being jealous of his neighbour with more fertile allocated land', or 'the neighbour who has more gentle slopes in his allocated land', or 'who is closer to the village site', are beyond the scope of the model.

Basically, the model works with *constraints*, mostly areas that can *not* be used for agriculture; therefore, are not suitable and are to be excluded from the target area. The second criterion is the *limiting factor*, the factor that diminishes or enlarges the size of the suitable area (Eastman, 1993, 1997). A limiting factor shows the *degree of* suitability of a certain part of the land. Limiting factors are used as a basis to define the *level* of suitability of parts of the land within the target area.

The number of the constraints and limiting factors should be defined in such a way as to have the model describe the problem situation as closely as possible. Moreover, when selecting the constraints and limiting factors, they should be *comprehensive, measurable, complete, operational, decomposable, non-redundant* and *minimal* (Malczewski, 2000). These considerations fit into the basic principles of modelling as mentioned before (i.e. *abstraction, generalisation, simplification,* and *representativity*). Consequently, the more evaluation criteria are used to establish the model, the more complex the model. This explains, why soil type and rainfall intensity are not included as limiting factors. They would only complicate the model and not add enough supplementary and relevant information.

This model belongs to the domain of spatial decision support systems. Such systems combine the human mind, i.e. the decision-maker's ability and the computer's capability to solve *semi-structured* or *ill-structured problems* (see e.g. Malczewski, 2000, Eastman 1993, 1997, Eastman et al., 1993 and Figure.1.8). For this type of problem, the computer alone can not evaluate and solve the problem without the involvement of human ability, by including human knowledge and experience. The combination of the decision-maker's ability, introducing the *subjective value,* and the computer's capability, analysing the *objective value,* such as 'hard data', e.g. remote sensing data or field observation results, leads to the *mixture of subjective and objective values*. This system differs, for example, from GIS (see, e.g. Aronoff, 1992, Burrough, 1993), which only can handle *well-structured problems* using 'hard data', without the involvement of the human mind, but which can not tackle *ill-structured problems*.

In relation to the above, a 'complex problem' (for instance an *ill-structured or semi-structured problem*) can only be solved by a 'complex problem solving' approach (see Table 1.4, and Schaik, 1988), Gorry et al., 1989, Guarisso and Werthner, 1989 and Densham 1989). A single problem solving approach, e.g. one limited to a mathematical, statistical or ecological approach, is not capable of solving a complex problem. The term 'complex' denotes that the problem is multi-faceted and contains mainly mutually dependent variables, and so a combination of more than one approach is needed. As an example, a land use planning problem is a multi dimensional problem, on which many interests rest; for this, as stated by Vanclay (1993) and De Gier (1995), a multi-sectoral approach in an integrated and comprehensive way is needed to solve the problem.

Consequently, different criteria, belonging to different domains, must be used together, such as the mixture of '*abstract*' criteria (e.g. mathematical 'factors', average numbers, etc) and '*operational, real'* criteria (such as maps, satellite images, ecological 'dosages'). Each of them solves part of the problem. For example, to solve the problem of deforestation failure, we need to have and to know several things. Maps and remote sensing images ('operational, real criteria') will be calculated ('abstract' mathematical factor). New tree species (ecological factors) that satisfy the needs of the local people enter into a model by virtue of biological and technical data. The attitudes and aspirations of the local people are introduced into the model using special evaluation methods, such as ranking instead of measuring (sociological factors).

The role of decision-makers in planning, constructing and implementing the model

When applying this approach to the real world, an active participation of decision-makers to obtain consensus in every step in the decision-making process is the key issue. The real allocation model will be developed together by all decision-makers involved in land management (e.g. representing forestry, agriculture, local authority, land office and local people) based on a stepwise decision-making procedure. Defining the constraints and the limiting factors, determining the weight of each limiting factor, etc., is a fundamental matter of rational arguments and consensus between the decision-makers involved. Questions arise like, 'why is the distance from the forested area more important than the distance from the village?' or 'how much more or less important is the slope steepness compared with the distance from the reservoir?' These questions should be discussed among many people, so as to obtain a general agreement *before* running the model.

The positive thing about the decision-making process in the proposed land re-allocation model mentioned before is to eliminate the sectoral approach, a lack of co-ordination, and rivalry between various agencies and/or people involved in a land use planning process, as often criticised (see Ceccarelli, 1997, FAO 1989 and 1995b). Indeed, different points of view of different institutions can be integrated in this approach, and every actor involved in decision-making on land re-allocation is responsible for the process and the results of the implemented model, considering that land 'belongs' to many bodies. The social philosophy and sociological method behind these statements are no part of the present study.

4.2. South Kalimantan

4.2.1. On allocated land and government policies

Forest versus non-forest

South Kalimantan is small, compared with its neighbouring provinces. But its geographical position close to Java, its natural resources such as coal mining, gems, forests, its accessibility with short distances between cities and a good road network, and its economic activities showing more wood based industries than neighbouring Central Kalimantan, are some important assets. Forestland occupies more than 50% of the land area. Most of the forests are production forests, which provide a significant amount of income to the region and meaningful work for its people. However, this is not comparable with the indigenous people in other places and other countries (see, for example Padoch and Peluso, 1996, van der Wal, 1999), where some indigenous people had lived a long time in the area and were strongly attached to the forests.

The Forestry initiative wanted to establish a *Forestry plan* (i.e. *TGHK*) in 1980 in a consensus way. This was a good step to confirm the status and area of the forestlands for a better forest management, and to anticipate the booming of forest exploitation and other large-scale land uses in the near future. However, it was not free from criticism, e.g. the imbalanced proportion between forestland and non-forest land, the inclusion of non-forested areas as forestland, the low accuracy of the data, and the long time it took to release forestland for non-forestry uses (Bappeda Kalsel, 1990, Dephut Kalsel, 1994, Pemda Kalsel, 1993). Criticisms of *'high sectoral ambition'* and *'obstructing development'* were often directed at the Forestry Agency. Nevertheless, the plan was implemented and used as the basis for forest management and the release of forestland for other uses for some years.

The criticisms may hit the mark, especially seen from the non-forestry angle. However, based on its mission, the Forestry is also right in defending as many areas of forestland as possible. There is no agreement on how much forestland area should remain in each region, in view of the highly variable nature of the forested area in different places. However, generally '*at least*' 30% of the area to be conserved as forestland is widely accepted a target percentage.

The increasing claiming of land for development is focussed on the forestland. This is triggered, for instance, by the need to increase regional incomes, to speed up regional developments, and to provide more jobs for an increasing number of workers. The forest becomes the target, since it is considered *unused land* and *reserve for development*. See also the next section on Forest policy.

On the continuing decrease of forestland and forestland fragmentation

In contrast to the previous case, i.e. the Riam Kanan river basin, where deforestation did not change the status of the forestland, deforestation at the provincial level causes a change in the very status as forestlands. The *potential loss* of the transfer of forestland to non-forestland will amount to hundreds of thousands of hectares (see Section 3.3 Forestland dynamics). Decreasing forestland, of course, means decreasing forest too, since the land will be under non-forestry use. The increasing demand for land will continue at the cost of the forestland. As soon as the actual Convertible Production Forest will be used up, new forestland will be allocated to this land use category. It will for a time satisfy the new needs. This kind of deforestation, which transfers forestland to non-forestland, is the indirect equivalent of intentional or institutional deforestation.

The potential loss does not only concern the continuously decreasing area of forestland, but also the break-up or fragmentation of the remaining forestland. The break-up of the forestland causes more forestland patches and consequently, smaller forestland patches. Moreover, some enclaves of small forestland patches also exist, which entails difficulties in managing and guarding the forestlands (see Section 3.4 Forestland fragmentation and Figure 3.6).

Both, the continuing decrease in forestlands and the breaking up of the forestland are closely related to sustainability issues. The first issue is clear. Indeed, there is no sustainable management if the area to be managed is constantly decreasing. Meanwhile, the yield of forest products decreases, especially of products taken from the natural forests. The protection and conservation functions of the forests are also impeded. In the second issue, the more fragmented the forestland, the more accessible the forestland to the outsider, which leads to more illegal cutting and forest encroachment. Moreover, the decreasing size and the unravelling of the forestlands will affect habitats needed by endemic flora and fauna species to survive and develop (see Riitters, et al., 2000, BFL, 2000, and Russ, 2002).

On forest policy

The conflicting laws and regulations, followed by unorganised land use, originated from the Act for Land Management (i.e. UU no 5/62) and the Act for Forest Management (i.e. UU 5/67 and UU 41/99). Both acts concern the authority to manage the land (Sandy, 1986). The National Land Agency is authorised to regulate and manage land in the country. However, the Forestry Agency is also authorised to designate and to manage forestland in the country. The latter authority was responsible for the *Forestry plan*. From the Forestry's point of views, the situation became complicated by the enactment of the Act of Spatial Management and the Presidential Instruction to establish a *Provincial Plan*. Since then, the Provincial authority has become actively involved as the main actor in establishing the *Provincial plan,* together with the provincial level National Land Agency.

Although in the Act for Forest Management, the Forestry's position remains the same, in reality the strong position of the Forestry was lost. The Forestry Agency is now only considered a land user, similar to other Agencies related to land. The acceptance of the *Provincial plan* by the Forestry without much change made manifest its weaker position in defining and controlling forestland (see Table 3.5). In this situation, the Forestry is not free to *designate* land as forestland under the Forestry authority anymore. The answer to the question '*who, among the Agencies and other public bodies, is responsible for what*' has become quite unclear.

Are the continuing decrease in forestland and the decreasing role of the Forestry caused by a *failing forest policy*? Be that as it may, according to Wyatt-Smith (1987), they are caused by the *ineffectiveness* of the *forest policy*, due to the lack of an overall integrated land use policy that surrounds and supports forest policy. This situation can be disastrous to the forestry, among others things regarding the long-term activities of the forestry that require stability and confidence, e.g. for investments and for the survival of the ecosystems. The very long-term nature of the forestry makes it certain that a lack of balance in forest policy will sooner or later be destructive for investments and the survival of forest ecosystems. According to Ecmuller and Van Maaren (1984), any future forest policy should be set up within the framework of a *general land use policy*, since a coherent land use policy provides a sensible base for defining the relationships between *forest policy* and other *sector policies*. Indeed, forest policy both influences and is influenced by the economic, social and environmental policies of the country, in a complicated web with numerous, sometimes indistinct interactions (Ecmuller and Van Maaren, 1984).

On strategic factors

The Indonesian practice of consensus in establishing a *Forestry plan*, and later the involvement of other land-related agencies in the gazetting process both show, to a certain degree, a form of *co-ordination* between the Forestry Agency, other sectoral Agencies and regional authorities in an *integrated approach* (FAO, 1989). However, attempts to reach a completely integrated approach are often hampered by inaccurate and incomplete data and a low accuracy level of the plans, caused by different factors (see chapter 1 General Introduction). Moreover, the plan is a sectoral plan, established following a sectoral approach. This is symptomatic of a sector-orientated and mono-disciplinary structure of typical government bureaucracy (FAO, 1995, RIN, 1984), which constitutes an obstacle to a really integrated approach (Ceccarelli, 1997).

The Forestry plan is meant to serve different sides in *a balanced manner*, namely as a guide to protect the forests and their surrounding areas, to sustain nature, to limit the use of forestland in the protected areas, and at the same time to utilise the land properly. In the context of *sustainability*, the main considerations in land use planning, namely *environmental* and *economic aspects* (Young, 1993, Ferguson, 1996) to a certain extent have been accommodated by conserving and preserving natural resources by the allocation of forestland for non-forestry uses on the base of the proper forest functions. Nevertheless, the criteria used to define forest functions were inappropriate. Some are qualitative, lack specificity, and rest heavily on *physical* attributes rather than on *socio-economic* considerations. In this way, the *social aspects*, or the *integration of socio-economic, environmental forces and biophysical components* (Conyers et al., 1984, Oldeman, 1990, UNCED, 1992,Young, 1993) were not fully accommodated.

Still, *minimising the loss* of productive land (FAO, 1989) and *preventing the excessive use* of forestland are mirrored by providing Convertible Production Forest, or by the obligation to provide a sufficient exchange area if using permanent production forest for non-forestry uses. On the one hand, this reflects some real *flexibility* (Virtanen, 1992) of the *Forestry plan,* and its being *responsive to socio-economic changes* (Fresco and Kroonenberg, 1992). On the other hand, these positive values are offset by the fact that the plan was never revised. The criteria used to define the forest functions remained unchanged (see Figure 1.5), and especially did no longer respond to the increasing needs for land for development. The dynamic response to changing socio-economic conditions hence was increasingly inadequate. In words: doing things 'half well' can also mean 'half badly'.

Those internal strategic factors were interwoven with external factors, namely *opportunities and threats*. Not all threats can be averted or opposed, at least not in the short term, in particular not as to the increasing demand for more land.

The decreasing tropical forest and the short supply of sustainable tropical forest management have become global issues and of international concern (WRM, 1990, MoF, 1993, UNCED, 1992, Bandung Initiative, 1993). The *Forestry plan* is a strategic response to these issues. It was established in line with the conditions set by the organisation involved (ITTO, 1990). The high contribution of forestland to the socio-economic development of the country and the role of the forest in sustained nature conservation and protection are essential, and therefore, the forests should be everlasting. Meanwhile, the achievement of forestry missions, i.e. increasing wealth for most people through protecting and conserving nature and producing forest products, became a national and even international concern. The consequence of this strategic position is the high responsibility of foresters and related decision-makers supported by other institutions to manage the forest in a sustainable way. Forests should indeed be considered permanent in time and space, because this is their nature. Interruptions of their continued existence are irreversible or, in the famous words of Gomez-Pompa (1984): *"extinction is forever"*.

The *ever-increasing demands for land* for various regional and sectoral developments led to the conversion of forests to allow non-forest use. The forest figured as a *reserve of unused land*, and became the main target for development (Donner, 1987). This could occur especially because the environmental benefits and the environmental cost associated with destructive deforestation were ignored (Sharma, 1992), and the area covered by forests was disregarded as having little value in its own (Oldeman, 1989, 1992, 1996). Forests are *undervalued* by not taking into account their non-quantifiable benefits or service functions (Van Maaren, 1984, but see De Groot 1992). Since the contribution of the forest sector to the economy is considered to be lower than the contribution by other land-use sectors, the forest sector is assigned a *low priority* (Sharma, 1992). Moreover, the *influential position* of more established sectors, can and does reduce the strength and the role of the Forestry in regulating and managing the forestland.

The *Provincial plan* can be considered either an *opportunity,* or a *threat* to the existence of forestland and to sustainable forest management. As it is used as the main basis for the allocation of land for various regional and sectoral developments in the province, the inclusion of forestland in this plan makes it more respected by other agencies in the region. A better planning and the implementation of forestland use plans towards sustainable forest management in the future would be more promising than before. On the other hand, since the Forestry is considered only a land user, it is not free to define areas as forestland, so its bargaining position is weak. In other words, the Forestry is *losing its strength*. There is no assurance for the permanency of "Permanent" Production forestland in the future; and therefore, achieving sustainable forest management has become an uncertain objective.

The term "permanence" needs precision before the plans and their implementation can be clear as to their intention. The whole historical and philosophical discussion has no place here and is more fully treated elsewhere (Oldeman 2002). Suffice it to say that permanence is an unchanging, everlasting state, conservation is the objective to keep things intact for the children, and sustainability depends on sustenance by work and money. The Indonesian concept "*lestari*" is closest to permanence by conserving the past for the future. Different concepts lead to different plans and actions. Internationally, the concept of sustainability so has become very vague because its meaning is confused with other terms. This study concerns an Indonesian situation, so Indonesian parties reading and/or using it are certain to think in terms of "*lestari*". Therefore, they risk misunderstandings when discussing with international partners thinking in terms of "sustainability".

In this situation, what could the Forestry do? This situation is similar to the case of the Riam Kanan river basin, where the 'enemy' (i.e. reforestation) should be turned into 'friend' of the local inhabitants. At a more encompassing scale, the *Provincial plan* should be considered 'a friend' and not 'an enemy' of foresters, among other things by implementing the strategies described before (see Section 3.6.1 The strategic factors and the possible strategies).

4.2.2. On planning forestland use

On the possible strategy

From the previous explanation, one may conclude that the *Forestry is always the loser, and so is the forest*. This statement may not be completely wrong. The best available land always goes to agriculture or to other more commercial uses, and the remaining parts go to the Forestry. If the best available land is finished, then again, the second best land will be taken away from the Forestry, leaving still lower quality land and ecosystems with the Forestry. This happens continuously (Cleuren 2001), until no more forestland is available, until the country becomes an industrialised country, or until the community changes its attitude. Can the Forestry stop it, or, at least *postpone* the disappearance of forest and forestland as long as possible? Compare the European experience, where the Forestry mostly came into action when it was already too late, and there was an acute shortage of wood (Oldeman, 1990).

That the *Provincial plan* came into force and that the *Forestry plan* suffered a lack of recognition and respect should be accepted as a fact. Accepting this fact does not mean 'doing nothing'. It means to be ready to join the efforts to ensure the future of the forestland by securing the planning process and its product (i.e. the *Forestry plan*) and the implementation of the plan. The strategies defined above (see Chapter 3 on Land allocation and land use planning) using internal and external strategic factors (Pierce and Robinson, 1991) should be used with this aim.

For the time being, the ever-increasing claims on forestland as a *threat* can hardly be avoided. Therefore, the combination of a *Strengths-Opportunities* approach (aggressive strategy) as a set of 'outward looking' strategies, and a *Weaknesses-Opportunities* approach (turn-around strategy) as a set of 'inward looking' strategies, will be the proper overall strategy to be adopted.

In the outward looking part, making 'friends' (i.e. allies), in terms of other government institutions, NGOs, local and international communities willing to support forests, is very important and should be continuously pursued, e.g. by publicity campaigns, extension and training. The global issue of decreasing tropical forest and sustainable forest management, which certainly will affect and if used properly will raise the economic value of forestland, are fast bringing national and international pressure to bear upon the country. This will most probably happen, since the tropical forest is assumed to be a "world heritage" and "a treasure house of bio-diversity" or "a carbon sink" (B. de Jong, 2000).

The inward-looking approach should be improved. Improvements should include the *quality* of the future *Forestry plans* and of the *processes* in forestland use planning. Improving the processes and mechanisms of the forestland gazetting by taking into account the needs of non-forest users, e.g. to count with shorter time-spans in non-forest land use, requiring faster decisions to accommodate the dynamic response to socio-economic forces. Meanwhile, wholly new ways of forest use with much better economic properties *dependent* on sustainable forest conservation, should also be designed and implemented (Oldeman, 1993, Global Forest Conference, Bandung Initiative, 1993).

On the future plan

In view of the preceding paragraphs, the question has to be raised whether or not forestry planning is at all possible? In view of the many failures in the history of such plans and in the context of the extreme complexity of social, economic and ecological interactions fostering unpredictability, one would be tempted to abandon strategic plans altogether. They would be an illusion, on a par with predicting and banning wars, famines or earthquakes. However, giving up on forestry planning would inevitably lead to or accelerate the final stages of total deforestation. Therefore the issue will be critically examined in these last paragraphs.

Problems in forestland use planning in several other countries are not very different from the Indonesian ones. Concrete difficulties among others are: the absence or inadequacy of clear, general land use policies, strategies and legislation; a lack of comprehensive land use plans; an overlapping and lacking co-ordination; conflicts in land use and jurisdiction; and a lack of conceptual clarity in basic and scientific information to ensure an objective process of choosing the alternatives in the decision-making process (Khairi and Hamid, 1985, Qureshi, 1981, Rapera et al.,1985).

Complicated by their interactions, these factors are precisely the ones that render the whole issue of planning so despairing. The only solution is to try and plan, not according to belief or theory, but according to reality.

Indeed, to be acceptable a plan should be *realistic*. What is the reality? It will be assumed that the known facts represent the reality of our forest situation (see Chapter 3 for the reality regarding the *Forestry plan)*. These facts can reflect the strengths that should still remain in the future plan, or the weaknesses that should be eliminated or compensated. Therefore, the new plan should accommodate the corrected version of the previous plan's weaknesses; otherwise the new plan will not be realistic.

In the practical sense, no plan can be realistic, unless all the data are checked against the ground truth, all the results of calculations or mapping are checked against the ground truth, and all results of the implementation of a plan continue to be monitored against the ground truth. It is an illusion that numbers would tell the truth without any checking, which leads to planning against a virtual background, of which nothing proves that it is conforming to reality (Oldeman, 2002, pers. comm.).

Quantification of the tangible and intangible benefits of the forest is important to counter the undervaluation of forests (see Van Maaren, 1984, Donner, 1987, Sharma, 1992, Oldeman, 1992). Although it is not an easy and simple task, it could be done stepwise (see for example B. de Jong, 2000, Kippie, 2002).

Precise re-calculation and re-assessment of existing forest functions, by calculating their economic value, in relation to land use changes (e.g. by reconsidering the classification of the forests based on their functions) is also indispensable. For example, the elimination of the Limited Production Forest class and its inclusion of its area either into Production Forest or Protection Forest will simplify forest management practices, reduce the room for arguments and complaints, and allow more accurate calculations in planning forest production. This decision can be justified by the fact that whatever the forest function, the protection aspect will always be inseparably included, for the simple reason that "no forest" means "no function".

In conjunction with the above, reconsidering the criteria used to define forest functions, namely from more physical criteria (i.e. soil type, slope steep and rainfall intensity) towards more specific and more quantifiable criteria, while at the same time reflecting on more socio-economic aspects, is necessary (De Groot 1992).

Whatever the elements of the plan, if it has to "make friends" it has to be attractive, and to be feasible in practice it needs to be authoritative, i.e. that people from many land use sectors will listen to it. To be both attractive and authoritative, the quality of the final product, i.e. the *Forestry plan* is of the utmost importance. The quality of the previous Forestry plan must be drastically improved by increasing the quality of the available data and the results of their processing, e.g. maps with improved accuracy, completeness, detail, and temporal resolution. More accurate, timely and comprehensive spatial data, such as various high spatial resolution satellite images are available. 'New' technology in analysing those data, e.g. digital image processing and analysis and Geographical Information Systems are currently widely available (e.g. Nezry et al., 2001, Nezry et al., 2002).

This whole operation should not be done in isolation. Co-ordination, integration, togetherness are some keywords towards a successful achievement of preparation, establishment and implementation of the plan. In this way, the negative statements as mentioned before (see the previous discussion on *Strategic factors*) can be avoided and eliminated, particularly by getting rid of every element that is not realistic.

4.3. Conclusions and recommendations

4.3.1. On the Riam Kanan river basin case

Deforestation in this river basin occurs at a small scale and at the subsistence level, so that the failure of reforestation seems to be a more serious drawback than the rate of deforestation. The underlying cause is clear. Reforestation is not considered beneficial to the majority of local people. Rather, it is considered a form of land use competing with agriculture and cattle husbandry. Reforestation on the gentle and shallow slopes of the land, for example, should be avoided, or at least should be the last priority. The popular perception that reforestation is an 'enemy' should be turned to that of a 'friend', among other things by planting fruit trees as a buffer to the forested area, where the local people can directly take the advantage from them (Oldeman 1996, unpubl.). Reforestation in hilly lands and on steep slopes should have first priority. These steps will be more fruitful if accompanied by a continuous stream of information to the inhabitants about proper land cultivation, and by extending technical aid, as was expected in the past by the local people.

The strong relationship between the local people, their settlements and their land is clear. The short distance away from their initial location after the filling of the lake, the types of agricultural and co-operative settlement, the existence of different levels of central places with their functions, are some of the concrete indications of this close relationship. Therefore, moving people away from their current settlement to some faraway, outside area is not a good option. Moreover, there is no perceptible assurance whatever for a better life for them. Considering the physical condition of the area, and the low rate of population dynamics, land re-allocation is a better way. There is room for agriculture and cattle husbandry on the gentle slopes and shallow land, and concentrating reforestation with 'unfamiliar trees' on the hilly and steep slopes is advisable.

The re-allocation model is only a replica or representation of the real world. Indeed, the model should be simple enough to understand. This model combines the decision-maker's ability and the computer's capability to solve *semi* or *ill-structured problems,* leads to a *mixture of subjective and objective values*. The 'complex problem' involving many interests, e.g. land use planning problem is a multi dimensional problem, and can only be solved by a 'complex problem solving' approach, in which a multi-sectoral approach in an integrated and a comprehensive way is needed. Consequently, different criteria must be used together, such as the mixture of '*abstract*' criteria and '*operational, real'* criteria.

Active participation of decision-makers reaching a consensus in every step in the decision-making process is the key issue. In reality, the model should be developed together by all decision-makers involved in land management, so as to obtain a general agreement. The positive thing about the decision-making process in the proposed model is the possibility to eliminate the sectoral approach, lack of co-ordination, and rivalry between various agencies and/or people involved in a land use planning, as often criticised (Ceccarelli, 1997, FAO 1989 and1995b). Indeed, different points of view of different institutions can be integrated, and every actor involved in decision-making is responsible for the process and the results of the implemented model.

To implement the model in the real world, many more things need to be taken into account, especially acceptance by the target group. Inclusion of all actors involved in land management, discussions and exchange of information and argumentation, in-depth considerations in defining constraints and limiting factors, defining the degree of importance of each limiting factor, are some steps to be taken in a proper decision-making process. All of these steps are means to arrive at an agreement or a consensus among all parties, all parties being responsible for the results and implementation of the model.

The following steps are recommended:

- To inform the local people, so as to give them a realistic impression of reforestation by indeed including more immediately useful aspects in the plan (e.g. better operational planning, more attractive species selection). In other words, to take the local people seriously and use their participation.
- To prepare and implement the re-allocation model by including all actors involved in land management, particularly the local people. To change or add the constraints and limiting factors as necessary based on the real situation, without leaving the basic principles of intelligibility, generalisation, simplification and ceaseless monitoring.
- To meet the need for continuous extension and government aid, together with law enforcement. These should also be explained very clearly to the inhabitants, perhaps already in school. Law enforcement is related to illegal cutting, forest encroachment and clearing steeply sloping land.

4.3.2. On the South Kalimantan case

Regarding forestland use, the Forestry was not the loser in the province as a whole. Its position in planning and regulating forestland use was strong. At the national and regional level, its role was not only perceived as one land user among other land-related agencies, but also as the land manager. The Forestry initiative to establish a *Forestry plan* was a good step towards better forest management. Although not free from criticisms, the *Forestry plan* was accepted by other agencies wanting to use the forestland. In this period, the forestland decreased in surface, but the decreasing area was related to the exclusion of the third parties' land from the forestland in the gazzetting process, and parts of forestland were released for other uses. Therefore, the decrease in area was an expected consequence when implementing the plan. It went according to plan as estimated before. In other words, this part was realistic.

In terms of its strategic factors, *Forestry plan* has some strengths and weaknesses. One strength is the success of the *Forestry plan* as a strategic response to the decreasing tropical forest and sustainable tropical forest management, global issues of international concern. On the other hand, e.g. the low accuracy of the plan and the un-balanced proportion between forestland and non-forestland are weaknesses. External opportunities and threats surround both, strengths and weaknesses. The high contribution of the forests to the socio-economic state of the country is an example of an opportunity, whereas the increasing need for land for various developments is one of the threats.

The Forestry became a loser by the enactment of the *Provincial plan*, in which it is only considered one land user among other agencies. The stronger position of the Forestry was lost. The total forestland surface decreased significantly. The new area of Convertible Production Forest, soon to be released for non-forestry uses, was established. Forestland fragmentation occurred in the new plan, by the breakdown in small patches of the forestland. Moreover, the existence of forestland enclaves in non-forestland, and non-forestland enclaves in the forestland are today's reality. All of these things make sound forest management difficult. The acceptance of this plan by the Forestry without much change shows its weaker position among the decision-makers.

Some strategies were proposed to improve the situation in the future. A combination of an 'aggressive strategy' (e.g. looking for allies and friends in international and national communities) as 'outward looking strategy', and a 'turn-around strategy', (e.g. improving the quality and the criteria used to define forest functions for the future *Forestry plan)* as 'inward looking' strategies, looks promising for the near future.

Finally, deforestation and decreasing areas of forestland cause many problems and disadvantages. However, the question now is, is there any advantage to deforestation? If deforestation, especially the indirect equivalent of intentional or institutional deforestation, is directed to increasing the quality of life for most people, such as a well-planned resettlement, or nucleus-plasma based crop estates, can we say that the disadvantages of deforestation remain larger than its advantages? Do the people outside the Forestry see deforestation in the same way as the Forestry does?

It is then recommended to work hard on improving the quality of the future *Forestry plan*, and on in-depth analyses of the new classification of forest functions and their new criteria. It is really a complex task, and much research and many in-depth studies are needed.

Concluding remarks

The motto *'Forests for people'* was used as the theme of the World Forestry Congress, at which thoroughly was examined how forestry may best serve humans, individually and collectively. It was stated there, that forests must be used on a sustainable basis for all people (WFC 1978, doc.). However, the term 'all people' is not limited to the current generation, but holds also for the coming generations. The saying: *'forests are not inherited from the older generation, but borrowed from the next generation'*, is highly relevant. Once, the forests should be returned to the 'owners", i.e. the coming generation, preferably in a better condition than before. However, forests do not belong only to the people; but they also belong to other creatures, which have the same rights as humans to live sustainably and to benefit from the forests.

Therefore, the forests should be kept in a sustainable way, by balancing their use in harmony, mixture of 'single functions' into 'multiple functions', each of them with their own rhythm, space and place (Oldeman and Kuper (1997) of protection, conservation and production functions. Better planning in forestland use is a first step forward. To this end, foresters should be in the front line as the main actors in planning and developing the forest (Oldeman, 1992). Nevertheless, foresters should not alone in doing this. To sustain the forests in an integrated way, shoulder to shoulder with other actors involved (e.g. the local people) is a physical and moral necessity. Forests belong to all the world.

SUMMARY

'Forestland: Its dynamics, disorganised uses and planning in South Kalimantan, Indonesia', discusses two interrelated subject matters in two different study areas. The first area is the Riam Kanan river basin, and the second area is South Kalimantan. The Riam Kanan river basin is located in South Kalimantan.

On land cover and land use processes

This study is aimed at analysing land cover and land use dynamics, and at identifying and evaluating the driving forces behind deforestation, by relating population dynamics, village distribution patterns and socio-economic indicators with spatial aspects of land cover changes. Remote sensing images were used to analyse the spatial aspects of land cover changes. This study is also aimed at knowing the conditions of the local people, their opinions and aspirations regarding conservation, i.e. through interviewing selected respondents in selected villages. This part of the study is concluded by establishing a land re-allocation model for agricultural land and protection forest, as an approach to solving the problem of disorganised land use.

In the Riam Kanan river basin, a dam was constructed, creating a reservoir to supply water for electricity generation, irrigation and drinking water, mostly for the outside areas. For this purpose, several villages had to be relocated to higher sites. To protect the watershed, the area was declared Protection Forest. As a consequence, no land-use activities affecting the protection function were allowed, although some villages inside the watershed still exist. As, however, another government regulation supports the continued existence of the villages, the land status and land tenure is unclear. This resulted in a competition between forest protection and agriculture. This has led to illegal cutting of natural forest, failure of reforestation and ultimately land degradation (as indicated by the high rates of erosion and sedimentation).

Land cover and land use dynamics

Comparing the land cover types and their areas with the situation in the past, it can be seen that the grasslands existed long before, even when the number of people and their activities was much lower than today. Conversion and modification, shifting to other use and intensification of the existing use happened in this area. These can be major, permanent and irreversible, such as the establishment of the reservoir, or a minor, temporary and reversible change.

It can be concluded that most of the houses in the villages were permanent and continuously used, while outside the permanent village sites, some temporary houses were built for seasonal use, mostly for periodic but regular usage during planting and harvesting seasons. All the villages in this area are considered *residential settlements,* characterised by the surplus of residences and a lack of employment. The settlements can also be considered *settlements with agricultural population.* Indeed, the majority of the active population is occupied independently and full-time in agriculture and related activities. Different levels of *central places* are found in this area*,* marked by their

special facilities, which not only play a role as distribution and supply centres in terms of commodities to the surrounding area, but also display a flow of information and administrative services.

Most of the existing permanent villages in the study area are established according to the *topographic relief*, in gently undulating areas, and with *access to water*. The climate and vegetation were not the main selection criteria for settlement sites. Roads to connect villages are not always available; therefore, rivers and reservoir are the main *means of transportation* for the daily needs. Concerning their *originality,* the settlements may have emerged spontaneously in the past in a *less-regulated*, or *less-organised way.* Later on they have developed into their present-day form. Since the existing settlements are not primary or original any more, their pattern has become a secondary or *developed form*, which step by step evolved from the original. The dam construction had no effect on the pattern and dispersion of the villages, while the mean distances between the villages before and after the dam construction were not so different.

Local people: their conditions and their aspirations

Based on their housing conditions, house appliances and their businesses, only few respondents considered themselves relatively wealthy. Less than 50% of the respondents lived in permanent houses, which indicated that, in general they were not yet in a good economic condition. The size of land they occupied did not have a direct relationship with their wealth, since not all of the land was productive and regularly utilised, cause e.g. by a lack of manpower and capital, weather conditions, and a marginal soil quality. Every respondent wanted to have a better live in the future, but this was hampered by their inadequate knowledge. They wanted to give their children a better education to secure their future. An underlying factor related to this answer is the fact that the education level of the older generation was low.

Regarding government involvement, improved infrastructure, education, capital and animal husbandry are their four main wishes. Better road networks and bridges, will reduce transportation cost and time required to go to other places. A higher level of education is very important to be able to take in new information and technology and compete with people from outside the area. Asking for capital, i.e. loans to increase their business or farming activities is also logical due to their limited economic resources. Developing cattle husbandry is based on the fact that grassland and cattle are closely related to their lives.

Slash-and-burn activities are commonly practised in this area. The reason is that it is easy, fast, cheap and habitual. The interesting opinion is that slash-and-burned does not destroy forest, since they practise it on non-forested area, and slash-and-burn does no harm, if the cycle is 3 years. The majority of the respondents said that there was no improvement on the land cover since the old times, in the sense that the grasslands already existed from the beginning. It is also understood that the reforestation sometimes takes place on the grassland in the lower part of the area, where the people also use it for their cattle husbandry. The failure of reforestation may have a relationship with the fact that people do not feel any advantage of the timber estates, especially not of *Acacia mangium*, mostly used for the reforestation programme. For them, fruit trees for the people were much better. People only joined the reforestation programme to get an additional income as workers of the project.

The decreasing water level in the dry seasons causes problems for the local people, especially for farming and transportation. Their opinion is that the decreasing water level is not due to forest degradation, but the result of less rainfall in the past years, and a longer dry season, and because the Electric Company increased their capacity to produce energy. Erosion and sedimentation may be of no consequence for the local people, but for the electricity supply it is a major problem. To this, respondents said that erosion and sedimentation could be avoided by cultivating flat land and applying soil conservation. They also said that a forest concession holding company in the neighbouring site was to blame for it.

The awareness of protection and conservation seems to be a matter of understanding rather than appreciation, which can be explained by the fact that most of the respondents (91.9%) have only attended the elementary school. Another possibility is that the respondents did not care about environmental conditions due to their limited economic situation.

As to land status and land tenure, most respondents fully understood that they were living in the protection forestland. For that reason, they knew that they were not entitled to a formal property right on the land they occupied. Many respondents said that they had no objections to moving under some conditions. However, in total, those who wanted to move were fewer than the remaining part who did not want to move. Those who refused to move had also logical reasons, such as historical reasons and the fact that they already had a stable business.

Deforestation

The spatial pattern of deforestation in the study area (i.e. irregular, small-sized, scattered on the fringes of the forest area) is related to the pattern of the village distribution (i.e. clustered in the lower area). Subsistence agriculture was dominant and there is no estate-like development in the area. Therefore, the deforestation in the study area must have been caused by illegal cutting and extending the agricultural land on an individual farmer basis. But other aspects related to the human population (i.e. a low level of education, level of affluence and level of technology) also contributed to the deforestation process in the study area. This is in line with the theory that human population and its activities are the most important driving force in land-use changes in a complex interaction.

Uncertainty about the formal land status led to conflicts between the forestry institutions and the local population concerning the use of land. Local people did not perceive deforestation as an illegal act. The formal land status as Protection Forest conflicting with the perceptions of the local population, may explain the limited success of reforestation in the study area. The government’s decision on formalising the land status may thus be regarded as a political driving force to the problem of deforestation, and the limited success in reforestation.

Land re-allocation model

The overall objective is to reallocate the river basin area to agricultural land and protection forest, following a set of constraints and limiting factors, so that the reservoir can function well and the continuation of the water supply is assured. In the meantime, local people must still earn their living in the same area, practising subsistence agriculture in a sustainable way. The specific objective is to localise the land able to sustain agriculture, to allocate suitable land for cattle husbandry, and the third specific objective is to allocate part of the area to be maintained as protection forest

There are four *constraints* to the re-allocation process. These obstacles define the properties of unsuitable areas, which will be excluded from the target or candidate area for the first specific objective, that is agricultural land use. These are: areas covered by forest and surrounding generator turbines, areas covered by water bodies, areas with a slope of more than 30%, and the maximum area to be allocated to agriculture of 9000 hectares.

Five elements are selected and used as limiting factors: proximity to the slope gradient, proximity to the forested area, proximity to settlements, proximity to water bodies, and land cover types.

On planning and allocation of forestland

The second part of the study deals with aspects of forestland use planning and forestland allocation, using South Kalimantan, Indonesia as study area.

In this study, two land allocation plans related to forestland uses were compared and analysed. These are the *Forestry plan* (i.e. the Forestland Use Plan) and the *Provincial Plan* (i.e. Provincial Spatial Management Plan). The first plan was made by the Forestry and related Agencies in consensus, aimed at reaching an agreement on the allocation and use of forestland; while the second was established by the provincial authorities, to be used as a base for all uses of the land in the province.

Forestland dynamics, which show a continuing decrease in forestland, were studied. A retrospective and descriptive evaluative study and a Geographical Information System analysis are among the methods used to specify the changeover of forestland from one forestland use class (or forest function) to the other. The decreasing role of the Forestry Agency in planning forestland uses was also described, as one of the main actors involved in the forestland use planning process. Forestland fragmentation resulting from intersection between two different forestland allocation plans is also discussed in this chapter, using perimeter/area and fractal dimension approaches.

A SWOT analysis was also used to identify the strategic factors, i.e. strengths, weaknesses, opportunities and threats related to forestland uses and forestland use plans, and a possible strategy to counter the problems currently faced by the Forestry Agency in planning forest land uses was formulated. A forestland use classification towards sustainable use of forestland is proposed.

The forestland dynamics

At the provincial level, 47% of the land changed class and 53% remained in the same class. Important changes took place in Permanent Production Forest and Convertible Production Forest. For the greater part these areas became non-forestland.

The total forestland area in the province has shown a continuing decrease. In total, the forestland decreased from 61.5% in 1984, to 56.9% in 1987 and 48.9% in 1993, while the permanent forestland decreased from 53.9% in 1984, to 47.7% in 1987 and 41.8% in 1993. In area, the decrease from 1984 to 1987 was 172,000 ha, and from 1987 to 1993 the potential decrease was 303,000 ha. The composition of permanent forestland use classes from 1984 to 1993 has shown the following tendency: Protection Forest and Conservation Areas increased, from 21.3% to 35.2% and from 6.9% to 11.2% respectively. Similarly, for Limited Production Forest. But, Permanent Production Forest showed a decreasing rate from 65.3% to 43.7%.

The underlying factors, implications and possible impacts of these dynamics were analysed. These are a low accuracy of data and the consensus used to establish the plan, a lack of balance in the Forestry plan, the continuing decrease in forestland, consequences for wood production, legal aspects, inconsistency in land use classification, the decreasing role of the Forestry Agency and environmental aspects. This last factor is important, in view of the multi-functionality of the tropical forest (i.e. protection, conservation and production), whereas the decreasing area of the production forest will affect the protection and conservation functions of the whole forest area. This is so, simply because in the natural tropical forest, whatever the function of the forest is, aspects of soil and water protection and genetic resources conservation will always exist.

Forest land fragmentation

The occurrence of forestland fragmentation was studied using some indicators, namely number, size and distribution of polygons, perimeter/area index, fractal dimension, and the existence of enclaves of forestland and non-forest land patches. The results of the study show that the number of small polygons (i.e. forestland patches) was on the increase, as well as the existence of the enclaves of small forestland patches in the non-forestland and small patches of non-forestland in the forestland. These situations will affect a sustainable forest management, e.g. in planning and monitoring purposes, especially if the forest functions are protection or conservation.

Towards solving the problems

In this part the strategic factors and the possible strategy of the plan were analysed to answer the following questions: Why is the Forestry plan no longer acceptable?, why is the Provincial plan needed and more acceptable?, and what can the Forestry provide or do?

The strategic factor consists of internal factors, i.e. strength and weaknesses, while external factors include opportunities and threats. By pairing the internal factors and the external factors, a possible strategy can be developed. There are four different possible strategies, namely the aggressive strategy, the diversification strategy, the turn-around orientated strategy, and the defensive strategy.

Since it is hardly possible to avoid the threats, in particular the ever-increasing need for land, the most feasible strategy for the best possible achievement is the combination of the aggressive strategy (Strengths-Opportunities approach), and the turn-around strategy (Weaknesses-Opportunities approach). This combination will come to a moderate approach from the "*outward-looking*" aggressive strategy and "*inward-looking*" turn-around orientated strategies. This will be something like the integration of the *new Forestry plan* into the *new Provincial plan*.

Forestland use classification

This part is concluded with a concept for a forestland use classification by proposing more factors to be included. In this part, principles of economic viability, social acceptance and environmental soundness were considered, which hopefully will lead to a sustainable way of managing forestland. The Limited Production Forest is proposed to be eliminated, and included either into Protection or Production Forest. The Community Forest area that gives more access to the local community is proposed to be established as an independent class or a subclass under Production Forest.

SAMENVATTING

Deze studie handelt over de ontwikkeling van de bossen in Zuid Kalimantan, in het bijzonder in het stroomgebied van de Riam Kanan.

Over begroeiing en landgebruik

De huidige studie is gericht op de verklaring van de dynamiek van de begroeiing en het landgebruik door de drijvende krachten op te sporen. Wordt. Deze dynamiek wordt daartoe in ruimtelijke zin beschreven met teledetectiemethoden. Sociaal-economische factoren, die de ontbossing beïnvloeden zijn onder meer de bevolkingsgroei en de ligging van de dorpen. De mening van de bewoners over bosbeheer en natuurbehoud werd gepeild in enige dorpen. Een herverdelingsmodel voor bos- en landbouwgrond wordt gegeven om het probleem van wanordelijk landgebruik op te lossen.

De Riam Kanan stuwdam dient voor electriciteitsopwekking, irrigatie en drinkwater-voorziening, vooral ten behoeve van andere gebieden. Enkele dorpen werden verplaatst vanwege de dam. Het gebied werd wettelijk tot schermbos verklaard. Dus is er geen landbouw meer toegestaan, hoewel er nog wat dorpen in het stroomgebied liggen. Deze dorpen worden beschermd door andere overheidsmaatregelen. Door de onzekerheid werd ten onrechte oerbos gekapt, werd herbebossing nagelaten en trad veel erosie op.

Dynamiek van begroeiing en landgebruik

Vergelijking van begroeiings- en gebruikstypen met het verleden toont, dat arealen begroeid met alang-alang gras al lange tijd voorkwamen, ook al was de bevolkingsdichtheid toen veel lager. Omvorming, verandering, verschuiving en intensivering van landgebruik waren hier eerder voorgekomen. Deze veranderingen kunnen permanent en onomkeerbaar zijn, zoals de aanleg van de stuwdam,ofwel gering, tijdelijk en omkeerbaar.

In de dorpen zijn de meeste huizen permanent en voortdurend in gebruik. Buiten de permanent bewoonde dorpen vindt men alleenstaande huizen, tijdelijk bewoond tijdens de veldarbeid. Men noemt de dorpen woongebieden, met een overschot aan woonruimte en een tekort aan werkgelegenheid. In zulke dorpen werkt men waar als zelfstandige in de landbouw of heeft soortgelijke bezigheden: nederzettingen met landbouwbevolking. Centrale dorpen hebben daarentegen een markt, een bestuurlijke functie en meer faciliteiten.

De meeste dorpen ligge, het relief volgend, in een glooiend gebied en aan het water. Het klimaat of de begroeiing waren in mindere mate een punt voor het vestigen van een dorp. Tussen de dorpen zijn wegen schaars, waterwegen zijn het belangrijkst voor transport. De vestiging van de dorpen was spontaan. Sindsdien zijn ze wel van aard veranderd, hun originele vorm is veranderd in een gegroeide vorm. Het stuwmeer had geen invloed op de ligging van de dorpen. Hun onderlinge afstand is vrijwel dezelfde gebleven als voor de dam gebouwd werd.

Plaatselijke bevolking: hun conditie en aspiraties

Slechts zelden beschouwde men zich in het gebied betrekkelijk welgesteld, gezien hun woning, huishoudapparaten en bezigheden.Minder dan de helft van de ondervraagden woonden in permanente huizen. Dit geeft hun zwakke economische positie aan. Er was geen of nauwelijks verband tussen het welzijn en de omvang van het grondbezit. Vaak is de grond onproductief, of wordt zij niet permanent bebouwd door gebrek aan arbeidskracht en kapitaal dan wel door weersinvloeden of slechte grondsoort. Iedereen wilde het beter hebben in de toekomst, maar zonder dat men wist hoe dit aan te pakken. Men wenste een beter onderwijs voor de kinderen, mede omdat de oudere generatie slechts elementair onderwijs genoten had.

Men wenst van de overheid een betere zorg voor de infrastructuur, het onderwijs, de kapitaalvoorziening en de veeteelt. Betere wegen en bruggen kunnen transportkosten drukken en tijd sparen. Door goed onderwijs kan men informatie van buiten assimileren en zich beter meten met mensen van buiten het gebied. Makkelijker toegang tot crediet kan hun landbouw- of ander bedrijf bevorderen. De wens om hulp bij de verbetering van de veehouderij ligt voor de hand want weidegrond en vee zijn van nabij verbonden aan hun leven.

Zwerflandbouw is hier algemeen. Het is eenvoudig, snel, goedkoop en gebruikelijk. Men meent dat ladang het bos niet aantast want het wordt uitgeoefend in een als "niet bos" beschouwd gebied en men de kap-en-brand cyclus van drie jaar zou geen schade doen. De meeste ondervraagden zeggen, dat de kwaliteit van begroeiing sinds mensenheugenis niet was verbeterd. Alang-alang-gebieden bestaan al vanouds. Herbebossing wordt soms ondernomen op benedenstroomse gronden, waar ook vee graast. De mensen zien geen voordeel in bosbouw-ondernemingen, vooral niet met *Acacia mangium*. Vandaar de mislukking van de bosplantages. Men ziet veel liever de aanplant van vruchtbomen voor locale consumptie. Alleen voor het verkrijgen van enig inkomen als arbeiders, deed men mee aan de herbebossing.

Het afnemende waterpeil in de droge tijd is lastig, vooral voor landbouw en vervoer. Men meent dat afnemend peil niet te wijten is aan de ontbossing maar aan de geringe neerslag en een langere droge tijd in de laatste jaren, alsook doordat de "Electric Company" meer energie opwekt. Erosie en sedimentatie zijn wellicht niet lastig voor de bewoners, maar voor de electriciteitsvoorziening vormen zij een groot vraagstuk. De bewoners antwoordden, dat erosie en sedimentatie kan worden voorkomen door alleen vlak land te bebouwen en de bodem te beschermen. Ze gaven de schuld van erosie en sedimentatie aan een naastliggende houtkapconcssie.

Het besef van de noodzaak van milieubescherming en –behoud lijkt meer te berusten op gebrek aan begrip van de situatie, dan op het niet zien ervan, zeker mede omdat 92% van de ondervraagden niet meer dan basisonderwijs hadden genoten. Een andere verklaring kan hun geringe welvaart zijn, waardoor het ze niet kan schelen.

De meeste ondervraagden begrepen heel goed, dat zij wonen in schermbosgebied. Zij beseffen dat zij daardoor de grond die zij bewerken niet in wettig eigendom hebben. Velen van hen zeiden, dat zij onder bepaalde voorwaarden wel wilden verhuizen. Zij waren in de minderheid. Zij die niet weg wilden hadden daarvoor redelijke argumenten van historische aard, dan wel wezen op hun goed lopend bedrijf.

Ontbossing

Het ruimtelijke patroon van de ontbossing, onregelmatig, kleinschalig, of verspreid langs de bosranden, hangt samen met het patroon van de ligging van de dorpen die gegropeerd zijn in het lagere deel van het gebied. De landbouwbedrijfjes zijn vooral zelfvoorzienend en er zijn geen grote landbouwbedrijven. De ontbossing moet dus zijn ontstaan door illegaal kappen en het uitbreiden van bouwland door individuele boeren. De geringe schoolopleiding, de schamele welvaart en het elementaire peil van de techniek zijn echter ook van invloed. Dit klopt met de theorie dat de omvang van de bevolking en zijn bezigheden de voornaamste factoren zijn bij het veranderen van het grondgebruik, in een ingewikkeld samenspel.

Onduidelijkheid over formele juridische rechten op de grond leidde tot conflicten tussen de bosautoriteiten en de bevolking. De mensen vonden ontbossing en houtkap niet onrechtmatig. De legale status van schermbos, in strijd met opvattingen van de mensen verklaren het geringe succes van de herbebossing. Het overheidsbesluit om de status van het land formeel vast te leggen moet dus gezien worden als de politieke drijfkracht die het ontbossen tot een probleem maakte en het succes van herbebossing beperkte.

Een model voor herverkaveling

Algemeen doel is verkaveling van het stroomgebied in landbouwgrond en schermbosgebied, aan de hand van beperkende factoren, zodat het stuwmeer naar wens werkt en men verzekerd is van voldoende water. Als tweede doelstelling moet de bevolking de kost kunnen verdienen in hetzelfde gebied door duurzame, zelfvoorzienende landbouw. In het bijzonder moeten gronden worden aangewezen voor permanente akkerbouw en veeteelt en, als derde objectief, schermbos.

Er zijn vier *beperkingen* bij de herverkaveling tot landbouwgrond. Deze bepalen de gronden die ongeschikt zijn voor landbouew, dwz. dat grond met bos, grond in de buurt van de electriciteitscentrale, grond onder meren en rivieren, en hellingen steiler dan 30% zijn uitgesloten als landbouwgrond. Er mag niet meer dan 9.000 ha aan landbouw worden toegewezen.

Verder zijn er nog vijf beperkende voorwaarden, namelijk nabijheid van hellingen, van bossen, van dorpen, van waterlopen en van bepaalde begroeiingstypen.

Planning en verkaveling van bebost land

Het tweede deel van de studie handelt over de plannen voor het gebruik van bossen en het toewijzen van bosgebieden in Zuid Kalimantan.

Het “Forestry Plan” (Plan voor Bosgebruik) en het “Provincial Plan” (Provinciaal Plan voor Ruimtelijke Ordening) worden in het tweede deel van deze studie vergeleken. Het eerste plan werd opgesteld door de instellingen ressorterend onder het Ministerie van Bosbouw (onder meer de Bosdienst) en andere diensten om in consensus overeenstemming te bereiken over toewijzing en gebruik van bosarealen. Het tweede plan werd vervaardigd door de provinciale overheid met het doel gronden toe te wijzen aan allerlei bestemmingen.

De dynamiek van het bosareaal, met afkalvende bossen, werd bestudeerd. Een evaluatie op grond van historische gegevens en beschrijvingen, alsmede een analyse met gebruik van Geografische Informatie Systemen waren de voornaamste methoden. De afnemende rol van de Bosdienst wordt beschreven en de gevolgen hiervan voor het bosplan. De versnippering van de bosgebieden als gevolg van het bestaan van twee plannen werd onderzocht door berekening van omtrek/oppervlakte verhoudingen en fractale dimensies. Verder werden met een SWOT-procedure de strategische factoren opgespoord voor een sterkte/zwakte en kansen/risico’s analyse. De mogelijkheden worden aldus bepaald voor de Bosdienst om de moeilijkheden bij de planvorming aan te pakken. Hiervoor worden nieuwe suggesties gedaan in de vorm van een concept-ontwerp.

Dynamiek van beboste gronden

In 47% van de provincie Zuid-Kalimantan veranderde het grondgebruik. Op het grootste gedeelte werd het bos gekapt, zowel Permanent Productiebos als Converteerbaar Productiebos. Het leeuwendeel werd zo tot gebied zonder bos. In totaal nam het bosareaal af van 61% in 1984 tot 42% in 1993, ofwel met 475,000 ha, zoals onderstaande table aangeeft. Over dezelfde tijdsduur nam het areaal permanent productiebos af van 65% tot 44%, terwijl het areaal Schermbos toenam van 21% tot 35% en dat van zowel Bosreservation als Beperkt Productiebos van 7% tot 11%.

De onderliggende oorzaken, konsekwenties en potentiële uitwerking van deze veranderingen worden onder de loupe genomen. Dit zijn de onnauwkeurige cijfers en vage consensus bij het opstellen van het Plan, de onevenwichtigheid hiervan, het nog steeds krimpen van het bosareaal, de gevolgen voor de houtwinning, wetten en voorschriften, warrige landgebruiksclassificatie, afnemende invloed van de Bosdienst, en kwalijke milieuaspecten. Dit laatste is belangrijk wegens de veelzijdigheid van het tropische bos (behoud, bescherming, productie). De krimp van het productiebosareaal beinvloedt de aspecten bescherming en duurzaam behoud van het hele bosareaal. Hoe het bos ook wordt gebruikt, altijd zal het een rol spelen bij het beschermen van bodem en water en het behoud van de biodiversiteit.

Versnippering van bebost land

De versnippering van het bosareaal werd bekeken aan de hand van de indicatoren aantal, grootte en spreiding van veelhoekpatronen (polygoonanalyse), de verhouding omtrek/oppervlakte, de fractale dimensie van het patroon en het voorkomen van stukjes bos in akker- en weiland. Het aantal kleine polygoontjes, nl. kleine stukken bosgebied, nam toe, maar ook het voorkomen van stukjes bos in het akker- en weideland en stukjes akkerland in bosgebieden. Dit gaat het duurzaam beheer van bos beinvloeden. Vooral op het maken van plannen en het toezicht houden, speciaal als de bestemming van het bos schermbos en natuurbehoudsbos is.

Naar oplossingen

Dit deel geeft op grond van de voorgaande analyse antwoord op de volgende vragen: Waarom is er een Provinciaal Plan nodig en waarom is het aangenomen? Waarom gebruikt men het Plan van de Bosdienst niet meer? Waar kan de Bosdienst in voorzien en wat kan zij doen ? De strategische interne sterkte/zwakte en externe kans/risico analyse van de dienst speelt een rol. Door interne en externe factoren te koppelen kan men een strategie ontwikkelen. Er zijn vier verschillende soorten van aanpak, namelijk een offensief, diversificatie, orientatie naar ommekeer en defensie.

De steeds toenemende vraag naar grond is een van de voornaamste risicofactoren, die men nauwelijks kan ontlopen. De best mogelijke strategie is daarom een combinatie van de extraverte agressie-strategie (kracht/kans) met de introverte ommekeer-strategie (zwakte-kans). In enigerlei vorm kan dit slechts leiden tot de integratie van een nieuw bosbeheersplan in een nieuw provinciaal plan.

Classificatie van bosgebruik

Tenslotte wordt voorgesteld, bij bosgebruiksclassificatie meer factoren te betrekken. Een gezonde economische aanpak, die sociaal aanvaardbaar is en waar de milieu-factoren tot hun recht komen zal leiden tot een duurzaam beheer van het bos. Voorgesteld wordt om het Beperkte Productiebos af te schaffen en het te voegen bij hetSchermbos, of bij het Permanente Productie Bos. Dorpsbossen van de plaatselijke gemeenschappen, die de laatsten toegang verschaffen tot bosproducten voor eigen gebruik, moeten een aparte status krijgen binnen het Schermbos.

GLOSSARY

Attribute (or *criterion*) is any basic item for a decision that can be measured and evaluated. Attribute consists of *constraint* and *factor* (Eastman, 1997). In this book, factor is termed as *limiting factor*.

Constraint is a restriction imposed by nature or by humans, which restricts the movement within the decision and selects the set of feasible alternatives. A constraint blocks certain actions necessary to implement one or more decisions out of the set of decision alternatives (Keeney, 1980).

Factor, i.e. limiting factor is a *criterion* that enhances or detracts from the suitability of the specific alternative for a considered activity (Eastman, 1990). Here, the term factor or limiting factor is a mathematical factor, and not a real factor existing in the real world, such as a landscape-ecological factor. In this study, a limiting factor shows a degree of suitability of a certain part of land, and therefore, is used as a basis to define the level of suitability within the target area.

Decision is a choice between alternatives based on some criteria, which may imply courses of action, hypotheses, land allocations, etc. (Eastman, 1993). No alternative means no decision to be taken.

Deforestation is forest cover loss because of various causal factors. A firm definition of deforestation is lacking in specificity, whether deforestation refers to just a permanent, or both permanent and temporary removal of forest cover. A related problem is how to define or conceptualise the 'agent' of deforestation (Sunderlin and Resosudarmo, 1996).

Dispersion is a one-dimensional characteristic of a spatial arrangement that measures the spacing of a set of objects in relation to an enclosing shape or to one particular shape of a given area (Mc Connell, 1966 in Vincent et al., 1976, Unwin, 1981).

Driving forces are various factors that effect land use changes, whereas the land use changes are indicated by landcover changes. The forces can be grouped into political, economic, demographic or environmental factors (McNeill et al., 1994). According to Turner et al. (1993), the relationship of Population, Level of Affluence and Technology have been linked to environmental changes.

Forestry, denotes all agencies dealing with forestry activities. This can be The Ministry of Forestry, or its subordinate agencies.

Flexibility is the ability to tolerate unexpected disturbances or changes in circumstances and to produce new or amended plans quickly when needed. Although often thought to be a good thing, it has possible risks. An over-flexible plan endangers a consistent and powerful development, and an earlier plan may be too easily rejected. And the quality of plans may decline because not all useful information can be collected and there is not enough time for thorough consideration (Virtanen, 1992).

Forestland is not only defined as the land where the forests grow, but it has an implication in laws and regulations as seen from the Forestry's point of view. Based on Indonesian Forestry law and regulations (UU 5/67 and UU 41/99), forestland can be seen as a forested area, or as a non-forested area that will be reforested. This term seems to be confusing and is not always understood by the lay person or by non-forestry institutions, who assume that forestland is the same as forested area.

Forestland use. Forest as a form of land use has some distinctive features. These are, a long time period, having many uses and values, a wide range of management intensity, the presence of conservation function, a sustained flow of output. Therefore, forestland need to be planned in space and time (FAO, 1987/1989).

Forestland use planning is the application of land use planning procedures to objectives that lie wholly or partly in the forestry sector. This includes the allocation of land for forestry and non-forest use, and the choice of the type of forestry system and method of management by considering environmental aspects (e.g. sustainability, natural resources conservation), social aspects (e.g. meet local people's needs, impacts on community) and meet economic acceptability (Young, 1993).

Forestry plan (in this book) is a term used for Forestland use Plan (1984 and 1987), or popularly named as Forestland use by consensus plan. Actually this plan consists of two different activities, namely the gazetting process of the outer forestland boundaries, and defining forest functions inside the forestland.

GIS stands for Geographical Information System, a system that consists of input, processing (including analysis) and output of the spatial data. The input data can be analog data (e.g. hard copy map, measurement data) or digital data (e.g. satellite remote sensing data). The analog data will first be transformed into digital data either through digitising or scanning. Overlaying maps and distance analysis are some of the analysis functions of GIS. The output can be in different forms, such as hard copy map, digital data (for other processing), tabulated data or graphs (see Aronoff, 1991 and Burrough, 1993).

Land is an area of the earth's surface, attributes of the biosphere and results of past and present human activities, that exert a significant influence on present and future uses (FAO, 1967 in Huizing, 1993). Limitation of land and an increasing population often causes conflicts, since basic human needs must be met from the land; and demands for arable land, forestry and other purposes are greater than the available land (FAO, 1989).

Land evaluation is the process of assessing suitability of land for alternative uses which support land use planning by supplying alternatives for land resource use (Fresco et al., 1992). It includes identification, selection and description of land use types as well as mapping, description and assessment of different land suitability type. Land evaluation for the Forestry is the process of assessing the performance of land when used for specific present or planned forms of forestry (Bennema, 1991).

Land cover is conceptualised as the layer of soil and biomass, belonging to a particular vegetation that covers the land surface, which may also include the physical structure built by humans, biotic phenomena and any types of development (Fresco, 1994).

Land use is the function of land determined by natural conditions and human intervention (Purnell, 1984). It is also defined as a phrase employed in a general sense to refer to any form of using land (FAO, 1989). Fresco (1994) describes it as the combined human action affecting land cover. According to Turner et al. (1995), land use involves the manners in which the biophysical attributes of the land are manipulated, and the intentions underlying this manipulation (i.e. the purpose for which the land is used). *Land use data* are useful to guide the formation of new policies and to assist with the implementation of the chosen policies (Rhind and Hudson, 1980).

Land use planning is a systematic way of changing land cover (Fresco, 1994). This is valuating options towards selecting combinations of land and land use, to make an efficient use of land to achieve production and protection objectives, and to make the land-use decision process open and visible (Derting, 1985). Therefore, it should be rational, flexible, require teamwork and be multi functional (Von Nelson, 1984 in Derting, 1985).

Macro determinant (in the context of population movement) includes socio-cultural and historical structural arguments, distribution of economic opportunities, infrastructure development. *Micro determinant* covers the maximisation of family income and risk minimisation, behavioural aspects, and forced migrations (Hugo et al., 1987).

Model is a representation of a real world, sometimes on a smaller scale; hence, the principles of abstraction, generalisation, simplification and representativity are applied. The model in this study, i.e. the land re-allocation model is used to link (i.e. as a communication tool) the model builder, i.e. decision-makers to the users, i.e. local people. Consequently, the model should be communicative, informative and easy to understand.

Objectives are statements about the desired state of the system under considerations that reflect all concerns relevant to the decision problem. Objectives can be complementary or conflicting. As to *complementary* objectives, land may satisfy more than one objective (e.g. using a unit of land for protection and conservation purposes). Therefore, desirable areas will serve these objectives together in specified manners. As to *conflicting* objectives, they compete for the available land that can be used for only one purpose (e.g. using the same land for hydrological protection and intensive farming).

Planning is a continuous process that involves decisions and/or choices on alternative ways of using available resources to achieve particular goals at one time in the future. It also means to make decisions concerning future actions and to create blueprints of the future (Conyers and Hill, 1984 in Hoanh, 1996).

Polygon represents an area in a spatial analysis, and is constructed by lines having no end point, and the lines consist of conjunction points.

Population is a term indicating a group of human beings with a certain organisation and structure (Van der Zee, 1995). Their characteristics fall into: absolute numbers, physical and socio-economic characteristics, and *population dynamics.*

Problem structure consists in a well-structured/structured, ill/semi-structured, and unstructured problem (Simon, 1960, Malczewski, 2000). The decision problem is structured, if the problem can be structured by the decision-maker or on the basis of relevant theory; while an unstructured problem occurs when the decision- maker is unable to structure the problem, or the problem cannot be structured based on a relevant theory. See also Geoffreon, 1984, Gorry and Morton, in Densham and Goodchild, 1989, Densham, 1989, and Guariso and Werthner, 1989).

Provincial plan (in this book) refers to the Provincial Spatial Management Plan. This is a land allocation plan developed by the Provincial authority, to be used as a common basis in using land at the provincial level. By implementing this plan, the Forestry plan is no longer valid as a base for the allocation of forestland. There were some differences between these two plans, including the difference in area and classification of the forestland.

Remote sensing image is an image of the earth's surface, taken by using remote sensing methods, such as aerial photography, or scanning from the space using satellite as the platform. *Remote sensing image analysis* involves detection, recognition, delineation, measurement, deduction, comparison, identification, classification and codification of ground objects in the image, by recognising the spatial and spectral elements, and temporal condition. It can be done in two different ways, either visually (i.e. the visual act of examining the images of ground objects to identify objects and judging their significance) or digitally (Howard, 1991). The digital analysis consists of *unsupervised classification,* applied when observational or documentary evidence of the land-cover types is insufficient, and the classification procedure is left to its own devices. Or, *supervised classification* done based on prior knowledge of the area shown in the image, before the chosen algorithm is initiated, which can be the result from fieldwork, aerial photo interpretation or map (Mather, 1987, Lillesand and Kiefer, 1994).

Rural is a word applied to areas of low population density, with small absolute size settlements, located in relative isolation from their surroundings; where farming forms the major economic base; and where the way of life is reasonably homogeneous and different from the 'city' (Clout 1972). *Rural settlements* are all settlements in a rural region outside the urban agglomeration; not only where the population derives their living from the direct exploitation of plant and animal life, but also where the settlement functions are closely associated with the agricultural surroundings (Lienau 1972).

SDSS stands for Spatial Decision Support System. This is a flexible problem solving environment to help decision-makers to solve ill/semi-structured problem through an iterative, integrative and participatory decision-making process (Densham and Goodchild, 1989). As the name says, the system employs spatial data and spatial analyses, respectively, as the main input and process.

Settlement covers all forms of grouping of human habitations (Stamp, 1976, Stamp and Clark, eds.1979, Mayhew and Penny, 1992). Settlements can be classified based on their morphological criteria; population size and functional features (Hagget et al., 1977). *Settlement pattern* is the distribution of settlements of varying sizes (The Oxford Guide, 1985, Johnston, 1981, Cox, 1972, Hudson and Fowler 1966 in Rogers, 1974, and Unwin, 1981).

Spatial refers to the word 'space' or room. S*patial data* are geo-referenced data, that is data having certain co-ordinates, e.g. in terms of points, lines or areas. This kind of data can be analysed using a *spatial analysis* method, such as an image analysis system or a geographical information system.

Strategic factors in a decision-making process consist of internal factors, i.e. strengths and weaknesses, and external factors or external environment, i.e. opportunities and threats (Wheelen and Hunger 1989). By matching internal and external strategic factors, a *strategy* can be selected (Pierce II and Robinson, 1991). There are four types of possible strategies, i.e. support for a turn-around-orientated strategy, support for an aggressive strategy, support for a defensive strategy and support for a diversification strategy.

Sustainability of a natural ecosystem is the dynamic equilibrium between natural inputs and outputs, modified by external events such as climatic changes and natural disasters. Human population growth is a primary driving force behind increasing land use. Therefore, to be sustainable, land use must display a dynamic response to changing ecological and socio-economic conditions (Fresco and Kroonenberg, 1992).

Sustainable use means the use of components of the biological diversity in a manner and to a degree which does not result in the long-term loss of biological diversity, as a result of which biological potential is retained and the needs and wishes of current and future generations are fulfilled (Agreement on biological diversity, 5 June 1992, Rio de Janeiro)

Abbreviation

MoF : Ministry of Forestry
MoA : Ministry of Agriculture
MoI : Ministry of Interior
MoPW : Ministry of Public Works
DG : Directorate General
SK : South Kalimantan
UU : Undang-undang (Law)
UUPA : Undang-undang Pokok Agraria (Law on the Basic Land Management)
UUPK : Undang-undang Pokok Kehutanan (Law on the Basic Forest Management)
TGHK : Tata Guna Hutan Kesepakatan (Forestland use by Consensus Plan)
RTRWP: Rencana Tata Ruang Wilayah Propinsi (Provincial Space Management Plan).
Inmendagri : Instruksi Menteri Dalam Negeri (MoI Instruction)

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APPENDICES

Appendix 1: Questionnaire for socio-economic data collection.

- General

Date		Surveyor		Resp. name			
Location	Village		Code Number		Status	h, w, o	
	Subdistrict		Occupation	f, m, g, o	Group	fl, nl, o	
	District		Originate	n, m	Last move:		

- Socio-economic condition

No. of family		Education level	e, j, s, h	Add. income source:	
No. of children		Highest educ.	e, j, s, h	House condition	p, sp, t
Land area used:		Land status	c, r, nr	Homestead stable	y, n
Currently: ha Total: ha		Means of subsist.	f, g, fi, o	Level of prosperity	h, m, l

- In case respondent is a farmer (in a broad sense)

Agriculture type		f, l, fi, o	Area in ha	f: l: fi: o:	
Dist. From house		vf, f, m, n	Since:	Mngm, intensity	i, e
Farming	Kind	r, a, p, o	Area in ha	r: a: p: o:	
	Annual yield: Rp.		Description:		
Livestock	Kind	c, wb, g, o	Area in ha	c: wb: g: o:	
	Grass type:		Number of each:	c: wb: g: o:	
	Annual yield: Rp.		Description:		
Fishery	Type	fh, n, c	Area in ha		
	Annual yield: Rp.		Description:		

- In case respondent is migrant

Origin	Subdistrict		Former occupation		Since	
	District		Reason to move	e, p, o	Adaptability:	
	Province		Recent condition	b, s, m		
	Approx. distance		Other information			

- Appreciation to conservation and environment

Slash and burn practice	y, n, nr	Reason:
Soil conserv. Practise	y, n, nr	Reason:
Using firewood	y, n	How to get:
Awareness to:	Decreasing water supply:	
	Erosion/lake siltation	
	Forest fire and smoke	
	Forest degradation	
Opinion	Loss of biodiversity	
	Effects of veg. Clearing	

- Additional information

Better life in the future: How to approach it:

The future of their children: What do they wish and how to achieve their wish (in terms of education and job).
How will the land looks like in the future (considering the slash and burn practises and illegal cuttings have been doing currently).
Comparing the recent coverage (lalang field, bareland and burned area) and the past (densely forested land). What do they feel? Is the difference makes sense?
What government should do to increase their prosperity? What do they hope?
What government should do to increase their prosperity? What do they hope?
Is moving to better place could be considered? If so, what are the requirements?
Others

Guideline to fill in the questionnaires sheet:

- General

Date	date of interview
Surveyor	initial of the surveyor' name
Code number	respondent' number
Occupation	**f**armer, **m**erchant, **g**overnment official or **o**thers
Originate	**n**ative or **m**igrant
Status	**h**ead of the family, house **w**ife or **o**thers
Group	**f**ormal **l**eader, **n**on-formal **l**eader, or **o**thers

- Socio-economic condition

Education level	**e**lementary school, **j**unior high school, **s**enior high school, or **h**igher education
Highest education	similar to the above
Land status	**c**ertificate, **r**egistered or **n**on-registered
Means of subsistence	**f**arming, **g**rassing, **f**ishing or **o**thers
House condition	**p**ermanent, **s**emi-permanent, or **t**emporary
Homestead stable	**y**es or **n**o
Level of prosperity	**h**igh, **m**oderate or **l**ow

- In case respondent is a farmer (in a broad sense)

Agriculture type	**f**arming, **l**ivestock, **f**ishery or **o**thers
Distance from house	**v**ery **f**ar (> 3 hours walking), **f**ar (2-3 hours), **m**oderate (1-2 hours), or **n**ear (< 1 hour)

Management intensity		**i**ntensive or **e**xtensive
Marketing		**l**ocal or **r**egional
Farming:	Kind	**r**ice field, **a**nnual crop, **p**erennial crop or **o**thers
	Area in ha	Area for each kind
Livestock:	Kind	**c**ow, water **b**uffalo, **g**oat or **o**thers
	Area in ha	Area for each kind
	Grass type	Type of grass
Fishery	Type	**f**ish **h**ook (or lure), **n**et or **c**age

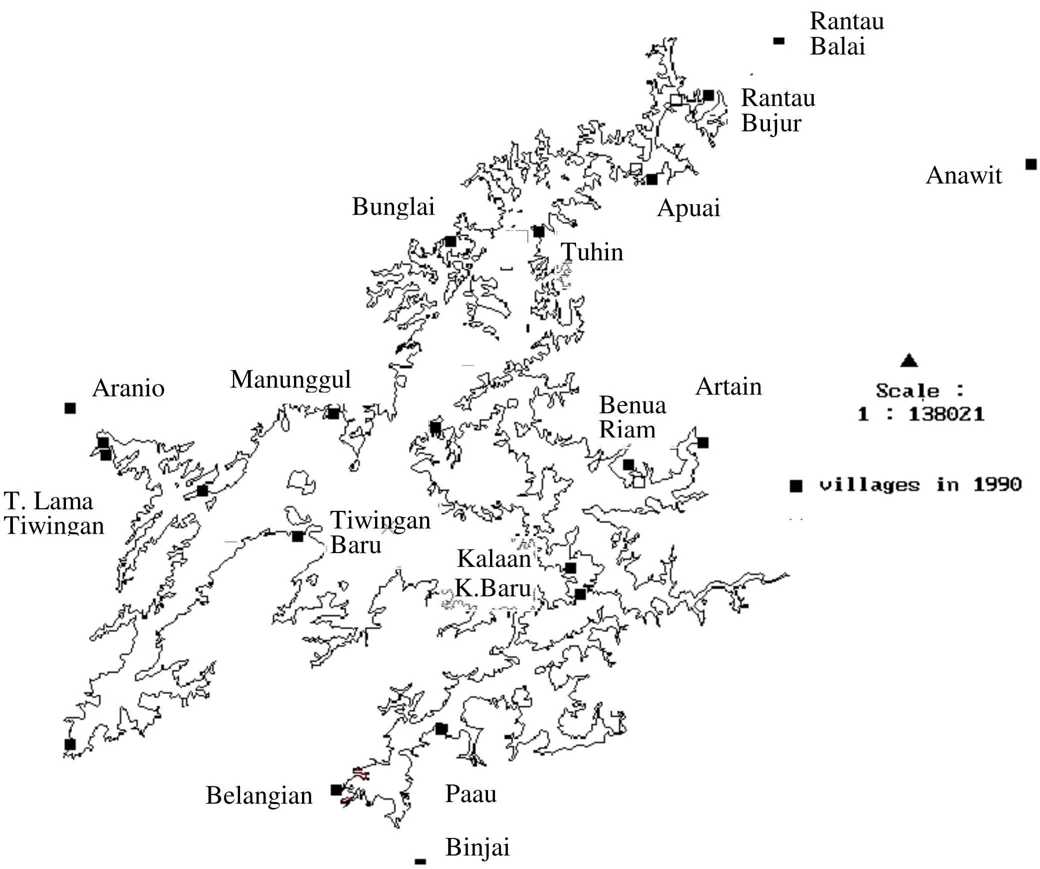
- In case respondent is migrant

Approx. distance	in km from the origin
Reason to move	**e**conomical, **p**olitical, or **o**ther reasons
Recent condition	**b**etter, **s**imilar or **w**orst compared to previous condition
Adaptability	**e**asily, **m**oderately or **d**ifficult to adapt

- Appreciation to conservation and environment

Slash and burn practise	**y**es, **n**o or **n**ot **r**elevant (e.g. for non-farmer respondents)
Soil conserv. practise	**y**es, **n**o or **n**ot **r**elevant (e.g. for non-farmer respondents)
Using fire woods	**y**es or **n**o

- Position of the villages in Riam Kanan river basin.



Appendix 2: Example of a macro language programme to calculate fractal dimension and landscape index.

FRACTAL DIMENSION

```
ARC MACRO LANGUAGE (AML)
Example:
Fractal dimension of "Protection Forest" with code number = 1 in
Provincial Space Allocation Structure Plan
---------------------------------------------------------------------

&echo &brief
tables
additem rstr1.pat logp 8 18 f 6
additem rstr1.pat logs 8 18 f 6
sel rstr1.pat
res area > 0
/* select for Protection Forest (Code = 1)
res rstr_code = 1
cal logp = ln PERIMETER / ln 2 - 2
cal logs = ln AREA / ln 2
unload rstr_c1_frct logp area perimeter logs
select
dropitem rstr1.pat logp logs
quit
&sys nedit rstr_c1_frct &
&echo &off
&return
------------------------------------------------------
Result: rstr_c1_frct (ASCII file)
Format file:
<dependent var> <x-value> <y-value> <independent var>
      .             .         .           .
      .             .         .           .
      .             .         .           .

------------------------------------------------------

[GRID] Regression rstr_c1_frct linear brief

------------------------------------------------------
Result:

coef #      coef
------ ------------
     0      -4.140
     1       0.695
------ ------------
RMS Error  = 0.283
Chi-Square = 4.895

Fractal Dimension is 2*0.695 = 1.39
```

ARCVIEW SCRIPT:

```
' ------------------------------------------------------------------'
Note: The author was modified bvreg.ave (ESRI) to describe
Landscape Indices
' ------------------------------------------------------------------

theView = av.GetActiveDoc
theFTheme = theView.GetActiveThemes.Get(0)
theFtab = theFtheme.GetFtab

flist = list.Make
for each f in theFtab.GetFields
  if (f.isTypeNumber = true) then
    flist.Add(f)
  end
end

if (flist.Count < 2) then
  exit
end

if (theFtab.GetSelection.Count = 0) then
  myAnswer = MsgBox.YesNo( "SELECT ALL POLYGONS ?", "Selection",
FALSE )
  if (myAnswer = False) then
    return nil
  else
  theFtab.GetSelection.SetAll
  end
end

AreaField = Msgbox.Choice(flist,"Choose 'Area' field:","Landscape
Indices")
  if (AreaField=nil) then
    theFTheme.ClearSelection
    return nil
  end
flist.RemoveObj(AreaField)
PerimField = Msgbox.Choice(flist,"Choose 'Perimeter' field:",
  "Landscape Indices")

  if (PerimField=nil) then
    theFTheme.ClearSelection
    return nil
  end

xsum1 = 0
ysum1 = 0
xmin = nil
ymin = nil
xmax = nil
ymax = nil
xsum = 0
ysum = 0
nn = 0

For each f in theFtab.GetSelection
  xret1 = (theFtab.ReturnValueNumber(AreaField,f))
  yret1 = (theFtab.ReturnValueNumber(PerimField,f))
```

```
  xsum1 = xsum1 + xret1
ysum1 = ysum1 + yret1

    if ( xmin = nil) then
      xmin = xret1
      xmax = xret1
      ymin = yret1
      ymax = yret1
    else
      xmin = xmin min xret1
      ymin = ymin min yret1
      xmax = xmax max xret1
      ymax = ymax max yret1
    end

xret = xret1.ln / 2.ln
yret = yret1.ln / 2.ln - 2

  'Check for null values

  if ((xret.IsNull = true) or (yret.IsNull = true)) then
    Continue
  end

  xsum = xsum + xret
  ysum = ysum + yret
  nn = nn + 1
end

XBar = xsum / nn
YBar = ysum / nn
XBar1 = xsum1 / nn
YBar1 = ysum1 / nn

c1 = 0
c2 = 0
rn = 1

For each ff in theFtab.GetSelection
  xret1 = (theFtab.ReturnValueNumber(AreaField,ff))
  yret1 = (theFtab.ReturnValueNumber(PerimField,ff))

  xret = xret1.ln / 2.ln
  yret = yret1.ln / 2.ln - 2

  if ((xret.IsNull = true) or (yret.IsNull = true)) then
    Continue
  end

  newc1 = ((xret - XBar)*(yret - YBar))
  newc2 = ((xret - XBar)*(xret - Xbar))

  c1 = c1 + newc1
  c2 = c2 + newc2
end

b = c1 / c2
a = YBar - (b*XBar)
fract = 2*b
pa = ysum1 / xsum1
```

```
si = 0.282*ysum1 / xsum1^0.5

'Report Results
Msgbox.Report("SIMPLE LANDSCAPE INDICES:"+nl+
" "+nl+
"Number of Patches = "+nn.AsString+nl+
"Sum of Perimeter = "+ysum1.Setformat("d.dddd").AsString+" m"+nl+
"Min of Perimeter = "+ymin.Setformat("d.dddd").AsString+" m"+nl+
"Max of Perimeter = "+ymax.Setformat("d.dddd").AsString+" m"+nl+
"Mean of Perimeter = "+YBar1.Setformat("d.dddd").AsString+" m"+nl+
" "+nl+
"Sum of Area = "+xsum1.Setformat("d.dddd").AsString+" m2"+nl+
"Min of Area = "+xmin.Setformat("d.dddd").AsString+" m2"+nl+
"Max of Area = "+xmax.Setformat("d.dddd").AsString+" m2"+nl+
"Mean of Area = "+XBar1.Setformat("d.dddd").AsString+" m2"+nl+
" "+nl+
"SHAPE RELATED INDICES:"+nl+
" "+nl+
"Perimeter/Area = "+pa.Setformat("d.dddddddddd").AsString+" /m"+nl+
"Shape Index = "+si.Setformat("d.ddddd").AsString+nl+
" "+nl+
"Coeff = "+b.Setformat("d.dddd").AsString+nl+
"Fractal Dimension =  "+fract.Setformat("d.dddd").AsString,"Landscape
Indices")

----------------------------------------------------------------------
Example:
Landscape Indices for "Protection Forest" with code number = 1 in
Provincial Space Allocation Structure Plan
```

RESULT:

```
-------------------------------------
SIMPLE LANDSCAPE INDICES:

Number of Patches = 61
Sum of Perimeter = 2735687.5630 m
Min of Perimeter = 5522.7460 m
Max of Perimeter = 1140971.7160 m
Mean of Perimeter = 44847.3371 m

Sum of Area = 4821193213.9850 m2
Min of Area = 1280746.0400 m2
Max of Area = 3347921866.4430 m2
Mean of Area = 79035954.3276 m2

SHAPE RELATED INDICES:

Perimeter/Area = 0.0005674296 /m
Shape Index = 0.01265

Coeff = 0.6952
Fractal Dimension =  1.3904
--------------------------------------
```

CURRICULUM VITAE

Hermawan Indrabudi was born in Yogyakarta, Indonesia on March 21, 1949. He graduated from the Faculty of Forestry, Gadjah Mada University, Yogyakarta in 1975. In 1977 he completed a one-year course on National Planning Programme at Indonesia University, Jakarta. From 1979 to1981 he took postgraduate course and an advanced course in Forest Survey and Aerial Photo Interpretation at The International Institute for Aerospace Survey and Earth Sciences (ITC) in Enschede, The Netherlands, and obtained an MSc degree. He has taken several training courses and workshops in his own country and abroad, especially in the field of forest inventory, remote sensing and land use planning.

Since 1975, he has continuously been working at the Ministry of Forestry, Indonesia. His jobs mostly deal with forest inventory, remote sensing, forestland use planning and organising training courses. From 1984 to 1989, he was a member of the Technical Working Group on remote sensing and information systems, ASEAN Institute of Forest Management (AIFM). From 1989 to 1993 he was stationed in South Kalimantan, undertaking forest inventory and forestland use planning activities, and this is where the idea to study the aspects of forestland uses arose.