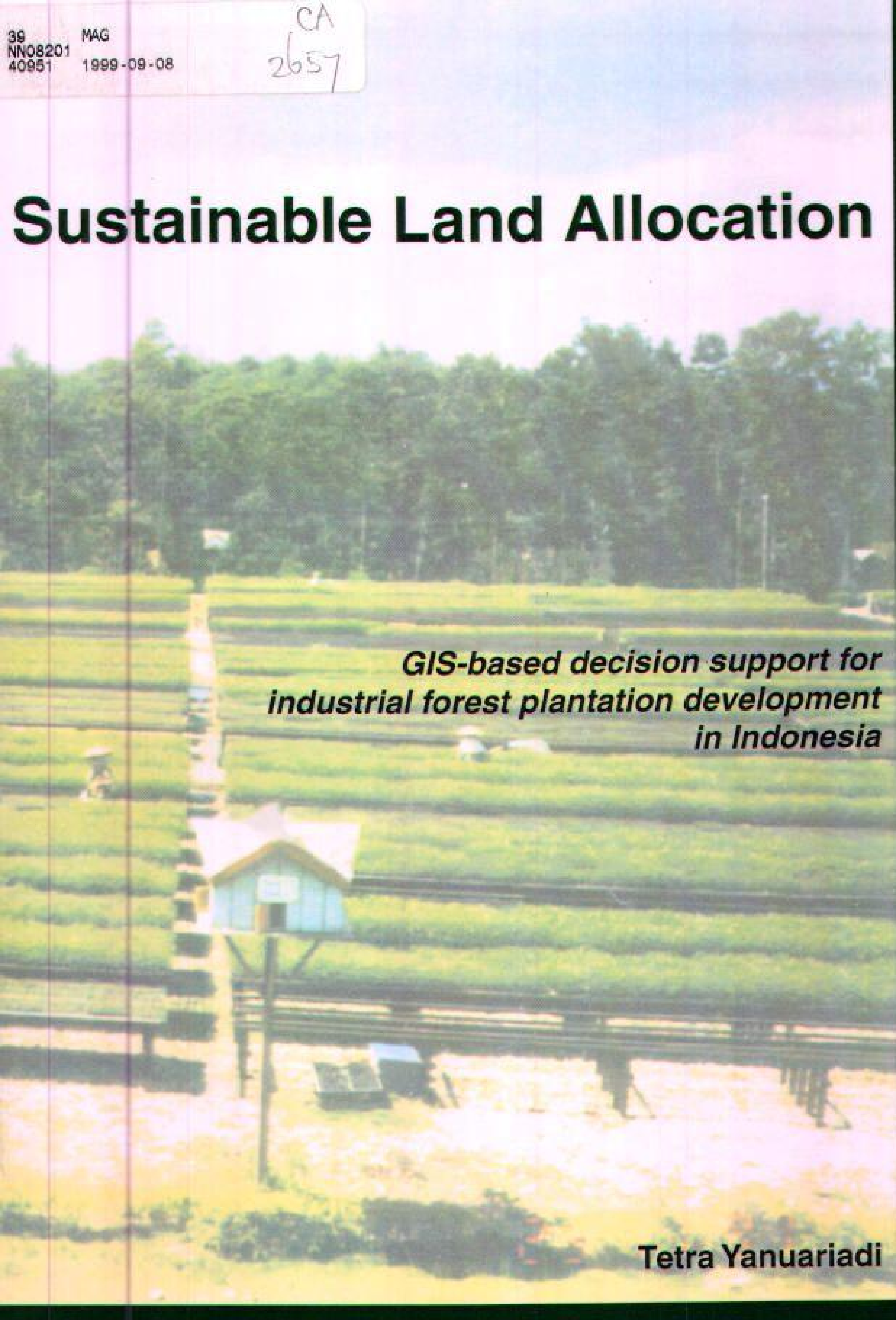

Sustainable Land Allocation

GIS-based decision support for industrial forest plantation development in Indonesia

Tetra Yanuariadi

Propositions

Tetra Yanuariadi (1999)
Sustainable Land Allocation
GIS-based decision support for industrial forest plantation development in Indonesia
(PhD dissertation)

1. Deciding about allocating land in a sustainable manner for industrial forest plantation development is deciding about people.
   - *This dissertation*

2. Sustainably allocating land for industrial forest plantation project development means reconciling stakeholders' objectives
   - *This dissertation*

3. "Unproductive land" as seen by the government and industrial forest plantation project disregards the productivity and potential productivity land has, as seen by the local people.
   - *This dissertation*

4. Considerations of economic viability and ecological soundness in land allocation decisions, get their importance only after social acceptability is assured, i.e., land for agriculture has been assured.
   - *This dissertation*

5. Labor opportunities in industrial forest plantation development are always significant for nearby villages, even when the impact on a regional scale is only moderate.
   - *This dissertation*

6. The protection of areas along rivers and roads not only protects these sites, but also creates ecological corridors between sites and habitats, essential for animal and seed movement, and for sustaining biodiversity.
   - *This dissertation*

7. From the information system perspective, a gap between information requirements and information availability in land resource management can frequently be seen as the inability of users to express their information needs.
   - *Yanuariadi (1991)*

8. In order to have access to up-to-date data and to meet data quality standards, the Indonesian Ministry of Forestry should work in close cooperation with agencies that produce data, and create information-sharing alliances with them.
   - *This dissertation*

9. Efforts should continuously take place to develop policies and mechanisms that promote, rather than inhibit, cooperation across organization boundaries.
   - *This dissertation*

10. In the situation of conflicting land uses in Pulau Laut, local people use fires as 'early warning system' towards the industrial forest plantation project authority. In Pulau Laut, forest fires have been repeated incidents over the years because the IFP manager uses different 'warning systems'.

11. Many logging companies are practicing 'shifting cultivation'.

12. Undertaking a PhD research is hard work, requiring great effort and time. However, implementing the results of the research is much more difficult, requiring even greater effort and longer time.

SUSTAINABLE LAND ALLOCATION

GIS-based decision support for industrial forest plantation development in Indonesia

Tetra Yanuariadi

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Tetra Yanuariadi
Enschede, June 1999

Chapter 1

GENERAL INTRODUCTION

This dissertation is about decision making in land allocation for the establishment of sustainable industrial forest plantation (IFP) in Indonesia. Problems in acquiring lands for such establishment are becoming ever more complex because the rate of land degradation is tending to increase, thus decreasing the availability of suitable lands. The increase in rural population, which occurs on a base of limited land resources, results in land shortage and poverty, a combination of negative factors that leads to unsustainable land management practices. That is why the factors that land use decision makers encounter in making spatial decisions are also becoming more and more complicated and intermingled.

How can decision makers deal with such complexity in their decision making, and how can the resulting decisions accommodate the objectives of all interested parties? To answer this, it might be very helpful for decision makers to have the support of a simplified abstraction, i.e. a model, of the real-world problem situation, in which the principles of sustainable forest development guide the way to constructing the model.

To be able to work with models, decision makers need information technology in order to address the challenges for sustainable forestry. According to Sayer et al. (1997), these challenges will include the shift of production from native forest to forest plantations in comparatively advantageous areas, more efficient processing to unlink end-use products from raw wood characteristics, increased demand, better information technologies to support decision makers, and more options for conserving biodiversity. This statement is of relevance for IFP development because its ultimate goal is the achievement of sustainable forest development.

Since decision support systems (DSS) have proven to be effective tools in supporting decision making, a spatial DSS for planning IFP land allocation is proposed. At the present time in the realm of information technology, tools such as geographical information systems (GIS) provide essential instruments for the efficient use of geographical information and for the production of high quality spatial information for decision makers. An appropriate GIS-based spatial DSS would be particularly useful in supporting decision makers in the effective planning of land allocation for IFP projects. To this end, this study focuses on providing a foundation on which to develop a spatial DSS that deals with analytical and practical problem solving in IFP land allocation.

1.1 The state and paradox of Indonesian forest development

Indonesia covers only 1.3% of the earth's surface, yet it harbors some of the world's richest biodiversity: 10% of flowering plants, 12% of the world's mammal species, 16% of all reptiles and amphibian species, 17% of the world's birds and a quarter of all marine and freshwater fishes. An estimated 40 million people (almost one quarter) of Indonesia's population are dependent on biodiversity for subsistence through the harvesting of coastal, freshwater and marine fishes, the collection of non-timber forest products (NTFP) or the cultivation of indigenous fruits, vegetables, cereals and spices (MacKinnon et al., 1996).

Indonesia's forests represent 10% of the world's remaining tropical forest (World Bank, 1995). Forestry is a land-based activity and plays an important role in the national development of Indonesia, generating local and foreign revenues and employment. The latest forestry statistics (MOF, 1997) show that, according to the Consensus Forest Land Use Plan or TGHK (Tata Guna Hutan Kesepakatan), the present area of state forest lands is about 140.4 million ha, and consists of about 113.8 million ha permanent forest lands and 26.6 million ha convertible forest lands (see Table 1.1). The state forest lands are controlled by the Government, following a centralized forest management system.

Table 1.1 Consensus Forest Land Use Plan (TGHK)

Function	Purpose	Timber exploitation permitted	Area (million ha)
Protection forests	Water and soil protection	None	30.7
Nature reserves and national parks	Nature preservation and genetic conservation	None	18.8
Limited production forest land	Timber production and prevention of erosion	Selective felling	31.0
Regular production forest land	Timber production	Selective felling or clear cutting	33.3
Convertible forest land	Conversion to agriculture, etc.	Clear cutting or maximum timber utilization	26.6

(Source: MOF, 1993b and 1995)

The natural forests, amounting to 64.3 million ha, are the main sources of timber in Indonesia (limited production forests and regular production forests). During the early 1960s, timber production was confined mostly to teak in Java. Large-scale exploitation of the natural forests started in 1967 in the Outer Islands, namely: Sumatera, Kalimantan, Sulawesi, Maluku and Irian Jaya. The Government encouraged the exploitation of commercially valuable timber in the production forests
but regulated this by specifying a selective cutting approach to the concession management. By combining this approach with careful logging and replanting, sustainable management of production forests was expected. However, in the early 1980s, the Government realized that the natural forests in the country were being seriously depleted, and thus concern was voiced over the possible degradation of the quality and potential of the forests as a result of these and other disruptive factors.

The paradox below (inspired by Kartodihardjo, 1999) depicts the current picture of forestry development in Indonesia:

- Natural forest resources of high economic value are being continuously depleted and utilized to generate inferior benefits, an example being the conversion to unsustainable practices of forest plantations.
- Parts of forest lands are being used for the short-term benefits of agricultural activities, whereas greater financial and economic benefits could be obtained from these lands through the establishment of sustainable forest plantations, including industrial forest plantations.
- Fire is the ultimate enemy of the forest. Forest fires cause huge losses in social, economic and ecological terms. Yet, forest fires occur repeatedly over the years.
- Habitats, plants and animals continue to decrease for no good economic reason. Forest for the tourist programme, providing economic and ecological benefits, receives lower priority in the forest development programme than timber exploitation-oriented activities.
- Reforestation and regreening programmes are successful in downstream areas, but not in the upstream areas where such activities are more necessary. However, the success relates only to the early years of growth whereas the expectation was for long-term benefits.
- Local communities lose their rights to utilize forest resources, although the facts show that because of their (indigenous) knowledge and (self) interests, they are often able to manage forest resources in a more sustainable way than extraneous people and organizations.

1.2 Forest plantation development

1.2.1 The history

The world's population is expected to double in the next 60 years, and social and economic development will increase the demand for, and consumption of wood products. This demand can only be met by appropriate forest conservation and development, including the establishment and improvement of the silvicultural management of plantations (ITTO, 1993). Although plantation efforts have increased in recent years, they still do not compensate for the deforestation rate. Currently, there are some 30 million ha of plantation forests in the tropics and some 100 million ha worldwide (Heinrich, 1995).

Poor forestry policies throughout the world have caused widespread damage to forests or led to deforestation. Deforestation is becoming a major problem in the world. According to a World Bank review (World Bank, 1997), the rate of deforestation has remained stubbornly high, at around 15 million ha per year. In Indonesia, the rate of deforestation is a matter of alarming concern, but the shortage of available data has led to widely varying estimates, ranging from 1.3 million ha to less than 300,000 ha per year (World Bank, 1995).

Until recently, the strategic role of forests in the national development of Indonesia has depended on the capabilities of natural forests to provide raw materials for the existing forestry-based industries. Currently, however, the natural forests can barely meet the increasing demand for raw materials. The role of plantation forests is therefore of importance, especially for conserving the remaining natural forests. Under proper management, it can be expected that high-yielding plantations are capable of meeting higher wood demands, thus reducing the pressure on natural forests.

Plantation forest establishment in Indonesia dates back to the 1880s, when intensive forest plantation commenced with teak (*Tectona grandis*) in Java. In the 1930s, important plantations of indigenous pine (*Pinus merkusii*) were established in North Sumatra, a practice later extended to the islands of Kalimantan, Sulawesi and Bali in 1975.

Since those early beginnings, there has been an ever-growing demand for poles, fuel and timber in heavily populated areas, notably Java. In the early eighties, foresters and environmentalists raised the need for plantation forests to public attention. The need to undertake protective planting in denuded areas, particularly in critical watersheds, and the desire to rehabilitate degraded forest and extensive areas of grass and scrub have resulted in a great upsurge in plantation activity in recent years (Kingston, 1981). This work has been carried out under a variety of forest plantation programmes, namely:

- for industrial timber production (mainly in Java);
- plantings within forest lands as a conservation measure (known as reforestation or rehabilitation); and
- plantings with people's participation to rehabilitate agricultural lands and watersheds outside forest lands (known as "regreening").

Concerted efforts to improve forest productivity through the establishment of an industrial forest plantation (**IFP**) programme in Indonesia started in 1984 (see Figure 1.1). This programme was developed and implemented using a number of incentives and structures. Referring to the background of the development, Mangundikoro (1984) mentioned two points:

- the existence of 15 million ha of unproductive areas in production forests; and
- the increasing need for wood, reaching approximately 90 million m^3 per year by the year 2015.

The Government of Indonesia considers the development of IFP as a political priority, necessary for managing the remaining forest resources on a sustained-yield basis and increasing utilization for national economic development. Most importantly, IFP development provides job opportunities, particularly for local people, and decreases their economic reliance on, and disturbance of , natural forests.

The establishment of IFP projects by state- and privately-owned forestry companies has further increased planting. However, the results so far of IFP development have not been encouraging. Many IFP projects have not fulfilled their early promise and a number of significant problems have arisen. The Ministry of Forestry (MOF)[♦] has decided to establish 6.2 million ha of plantation forests in the long run, including some 1.8 million ha of plantation forests that have been established by Perum Perhutani, a state-owned forestry company, in Java. The projected date for this establishment is the year 2004. The actual achievement of IFP development up until 1998 has reached some 2,409,630 ha (DJPH, 1999).

[♦] Since March 1998, the Directorate of Estate Crops of the Ministry of Agriculture has been merged with the MOF. Since then, the official name of the MOF has become the Ministry of Forestry and Estate Crops. However, "MOF" will be consistently used throughout this dissertation as the abbreviation for the Ministry.

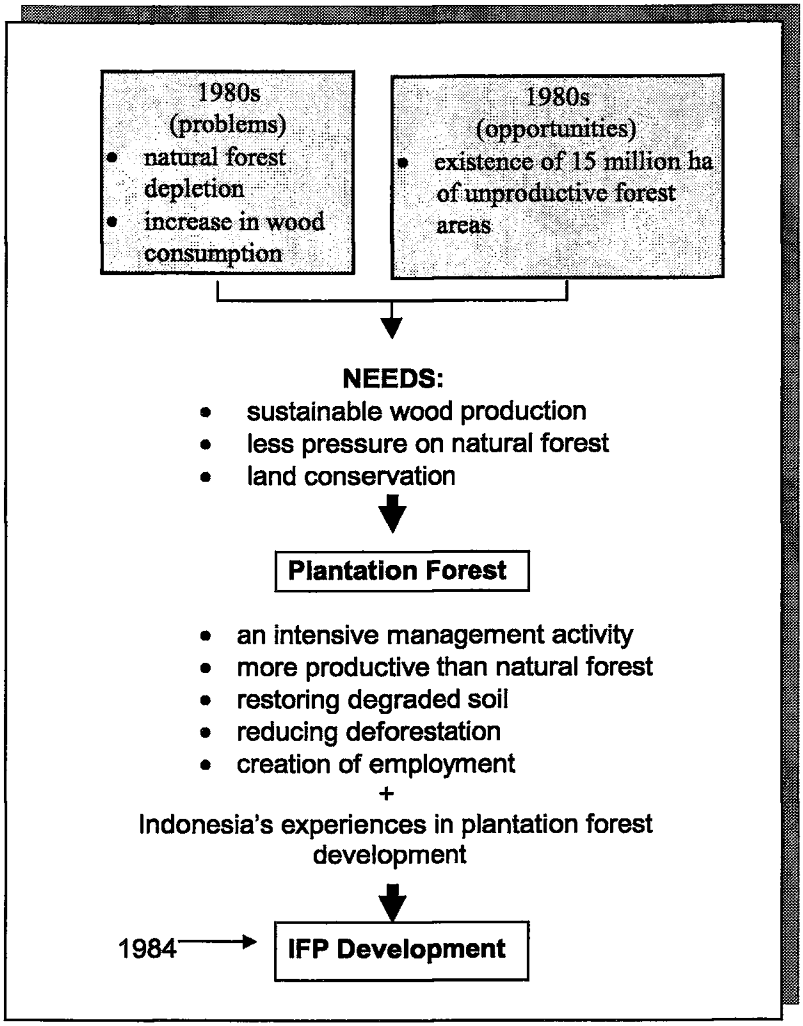


Figure 1.1 The history of IFP development

1.2.2 Organization (coordination) instruments

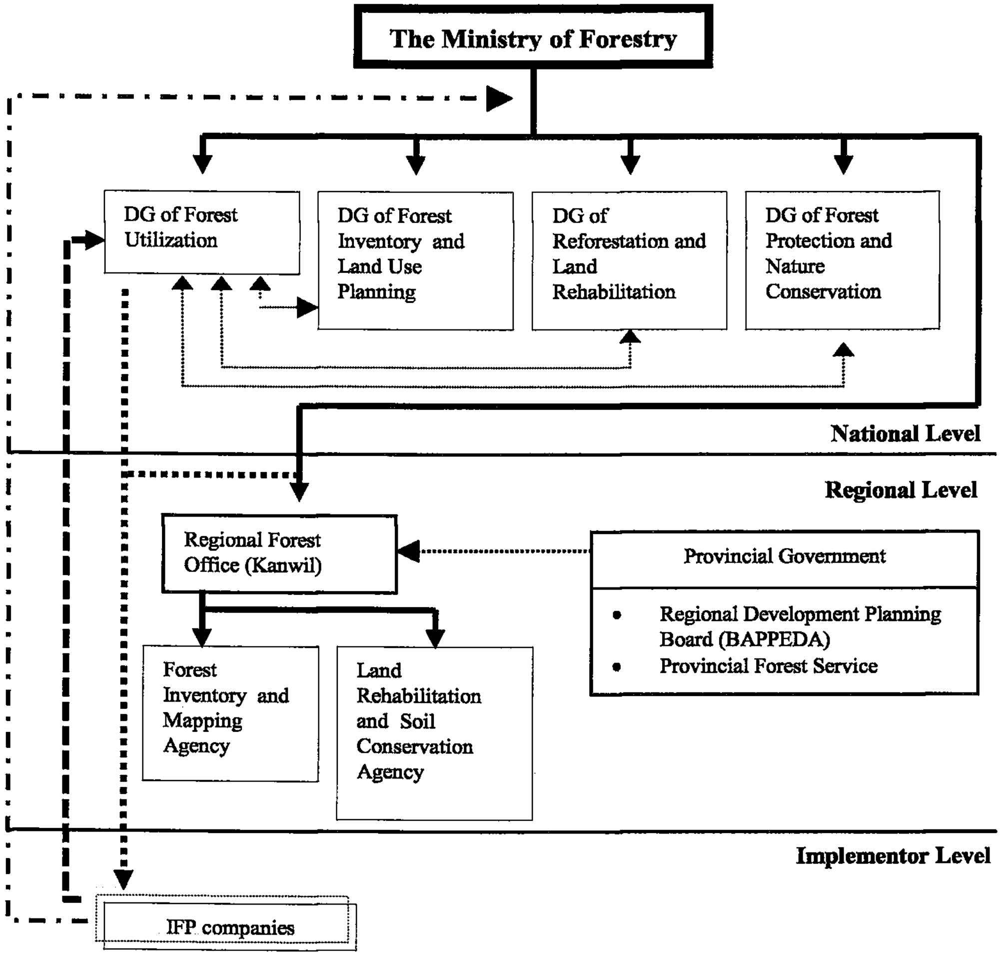
The IFP Directorate (under the Directorate General of Reforestation and Land Rehabilitation of the MOF) was established in 1989. The Directorate was responsible for accomplishing and implementing the national IFP development programme and for providing guidance for the accomplishment of the regional IFP development programme. The functions of the Directorate were:

- to plan and administer the preparatory procedures (applications and approvals) and programmes for IFP;
- to provide guidance on the establishment of IFP;
- to monitor, evaluate and direct the progress of IFP.

In early 1993 the Directorate was disbanded and all its functions were transferred to the Directorate General (DG) of Forest Utilization. All IFP development processes and procedures are organized and coordinated by directorates within the DG and involve some other forestry agencies (at both national and regional levels) and implementing agencies (implementor level). The DG directorates involved are: Forest Utilization Planning, Forest Harvesting, and the Forest Utilization Secretariat. The hierarchy and relationships of the involved agencies can be seen in Figure 1.2.

At regional level, the Regional Forest Office (Kanwil), as an extension of the MOF, is the coordinator and agency responsible for realizing the IFP programme. The Kanwil coordinates the Provincial Forest Service and forest technical implementation units, namely: the Forest Inventory and Mapping Agency (Biphut) and the Land Rehabilitation and Soil Conservation Agency (BRLKT). The Kanwil also discusses the proposed IFP development with the Regional Development Planning Board in order to synchronize development in the province with other sectors.

The MOF has five state-owned forestry companies, namely: PT. Inhutani I-V. These state-owned companies have a profit objective, but are also required to fill a social development role. One of the functions of the companies is to implement the IFP programme; another is to be the holder of government equity in new joint-venture IFP companies with the private sector. As state companies, PT. Inhutani should be able to play the role of leading agencies in the development of IFP (as a model for sound management of IFP development). In addition to these types of IFP companies, there are also purely privately-owned forestry companies.



Note: Hierarchy line; Reporting line; Coordination line; Application; Command line

Figure 1.2 The hierarchy and relationships of the agencies involved in IFP development

1.2.3 Land criteria for IFP development

Land classified as production forest but currently not carrying a natural forest, e.g. grassland and scrub, is considered to have long-term sustainable production potential and is therefore targeted for IFP development. At present, some of the production forest land has a natural forest concession status (logging concession) and can only be used for IFP development if it is excised from the concession area. Much of the better land for production forest is already being used by the existing rural population for subsistence and cash-cropping activities.

An IFP project may also be established on forest areas that still carry natural forest, but where the presence of commercial species with a diameter greater than 30 cm is no more than 20 m^3 per ha. According to Ministrial Regulation (MR) 495 '89, this kind of forest is defined as sparse forest and may occur both in production and convertible forest lands. Before converting sparse forest to an IFP project, a harvesting license is required from the Kanwil.

1.2.4 General problems encountered in IFP development

A number of important problems relating to the expansion of IFP development in Indonesia deserve serious consideration (Davis, 1989). These include:

- ensuring high productivity and quality consistent with environmental standards;
- mobilizing the needed investment and skilled manpower;
- allocating the areas for IFP development;
- selecting species suitable for the areas;
- siting of industry, such as pulp mills;
- designing the area for efficient operation;
- involving the local people.

In this dissertation, the main emphasis is on the third aspect, i.e., allocating the areas for IFP development.

The Government has been developing and implementing the IFP programme, using various incentives and structures. The establishment of large-scale IFP projects by state- and privately-owned companies has increased planting. However, the quality of the stands is reported to be disappointing. To varying degrees, these schemes have generated conflicts with local communities (MOF, 1993a and 1993b).

The resulting conflicts over the rights to use the land, which amounted to a legal dispute over land tenure between the Government, local communities and IFP companies, have led to the withdrawal of some potential investors in IFP development. The unwillingness of some companies, often foreign investors, to tackle the complex issue of the availability of land for development, is undermining investment for forest plantations.

In respect to issuing IFP concession rights and planning individual IFP projects, the MOF has identified some limitations of the Consensus Forest Land Use Plan (TGHK). These are:

- The categories of forest area were identified on a small-scale map (1:500,000), and the resulting maps do not provide sufficiently detailed information for operational scale, planning and control.
- The TGHK did not separately identify land already being used by rural populations for subsistence farming and cash cropping.
- The scale of planning was not detailed enough to identify land that requires protection from IFP development for environmental reasons at an operational scale.
- The TGHK does not provide details of the existing condition of the vegetation cover.

The Indonesian Silva Conference (1990) in Bogor identified the main problems in IFP development, e.g. the difficulties in obtaining appropriate land that is free from other uses. Difficulties in getting approval (slow process at regional/provincial level) of the company's IFP Annual Working Plan caused delay in implementing the plans. Besides lack of professionalism, the weakness of IFP work reports and unstable (constantly changing) government regulations generated uncertainty among IFP implementors as regards investing their financial capital.

1.3 Statement of the research problem

IFP development has experienced many problems. Although IFP implementors are empowered by a formal decree from the Government to establish the IFP projects, in reality they are faced with problems such as claims from local people, conflicting uses with other sectors, and other factors.

Land allocation decision making has been perceived to be fundamentally the problem of the IFP implementor. This refers to land for IFP development as identified by the implementor and allocated by the MOF on a gross basis. Consequently, the IFP implementor bears great responsibility regarding the allocation of land to be planted, and related environmental and social issues. However, local people's needs are little considered in the early stages of the decision making process in IFP land allocation.

Land resource use will be most efficient and sustainable when the objectives of all those who are using the land are considered in the decision making processes. For the success of an IFP project, there is a need to understand the objectives of each IFP stakeholder. From the IFP implementor's point of view, the problem can be described as how to render the implementor's objectives compatible with those of other stakeholders. This compatibility should satisfy and not violate the stakeholders' objectives.

The use of models in land allocation for IFP development will give the implementor insight into the core problems, reduce uncertainty and, finally, will improve the decision making process. These models can provide decision making in land allocation with additional information, or at least indicate the possible consequences of decisions, so that the final decision (i.e. a selected site) reflects a compromise between the stakeholders. This compromise can be achieved by the participation of stakeholders in the decision making process and by providing them with the opportunity to present their needs. The use and development of the models should be considered as a component of a larger information system to support decision makers, in other words, a DSS.

1.4 Initial research objectives (prior to fieldwork execution)

Initially, the research objectives were formulated with the emphasis on analyzing the existing situation of ongoing decision making processes within the framework of IFP development. This included elaboration on the decision space of each level of management. The decision space itself encompassed problems and constraints in decision making as seen from different points of view; measures taken to overcome these problems; discrepancies among levels of management; and the information required to deal with decision making.

These initial objectives were:

- to determine the information requirements in the decision making processes of IFP development;
- to select and support decision problems encountered by the manager of an IFP project;
- to design models of decision making at the strategic, tactical and operational levels of IFP management.

To operationalize the objectives, relationships between levels of management and the addressed research questions were formulated as shown in Figure 1.3.

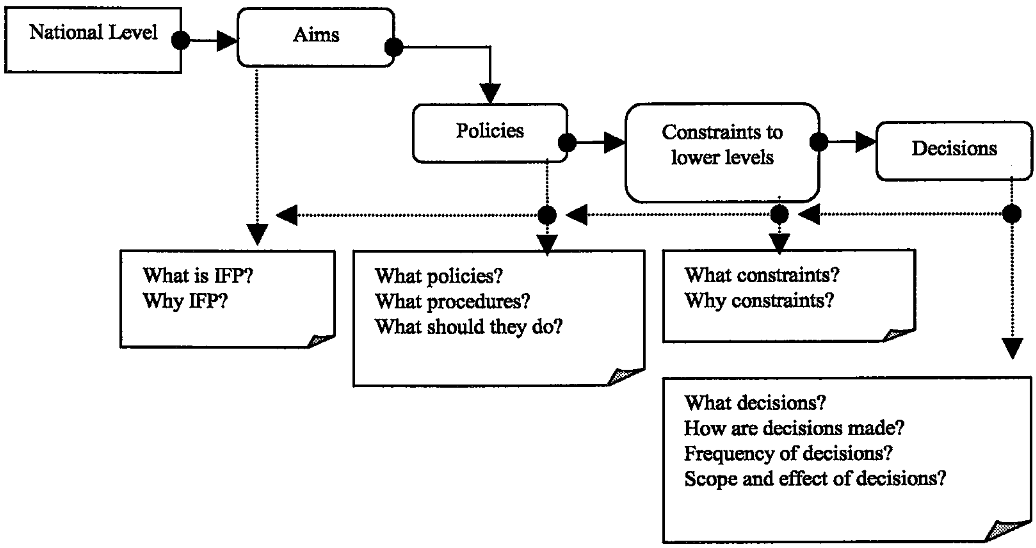


Figure 1.3 Relationships between levels of management and the research questions

1.5 Conceptual framework

This research included the following activities: collating and reviewing the documents and reports related to IFP development, fieldwork, construction of an IFP land allocation model, and appraisal of the model through a case study.

Collating and reviewing the documentation led to an understanding of the nature of process and procedure in IFP development, which was necessary to formulate the research problem encountered and define the scope of the research.

A system view of problem solving from Mitroff et al. (1974; see Figure 1.4) was adopted, and served as a general method for the research. As described by Hofstede (1992), solving organizational problems is viewed as a network of activities in which a variety of paths can be followed. Figure 1.4 depicts a clockwise cycle: *conceptualization*, *modeling*, *model solving* and *implementation*. This resembles an operations research approach to problem solving, in that a problem, as a conceptual entity abstracted from an organization, stands central and is considered as a formal problem. The activities involved in the four phases are of very different nature and, consequently, each phase requires something different from the problem solver.

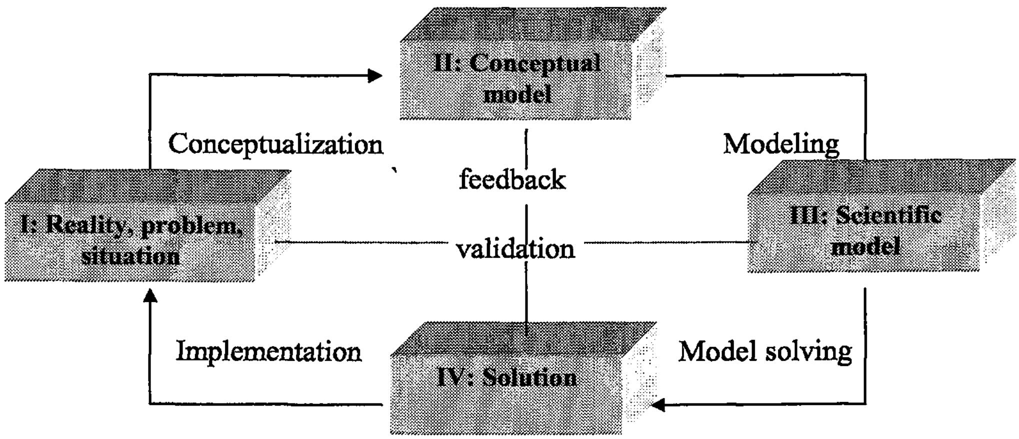


Figure 1.4 A system view of problem solving (Mitroff et al., 1974)

Fieldwork was carried out twice and visits were paid to agencies at three levels of decision making, namely: national level, regional level and implementor level. During the fieldwork, interviews were the main tool for data collection. Interviews were held with the heads of selected agencies and their key officials (selected during discussions with the heads of the respective agencies). Local communities in the surrounding villages were also interviewed.

The general approach of the investigation during the fieldwork was as follows (see also Figure 1.5):

- Investigation started at IFP project level.
- Based on the investigation at IFP project level, decisions at higher levels of organization within the framework of IFP development (which directly affected decision making at project level) were studied. This included the identification of persons to be interviewed.
- The results of the investigation at higher levels of organization were compared with the results of the investigation at the lower level. Where discrepancies/gaps occurred, validation tended towards the manager of the IFP project and towards the higher level of organizations.

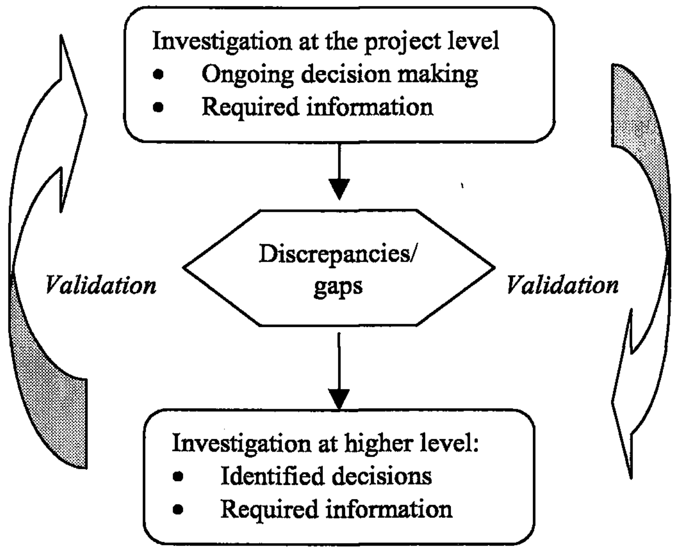


Figure 1.5 General approach of investigation during the fieldwork

1.6 Fieldwork execution and research objective reformulation

1.6.1 Fieldwork execution

The initial fieldwork was executed during the period July to October 1996, with the purpose of assessing the following: the current situation of IFP development; the need for changes; ongoing decision making processes for land allocation; information required for decision making; and future information system development. The result of the first fieldwork assessment led to the need for modeling IFP land allocation. Following completion of this fieldwork, the preliminary construction of the IFP land allocation model took place.

Fieldwork was again executed during the period September to December 1997. During this time, the constructed conceptual model of IFP land allocation was used as the main platform for data collection and discussion with stakeholders.

During the first fieldwork period, three IFP projects (the Semaras and Pleihari IFP projects in South Kalimantan and the Batu Ampar-Mentawir IFP project in East Kalimantan) were visited and their managers were interviewed. In addition, the manager of the Senakin IFP project in South Kalimantan was also interviewed but his project area was not visited. During the second fieldwork period, the IFP companies visited were the Semaras IFP project in South Kalimantan and the PT. Surya Hutani Jaya project in East Kalimantan. Summaries of the findings from the visited IFP project areas are given below.

1) The Semaras IFP project of PT. Inhutani II in Pulau Laut, South Kalimantan Province, was initially planned as a 50,000 ha plantation project. The project started in 1984 and by 1997 the planted area had reached 28,373 ha. Currently, new plantation in the remaining areas cannot proceed because of an unforeseen situation owing to a decision made by the Minister of Forestry. The Minister considers that the areas are not appropriate for the current management practice (clear-cutting system) of the project and has requested the company to maintain the forest areas as they are, otherwise a different silviculture system has to be proposed. Other problems faced by the company concern claims from local people regarding land ownership.
2) Another IFP project of the company (Senakin IFP project) within the same province has also identified a problem in land allocation. Out of the 34,500 ha allocated, some 10,500 ha have been planted. However, new planting establishment activities in the remaining areas cannot be carried out. The project is facing problems in the form of claims from local people and land use conflicts with non-forestry activities, namely: mining and non-forestry plantation projects.
3) The Pleihari IFP project of PT. Inhutani III in Tanah Laut, South Kalimantan Province, has an area of 27,500 ha, of which about 55% are grasslands and scrubs with secondary forest found mostly along river banks, and the remaining 45% are swamps. Some 11,138 ha of the area have been planted. The land allocation problems faced by the project are claims from local people and the presence of unsuitable areas (swampy areas) for plantation.
4) The Batu Ampar-Mentawir IFP project of PT. Inhutani I is located in Balikpapan, East Kalimantan Province. The size of the allocated area for the project is 16,570 ha, of which some 4,562 ha have been planted with *Hevea brasiliensis* (rubber) and some 1,200 ha with *Shorea* sp. Five years after planting (1996), the stand quality–particularly for rubber–was very poor. It was reported that the selection of species for rubber was based only on the demands of the wood industries at the time of the establishment and, consequently, careful assessment of the biophysical factors of the land was omitted.
5) The IFP project of PT. Surya Hutani Jaya (a privately-owned forestry company) is located in the district of Kutai, with a concession area of 183,300 ha, of which some 104,000 ha are expected to be used as plantation areas. The forest area was formerly logged over by logging companies but was devastated by the fire tragedy in Kalimantan in 1983. The concession area is divided into three sites, each one approximately 35,000 ha. The development of the

project started in the fiscal year 1989/1990 with the objective to supply wood for pulp, for medium-density fiber board and to wood-working industries. The main planted species are *Acacia mangium*, *Gmelina arborea* and *Eucalyptus* sp. with eight years' rotation. By the end of 1997, the established plantation of about 92,520 ha had been achieved. Some of the project area is being claimed by the local people.

Executing fieldwork enabled the current situation regarding IFP development to be studied. Information gained by interviewing IFP project managers and high-ranking company and MOF officials revealed that land allocation is the most common problem hampering implementors and the progress of their IFP development. The IFP stakeholders that should participate in the land allocation decision making and their objectives and perceptions on forest resources are listed in Table 1.2.

Table 1.2 IFP stakeholders and their objectives

Stakeholders	**Central objectives**	**Perceptions of value**
Government of Indonesia (MOF/forest agencies and provincial government)	Long-term sustainability of forest resources Contribution to national and regional forest and economic development Promote land productivity and environmental quality	Source of timber Environmental protection Job opportunities
IFP company	Financial gain from sale of timber	Source of timber for exploitation
Local community	Contribution to livelihood system (income and security)	Job opportunities Source of agricultural land (agroforestry)

1.6.2 Reformulation of research objectives and questions

During the first fieldwork period, increased knowledge was acquired about the state of the art of IFP development, giving a better picture of the problems encountered. As a consequence, it was necessary to reformulate the direction of the initial objectives. Fieldwork identified the essential decision environment, i.e. that strategic decisions in the planning process of IFP land allocation are made by the IFP manager, and also that the needs of other stakeholders should be considered by the manager in order to achieve greater commitment to land allocation plans.

In establishing an IFP project, the IFP manager deals with strategic, tactical and operational decision making. Meanwhile, the international forestry community is asking for greater concern for the principles of sustainable development to be shown in all forest management practices. Hence, given these two requirements ***the general objective of the research*** is reformulated as follows: "To contribute to the improvement of the decision making process in sustainable land allocation for IFP project development in Indonesia."

The improvement is achieved through constructing an IFP land allocation DSS that accommodates the objectives of the IFP stakeholders (as identified in Table 1.3) and incorporates the principles of sustainable development. For this purpose, the general objective is further broken down into ***specific objectives***, as follows:

1) To develop sub-models of sustainable IFP land allocation, namely: economic viability, ecological soundness and social acceptability.
2) To integrate the sub-models into a generic IFP land allocation DSS.
3) To appraise the DSS through a case study in an IFP project of a state-owned forestry company in Pulau Laut, South Kalimantan.

With these specific objectives, several essential ***research questions*** are highlighted:

1) How can the stakeholders' objectives be accommodated in the sub-models?
2) How can the principles of sustainable development be incorporated in the sub-models?
3) How can the sub-models from different perspectives be integrated for effective problem solving in IFP land allocation?

1.6.3 The case-study area

With the research problems and objectives in mind, a case-study area needed to be chosen. The selected study area had to represent state-of-the-art IFP development in Indonesia, with the complexity of conflicting land uses. For this reason, the Semaras IFP project of PT. Inhutani II in Pulau Laut was selected. Other reasons for selecting this IFP project were as follows:

- As a state company, PT. Inhutani II should be able to play the role of a leading agency in the development of IFP (as an example of sound management of IFP development). The results of this research should stimulate contributions to accelerate fulfillment of the company's role.
- Data and information were available and accessible.
- The IFP project of PT. Inhutani II in Pulau Laut was used in the case study of the author's MSc research in 1991.

In this section, the selected case-study area is briefly introduced. The discussed regional context of the study area is mostly based on a number of reports and publications (PT. Inhutani II, 1985; PT. Inhutani II, 1993; BPS Kalimantan Selatan, 1994; BPS Kabupaten Kotabaru, 1996; and Turvey, 1995).

The Semaras IFP project is located inside the forest concession area of PT. Inhutani II, in the southern part of Pulau Laut (Laut Island). Pulau Laut is part of the Kotabaru District territory of South Kalimantan Province. Geographically, Pulau Laut is situated between $3^0 12' 44''$ to $4^0 56' 14''$ S latitude and $116^0 0' 11''$ to $116^0 20' 3''$ E longitude. To the south of the island is the Java Sea, in the west is the Laut Strait, which separates the island from Kalimantan Island, and in the north and east is the Makasar Strait.

Pulau Laut has an area of about 207,458 ha and in 1995 had a population of about 87,593. The island is divided into four sub-districts, namely: Pulau Laut Utara (North Pulau Laut), Pulau Laut Barat (West Pulau Laut), Pulau Laut Selatan (South Pulau Laut), and Pulau Laut Timur (East Pulau Laut).

Transportation to the island is possible by means of air, sea and road. An airport for small airplanes is located in Stagen, 12 km from Kotabaru, the capital of Kotabaru District. Sea transportation connects the island with major cities in Java, Sulawesi and Kalimantan. Transportation includes ferries crossing the Laut Strait and transport cars from Kalimantan Island to Pulau Laut.

Topographic characteristics

The terrain of Pulau Laut varies from flat to hilly. Elevation ranges from 0 to 715 m above sea level. The highest point is the peak of Sebitung mountain (715 m), which is situated in the north of the island, while other mountains in this area reach heights of 500 m, 679 m, 625 m, 631 m and 676 m above sea level. In the central part of the island, there are mountains that reach heights of 521 m, 289 m, 337 m, 296 m, 231 m, 208 m and 150 m above sea level.

The flat areas (one third of the island) can be found in the southern part of the island, where the IFP project is located. Numerous depressions of varying sizes, which become wet and/or waterlogged during the rainy season, are found along the streams and rivers.

The different characteristics of the topography in the area have resulted in different kinds of rivers. In the north, the rivers are smaller and with more branches than in the central and southern parts of the island. The water catchment areas are also smaller. The main rivers are Sejaka, Kapis and Seloka located, on the east coast, and Sekoyang, Semaras and Sebanti, located on the west coast. The variation in topography is reflected in the farming patterns.

Soils and geological characteristics
The major soil types found in the area are alluvial soils, yellow and red podsolic silty clays, and latosols. The yellow and red podsolic silty clays have a pH value ranging from 4.5 to 6.5, a lack of nitrogen (N), phosphorous (P) and potassium (K), and are susceptible to erosion. These soils dominate the whole island and the sites are used by the local people for shifting cultivation, which in turn leads to the occurrence of grassland over the area. The latosols can be found in the northern part, and the alluvials in the eastern and western coastal areas of the island. The latosols are not susceptible to erosion and in Pulau Laut this soil type is found under forest vegetation, where little human disturbance takes place. The alluvial soil is fertile, but the sites covered by this soil type are frequently affected by floods and are therefore not appropriate for agricultural activities. The geological formation of the island consists mostly of palaeogene sediments, the rest being formed of alluvium and of volcanic sediments.

Climate
The climate belongs to climatic type A and B under the Schmidt and Ferguson classification. About 30% of the area (in the northern part of the island) belongs to climatic type A with a Q index of 0.0 to 14.0%, while the remaining 70% (in the central and southern parts of the island) belongs to climatic type B with a Q index of 14.0 to 33.3%. From the data collected at the Semaras Meteorological Station from 1986 to 1992 (see also Table 1.3), the rainfall can be characterized as follows:

- average annual rainfall - 2545 mm
- average annual rainy days - 125 days
- wet months (10 consecutive rainy days or more) - November to May
- dry months (less than 10 consecutive rainy days) - June to October

The rainfall pattern varies considerably. Annual rainfall ranged from 4,339 mm in 1988, with no apparent dry month, to 1,593 mm in 1990, with a dry period from May to November. Mean temperatures for the area range from 31^0 C to 32^0 C. The lowest temperature is reached in July and the highest in September. The monthly average humidity ranges from 82.7% to 88.6%.

The intensity of the rainfall in Pulau Laut is considerable. This condition is highly advantageous for reforestation activities; for planting especially, it means ample time for field activities and low costs for watering seedlings in the nursery. However, the high rate of rainfall also brings disadvantages for forest harvesting activities—for example by hampering the mobility of heavy equipment—and induces more erosion.

Forest resource
Forest resources in Pulau Laut are characterized by a tropical rain forest that is rich in tree species. There are about 100 known commercial and non-commercial species. Forest cover in the northern part is very dense, but less so in the southern part. Because of the different terrain characteristics on the island, in the mountainous area, with an elevation of more than 500 m above sea level, the dominant species is *Shorea polyandra*. In the central part, the dominant species are *Shorea ovalis*, *Shorea parvifolia* and *Shorea leptocladis*. *Dipterocarpus cornutus* is found in the southern part. *Eusideroxylon zwageri* is found everywhere in the northern and southern parts of the island, mixing with other species.

On the east coast of the island, there are peat forests that are dominated by *Rhizopora* sp., *Bruguiera* sp., *Avicennia* sp. and *Nipa fructicans*. These forests were designed as conservation areas by the MOF. In the northern part of the island, there is also a conservation area designed to protect the primary forest of endangered species, e.g. *Shorea polyandra*, *Dryobalanops camphora*, *Palaquium cutta*, *Trenga jainnata*, *Excoacaria* sp. and orchid species. In addition, the area is also intended to protect freshwater resources and maintain the stability of soil fertility in the mountainous areas. There are large areas of *Imperata cylindrica* growing because of previous shifting cultivation in the southern part of the island. During the dry season, this area often becomes the source of fire. Secondary forest and scrub are mostly located in the middle and southern parts of the island as they were formed through, respectively, exploitation by forest concessionaires and agricultural activities by the local people.

Table 1.3 Monthly and annual rainfall (mm) for Semaras, Pulau Laut for 1986-1992

	MONTH													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total per year	Average per month
1986	240	116	95	108	263	204	63	34	52	329	376	190	2 068	172
1987	225	425	225	610	610	75	10	5	0	127	593	410	3 315	276
1988	404	215	211	234	619	473	479	734	330	162	143	319	4 320	360
1989	302	288	146	158	194	213	251	243	13	147	230	157	2 348	195
1990	184	434	243	122	68	51	66	41	93	32	70	180	1 582	132
1991	331	300	299	313	211	7	4	0	0	0	242	345	2 049	171
1992	324	126	110	299	86	208	246	29	91	179	285	155	2 138	178
Ave.	287	272	190	263	293	176	160	155	83	139	277	251	2 545	212

Source: PT. Inhutani II (1992, in Turvey, 1995)

The dominance of *Shorea polyandra* in Pulau Laut requires the application of a silviculture system, the so-called "Tebang Pilih Tanam Indonesia" (Indonesian Selective Cutting and Planting System/TPTI). This species of *Shorea* is a semi-light-demanding species that can grow naturally and demands increasing intensity of light following its maturity. The natural regeneration of this species needs light input, otherwise the seedlings will remain stagnant or even die. In the central part of the island, there is the possibility to undertake regeneration with the indigenous species *Shorea ovalis*. During the seedling period, this species can associate with scrubs, and at the sapling period it becomes a semi-light-demanding species. This species is also called a "gap opportunist species". The climatic type and topographic characteristics of the southern part of the island support the promotion of forest plantation through a clear-cutting system. Hence, in comparison with other parts of the island, in the southern part the establishment of an IFP project will face lower risks.

Socio-economic aspects
The main socio-economic aspects relevant to the establishment of the IFP project can be summarized as follows:

- There are 60 villages in Pulau Laut. Under the Transmigration-IFP programme, there are 300 households (about 1,500 inhabitants) of transmigrants that have been settled to work for the Semaras IFP project.
- The farmers use traditional farming practices to provide for their basic food and their economic livelihood. Food production is seasonal, being carried out mostly during the rainy season. The production of major crops is presented in Table 1.4 below.

Table 1.4 Production of crops in Pulau Laut from 1992 to 1996 (tons)

Crops	1992	1993	1994	1995	1996
Rice (irrigated)	65396	67826	86458	104906	114148
Rice (non-irrigated)	40319	40439	22097	43106	41665
Maize	9157	10102	8641	13824	12399
Cassava	52326	53099	48226	64175	68011
Sweet potato	5975	2745	3277	3324	4584
Soybean	4275	4455	5905	7930	8983

Source: BPS Kabupaten Kotabaru (1996)

- Many of the economically active population supplement their income through secondary employment in agriculture, livestock, fisheries, forest-related industries, gold panning and handicrafts.

- In 1980, the average per capita income was US$ 134, while by 1993 income had risen to US$ 231 per year. There is a high incidence of poverty among the local population. During the author's 1997 fieldwork, it was found that the average income was down to US$ 150 per year. This decline in income was due to depreciation of the rupiah against the US dollar. The gross domestic product (GDP) at district level from 1993 to 1996 is shown in Table 1.5 below.

Table 1.5 The gross domestic product (GDP) of Kotabaru District from 1993 to 1996

Year	GDP (Rupiah)
1993	2 612 221
1994	2 946 436
1995	3 116 858
1996	3 425 657

Source: BPS Kabupaten Kotabaru (1996)

- The prevailing level of education is low. The majority of the people have not completed primary education.
- Many of the households do not have access to electricity.
- About 90% of households rely on wood as the source of energy for cooking. Fuelwood consumption is estimated at 8 m^3 per year per household.
- There are adequate numbers of unskilled laborers to meet the needs of the tree plantation project. However, there are few skilled workers or administrative personnel available locally and these would have to be recruited from outside the district.

The history of forest utilization in Pulau Laut

The utilization of forest resources in Pulau Laut was started in 1964 by BPU Perhutani, a state-owned company. Later, in 1967, the company entered an agreement with MOFDECO, a privately-owned Japanese company, to optimally exploit the logs. The joint-venture company exported logs to Japan, and the volume of logs increased every year. This joint operation was terminated after five years.

PT. Inhutani II was established in 1975 and the forest area concession (110, 925 ha) in Pulau Laut was given to this company. Besides Pulau Laut, the company also holds other forest concessions in several provinces of the country:

- 321,200 ha of natural forest in South and East Kalimantan under the Indonesian Selective Cutting and Planting System;
- 1,595,950 ha of degraded forest for rehabilitation, located in Kalimantan and Sulawesi;
- 151,000 ha of timber plantation in East and South Kalimantan.

Management of the forest concession is carried out in accordance with a 20-year management plan. The first management plan covering the period 1973 to 1993 was completed. The company is now implementing the second term of the management plan for the period 1994 to 2014.

With the Indonesian Selective Cutting and Planting System, the minimum diameter limit for cutting is 50 cm. The forest stands in Pulau Laut have an average potentially exploitable volume of 130 m^3 per ha. However, to ensure that enough residuals are left for succeeding cutting cycles, only about 40 to 80 m^3 per ha are cut. Sample plots in residual forests revealed that the mean annual growth is 15.8 m^3 per ha. Silviculture treatments are applied to promote successful regeneration. Enrichment planting with valuable timber species is undertaken where natural regeneration is insufficient. To support this activity, the company has nurseries in Stagen, Sei Kawau and Semaras to propagate seedlings. Clonal seed orchards of *Gmelina arborea* and *Shorea* sp. are located in Semaras and Mekarpura.

At Stagen, PT. Inhutani II has a sawmill that was established in 1978 with a capacity of 60,000 m^3. It processes logs harvested from the natural forests, mainly of the *Shorea* and *Dryobalanops* species. It is expected that the IFP project will supplement production from the natural forest, and thus ensure continuity of production for processing units and job security for the people.

PT. Inhutani II is one of the state-owned companies that have the task of establishing timber plantations in several provinces of the country. The Semaras IFP project is one of the company's projects. Figure 1.6 shows the plantation blocks of the project. Figure A1 in the Appendix 1 shows situation of Pulau Laut in Indonesia Archipelago. The objectives of the Semaras IFP project are:

- to establish timber estates for pulpwood and saw logs;
- to provide employment and other benefits to local inhabitants;
- to improve local ecological conditions;
- to strengthen the capability of PT. Inhutani II in IFP development and management.

The planned annual production of timber is 390,000 m^3, starting from year 12. The planted species are: *Eucalyptus* sp., *Acacia mangium*, *Pinus merkusii*, *Peronema canescens*, *Swietenia macrophylla*, *Albizia falcataria*, *Gmelina arborea*, *Shorea* sp. (trial planting), *Eusideroxylon zwageri* (trial planting) and others (trial planting). So far, the harvesting activity has reached some 517 ha and produced 33,410 m^3 of timber.

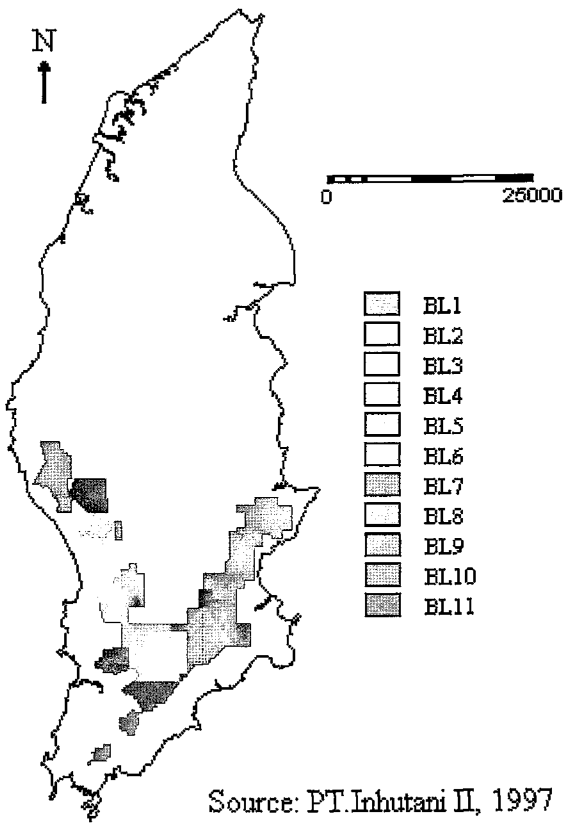


Figure 1.6 Plantation blocks of the IFP project of Pulau Laut

1.7 Organization of the dissertation

This dissertation consists of five chapters:

Chapter 1 presents a general introduction to the study.

Chapter 2 explains the theoretical perspectives that provide the foundation for this study. These perspectives focus on the state of the art of forest plantation, the concept of sustainable development, decisions and decision making processes, and the nature of decision support systems (DSS).

Chapter 3 outlines the conceptual model of IFP land allocation. This chapter consists of sections that describe the decision space of IFP land allocation, and the existing situation of information flows, information requirements and information problems. Furthermore, sections of this chapter deal with the structure of the model and the sub-models of social acceptability, economic viability and ecological soundness, with the integration of the sub-models, and finally with the database model and data repository.

Chapter 4 contains the operationalizations of the concepts underlying the IFP land allocation model outlined in Chapter 3. This chapter discusses how the sub-models work and how they were integrated to form the DSS IFP land allocation. The chapter starts with the background to the scenarios developed to test the model. The last section elaborates the strategies to implement the model.

Chapter 5 reflects on, and concludes the discussions in this study. Particularly, the extent to which the research objectives and research questions have been met and answered are discussed. The practical use of the DSS, its applicability and contribution to modelling forest management are also elaborated. Furthermore, directions for further research are suggested.

Chapter

2

THEORETICAL PERSPECTIVES: FOREST PLANTATION, SUSTAINABILITY AND DECISION MAKING

2.1 Sustainable management of forest plantation development

Sustainable management is the ultimate goal of any activity in the field of forestry development. In this section, discussion on the concept of sustainability will inform readers about the underlying principles, and the direction of sustainable development followed in this research for the particular purpose of achieving sustainable land allocation for the establishment of IFP projects. To enable operationalization of the definition of sustainability, most aspects of sustainable management encountered in forest plantation are synthesized. The major elements necessary in the IFP land allocation model are identified.

2.1.1 Perspectives on forest plantation

Deforestation of all kinds is increasingly becoming a major problem in the world. Environmental concerns, social pressures and rapidly diminishing forest resources all contribute to a need for tropical countries to move towards sustainable wood production systems on smaller land areas. Plantation forestry offers an important opportunity for meeting wood demands, restoring degraded soils and reducing deforestation by decreasing pressures on natural forests (Cossalter, 1995).

A forest plantation is defined as "a forest crop or stand raised artificially either by sowing or planting" (Ford-Robertson, 1971, in Evans, 1984, and in Poore et al., 1989), and such plantations are generally areas where the naturally occurring tree species have been totally replaced by planted trees. The word "artificially" in the definition has the same meaning as "man-made" in most modern forestry literature.

Planted forests are an important element of land use in the tropical world. Planted forests can fulfill many of the productive and protective roles of the natural forest.

When they are adequately planned, planted forests can help stabilize and improve the environment (ITTO, 1993). Interest in plantation in the tropics is increasing rapidly because of the silvicultural, economic and environmental benefits (Evans, 1984). Forest plantation is becoming more and more an intensive land management activity, with the introduction of fast-growing species and varieties, genetically improved seeds and planting stocks, and the mechanization of nursery and plantation activities (Davis, 1989).

Industrial forest plantations focus on supplying timber for industry, but differ according to the essential end-uses of products needed by each country. The main end-uses for timber are sawn wood or panel wood, pulpwood, etc. The small wood, bark and remaining biomass of the trees are used mainly as a source of energy by the rural people or urban poor. In conclusion, the needs of the local population are subordinate to the needs of the country, but the local population will benefit partially from industrial forest plantation, in terms of employment generation and the use of felling residues and by-products (Adkoli, 1992).

Plantation as a tool for socio-economic development

Plantation forestry in the tropics can significantly aid the socio-economic development of developing countries. Some of the benefits are (Evans, 1984):

- resource creation, rather than solely exploitation, to meet the demand for wood products;
- development of a flexible resource able to yield many kinds and sizes of products for internal demand or for export;
- use of land of often little or no agricultural value;
- creation of employment in rural areas;
- high level of employment per unit of investment (plantation establishment is labor-intensive);
- extensive plantations bring the development of an infrastructure of roads, communications, services, houses, shops, schools, etc.—often to remote areas;
- important secondary benefits include the integration of tree planting with other land uses, and the environmental role of forests.

Land availability and high productivity

Many tropical countries have low population densities and large areas of virtually unused land. Much land, ill-suited to agriculture, is potentially available for forest plantations (Evans, 1984).

Forest plantations have a comparative advantage in their capacity for sustainable wood production, being four to 15 times more productive than natural forests (FAO, 1994, and Burgess, 1993, in De Gier, 1995). Furthermore, Sargent and Bass (1992) indicated some advantages of industrial forest plantation over natural forests, namely:

- The ability to select the forest location, infrastructure, transport and labor opportunities.
- The greater ability, relative to natural forests, to protect the boundaries and control the use of plantations. Other things being equal, investment will be preferentially attracted to plantations.
- The ability to pre-determine fiber supply characteristics through species/variety selection.
- The ability to apply "industrial" techniques to better regulate input and output in circumstances of bulk demand and industrial imperatives for efficiency, and hence to produce socially desirable products at the lowest possible cost.

Discouraging factors

However, factors that discourage plantations were also indicated by Sargent and Bass (1992). These are:

- The continued availability of forest products from natural forests at lower costs than those from plantations.
- The availability of cheap wood imports.
- The high price of capital in many rapidly developing economies.
- The fluctuation of plantation policies. This factor encompasses a range of unknowns:
    - ◊ difficulties in assessing future markets and forecasting demands
    - ◊ uncertainties about technological changes and the consequent demands for wood
    - ◊ changing assessments of the silvicultural possibilities of producing products of the desired quality
    - ◊ hence, changing assessments of the economic viability of plantations over the rotation
    - ◊ and, today especially, concern about changing climatic and pollution conditions over the life of a plantation crop.
- Risk reduction. Many land use policies have tended to favor risk reduction and the gain of more immediate benefits. In particular, they have favored short-term agricultural production on cleared land.

According to ITTO (1993), poorly designed plantations may even accelerate erosion, water pollution and streambed sedimentation. In some cases, plantations have been established but not adequately maintained. In other cases, plantation forests have successfully reached maturity—only then was it discovered that there was no market for the species grown. There is therefore a real need to ensure that the establishment of industrial tropical timber plantations does not lead to an over-production of particular species or classes of forest products, similar to the over-production of many agricultural plantation crops that has occurred in the tropics with such devastating economic consequences.

2.1.2 The perspective of sustainability

The German term for sustainability (*nachhaltende*) made its appearance in the very first forestry textbook published in German, in 1713, and consequently underwent many changes as to definition, context and meaning. The concept of "sustainability" was joined in the course of the 19th century by the concept of the "role of the forest in nature". In the 20th century, there followed the forest political theory of the different forest functions and, finally, the modern sustainability concepts (Schuler, 1998).

Principle 4 of the Rio Declaration on Environment and Development (UNEP, 1992) states that in order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it. The concept of sustainable development represents the challenge to reconcile the objectives of maintaining the long-term ecological resource base and short-term economic development (Van Pelt, 1993). Ecologically sustainable development refers to the situation whereby the present generation limits its use of natural resources, with the aim of offering future generations the opportunity of achieving morally acceptable welfare levels. The idea that existing ecological conditions will set limits to resource use by IFP projects is essential in sustainability-oriented projects.

In terms of forest management, Sayer et al. (1997) observe that sustainability is not merely an issue of natural forests versus plantations, or clear felling versus selection logging systems; it involves more fundamental questions about the functions and services provided by forests, and about stakeholders, equity and expectations.

A generally accepted definition of sustainability that was given by The World Commission on Environmental and Development (Brundtland, 1987) is used as the main reference in this research: sustainable development is "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs". "Needs" may be interpreted in terms of social welfare levels; "ability" refers, among other things, to the availability of ecological resources.

2.1.3 The concept of sustainability in IFP land allocation

The role of plantations in the environment must be judged by the criterion of "sustainability". A forest plantation can play an important role in environmental protection, e.g. by preventing erosion, controlling water run-off in catchment areas, and providing shelter from wind and heat and against sand and dust storms. Also important in the environmental context are the integration of plantations with farming (agroforestry) and the raising of agricultural yields by lessening environmental hazards. The eventual role of a planted forest in the general pattern of resource use depends on a mix of social, economic and environmental factors. Decisions on location, site, species, silviculture, management and objectives must therefore comply with local and national political, social, economic and environmental conditions. Of central importance are the purpose and functions of planted forests and the way in which these are achieved.

The Ministerial Conference on the Protection of Forest in Europe, held in Helsinki in 1993, defined "sustainable management of forests" as the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity and vitality, as well as their potential to fulfill, now and in the future, relevant, ecological, economic and social functions at local, national and global scales, and which does not cause damage to other ecosystems. This definition gives an appropriate basis for the discussion of sustainability in structuring the model of IFP land allocation in this research.

Principle 2 of ITTO guidelines for the establishment and sustainable management of planted tropical forests (ITTO, 1993) states that provisions for the establishment and sustainable management of planted forests must be considered in the context of an integrated land use plan for national economic and social development. Thus planted forests should normally be established only on lands known to be capable of supporting all aspects of their long-term management and utilization without soil degradation. The creation of plantations must be balanced with the need for protecting the site and environment and for conserving biological diversity of all types, the needs and aspirations of the present people, and the potential demands of future generations.

Zonneveld's (1990) concept of sustainability wraps up the above discussion. He observes that sustaining desired ecosystem conditions requires management goals and actions to fall within the intersection of three spheres: that they be simultaneously ecologically viable (environmentally sound), economically feasible (affordable) and socially desirable. If the balance between these three criteria is not reasonable, it is highly likely that the desired conditions will not be sustainable because of failure in one or more of the spheres (Figure 2.1).

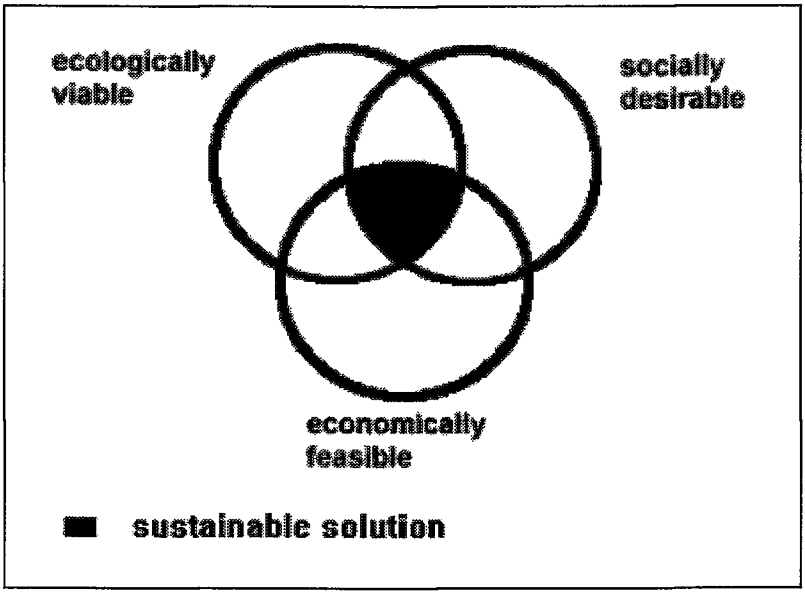


Figure 2.1. Ecosystem management (after Zonneveld, 1990)

2.2 The decision making process

2.2.1 Definitions

In this dissertation, decision making about land allocation will be considered to be solving a problem. We shall use the definition presented by Bots (1989), an adapted version of Ackoff's problem definition (1981). This definition places humans at the center of problems and problem solving:
"By a problem we mean a situation that satisfies three conditions: first, a decision making individual or group has alternative courses of action available; second, the choice made can have significant effect; and third, the decision maker has some doubt as to which alternative should be selected."

2.2.2 Phases in decision making processes

When attempting to understand the decision making processes, mention must be made of Simon's model, which depicts human decision making as a three-stage process. These stages are (Simon, 1960):

- intelligence: problem identification and data collection, searching for conditions that call for decisions;
- design: inventing, developing and analyzing possible courses of action;
- choice: selecting a course of action from those available. A choice is made and implemented.

The decision making process is an iterative process. The activities in the process may need to be repeated several times before the management alternative (decision) is finally determined. The result of each activity needs to be evaluated by the decision maker. In the case that the result is rejected, there may be a return to a preceding phase.

Working on the basis of Simon's model, many efforts have been made to refine it in practical terms; for instance, Mintzberg et al. (1976) extended the Simon trichotomy to include decisions that involve many stakeholders. They distinguished a number of different decision categories (see Figure 3.2). These categories were distinguished according to the stimuli that evoke a decision, ranging from *opportunity decisions* in cases of improving an already secure situation to *crisis decisions* in cases of intense pressure where immediate action is necessary. *Problem decisions* fall in between *opportunity decisions* and *crisis decisions*, evoked by milder pressure than crises.

Four types of solutions to the decision problems are distinguished, namely: decisions with a given *fully developed solution* at the start of the process, those with a *ready-made solution*, those with a *customized solution*, and those with a *modified ready-made solution* that combines ready-made and custom-made features.

The central framework of the theory of Mintzberg et al. is the elaboration of routines in each of the decision making phases. In the identification phase, there are two routines: decision *recognition* and *diagnosis*. *Recognition* itself is the process in which decision makers become aware of the fact that there is a problem. The first step following recognition is *diagnosis*. *Diagnosis* is required to acquire and combine information to clarify and define the problem. Although *recognition* is the starting point, *recognition* and *diagnosis* can be an iterative process before the next phase is entered.

The development phase is the heart of the decision making process, which results in the development of one or more solutions for the problem at hand. Development can be described in terms of two basic routines: *search* and *design*. *Search* is evoked to find *ready-made solutions*. *Design* is used to develop *custom-made solutions* or to modify *ready-made* ones.

The selection phase is considered to be the last step in the decision process and, because complicated decision problems are divided into sub-problems, it is entered many times during the development phase. In this phase, Mintzberg et al. (1976) distinguish three routines: *screening, evaluation/choice* and *authorization*. The evaluation/choice routine is used to determine the feasibility of the solution(s) and to choose a course of action. In many cases, especially when a government is involved, the course of action also has to be authorized by a higher level. The evaluation/choice routine may be considered to use three modes: judgment, bargaining and analysis. Analysis is the factual evaluation and is generally carried out by technocrats. In the case of judgment, one person makes the choice, whereas in the case of bargaining a group of decision makers with multiple objectives make the choice together. The *bargaining mode* results in various design cycles.

2.2.3 Organizational decision making

Browne (1993) identifies four main approaches in which decision making relevant to organizations has been studied in recent times. These can be summarized as follows:

Prescriptive or Normative
This approach sets down the "best way" and describes how decision making should be carried out in a well-run organization. The inference is that if you do not follow the approach your decision will lack quality.

Descriptive
The descriptive approach tells it like it is and is concerned with what actually happens in an organization rather than what someone thinks should happen. It is based on observation of the real world of organizations and allows for the influence of values and the environment, and for an element of non-rational behavior.

Analytical
This approach assumes that decision making takes place in one of three situations: certainty, risk or uncertainty. The analytical approach is based on the quantitative disciplines, and it uses mathematics, probability, linear programming and other techniques to model decision processes and predict decision outcomes.

Behavioral
The human aspects of decision making are the focus of interest here. This approach, by focusing on the person, seeks an understanding of how decisions are made and how information is used in the process.

In this dissertation the main stance taken is a descriptive one, using models that make predictions on the basis of available data in the social, economical and ecological domains.

Furthermore, Browne (1993) elaborated models of strategic organizational decision making that can be linked to the above categorization, namely:

The classical, rational model
This model is considered prescriptive or normative, that is, it describes what ought to be. Important assumptions in what is called the rational model include:

- decision makers have complete information about the situation in hand;
- decision makers know all that the alternatives offer and the consequences of choosing each one;
- decision makers will choose the alternative that will maximize efforts;
- decision makers have only one goal, and power, bias or conflict have no role in the process; and
- the decision is being made by one person alone.

The bounded rationality model
This model is considered descriptive of non-routine decisions, therefore, of what actually happens in organizational decision making. The assumptions in this model are:

- not all alternatives are known;
- not all possible choices or actions are known; and
- the consequences of choices or actions are not known.

In the decision process occurring within the framework of bounded rationality, the decision maker would look for a satisfactory solution by means of sequential searching and evaluation of information on alternatives.

The political model
The political model has much in common with the bounded rationality model. The model focuses on compromise or bargaining strategies in decision making and sees the process as being concerned with finding an alternative that is acceptable to all interested parties. Other characteristics of the political perspective of decision making are that:

- it does not consider all alternatives but rather those that differ from existing policies;

- it considers only a small number of alternatives and for these only a restricted number of consequences;
- it continually redefines the problem, with countless adjustments to make the decision more manageable;
- there is no one decision or "right" choice but instead a series of attacks on the problem by individual analysis and evaluation;
- it focuses on short-term rather than long-term problems.

From the prescriptive perspective, the point of departure for discussing decision making in organizations is the notion that the decision making is rational. This means that the required information should be complete, accurate and available. In practice, this rational decision making is rarely obtained. Consequently, in many publications the discussion of decision making theory has shifted to the phenomenon that Simon (1976) dubbed "bounded rationality". In this study, bounded rationality is the assumption. However, we acknowledge the crucial importance of the political model in the daily life of the IFP company. The aim in this work is to provide the stakeholders with analytical tools that can wider the bounds of their rationality.

2.2.4 The structure of problems

The type of problem determines which phase of the decision making process should be emphasized. Several problem taxonomies have been developed. Simon (1960) describes the most widely quoted taxonomy as the one that categorizes problems as either well-structured (programmed decisions) or semi/ill-structured (non-programmed decisions). An ill-structured problem has no definitive formulation (Bots, 1989). It requires more emphasis on the intelligence and design phases of the decision making process (Van Schaik, 1988). The uncertainty inherent in ill-structured problems often means that the greatest difficulty in finding the solution lies in actually defining the problem (Riemenschneider and Bonnen, 1979).

By contrast, a problem is said to be well-structured if the goals, as well as the set of possible instruments, are clearly understood and under control, and, consequently, the solution to this problem can be found in a programmed manner. A well-structured problem requires more emphasis on the choice phase of the decision making process (De Man, 1985).

Since in this study the relevance of the allocation to many stakeholders is one of the points of departure, it follows that the problem formulation cannot be taken for granted, so that the problem should be considered as ill-structured one.

2.3 Decision support systems (DSS)

2.3.1 Definitions

Concerted research efforts to aid human decision making commenced in the 1950s and pre-date both the advent of the commercial computer and the coining of the term "decision support systems" (Copas et al., 1991). In the early '70s, the concept of decision support systems (DSS) emerged, concentrating on computer-based support for ill-structured management problems. The term "decision support systems" was first used by Gorry and Scott Morton (1971) in their article "A Framework for Management Information Systems" to describe a new class of information systems (Bots, 1989). They defined a DSS as a system that focused on managers' decision making activities and needs while extending their abilities.

The goal of a DSS is to increase the decision making power of the human by providing easy access to useful data, information and knowledge. This implies that the focus is on the quality of the decision process rather than on the quality of the final decision or—in the terminology of Simon—the objective is to improve the procedural rationality rather than the substantive rationality of a decision process (Janssen, 1992).

Rauscher et al. (1995) observe that DSS are systems that help managers make decisions in situations where human judgement is an important contributor to the problem-solving process, but where human information processing limitations impede decision making. As a consequence of the diversity of definitions, Silver (1991) provided an extremely broad definition: "A DSS is a computer-based information system that affects or is intended to affect how people make decisions."

It is important to understand that DSS only assist people who are responsible for making decisions; DSS cannot make the decisions themselves. Ahituv and Neumann (1982, in Checkland and Scholes, 1990) succinctly express this conventional view:
"It is important to note that design-aid systems never replace human decision making! They are capable only of supporting decision making processes. At this level of management there are always additional factors that cannot be computerized, such as morale and ethics. Therefore, we often call them decision support systems (DSS)."

In summarizing this diversity of definitions, Emery's views (1987, in Silver, 1991) on DSS provided a proper expression:
"A decision support system provides computer-based assistance to a human decision maker. This offers the possibility of combining the best capabilities of both humans and computers. A human has an astonishing ability to recognize relevant patterns among many factors involved in a decision, recall from memory relevant information on the basis of obscure and incomplete associations, and exercise subtle judgements. A computer, for its part, is obviously much faster and more precise than a human in handling massive quantities of data. The goal of a DSS is to supplement the decision powers of the human with the data manipulation capabilities of the computer."

Another term in the field of DSS should also be mentioned, namely: spatial decision support systems (SDSS). SDSS are described by Densham (1991, in Eweg, 1994) as systems explicitly designed to support a decision research process for complex spatial problems. SDSS provide a framework for integrating database management systems with analytical models, graphical display and tabular reporting capabilities, and the expert knowledge of decision makers.

The terms DSS and SDSS are being increasingly applied to GIS in the geographical literature (Armstrong and Densham, 1990). GIS are often implicitly designed to support users in their decision making (Copas et al., 1991). In developing countries, where natural resources provide a major source of income to support development, geographical information systems (GIS) have potential benefits not only as an inventory and mapping tool, but also increasingly as the basis of spatial DSS (De Man and Weir, 1995).

DSS definitions will continue to vary because as technology advances, new forms of computer-based decision support are continually being invented (Silver, 1991). Fedra and Reitsma (1991, in Eweg, 1994) pointed out that there is no generally accepted definition of DSS: "any computer-based system from database management or information systems via simulation models to mathematical programming or optimization could conceivably support decisions." We shall adopt this broad perspective of DSS, avoiding to apply any label or narrow definition. Graphical displays that allow for visual pattern recognition will certainly be an important element in the IFP land allocation decision.

2.4 DSS research for forestry

2.4.1 Introduction

Much of the work of forest managers concerns making decisions and solving problems. In doing this, the forest manager has to take into account that a forest is a very complex ecosystem in which many variables determine the state and the course of development of the system (Bos, 1996). So making decisions in forest management is a very complex process. When managing forests for multiple use, decision making is complicated by non-complementary relationships between functions: a change in characteristics that promotes one function may hinder another. The forest manager must therefore anticipate the long-term as well as the short-term effects of his decisions (Johnston et al., 1967, in Bos, 1996).

Basic decisions in forest land use planning

The basic kinds of planning decision found in forest land use planning, including development projects and forest management, are as follows (FAO, 1984):

1. What kind of land use? Such decisions include the conversion of forests to agriculture; the conversion of other land uses to forestry, as in the establishment of forest plantations; and the allocation of land among different uses.
2. What kind of forests? The basic choice is between forests intended first and foremost for timber production and those in which conservation is the primary aim.
3. What kind of forest management? This decision relates to choosing methods of forest management designed to achieve specific aims.

Decision space in forest management

The decision space in forest management is restricted by some constraints that complicate decision making in forest management. The complications arise from a number of related sources (see also Bos, 1996):

- many of the goods and services produced by a forest are difficult to quantify (intangible);
- goods and services are often non-marketable;
- natural processes (the inherent uncertainty attached to natural processes);
- length of production period (risk and uncertainty are attached to the desired future forest);
- trees are the product, stock and production factor.

Multiple use complicates decision making in forest management. It leads to not only additional decisions, but also to the need for extra information—related to multiple production processes—which is not always available (Bos, 1996).

Managing forests for multiple values such as visual quality, wildlife habitat, wood products and watershed protection, while maintaining the sustainability of the full system in an integrated manner is even more difficult and complex. This situation defines a classic need for decision support systems to assist in developing and defining both problems and solutions in forest management (Rauscher et al., 1995).

2.4.2 DSS for forest management

Managers need good assessment and decision support systems that enable stakeholders to participate in decisions, costs and benefits. Sayer et al. (1997) mention that the important technologies for sustainable forestry are those that foster better communication between stakeholders and allow informed decisions spanning scales from gene to ecosystem.

Erdle and Wang (1992, in Hunt and Jones, 1994) identify three general requirements for a forest management DSS:

- the ability to address the effects of forest management activities on a number of resource values such as timber, wildlife, water, etc.;
- the ability to accommodate a flexible management strategy, including types of treatments, geo-administrative and management control factors, and dynamic treatment allocation criteria; and
- the capability to work with flexible, geographically explicit forest land units, ranging from sub-stands to the whole forest.

In the years to come, decision makers may expect to have better information through the integration of remote sensing, GIS and other technologies into decision support systems. In the field of forest management, efforts to develop DSS have been concentrated in the developed countries. These DSS include those given below:

- From Canada: The *FORMAN2000 Forest Management Decision Support System* focuses on three distinct decision making stages, i.e. *management design, management implementation* and *management assessment.* These stages are identified as a logical framework of the research and tied together with a GIS database and data processing tools (Jordan and Wightman, 1993).
- From the USA: The *Forest Management Advisory System (FMAS)* is a DSS for the management of even-aged stands of aspen and red pine, where timber products are the only objectives (Nute et al., 1995).

- From Australia: The *Forest Zoning System* demonstrates the application of a five-component model to design an SDSS (spatial DSS). These five components are: the current world, the solution, the desired world, the evaluation function and the gap function. These permitted uses range from strict preservation to replacement by plantations. This SDSS aims at policy formulation for the preservation, conservation and use of Australian forests (Cameron and Abel, 1997).

The development of a GIS-based DSS for forest management in Indonesia is still in its infancy. However, the awareness among decision makers at higher levels of forest management in both government and private forestry organizations about the capability of GIS to support spatial decision making has grown since the early '90s (Yanuariadi, 1991). This will accelerate any efforts to develop spatial DSS to solve problems in forest management. A spatial DSS is essential in solving the land allocation problem in the IFP development. This is an ill-structured problem on which uncertainty, lack of data and ambiguity of goals involve in causing the ill-structuredness.

Beulens (1990) makes a number of pragmatic observations about organizational factors that affect performance requirements for DSS:

- It is difficult to give automated support for tasks that are unstructured in respect to problem demarcation or available data. DSS usually need high-quality data.
- Managers deal with tens of problems simultaneously. Thus they may have to use various DSS at the same time for related problems. This may be too demanding, resulting in failure to use the systems.
- Organizational roles and procedures determine which role a DSS user plays in decision making. A planner's perspective may not be beneficial to the organization as a whole.
- DSS are not always available when needed.
- DSS usually change the work of their intended users. This means that implementing DSS is a process of organizational innovation, not just a new way of doing the same thing. The consequences cannot be foreseen, so one should be prepared to respond creatively to unexpected developments.
- Organizations change continually. Usually, DSS are not sufficiently adaptable to cope with this.

The above observations may be useful to decision makers when deciding whether they need a DSS or not in making decisions. Furthermore, Beulens (1990) remarks that in so far as a DSS requires a certain decision making procedure, "building and implementing DSS can heavily affect the organization of decision making processes and the tasks to be performed by users. It must be regarded as an organization innovation process that may have a great impact on the organization."

This is because, if a DSS is to be effective, its use must be integrated in the decision making process. Beulens also remarks that, to mitigate any disruptive effects of DSS introduction, a DSS must be flexible and adaptable to changes in the problem context, in the organization and in the decision making process.

Apparently, in the field of forest management, there should be an ideal system that can provide extensive support for the organization. This ideal system should have a number of functions (Hunt and Jones, 1994):

- to effectively solicit, synthesize and incorporate multi-stakeholder values and regulatory requirements;
- to be able to organize, maintain, access and report on all forest land information required to monitor resource values, conduct management planning functions, and control and schedule resources;
- to construct, project and compare multiple alternatives and outcomes for medium- to long-term management plans that meet wood supply and product requirements, include wildlife habitat and population goals, comply with water quality and quantity regulations, and consider many other similar resource values;
- to translate strategic goals into feasible, tactical plans at the operational level, in terms of where (analysis within a geographically referenced framework), when (determine a schedule) and how (allocate methods and resources required for activities such as road building, harvesting, site preparation, habitat enhancement, recreational development, etc.);
- to monitor resource flows, processes and qualities (indicators), and record events approximately as they occur and report on them relative to the initial management objectives and goals; and
- to have the ability to reiterate all the above functions regularly (i.e. adaptive management).

Chapter

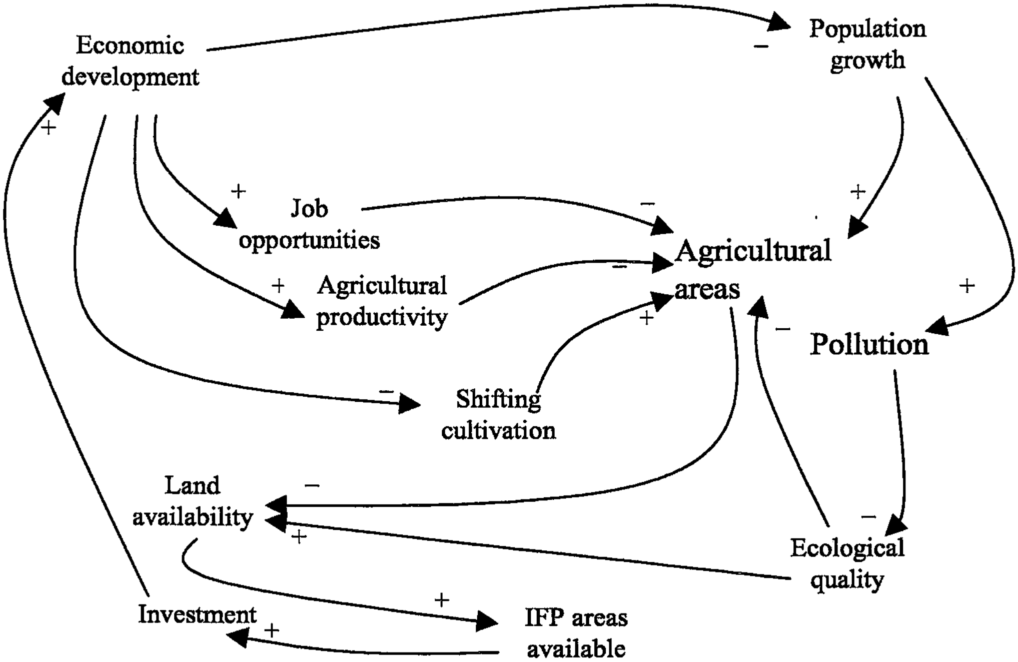
3

IMPROVING THE LAND ALLOCATION DECISION MAKING PROCESS

3.1 Problem structure of IFP land allocation

To appropriately solve the problem encountered, i.e. to improve the effectiveness of decision making in land allocation for IFP project development, the problem should be diagnosed (in terms of Mintzberg's model, Figure 3.2) in a way that can depict interfaces between the influencing factors and their relationships. According to Keen and Scott Morton (1978), the effectiveness involves identifying what should be done and ensuring that the chosen criterion is the relevant one. The picture of the relationships among the factors justifies the use of scenarios in the development of models to improve the effectiveness of decision making.

For the above purpose, a *causal diagram* (Figure 3.1) was made to delineate the structure of the decision making problem in IFP land allocation. The factors that influence decision making are contingent upon macro-economic and societal development. A positive growth in ***economic development*** will reduce ***population growth***, increase ***job opportunities***, increase ***agricultural productivity*** and reduce ***shifting cultivation*** activity. Increased job opportunities and agricultural productivity will certainly reduce the need for ***agricultural areas***. Meanwhile, an increase in population and shifting cultivation will also lead to increasing demands for agricultural areas, and more ***pollution***. With more pollution, the quality of ***ecological areas*** is reduced. Increase in agricultural areas will reduce ***land availability*** for IFP development, whereas increase in ecological quality will increase the availability of land. Increase in land availability will increase the availability of ***IFP project areas*** and in turn increase ***investment***. If more investment is taking place, then economic development will also increase.



Note: "+" indicates that if variable at the back of the arrow increases, then the variable at the front of the arrow will also increase; "-" indicates that if variable at the back of the arrow increases, then the variable at the front of the arrow will decrease.

Figure 3.1 Causal diagram showing interconnected factors of the decision making problem in IFP land allocation

3.2 The IFP land allocation decision making process

3.2.1 Introduction

This research takes the IFP company, which is formally held responsible for the IFP land allocation decision, as its main problem owner. The decision making process that will be supported is primarily the IFP company's. However, as was argued in the previous paragraphs, the potential success of a particular allocation of IFP land heavily depends on factors that are outside the IFP company's span of control. Likewise, the IFP land allocation decision affects the lives of many people who could undermine its success if they resented the decision.

Therefore we understand allocation of forest land for IFP project development as finding a consensus between the objectives of various stakeholder groups: the Government, the IFP company and the local people. Hence, the allocated forest land for IFP development can be considered as a compromise between the determinants of economic viability, ecological soundness and social acceptability (representing the respective stakeholders' objectives). A balance between these three determinants of IFP land allocation is complex and difficult to obtain. If high-quality decision making is to be achieved, then the decision maker needs to see through the problem and its complexities. The problems inherent in the land use decision making process, as described by Ells et al. (1997), are as follows:

- the objectives of society are ill-defined;
- the values that society attaches to various forest activities (such as recreation or the preservation of biodiversity) are imprecise at best, or simply unknown;
- the effects of silviculture and other forest management decisions are uncertain, from both a biological and a socio-economic perspective;
- land use and silvicultural decisions often pertain to a distant and an uncertain future; and
- there is uncertainty about forest tenures, the macro economy, future product prices, and the ability of, or need for governments to reduce deficits/debts.

The complexity of the decision making process in IFP land allocation was discussed in Chapter 1. This discussion recognizes the need to understand the objectives of each IFP stakeholder and to decompose the problems accordingly. To cope with the above difficulties and with the involvement of the stakeholders in solving the decision problems, it is necessary to improve the ongoing decision process in allocating land for IFP development. For this purpose, the current process of decision making is analyzed, indicating the bottlenecks. IFP land allocation is a multilevel form of decision making, involving decision processes at national, regional and implementor levels. The Mintzberg et al. (1976) model of decision making phases is used to represent the decision making process in IFP land allocation. With this model, the nature of the decision can be analyzed in terms of process, information measurement, effects and the decision environment. In Mintzberg's terms, IFP land allocation is best viewed as a problem decision with a customized solution.

Estimates of impacts from decisions can be obtained from model calculations and, ultimately, used as inputs for improving decision making and thus policy and management. The modeling of the object system, i.e. the IFP land allocation DSS, is to be carried out by investigating and modifying existing models relevant to the object system. This is done by developing the concept of modeling land allocation for IFP development, based on the integration of the information requirements of the parties involved. The conceptual model is then to be implemented in the study area (the IFP project of Pulau Laut, Indonesia) using information technologies such as the GIS tool, in order to assess their capabilities to support decision makers in spatial planning. In our present world, decision making is shared between the human and mechanized components of man-machine systems (i.e. computers).

3.2.2 Current IFP land allocation decision making

As described in Chapter 1, to reduce the problems associated with forest depletion and increasing domestic and world demands in wood consumption, there is the opportunity to develop sustainable wood production in unproductive forest areas. In this regard, the Government of Indonesia has introduced the IFP development programme.

The above approach represents a decision process associated with allocating unproductive forest areas, which aims at solving the tension between pressure, on one side, and opportunity, on the other, to increase land productivity and environmental quality. In order to determine the decision process factors that can be supported by any information technology, a description of that process is needed. This decision process is strategic and of the kind studied by Mintzberg et al. (1976). It is depicted in Figure 3.2.

The IFP land allocation problem requires a customized solution. It means that a new solution to the problem will be introduced to replace the old solution. The decision process has similar characteristics to those of a *basic design decision process*, and can be called a *problem decision* since the development is intended to improve the existing situation by making better use of unproductive lands and improving the supply of wood. In special cases, for want of an acceptable solution the decision process may turn out to be a blocked design decision process. In this situation, solutions may be rejected in the evaluation choice because the payoff is too low; they may meet with constraints they cannot satisfy; or they may simply not appeal to those expected to authorize them. Faced with no acceptable solution, the decision maker may simply delay until a solution appears, or s/he may change the criteria so that a solution previously rendered unacceptable becomes acceptable. For example, we may face a blocked design decision process if the Ministry of Forestry (MOF) has a different opinion about the potential of the selected site (e.g. that it is more appropriate for conservation purposes). In this case, the decision process will not be completed within a given time, or may even be terminated.

In the implementation of IFP development, a plan by the IFP company to establish an IFP project leads to *recognition* that an IFP concession right has to be issued and that, consequently, land allocation for the IFP project is needed. This is the initialization of the decision process. *Diagnosis* is difficult in IFP land allocation as different values are placed on the forest resource for multiple uses (strong resistance to changing land use objectives and environmental measures by environmentalists; land tenure of local people). The decision regarding land allocation is part of a bigger set of decision processes related to national and regional forest land use planning and provincial spatial planning. This involves negotiations between the IFP implementor and the MOF, and between the MOF and the Provincial Government, but not with the local people who are affected by the decision and must bargain for their respective needs.

For the IFP land allocation problem, *design* is used to develop custom-made solutions, and is normally at first a rather vague idea about a solution. The decision in the *design* routine is factored into a sequence of nested design sub-problems of decision making process, which, when solved, lead to a clearer picture. In the case of IFP development, an external interruption can occur, creating a new design cycle when the planned forest land has uses that conflict with non-forestry sector development.

A characteristic of the decision problems in IFP land allocation is that the use of information in the process of decision making—particularly on the potential and legal status of forest land—is extensive but incomplete. An intensive and expensive field survey is required.

Effects of the decision occur in both the short term and the long term. To some extent, the decision may disturb the richness of biodiversity and may result in irreversible impacts. The decision is sequential and involves many participants in extensive negotiations with the local people. The needs of local people should be assessed through social surveys regarding their perception of IFP development.

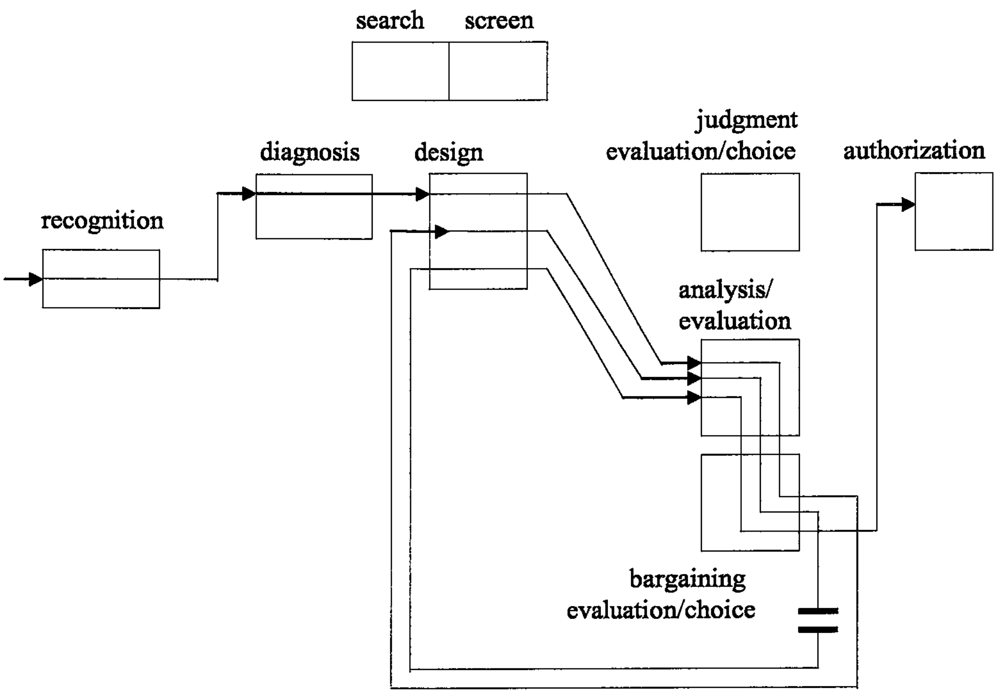


Figure 3.2 A basic design decision process: land allocation for an IFP project (adapted from Mintzberg et al., 1976)

3.3 Information requirements for the decision making process in IFP development

3.3.1 Information requirements

The importance of natural resources to Indonesia's economic wealth makes the need for information for natural resources policy and decision making a pivotal issue. The policy and decision makers must therefore have access to the information they need for this purpose. Salmona and Salomonsson (1973) state that a developing country needs data even more than a developed country. Proper decision making depends on information. The more adequate and accurate the information, the smaller the risk of making a wrong decision—and a wrong decision is something a developing country cannot afford to make since the cost involved is comparatively much higher than in a developed country. Clearly (in the Indonesian case), decision makers—and particularly policy makers—are lacking important information at the present time, and it is therefore essential to take the necessary steps to change this situation.

From the above discussion, it is concluded that the diversity of decision making results in a variety of information needs within an organization. The type and detail of information needed are related to the levels of decision making, and the information to be collected should reflect their information needs. The identification of specific information requirements for a particular level of decision making plays an important role in avoiding the supply of unnecessary information.

The approach to defining information requirements used here is UNESCO's *Conceptual framework and guidelines for establishing GIS* (De Man, 1984). It mentions two approaches to identifying users of information, i.e. (1) an inventory of existing flows and utilization of information; (2) an inventory of the relevant decision process and potential information users at different levels of responsibility.

3.3.2 Existing information situation of the organizations involved in IFP development

Investigation into the existing information situation leads to a discussion as to whether the situation is already satisfactory or needs further improvement. It also provides the possibility to identify the data and information needed by their users. Knowledge about the information and, consequently, the data needed is important because any discrepancy between information supply and information demand will propagate information gaps.

In general, data and information requirements for strategic decision making purposes within the framework of IFP development cover the following aspects (MOF, 1995):

- information on potential forest areas for IFP development;
- information on areas effectively planted under IFP development;
- information on growth rates and anticipated MAI (mean annual increments) of areas planted (based on species and site information);
- forecast or prediction of the expected future wood flow volumes from IFP development;
- information on planning and sustainability issues (costs, profitability, wood utilization, social and environmental impacts);
- information on employment and business opportunities provided.

Technically, required data to generate information encountered in IFP development can be categorized according to presentation type, namely: maps, remotely sensed data, tables and text.

Maps
Topography, forest land use by consensus (TGHK), forest concession, soils, geology, vegetation, hydrology, climate, land suitability, general land use, provincial land use planning, mining concession, non-forest plantation, proposed IFP project area, fixed IFP project area, annual plan area, planted IFP area and project boundary area.

Remotely sensed data
Landsat TM/MSS, SPOT, aerial photographs and radar imagery data (such as ERS and JERS).

Tables
Forest inventory (diameter, height, basal area, volume, age, density, species), tree growth (increment, rotation) and yield table (volume/ha, age, site class).

Text
Available literature/documents/publications/reports (soil, climate, forest potential, silviculture techniques, species characteristics and other related subjects), weekly reports of the project (technical aspects of establishment), monthly reports of the project (technical and financial aspects of establishment), yearly reports (development progress), feasibility study (technical, site, ecological, economic and financial aspects), master plan (general directions for development), annual plan (physical activities and scheduling), field observation notes/reports.

In describing each type of data, two matrices were prepared. The first matrix addresses the consumers (indicated as "C") and producers or providers (indicated as "P") of data according to the agencies. The second matrix addresses data used (indicated as "U") and generated (indicated as "G") according to the phases of activities. These two matrices indicate the ideal situation based on involved agencies' functions in the case of consumers/producers of data, and based on practical and theoretical perspectives in the case of activity phases.

Table 3.1 shows the matrix of relationships between data production and consumption among the agencies involved in IFP development that were visited during fieldwork and the agencies that were not visited but are known to be data and information sources. The matrix also shows that some agencies can be a producer or consumer for only a certain type of data, while other agencies can be both a consumer and a producer. Another thing that can be derived from the matrix is that certain types of data can be produced by more than one agency. An agency may receive a certain type of data but, because the content is insufficient, the agency generates the same data in more detail.

Table 3.2 shows the matrix of relationships between the phases of activities in IFP development and the respective data required. It addresses the two main activities, i.e. the planning phase (feasibility study and environmental impact assessment, master plan, and annual plan) and the establishment phase (site design, species allocation, nursery establishment, pre-planting, planting, tending, forest protection, forest harvesting and product transportation). In the matrix, the required data are indicated by their utilization and production (indicated as "used" and "generated"). There is a possibility that a certain type of data is generated repeatedly in different phases. This is because the data need to be more detailed in the phase concerned.

3.3.3 Data problems and solutions strategy

The successful implementation of any information systems, especially GIS-based resource management, is seriously impeded in developing countries, not only by a range of managerial difficulties and organizational constraints, but also by a lack of data, poor quality data and inconsistencies in data derived from different sources. Recalling the information required for IFP development, problems do exist in the sources of the required data and information, such as inconsistencies in the demand and supply relationship, timeliness (with regard to updating the data and information process), and unavailable data and information.

The existing forest basemap (TGHK) used as the basis for making decisions in IFP development is not considered to have the level of detail (accuracy, scale) required for land use planning at project level. However, it provides the legal status for making decisions that are related to forest lands. Non-forest themes are collected from agencies outside the MOF, and in some cases the original scales and projections of the source maps are unknown. Differences in the standards applied by the sources of required data and information will result in inconsistencies and the production of useless information. This is due to the lack of understanding between suppliers and users in the need for information. There is a lack of information on forest potential as the Forest Inventory and Mapping Agency does not regularly conduct forest inventory activities. The use of remotely sensed data has a great potential to overcome this data and information gap.

Table 3.1 Matrix of data producers/consumers (continued on next page)

Agencies	MAPS																	
	Topo	TGHK	Forest Concession	Soil	Geology	Vegetation	Hydrology	Climate	Land unit.	Land use	Exist. land use	Mining	Non forest plant.	Proposed IFP	Fixed IFP	Annual plan	Planted IFP area	Boundary
DG of Forest Utilisation	C	C	PC	C	C	C	C	C	C	C	C	C	C	C	PC	C	PC	C
Dir. of Forest Land Use	C	PC	C			PC	C	C		C	C	C	C	C	PC		C	C
Dir. of Nat Conserv. Area	C	C		C		C	C	C						C	C			
Dir. of Reforestation				C	C	C	C	C										
Kanwil	C	C	C	C	C	C	C	C		C	C	C	C	C	C	PC	PC	C
Dinas	C	C	C								C			C	C	C	C	C
Biphut	C	C	C							C	C			C	C	C	C	PC
BRLKT				C	C	C	C										C	
Implementor Head Office	C	C	C	C	C	PC	PC	PC	C	PC	C	C	C	PC	C	PC	PC	C
Implementor Branch Off.	C	C	C	PC	C	PC	PC	PC	C	PC	C	C	C	PC	C	PC	PC	C
IFP Project	C	C	C	PC	C	PC	PC	PC	C	PC	C	C	C	PC	C	PC	PC	C
Bakosurtanal	P																	
Lapan																		
Min. of Transmigration										P								
Bappeda										P								
Dir. of Geology					P													
Center for Soil Research				P					P	P								
Meteorology Office								P										
Military Topo. Service	P																	
Bureau of Statistic																		

Note: P = producers; C = consumers

Table 3.1 (continued)

Agencies	RS data				Tabular			Text
	Landsat	SPOT	Aerial photo	Radar	For. inv.	Plant grow.	Yield table	Reports, plans, etc.
DG of Forest Utilisation	C	C	C	C	C	C	C	PC
Dir. of Forest Land Use	C	C	PC	C	C			C
Dir. of Nat Conserv. Area								C
Dir. of Reforestation					C	C	PC	C
Karwil	C	C	C	C	C	C	C	PC
Dinas	C	C	C	C				PC
Biphut	C	C	C	C	C			C
BRLKT					C	C	PC	C
Implementor Head Office	C	C	PC	C	C	PC	PC	PC
Implementor Branch Off.	C	C	PC	C	C	PC	PC	PC
IFP Project	C	C	PC	C	C	PC	PC	PC
Bakosurtanal			P					
Lapan	P	P		P				
Min. of Transmigration								
Bappeda								
Dir. of Geology								
Center for Soil Research								
Meteorology Office								
Military Topo. Service	P							
Bureau of Statistic								

Table 3.2 Matrix of data used/generated for each phase of activities (continued on next page)

Phases	MAPS																	
	Topo	TGHK	Forest conces-sion	Soil	Geology	Vege-tation	Hydro-logy	Climate	Land suit.	Land use	Prov. land use	Mining	Non forest plant.	Proposed IFP	Fixed IFP	Annual plan	Planted IFP area	Boundary
FS & EIA	U	U	U	GU	U	GU	GU	GU	GU	GU	U	U	U	GU				
Master Plan	U	U	U	GU	U	GU	GU	GU	GU	GU	U	U	U		GU			G
Annual Plan	GU	U	U	U					U	GU	U				U	GU		U
Site design	U									GU					U			U
Species allocation				U		U			GU	GU					U	U		
Nursery establishment	U			U		U	U								U			U
Pre-planting				U												U		
Planting				U												U	G	
Tending				U												U		
Forest protection	U		U			U	U	U		U					U	U		U
Forest harvesting																U	U	
Product transportation	U			U	U		U								U	U		U

Note: U = used; G=generated

Table 3.2 (continued)

Phases	RS data				Tabular		Text	
	Landsat	SPOT	Aerial photo	Radar	Forest inventory	Plant growth	Yield table	Reports, plans, etc.
FS & EIA	U	U	U	U	GU		U	GU
Master Plan	U	U	U	U	GU		U	GU
Annual Plan	U	U	U	U	GU	GU	U	GU
Site design	U	U	U	U	U		U	GU
Species allocation					U		U	GU
Nursery establishment	U	U	U	U	U			GU
Pre-planting					U			GU
Planting					U	G		GU
Tending					U			GU
Forest protection	U	U	U		U			GU
Forest harvesting	U	U	U		U	U		GU
Product transportation	U	U	U		U			GU

The integration of the required data and information for IFP development is necessary to overcome the lack of understanding between suppliers and users of information. In this way, "information-sharing alliances" should be stimulated. As Obermeyer (1991) and Obermeyer and Pinto (1994) suggest, we should consider the power distribution between the suppliers and users of information and follow a strategy to achieve an information-sharing alliance by bargaining, by appeal to professionalism and even by coercion. The strategy employed to achieve information sharing will depend primarily on the relative power of organizations involved. Figure 3.3 identifies which tactics are appropriate under which power structures.

		Owner of Information	
		Powerful	*Powerless*
Seeker of Information	*Powerful*	Bargaining	Coercion
	Powerless	Appeal to Professionalism	Bargaining

Figure 3.3 Distribution of power and strategies to achieve information-sharing alliances (Obermeyer, 1991; Obermeyer and Pinto, 1994)

There is an important additional benefit of sharing data, as Dangermond (1989) indicates, namely that it can reduce redundancy and inconsistency between databases. GIS technology helps to alleviate such problems through sharing data resources in a common database, thus eliminating the need for duplicate data. Of the agencies involved in the framework of IFP development, the powerful agencies provide non-forestry resources information such as soil, climate, geo-referenced data, etc. In order to have access to up-to-date data and meet data quality standards, the MOF should work in close cooperation with these agencies and create an information-sharing alliance. Efforts should continually take place to develop policies and mechanisms that promote, rather than inhibit, cooperation across organization boundaries.

3.4 The conceptual model of IFP land allocation

3.4.1 Introduction

Models are information generators. They permit the manager to understand his circumstances and to influence them through his decisions. Models also help the manager to ask better questions and to reformulate the purpose of his question (Duerr et al., 1982). So, we use models for understanding reality, i.e. for getting information about reality and for influencing it by predicting alternatives that can be ranked and acted upon.

A model in land allocation for an IFP project is developed to determine the future land development that can meet the objective of sustainable development. By testing different development scenarios and land consumption parameters, the model can be used in different areas of Indonesia that are under great pressure from competing land uses.

> A new wave of interest in GIS from the environmental sciences (i.e. ecology, biology, hydrology, etc.) is evident from the number of researchers involved in integrating environmental modeling with GIS. The difficulties of linking models to GIS, as well as the inherent problems associated with data/model quality and the resultant uncertainties surrounding model prediction, are recognized. Environmental modeling with GIS is generally deficient in that (Carver et al., 1995):
>
> 1) Confidence in the data is generally lacking, particularly where existing digital datasets are used.
> 2) Modeling can be divorced from field knowledge and local input.
> 3) The modeler is often unable to verify model predictions through direct field observations.

Eventually, the decision maker can use the model as a decision support system to allocate land for future IFP development based on the principle of sustainable development. The model can also be used to evaluate past land consumption and compare it with the rational land development generated by the model.

In Chapter 2, the principle of sustainability was intensively discussed. To clarify how sustainable development might be operationalized, the general features of development and development strategies are illustrated in Tables 3.3 and 3.4.

Table 3.3 General features of development (after B. Lane, in Satoh, 1995)

Non-sustainable	*Sustainable*
Rapid development	Slow development
Maximizes	Optimizes
Socially/environmentally inconsiderate	Socially/environmentally considerate
Aggressive	Cautious
Uncontrolled	Controlled
Without scale	In scale
Short term	Long term
Sectoral	Holistic
Remote control	Local control
Quantitative	Qualitative

Table 3.4 Development strategies (after B. Lane, in Satoh, 1995)

Non-sustainable	*Sustainable*
Development without planning	First plan, then development
Project-led schemes	Concept-led schemes
Development by outsiders	Local developers
Employee imported	Employment according to local potential
Development only on economic grounds	Discussion of all economic, ecological and social issues
Farming declines	Farming economy retained and strengthened
Community bears social costs	Developer bears social costs

3.4.2 The structure of the IFP land allocation DSS

Burrough (1996) observes that models should be parsimonious (not more complex than necessary), modest (not too ambitious), accurate (unbiased) and testable. He distinguishes four types of model, as follows:

- rule-based (logical models);
- empirical or black box (regression models);
- physical-deterministic or white box (process-based—in principle everything about the process is known);
- physical-stochastic (the process is only approximated by the model but probabilities are known).

The conceptual model of IFP land allocation is developed in a GIS-based manner, which basically follows rule-based logic models. Data inputs to the model, which provide values for model parameters and attributes, are the translated stakeholders' objectives, reflecting the needs of:

- the local people: *for job opportunities, access to forest lands for farming activities, and access to IFP products;*
- the IFP company: *for financial gain;*
- the Government: *for sufficient wood supplies, to make use of unproductive areas, to promote potential species, and for land conservation.*

The expected outputs of the model are optimal alternatives of land allocation for the IFP project. The IFP land allocation DSS is conceived as the integration of the sub-models accounting for stakeholders' objectives (i.e. the social acceptability sub-model, the economic viability sub-model and the ecological soundness sub-model). Figure 3.4 shows the steps in constructing the IFP land allocation DSS.

In the conceptual model, the methodological and the representation models that have been proposed and chosen will then be implemented in a real IFP development project. For this, as already mentioned in the introduction of this chapter, a study area has been selected, i.e. Laut Island in South Kalimantan, Indonesia, where the IFP project of PT. Inhutani II is located. The framework of the model is subjected to various kinds of evaluation, namely: simulation, comparison with actual practices, and discussion of the method used in constructing the model.

Roles of the model

The IFP land allocation model provides the means for IFP implementors to effectively and efficiently identify suitable areas for IFP projects. Essentially, the model is constructed to improve implementors' understanding of the problem of equitably accommodating the different stakeholders' objectives. The model of IFP land allocation, as a compromise between stakeholders' objectives, should be able to describe the relationships among their variables and identify the compromise land allocation for IFP development.

Model requirements

Because of the complexity in the decision making process of IFP land allocation, the model is required to define the scope of the problems. Preferably, the IFP land allocation model would tackle the question: "Which economic viability, ecological soundness and social acceptability variables contribute the most to decision making on land allocation for IFP development?"

The intended model should not be complicated, but should still reflect the stakeholders' needs. Therefore, the following issues must be considered when choosing a model to develop (Toxopeus, 1996):

- Can the model meet the user's objectives? The user is often forced to prioritize his needs and objectives and select the model with strengths in those specific areas of concern.
- Is the resolution and detail of the model appropriate for the intended use?

The considerations—as requirements that have to be fulfilled—in constructing the conceptual model of IFP land allocation were:

- The model should have the power to explain the relationships among variables within the framework of the land allocation process for IFP development in different locations. In other words, the challenge is to design a conceptual model that would adopt a sufficient degree of abstraction and flexibility to be applicable in a "country-wide" context.
- In each location context, the model should be able to reflect the dominant variables. Hence, the quantitative relationship between variables and their relative weights will be different in each location context.
- The model should also have the power to formulate assumptions about future development, such as predicting the continuous supply of timber or, in the socio-economic context, such as predicting the supply and demand of agricultural land.

Spatial and time dimensions of the model

The IFP land allocation model deals with spatial dimensions, and the spatial modeling approach is performed by linking GIS to the model. With a spatially explicit model, there is the possibility of getting a clear picture about the relationship between the land allocation process and the input data (e.g. remotely sensed data).

The gross area of an IFP project, according to the Government's criteria, consists of currently unproductive forest areas, which are the target of IFP development, and productive forest areas, which should not be used for IFP development. Moreover, due to the lack of information to categorize the forest into productive or unproductive areas, there may also be unknown areas. Spatially, the IFP land allocation model focuses on the values of variables within a given area, and assesses the area so that a distinction can be made between tracts proposed for IFP development and tracts that must be excluded.

The time dimension to be considered in the model is 50 years, following the term of an IFP concession right (35 years) plus one rotation of the main species (in this case assumed to be 15 years).

Selection of key variables

Any model involves assumptions for simplifying the problem. An important step towards simplifying reality is to select a few of the most important factors. The incorporation of too many variables into a model may render it analytically intractable. The factors included in a model are not necessarily the only ones that are important. However, a model should not fail to include factors that significantly affect the question under consideration (Lambin, 1994).

The relationships between variables may be differentiated as attribute relations and spatial relations. Zhu (1997) mentions that attribute relations are represented by analytical models (procedures composed of mathematical equations, such as arithmetic equations, probabilistic formulae, regression equations and linear programming functions) or rule-based models (set of knowledge-based rules that perform reasoning to infer the solution to a particular problem). Spatial relations are represented by GIS models (constructed using GIS analysis functions), which operate on spatial data or digital maps.

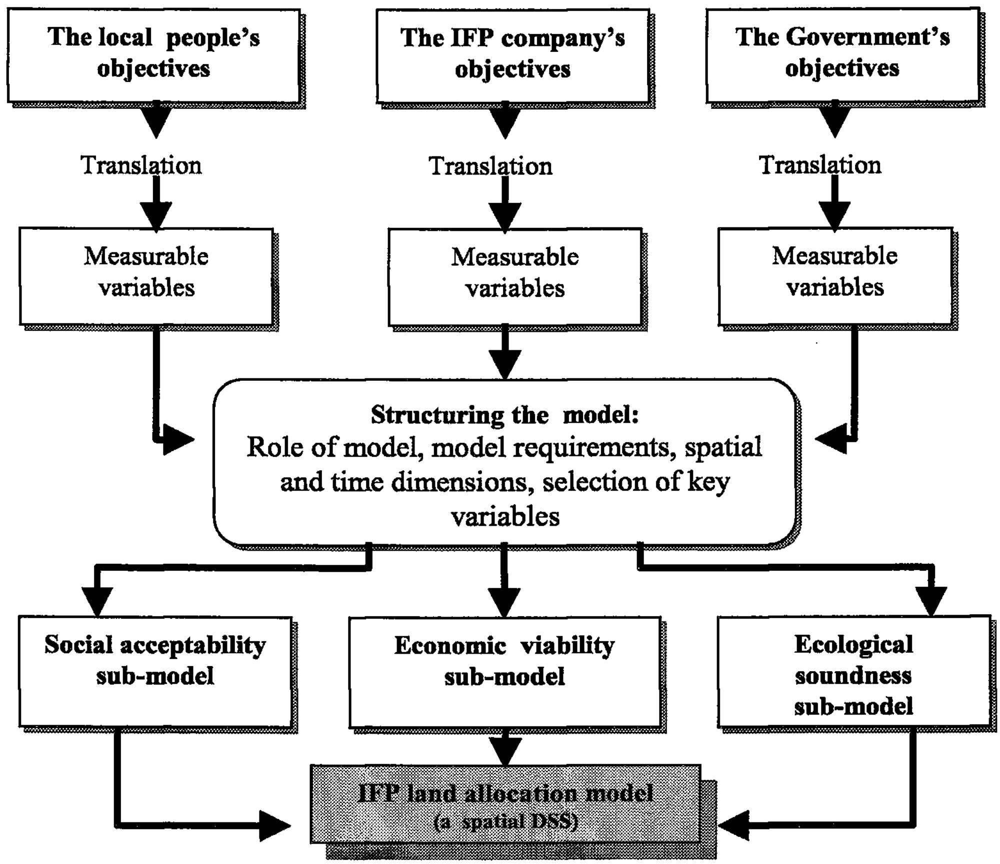


Figure 3.4 Steps in structuring the model of IFP land allocation

3.4.3 Social acceptability sub-model process

Social sustainability is a development process that brings about a steady growth with greater equity of income and asset distribution, to ensure a substantial improvement in the entitlements of the broad masses of population and a reduction in the gap in standards of living between the haves and the have-nots (Schreckenberg and Hadley, 1991). Failure to integrate economics and the environment has had profound social consequences. In the USA, decisions to sacrifice environmental quality for economic development have sparked charges of racism and cast into doubt whether practices that burden poor minority communities with environmental costs for the benefit of the majority are "sustainable" (Basiago, 1995).

Forest lands form part of the way of life of local communities. They may be used for gathering fuelwood, fruits or roots; hunting and fishing; grazing livestock; or for traditional shifting cultivation. Forests may also have a role in non-economic needs, for example, religious functions, the social element of hunting, or recreational use. Changes in land use have consequences for national and local objectives, such as employment, reduction in the numbers of landless people, regional development, or changes in income distribution among sectors of the community (FAO, 1984).

The sub-model of social acceptability deals with the projection of the local people's needs for agricultural land and off-farm employment provided by the IFP project. As long as the demand for agricultural land remains unsatisfied, the encroachment of forest areas will continue to take place. It is therefore necessary to predict the magnitude of agricultural land expansion over a certain time horizon and accommodate it in forestry development planning, including IFP development project planning.

Demand for agricultural land

The existing area production model (APM), originally developed by Nils-Erik Nilsson for FAO in 1984, will be used in this research. This APM-numerical is a simulation of land use changes in response to growth in population, growth in gross domestic product (GDP) and growth in agricultural productivity. On the basis of these three factors, the model can predict the amount of land that will be transferred from forest and other land uses to agriculture. The relevant part of the APM was transferred to a spatial model, using ILWIS-GIS (De Gier and Hussin, 1993; Bode, 1995).

In many developing countries, increasing demand for agricultural land is the most important factor for the land use changes. The APM model simplifies the process of land use transfer using the demand for new agricultural land. The agricultural development is assumed to be controlled by two parameters, namely (FAO,1986): demand and production.

Demand differs according to the types of crops. For example, the demand for subsistence crop is assumed to be controlled by the total population only. On the other hand, the demand for local market food crops and industrial/export is likely to be heavily influenced by economic factors and may not be projected through population. Production depends on productivity and area cultivated. Productivity increase is expected to be the most important of these factors in deciding the actual need for land. Increase in the crop productivity will reduce the need for land. This is because of more crops production can be produced from smaller size of agriculture area.

The original document of the APM model does not give the boundary conditions within which the model is applicable. Discussions with the researchers at ITC that used the APM model in their work revealed that the model is applicable in the situation where the positive demands of new land for agriculture are taking place. However, the APM model has a steering formula that rely on agricultural emphasis. The model does not take care the effect of other sectors development that may influence the demand for agricultural land. The simulation of land use changes needs information on the existing agriculture areas. On the basis of the information on the existing agricultural areas, the APM model predicts the agricultural expansion of each of the crops types (i.e. subsistence food crops, local market food crops, and industrial/export crops) and the aggregation of the three crop types. In this case, the result of the projected area will be in hectares.

The APM-numerical model has been tested in several developing countries and proved to be fit for the condition there (FAO, 1986). According to Hussin et al. (1994), the model has been tested by FAO in East Java, Indonesia, and by FAO and USAID in two parts of Peru. In both cases tropical rain forest areas were included. The conclusions were that the model was adequately and sufficiently adaptable for extension as well as modification.

The APM-numerical consists of five parts (FAO, 1986):

- land use simulation;
- supply and demand balance of biomass energy;
- plantation development and management alternatives to deal with simulated conditions of the biomass energy balance;
- simulation of the present forest resources under projected land use change and management policy;
- integration of the results from parts 1 to 4, and presentation of the simulation results.

In this study, only the first part of the model will be discussed, in which land use changes due to agricultural development are simulated. Land use is divided into three main land use classes, namely:

- agricultural land;
- forest land;
- other land.

These classes are further divided into 15 sub-classes, as shown in Figure 3.5. Definitions of some terms used in the land classification are described below.

- *Subsistence food crops*: agricultural crops cultivated to satisfy the basic needs of the people.
- *Local market food crops*: food crops cultivated for local marketing.

- *Industrial/export crops*: agricultural crops grown for industries or export.
- *Farm forestry*: forestry where the main purpose of management is to provide the farmer with fuelwood, fodder, fruit and tree products for own consumption (community forestry, village forestry, social forestry, subsistence forestry).
- *Industrial forestry*: forestry where the main purpose of management is to produce industrial wood such as sawn timber and pulpwood.
- *Environmental forestry*: forestry where the main purpose of management is environmental protection and conservation.
- *Potential agricultural/forestry land*: land not used as such, but with the potential for agricultural/forestry development.
- *Unproductive land*: land that cannot be used for agriculture or forestry (urban areas, deserts, high mountains, lakes, etc.).

When the demand for agricultural land is positive, the transfer of land from non-agricultural land (such as forests and other land) to agriculture will begin. Deforestation may be the result. In using the APM, the order of land transfer depends on the so-called priority rule (the sequence of land uses to be transferred to agriculture) set by the users. The order of transfer starts from the lower priority classes. Transfer of land from a higher category will not start until all the land in the lower priority class has been transferred.

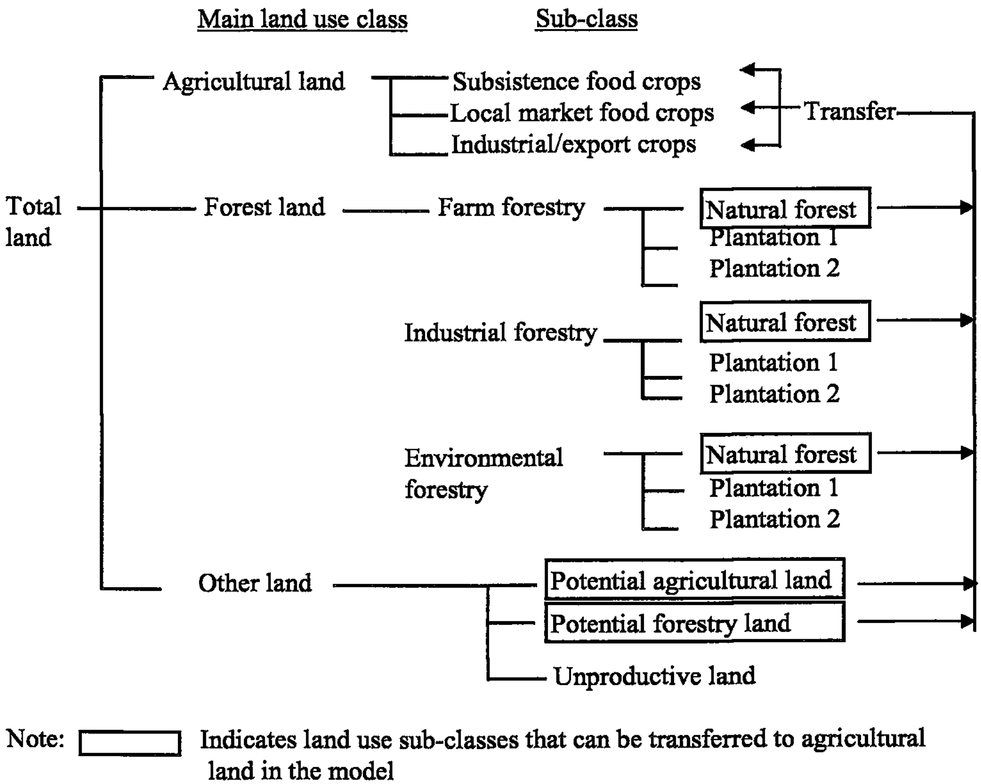


Figure 3.5 Land use classification according to APM categories

Operationalization of the variables of agricultural land demand

According to APM-numerical, demand for new agricultural land is calculated using the following formula:

Local market food crops

$$D_{mc} = PA_m * G_{GDP}/G_{pmc}$$

Industrial/export crops

$$D_{cc} = PA_c * G_{GDP}/G_{pcc}$$

Subsistence food crops

$$D_{sc} = PA_s * G_{pop}/G_{psc}$$

where:

D_{mc} = demand for new land for local market food crops

D_{cc} = demand for new land for industrial/export crops

D_{sc} = demand for new land for subsistence food crops

PA_m = present area for local market food crops
PA_c = present area for industrial/export crops
PA_s = present area for subsistence food crops
G_{GDP} = growth rate of gross domestic product
G_{pmc} = growth rate of crop productivity for local market food crops
G_{pcc} = growth rate of crop productivity for industrial/export crops
G_{psc} = growth rate of crop productivity for subsistence food crops
G_{pop} = growth rate of population

Total projected area of agricultural land demand is calculated using the following formula:

$$D_{agric} = (PA_m * (G_{GDP}/G_{pmc})^n) + (PA_c * (G_{GDP}/G_{pcc})^n) + (PA_s * (G_{pop}/G_{psc})^n)$$

where:

D_{agric} = projected area of agricultural land demand
n = number of years of simulation

The mathematical formula used to calculate the agricultural expansion allows any range of growth factors to be input. However, zero value of the growth factors can not be accepted because it will give an infinite result and negative value of the growth factors will give negative transfer of land or reducing the extent of agriculture areas.

In the absence of other data on model sensitivity or validity, the author performed a small sensitivity test of the APM model. In the case of subsistence food crops, if the denominator (i.e. the growth rate of crop productivity for subsistence food crops) or the nominator (i.e. the population growth) has negative value then the result of the model will indicate that the area of subsistence food crops will reduce. The relationship between the denominator and nominator of the formula for predicting the local market food crops and industrial/export crops has the same nature as in the case of subsistence food crops. If the denominator (i.e. the growth rate of the respective crop productivity) or the nominator (i.e. the GDP growth) has a negative value then the result of the model will indicate a reduction of the area for agriculture. However, this situation will hardly ever occur in reality since the farmers in Pulau Laut are asking for more and more land for their agricultural activity.

The projection of agricultural expansion can be simulated up to a period of 50 years. The situation in Pulau Laut falls in the range that all the three crop types can be simulated with the APM model. At least a negative demand for new agricultural area can not be seen to occur in many years to come.

Simulation of agricultural land expansion using APM-spatial

The construction of the APM-spatial to predict the expansion of the agricultural area is based on the numerical APM. De Gier and Hussin (1993) described how the spatial component was developed and linked to the model for the Kali Konto area in East Java, Indonesia. All spatial data used were in digital form. The results of this spatial implementation show the suitability of GIS for combining the spatial component and the numerical output from the APM. The results also indicated that the spatial component of the APM significantly improved the model's behavior and interpretation capabilities.

Figure 3.6 below shows the structure of the model in a GIS-ILWIS environment. The software used to run the APM-spatial is ILWIS 1.4 (non-windows version), in which the program of the model is written. Map Calculation (Mcalc) and Table Calculation (Tabcalc) are the major ILWIS facilities used to implement the employed rule-based spatial analysis.

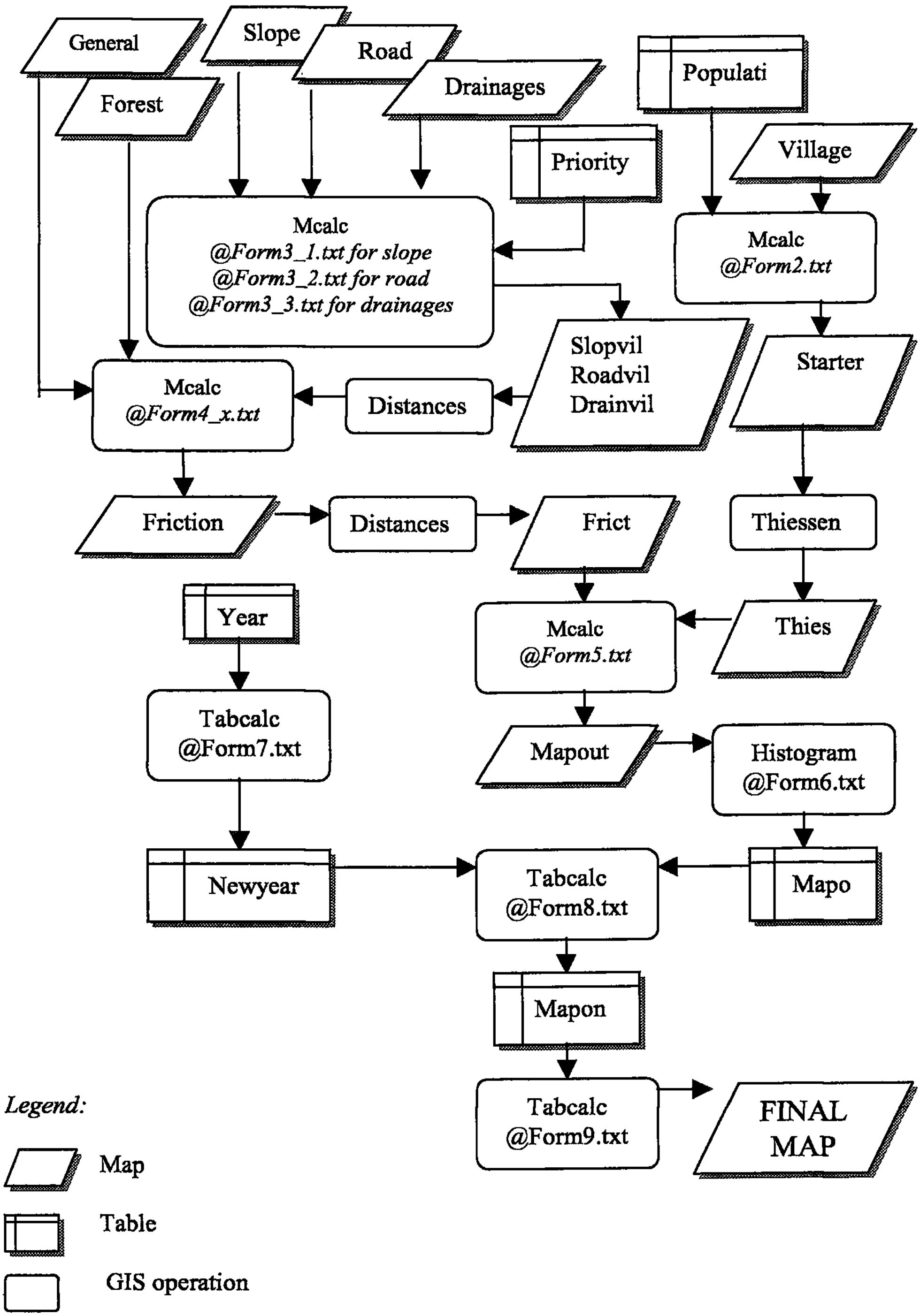


Figure 3.6 GIS procedure for the APM-spatial

Employment
The role of forest plantation in providing employment, particularly in rural areas where there is often serious unemployment and poverty, is an important consideration in assessing development value. Since IFP development is intended to provide employment for local people, the availability of labor will become a constraint factor for an IFP project. The availability of sufficient labor in the area will benefit the IFP project. Or to put it another way, if the IFP project provides few job opportunities, the degree of social acceptability of the project will be reduced. In the latter case, the IFP project should provide the local people with greater accessibility to the project area for such purposes as collecting fuelwood and carrying out agroforestry, among others.

Segerstrom (1976, in Evans, 1984) points out that forest plantation provides considerably more employment than the management of natural forest. For the clear felling and transport of timber in natural forests, he quotes an average of 60 man-days/ha and for the establishment alone of plantations about 100 man-days/ha.

The different types of species for IFP development (i.e. fast-growing species and local commercial species) and their different silvicultural systems mean that labor requirements differ accordingly. For each species type, the labor requirements are calculated on the basis of establishment activity, i.e. site preparation, planting, tending and nursery operations.

3.4.4 Economic viability sub-model process

Economics is, generally speaking, concerned with choice problems emerging from the alternative uses of scarce resources (Nijkamp, 1987, in Braat and Lierop, 1987). The management of planted forests for timber and other benefits can only be sustained in the long term if it is economically viable. Sedjo (1983) reports that the ability to control forest location will permit the selection of forest lands. Choice of plantation location also increases flexibility in developing a forest land configuration appropriate to efficiently providing wood feedstock to the processing mill. If they are properly located, high-yield plantations will require less land area to continuously service a given processing complex, thereby reducing road building and local transport costs. In addition, sites can be selected on the basis of desirable characteristics, in terms of terrain and other cost-reducing features.

Factors that can influence the value of forest land include (Filius, 1997):

- site quality for timber production;
- value of current timber stand;
- accessibility;

- distance to market for end products;
- institutional factors such as taxation and subsidies;
- expectation about inflation.

In this research, not all factors need to be taken into account in the sub-model. The necessary factors in any particular case are context-dependent. The sub-model cannot definitively explain all variations in land values and does not seek to do so. The intention to consider only certain factors in the sub-model is related to the development of the model in a GIS environment. The basis of the spatial dimension to quantify the economic value of land is the land mapping unit; such units enable tracts of forest land to be compared in terms of the value.

The economic viability sub-model should be able to identify the highest economic value of the selected land from the IFP company's point of view, in order that financial benefit may be obtained. For this reason, let us first interpret the company's decision criterion (summarized from the IFP company's reports and interviews) as: "Forest lands must be managed in a way that will maintain and improve the timber productivity capacity to ensure maximum long-term financial returns to the company. This management goal must be achieved without damaging the other uses of forest land."

To determine the value of a tract of land on the basis of the income that the tract gives, the income should be capitalized. This means that the sum of the present value of the future income the tract will give has to be calculated. For this purpose, an investment criterion of land expectation value (LEV) is used to calculate the value of each land unit. This criterion calculates the present value of all future incomes as if the project were repeated for an infinite number of times.

The LEV is calculated according to the formula of Faustmann (Filius, 1997):

$$\mathrm{LEV} = \sum_{j=1}^{t} (\mathrm{B}_j - \mathrm{C}_j)(1+i)^{t-j} \Big/ (1+i)^t - 1$$

in which:

B_j = revenues in year j; C_j = costs in year j;
i = discount rate; t = rotation age

Spatial factors that are considered are:

Topography
Topography, which refers to the shape of the terrain, determines the ease with which land can be used profitably. For example, the steeper a piece of land, the higher the operational costs for planting and harvesting activities. For IFP development, the slope criterion is maximum 25%.

Locational factors
Distance to existing roads and rivers is of importance as this plays a role in determining the operational costs. The greater the distance, the greater the cost. In many areas, roads and rivers are an important indicator of land value, as they provide accessibility for the transport of forest plantation products and the delivery of inputs.

Land use/cover
Existing land use and cover determine the operations and costs of establishing a proposed land use. Type of cover relates to clearing and land preparation costs. For example, site preparation will cost less in grassland than in secondary forest or scrub. The land cover types for IFP development are scrub, grassland and secondary forest or logged-over areas.

3.4.5 Ecological soundness sub-model process

According to Sedjo (1983), from an ecological point of view, plantation forest is probably a better use of much of the land than most alternative commercial uses, such as croplands or pasture. In addition, it can be argued that high-yield plantations potentially offer one of the better means of protecting the world's remaining natural forests, and particularly tropical moist forests, from future destruction.

The systematic use of ecological principles in development planning is beneficial in four main ways: by fostering the productivity of natural resources on which all development depends; by favoring the maintenance of environmental quality; by promoting efficient and sustainable natural resource use; and by avoiding unexpected negative consequences of actions (Goodland, 1990).

Nature conservation involves two distinct but related objectives. The first is the maintenance of the maximum degree of biodiversity. The second objective is the development, management and maintenance of ecological infrastructure/networks through the management of protected areas (Haines-Young et al., 1993). Wilson

(1994, in Basiago, 1995), the Harvard biologist who has led biodiversity conservation efforts, defines biodiversity as "the genetic-based variation of living organisms at all levels", including the variety of genes within a species and among species and the variety of natural ecosystems.

As explained in MacKinnon and MacKinnon (1986), according to the theory of island biogeography, small protected areas isolated by modified habitats behave like "islands" and will lose some of their original species until a new equilibrium is reached, depending on the size, richness and diversity of the area, and its degree of isolation from other similar habitats. Larger reserves lose fewer species at a slower rate, but any loss of natural habitat will lead to some loss of species. The main guidelines for protected area design, selection and management are summarized below:

- Protected areas should be as large as possible and preferably include thousands of individuals of even the least abundant species. They should be of a compact shape with biographically meaningful boundaries.
- Protected areas should encompass as wide a contiguous range of ecological communities as possible (e.g. altitude range) as few species are confined to a single community and few communities are independent of those adjacent to them.
- Precautions should be taken against protected areas becoming completely isolated from other natural areas. If possible they should be located in clusters rather than dispersed, or they can be joined by corridors of semi-natural habitats.

Figure 3.7 shows suggested geometric principles for designing nature reserves. In each of the six cases labeled A to F, species extinction rates will be lower for the reserve design on the left than for the reserve design on the right.

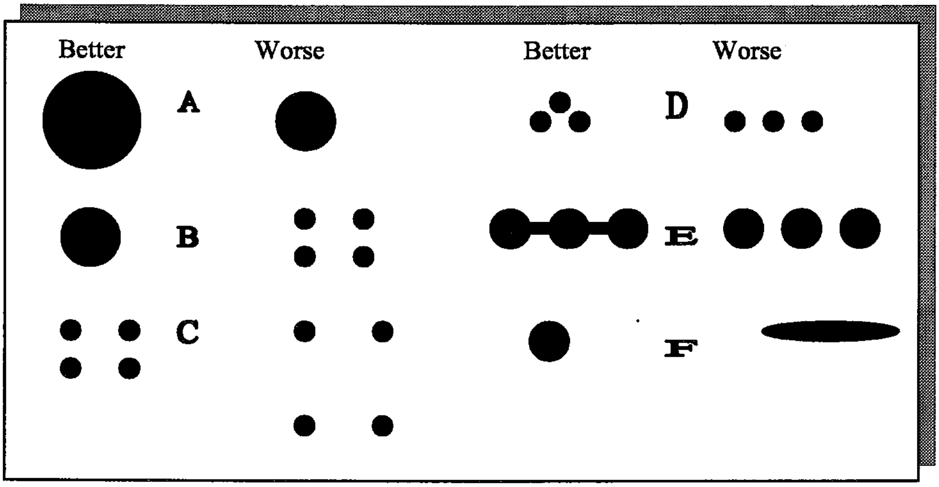


Figure 3.7 Suggested geometric principles in designing nature reserves (Diamond, 1975 in MacKinnon and MacKinnon, 1986)

In allocating land for different uses, it is necessary to identify fragile areas, land still retaining much of the natural conditions (i.e. those areas of land that have experienced/are experiencing little interference from man). These are the domains left with the most valuable natural properties in terms of plant and animal species and ecological undisturbedness. The preservation of such areas and the reduction of human interference therein are necessary to establish more natural and thus sustainable situations (Van Lier et al., 1994). The fragile areas, as found in various regulations of the MOF, include:

- Ravines, defined as land with a slope exceeding 40%;
- areas within 200 m of a lagoon;
- areas within 100 m of a river (or 200 m if it is in swamp forest);
- areas within 50 m of a creek (or 200 m if it is in swamp forest);
- areas within 500 m of dams or lakes.

In relation to the above-mentioned principles, the ecological soundness sub-model in this research has aimed at determining factors that impose constraints on the availability of land for IFP development. These factors are: (1) protection forests; (2) forests set aside for plant and animal species and ecosystem preservation; and (3) protective beds along river and road networks. These areas will be excluded from IFP land allocation.

3.5 Conflict resolution: sub-model integration

The IFP land allocation DSS is formed by integrating the sub-models through which compromises regarding the stakeholders' objectives are reached. For this reason, it is necessary to establish a platform for negotiation. Röling (1993) notes that the term "platform" has links with such notions as: arenas for negotiation, organizational capacity and strategy, collective action and collective agency, and leverage through enrolling more and more persons and interest groups. The IFP land allocation DSS will provide the decision maker (IFP manager) with IFP land allocation alternatives from which to select the preferred/satisfying land option for the IFP project.

A schematic representation of the IFP land allocation DSS is shown in Figure 3.8 below. The gross area, which consists of productive and unproductive areas, is the forest area that will be assessed by the IFP company for the IFP project. The unproductive forest area is where the IFP project is allowed and this area is proposed by the IFP company, based on MOF regulations. The unproductive forest area needs to be assessed in terms of its social value, economic value and ecological value as to its feasibility for the IFP project. The proposed area for the IFP project is an IFP land allocation alternative resulting from the building of different scenarios.

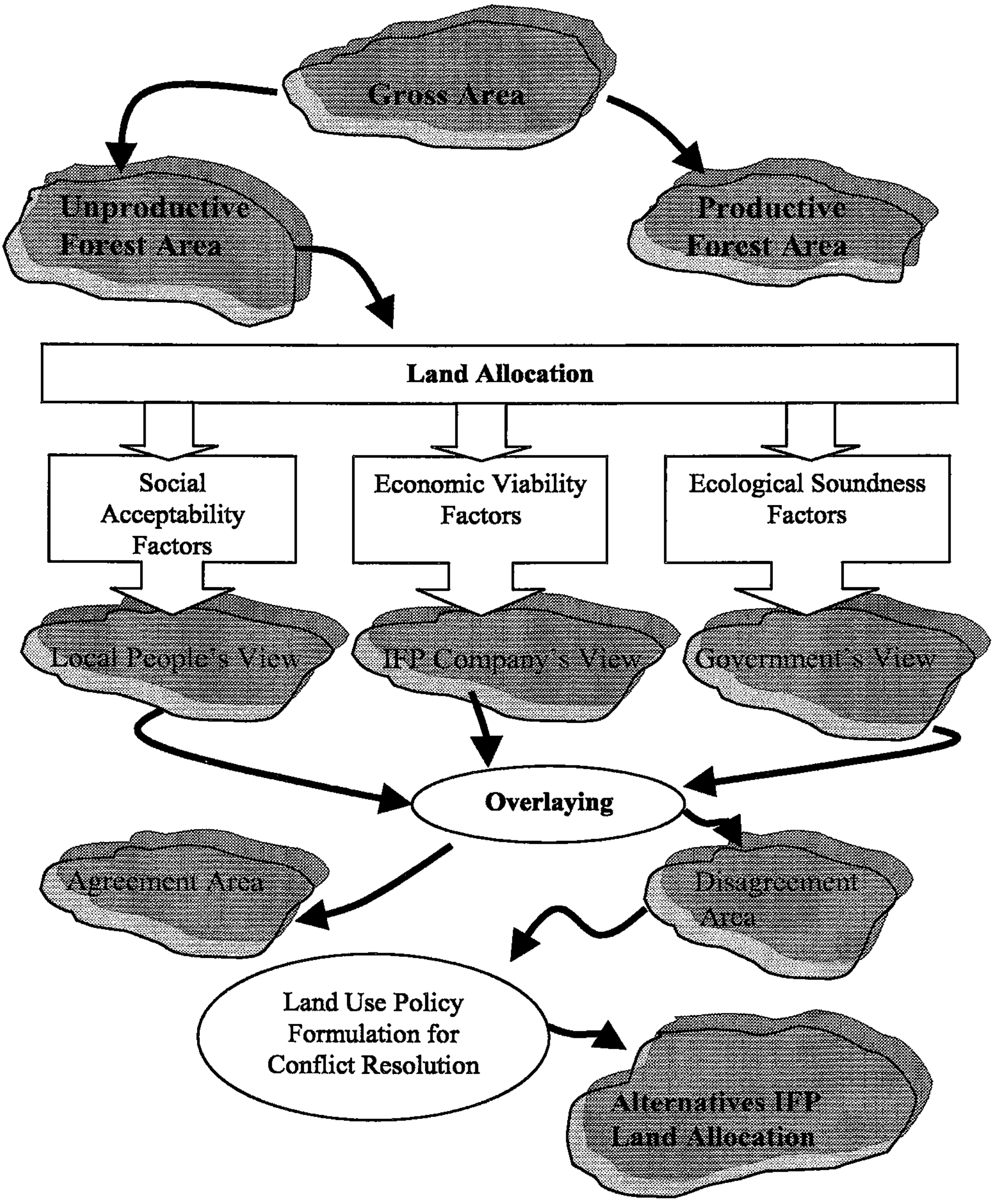


Figure 3.8 The IFP land allocation DSS

3.6 Database and repository

3.6.1 Introduction

A database system is essentially nothing more than a *computerized record-keeping system*: that is, a system whose overall purpose is to record and maintain information. The information concerned can be anything deemed to be of significance to the organization the system is serving—anything, in other words, that may be necessary to the decision making processes involved in the management of that organization. The data stored in the system is partitioned into one or more databases. The database itself can be regarded as a kind of electronic filing cabinet; in other words, it is a repository for a collection of computerized data files (summarized from Date, 1981 and 1995).

In recent years, the development of relational database management systems (RDBMS) has had a significant impact on data management. RDBMS organize information as a set of tables or files, with relationships between files determined by common values in the related tables. Thus the RDBMS model for organizing data offers a flexible database structure that is easy to define, expand and change (Heywood and Watson, 1995).

As explained previously in Chapter 2, the database management system (DBMS) is one of the key components of the DSS. The DBMS provides access to data, as well as to all the control programs necessary to get those data in the form appropriate for the analysis under consideration, and also facilitates the merging of data from different sources (Sauter, 1997). In addition, the DBMS serves as a repository for results obtained from different analyses that used its data.

A database is designed to service the needs of a group of users. Such needs are called the information needs of the users; these are the goal, and a database can be a good means of reaching that goal. In fact, the correct design of the database structure is considered essential to the success of the database design (De By, 1998). The repository functionality of the designed database in this research can be seen in Figure 3.9, which shows the interaction between the decision maker, in this case the IFP project manager, and the application of the IFP land allocation DSS.

For constructing the conceptual schema design of the data model, the *entity relationship (ER) modeling* approach (usually known as "extended" or semantic models) will be used. This approach is frequently used for the conceptual design of database applications, and many database design tools employ its concepts. The next step after knowing the users' data/information requirements is to create a conceptual schema for the database, using a high-level conceptual data model. This step is called conceptual database design. The conceptual schema is a concise description of the data requirements of the users and includes detailed descriptions of the data types, relationships and constraints. The high-level conceptual schema can also be used as a reference to ensure that all users' data requirements are met, and that the requirements do not include any conflicts. The basic object that the ER model represents is an *entity*, which is "something" in the real world with an independent existence. Each entity has particular properties called *attributes*, which describe it. A particular entity will have a value for each of its attributes. The attribute values that describe each entity become a major part of the data stored in the database (summarized from De By, 1998).

It is important to note that in general there will be *associations* or *relationships* linking the basic entities together. The entities involved in a given relationship are said to be the participants in that relationship (Date, 1981 and 1995). A *relationship type* R among N entity types E_1, E_2, ..., E_N defines a set of associations among entities from these types. Mathematically, R is a set of relationship instances r_1 where each r_1 associates N entities (e_1, e_2, ...e_N), and each entity e_j in r_1 is an occurrence of entity type E_j. Informally, each relationship instance r_1 in R is an association of entities, where the association includes exactly one entity from each participating entity type. Each such relationship instance r_1 represents the fact that the entities participating in r_1 are related to each other in some way in the corresponding mini-world situation (De By, 1998). An important property of a relationship is its degree. There are three possible kinds of relationship degree, each corresponding to different pairs of enterprise rules for relationship, namely: *1:1 relationship*, *1:many relationships*, and *many:many relationships* (Howe, 1989).

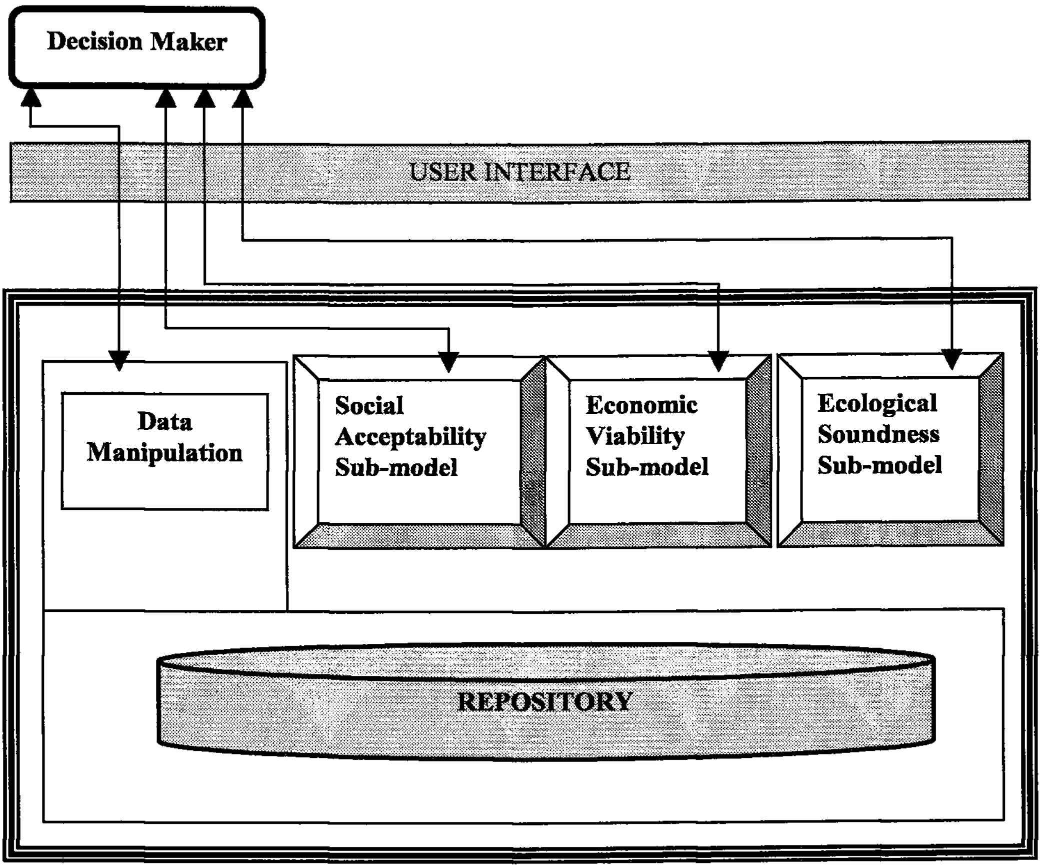


Figure 3.9 The decision maker and the application of the IFP land allocation DSS

3.6.2 The conceptual data model of the IFP land allocation DSS

The conceptual data model, as a conceptual abstraction of entities involved in the IFP land allocation DSS, is shown in Figure 3.10. The figure depicts the whole entities with their relationships. These entities and their main attributes are grouped according to their domains, as explained below. The logical model of the database is achieved by transforming the general data model into the form of skeleton tables and their relationships. The structure of the skeleton tables is presented in Appendix 2.

Government Administration

1. Province: province name, area.
2. District: district name, area, GDP, number of plantation area.
3. Sub-district: sub-district name, area, number of plantation area.
4. Village: village name, area, number of inhabitants.

Land Characteristics

1. Land unit: land unit number, land cover type, suitability class, area.
2. River: river segment, river name, river length, distance class, area.
3. Other water bodies: type 1, type 2, distance class, area.
4. Ravine: ravine number, area.
5. Road: road segment, road type, road length.
6. Slope class: slope class, slope %, area.
7. Soil type: soil type, area.

Plantation Management

1. IFP company: company name, etc.
2. IFP project area: IFP area, area.
3. Plantation block: block number, area.
4. Compartment: compartment number, area.
5. Sub-compartment: sub-compartment number, area.
6. Species: species name, sub-compartment, year of planting, spacing.
7. Treatment: treatment type, sub-compartment, date of treatment.
8. Plantation activity: activity type.
9. Employment: number of laborers, activity type.

Economic

1. Land value: land value, land unit, area.
2. Costs: activity costs, land unit.
3. Benefits: benefits, land unit.

Ecological

1. Protected area: protected area number, area.

Agricultural

1. Agricultural area: area number, agriculture type, area.
2. Cash crops: area number, area, productivity.
3. Market food crops: area number, area, productivity.
4. Subsistence crops: area number, area, productivity.

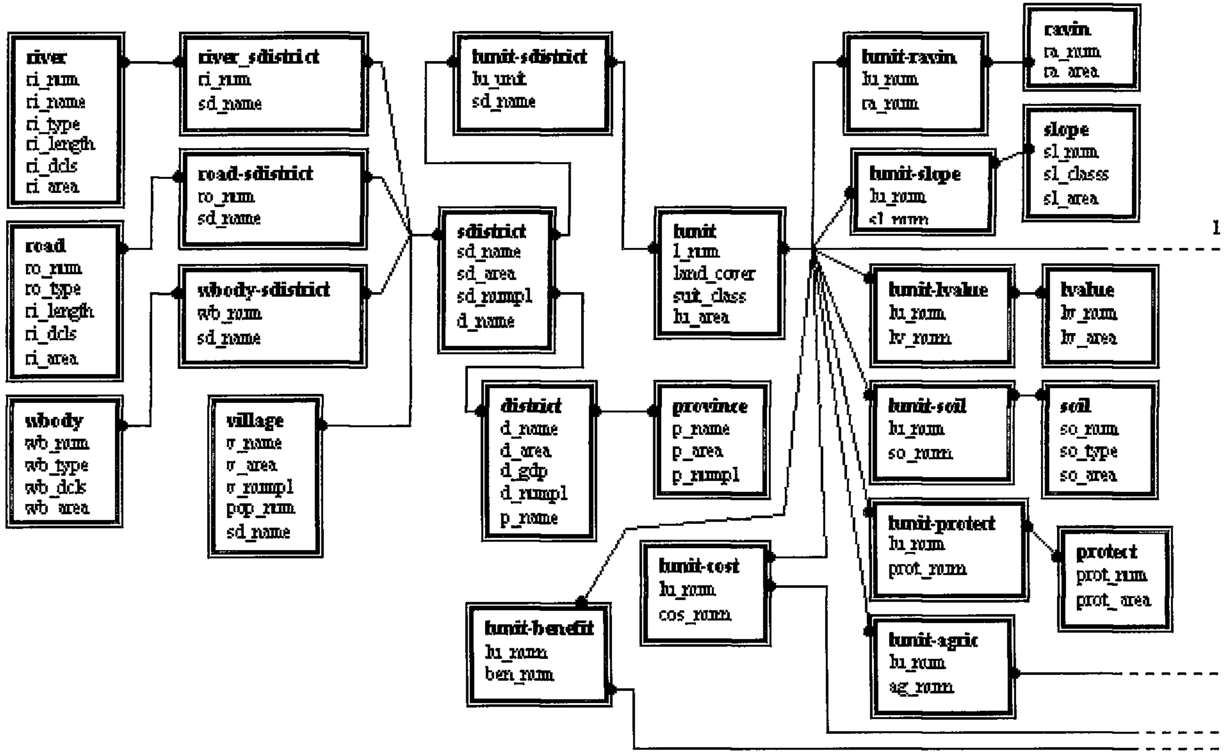


Figure 3.10 General data model of IFP land allocation (continued next page)

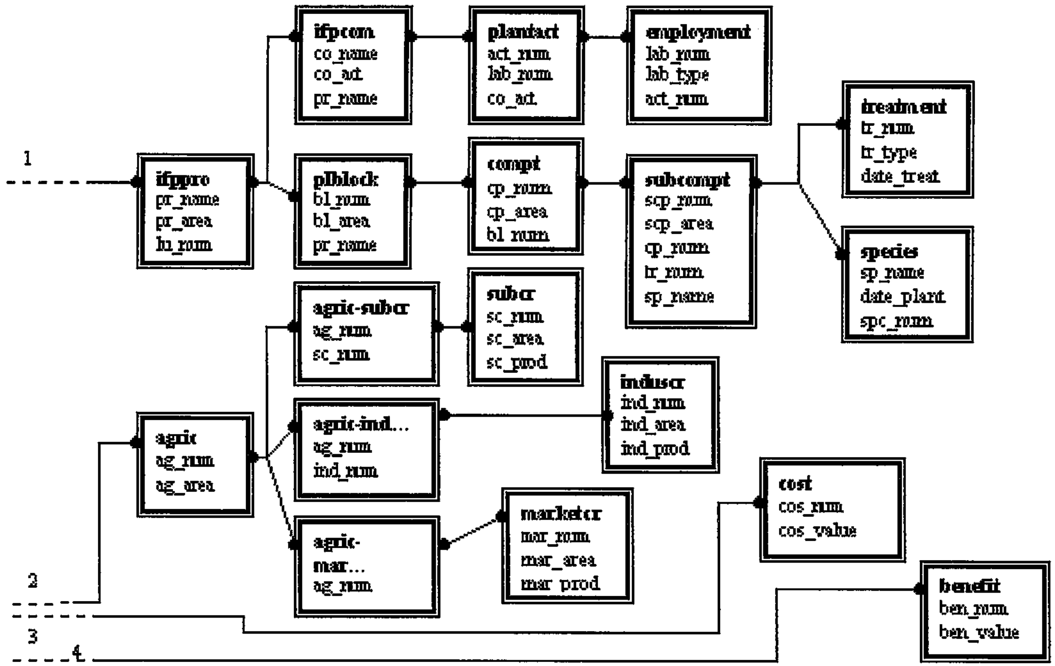


Figure 3.10 General data model of IFP land allocation (continued)

Chapter

4

MODEL IN OPERATION: LAND ALLOCATION FOR INDUSTRIAL FOREST PLANTATION

This chapter deals with the implementation of the conceptual model that was developed in Chapter 3 to solve the ill-structured problem of land allocation in the IFP development. Implementation is achieved by developing scenarios that provide course-of-action choices to the IFP development project decision makers. With this intention, prior to developing and implementing these scenarios, a background for each is formulated in Section 4.1 to explain the justification/basic reasons for, and expectations of the model, and to give a clear picture of the implementation process.

In Section 4.2, the scenarios are elaborated and in Section 4.3, implementation of the model starts by simulating the allocation of land according to the objective of the social acceptability sub-model, i.e. the projection of agricultural expansion areas. Section 4.4 deals with the implementation of the economic viability sub-model for allocating the best possible choices of new IFP project areas as seen from the IFP company's point of view. The last sub-model, i.e. the ecological soundness sub-model, is outlined in Section 4.5. This section explains the Government's view of the allocation of land for the benefit of the environment of the area.

Section 4.6 elaborates on the conflict areas, where certain tracts of land are allocated by several sub-models. The identification of conflict areas and the resolution of the conflict are achieved through integration of the sub-models. In this integration, a policy formulation for consensus building is established to indicate land use priority when allocating land for a certain use.

Throughout Chapter 4, three scenarios will be used, namely: the moderate scenario, the optimistic scenario and the pessimistic scenario. These scenarios differ in terms of the use of growth factors, i.e. population, GDP and agricultural productivity.

4.1 Background to the IFP land allocation scenarios

To activate the conceptual model, scenarios in which the model is instantiated need to be developed; the premises behind the scenarios represent the basis that supports scenario development. A scenario consists of a set of assumptions about input data, together with model outcomes based on those assumptions. In this research, the scenarios depict three important aspects of reality: social, economical and ecological. They will be started by projecting the need of the local people for agricultural land according to the sub-model of social acceptability. This will be represented in three scenarios, i.e. the moderate, the optimistic and the pessimistic scenarios.

In the face of uncertainty concerning developments in population, GDP, and crops productivity, three tentative scenarios were developed. The so-called pessimistic scenario assumes the population growth will increase while GDP and crops productivity growths will decrease. At the other end of the scale, is the optimistic scenario, which assumes the population growth will decrease while the growths of GDP and crops productivity will increase, The moderate scenario is in between the two others (see Table 4.1 through 4.3).

The results of running the three scenarios in the sub-model of social acceptability will then be used as reference in running the sub-models of economic viability and ecological soundness. Finally, the results of the sub-models will be integrated for consensus building in allocating the land for IFP project development.

Multiple use of a piece of land is rarely attainable. Conflicts between land uses arise as a consequence of land use allocation decisions by individuals and groups with incompatible goals. Therefore, sustainable development depends, among other factors, on careful land use (Rodriguez, 1995). In his research on district-level land use conflicts in Venezuela, Rodriguez (1995, citing Shepard, 1964) elaborates that demand for utilities provided by land resources varies depending on the goals and values of individuals and groups with different levels of aspiration. However, a minimum standard of needs has to be set for each party in order to make any comprehensive decision about land use. One alternative might be better with respect to some attributes, another better with respect to other attributes, thus resulting in a source of conflict. In such cases, one attribute must be balanced against another. The final resolution of the conflict will obviously depend on the relative weight assigned to each factor.

When the IFP project was introduced in Pulau Laut, problems of conflicting land uses among the land users started to arise. In relation to time, conflicts can be seen as current or potential. In this case, the sub-model of social acceptability is designed to simulate the development of people's need for agricultural areas for 50 years starting from 1980. With this time-frame setting, the possibility of conflicting land use can be predicted until the year 2030. The projected agricultural lands are confronted with the need of the IFP project management to expand their plantation areas and the need of the Government (and environmentalists) to protect forest land resources.

During this section, Mintzberg's model of the decision making process will be used as a reference for the analysis. It is intended to improvethe existing situation in Pulau Laut by making better use of unproductive lands. So understanding the process of land use changes in the area is of prime importance to appropriately solving the encountered problems. Human activities change the use of land from its original status (i.e. forest land resource) into many forms of usage. Forests change into croplands and built-up areas because of people's need for more agricultural areas and settlements. At a later stage, part of the croplands become permanent cropland while other parts become grassland for grazing and scrubland for shifting cultivation. Unproductive lands develop as *alang-alang* grasslands, especially in the southern part of Pulau Laut, as evidence of the overuse of land for agricultural activities.

In the *diagnosis stage* of the decision process, important potential aspects of conflict need to be taken into consideration; the platform for diagnosing the encountered problems is formed by the objectives of each of the identified stakeholders. In considering the land targeted for ecological purposes, the fragmented forest areas that resulted from the projection of future agricultural land are used as the basis for acquiring the ecological zone, i.e. the area within certain distance of rivers and road networks. Determination of islands/habitats for local protected and endangered species of plants and animals is based on the results of the environmental impact assessment (EIA) study undertaken by the IFP company in the study area.

In the *design stage* of the decision process of the IFP land allocation problem, a custom-made solution is supposed to be developed. From the IFP project management point of view, the allocation of unproductive forest lands for the project establishment must provide good revenues for the company in the long run. This includes the analysis of scrub, grasslands and logged-over production forest areas, in which their LEV (land expectation value), together with ease of accessibility, determines the prioritization of land acquisition.

The *analysis/evaluation stage* of the decision process deals with superimposing the results of the sub-models by means of overlaying maps of stakeholders' views in order to identify areas of land use agreement and disagreement. The land use options selected by the local people, the IFP project management and the Government may coincide, so that a planning consensus is reached. On the other hand, opinion discrepancies may occur and planning conflicts arise with respect to areas showing multipurpose suitability. In the *bargaining/evaluation stage*, such areas must be subjected to a compatibility process in order to reach land use compromises. Settling disagreements among stakeholders is a kind of public participation in the decision making process.

4.2 The three scenarios

Three different scenarios are developed to predict the expansion of the agricultural area in Pulau Laut over 17 and 50 years starting from 1980. The prediction of 17 years' (1980-1997) agricultural expansion is necessary to provide an approximation of current agricultural expansion. The 50-year prediction (until 2030) is meant to simulate the situation of agricultural expansion during the lifetime period of the IFP project.

These scenarios are the moderate scenario, the optimistic scenario and the pessimistic scenario. The growth factors for each parameter should be given for each five-year period of the simulation period (up to 50 years). These growth factors – population, GDP and agricultural crops production – are given as yearly growth and expressed as e.g. 1.07 for 7% growth. The average of each of the growth factors, i.e. population, GDP and agricultural productivity, will be used to calculate the required land to be transferred to agriculture. The APM-spatial assumes that the transfer of land to agricultural land is based on a land transfer priority, i.e. the sequence in which subsequent land categories are used for transfer to agriculture. During fieldwork, the order of priority for transferring land to agricultural land use was obtained, i.e. (1) scrub, (2) forest land and (3) grassland.

Simulation of the agricultural expansion area in the APM-spatial assumes that the spread of agricultural land will start from the boundary of existing agricultural land. Absolute barriers are given to built-up areas, a conservation area of tree species, and protection forest. The total projected agricultural land demand area is calculated using the formula elaborated in Section 3.4.3 of Chapter 3. As this research considers both permanent agriculture and shifting cultivation, the expansion of the agricultural area is calculated proportional to the ratio of the two, namely 64% for permanent agriculture and 36% for shifting cultivation. However, because of the nature of the rotation period (10 years) of shifting cultivation and its use of a land for two years, the 36% portion is multiplied by factor 5. Hence, the adapted formula is:

$$\mathbf{D}_{agric} = \{[(PA_m * (G_{GDP}/G_{pmc})^n) + (PA_c * (G_{GDP}/G_{pcc})^n) + (PA_s * (G_{pop}/G_{psc})^n)*0.64] + (PA_m * (G_{GDP}/G_{pmc})^n) + (PA_c * (G_{GDP}/G_{pcc})^n) + (PA_s * (G_{pop}/G_{psc})^n)*0.36*5]\}.$$

For the moderate scenario, the growth-of-population factor is adapted from the growth trend of South Kalimantan Province (BKKBN, 1998). The trend in population growth is assumed to slow down because of the influence of the family planning programme that has been intensively carried out. At the beginning of the simulation period (1980-85) population growth is 2.2% and by the end of the period (2025-30) it is assumed to be 0.8%.

The growth of the GDP factor is calculated from the trend in the agricultural sector at the provincial level of South Kalimantan provided by Bappenas (1998). GDP growth reached its peak (6.1%) in the period 1990-1995, following the country's economic boom. The recent economic crisis is responsible for the declining trend in GDP growth until period 7 (years 2010-2015). At this period, GDP growth is assumed to be 3.5%. Afterwards, GDP growth is assumed to regain its positive growth from the period 2015-2020 until the end of the simulation period (year 2030).

The growth of subsistence crops productivity is obtained from the average national growth of paddy productivity. For the first three simulation periods, productivity growth is rather high as a result of the agricultural intensification programme to meet the country's target for self-sufficiency in rice production. In fact, in 1984 FAO acknowledged Indonesia for its success in the programme for self-sufficiency in rice production. However, this achievement could not be maintained. Since the mid-90s, Indonesia has again depended on other rice-producing countries to meet its need for rice. Therefore, the subsistence crop productivity growth is assumed to slow down by 0.1% per period from the period 1995-2000. Starting from the period 2015-2020 until the end of the simulation period, productivity growth is assumed to rise, following the country's recovery from the economic crisis.

The productivity growth of local market food crops and industrial/export crops until period 3 was obtained from the offices of the agricultural sector and the Bureau of Statistics of Kotabaru District. From the period 1995-2000 until the end of the simulation period, the growth factor was adapted from the estimation by the Ministry of Agriculture (Departemen Pertanian, 1998). From the period 1995-2000, growth in the local market food crops and industrial/export crops productivity is assumed to slow down. The last three periods of the simulation assume that agricultural development will be more stable. During these periods, agricultural productivity growth will regain its positive trend.

These above-mentioned growth factors are presented in Table 4.1 and they will be used in the simulation of the APM-spatial for the moderate scenario.

For the optimistic and pessimistic scenarios, the growth factors are presented in Tables 4.2 and 4.3. The optimistic scenario assumes that starting from the period 2010-1015 GDP growth will increase. This assumption is based on the prediction that Indonesia will recover from the economic crisis. This recovery is due to growing commitments from developed countries and international finance agencies to provide financial support. The positive growth in economic development will generate an increase in agricultural productivity. This is because a better agricultural subsidy can be provided by the Government. Meanwhile, population growth tends to slow down, following the success of the government programme in family planning.

The pessimistic scenario assumes that population growth tends to decrease very slowly because of the failure of the family planning programme. Because of the negative growth of economic development, the growth of the GDP and agricultural crops productivity will also decrease. However, during the last two periods economic development is assumed to increase. Consequently, the growth of agricultural productivity will also increase.

Table 4.1 Growth factors for the moderate scenario

5-year	CROP PRODUCTION				
Period	POP	GDP	Subsistence	Local market	Industrial/export
1980-85	1.022	1.045	1.019	1.010	1.022
1985-90	1.023	1.041	1.015	1.015	1.031
1990-95	1.018	1.061	1.013	1.020	1.025
1995-00	1.016	1.041	1.010	1.018	1.022
2000-05	1.015	1.039	1.009	1.015	1.019
2004-10	1.014	1.038	1.008	1.012	1.018
2010-15	1.012	1.035	1.007	1.015	1.020
2015-20	1.010	1.037	1.009	1.018	1.021
2020-25	1.009	1.039	1.010	1.019	1.022
2025-30	1.008	1.040	1.010	1.020	1.022

Table 4.2 Growth factors for the optimistic scenario

5-year Period	POP	GDP	CROP PRODUCTION Subsistence	Local market	Industrial/export
1980-85	1.022	1.045	1.019	1.010	1.022
1985-90	1.023	1.041	1.015	1.015	1.031
1990-95	1.018	1.061	1.013	1.020	1.030
1995-00	1.014	1.041	1.013	1.018	1.025
2000-05	1.010	1.040	1.015	1.018	1.025
2004-10	1.008	1.040	1.017	1.019	1.027
2010-15	1.004	1.041	1.019	1.020	1.027
2015-20	1.004	1.041	1.019	1.022	1.029
2020-25	1.002	1.042	1.020	1.024	1.030
2025-30	1.002	1.042	1.020	1.025	1.030

Table 4.3 Growth factors for the pessimistic scenario

5-year Period	POP	GDP	CROP PRODUCTION Subsistence	Local market	Industrial/export
1980-85	1.022	1.045	1.019	1.010	1.022
1985-90	1.023	1.041	1.015	1.015	1.031
1990-95	1.018	1.061	1.013	1.020	1.030
1995-00	1.018	1.041	1.010	1.015	1.020
2000-05	1.017	1.039	1.008	1.009	1.015
2004-10	1.017	1.036	1.007	1.008	1.010
2010-15	1.016	1.034	1.007	1.006	1.008
2015-20	1.016	1.032	1.008	1.006	1.008
2020-25	1.015	1.033	1.009	1.005	1.007
2025-30	1.015	1.035	1.009	1.005	1.007

4.3 Implementation of the social acceptability sub-model

In this sub-model, the types of agricultural activities are categorized as permanent farming and shifting cultivation. Addressing the problem of shifting cultivation in this research becomes prominent because rapid population growth and the competition for land have made shifting cultivation one of the main causes of deforestation and land degradation. Consequently, the shifting cultivation activity will affect the scale of IFP projects (in terms of availability of land for plantation) and also the degree to which the protection and conservation of forest land resources need to be planned.

In the case of shifting cultivation, Sardjono (personal communication, 1998) mentions that in the current situation in Kalimantan, cultivators generally use a patch of land for a brief period (two years) and then leave it fallow for eight years while they move on to work on another piece of land. The rotation period for this activity is 10 years. Chomitz and Griffiths (1996), in their study of deforestation and shifting cultivation, reveal that in Kalimantan the ratio of shifting cultivator households to permanent agricultural households is 36% : 64%. The outlined rotation period and the ratio of shifting cultivation will be used for predicting expansion of the agricultural area in the sub-model of social acceptability.

4.3.1 Simulation of land use change using the APM-spatial

Land use classification and matching

The land use data are one of the most important and influential sets of data for the simulation results. The available data on land use were derived from the land use/land cover maps of Pulau Laut. These maps were obtained from different sources, namely: BPN (1979/1980), Bakosurtanal (1980/1981) and PT. Inhutani II (1997). The maps were analyzed and matched with the APM land use classification. Table 4.4 and Figure 4.1 show the results of the matching.

For this study, paddy rice is considered as the subsistence food crop. Vegetables and other miscellaneous crops are classified as local market food crops. Rubber and coconut are classified as industrial/export crops. Industrial forest land includes production forest, industrial forest plantation (IFP) and non-forest estate, such as palm oil. Environmental forest land encompasses protection forest, conservation forest and peat/mangrove forest. Other land includes scrub, grassland and built-up areas.

Table 4.4 Land use classification after matching land use with APM land use categories

APM Land Use Categories	Current Land Use	Area (ha)
1 Agricultural Land		
1.1 Subsistence Food Crops	11 AL Paddy	4249.08
1.2 Local Market Food Crops	12 AL Mix Garden	6053.04
1.3 Industrial/Export Crops	13 AL Fruit Trees	509.40
2 Forest Land-Farm		
2.1 Natural Forest	21 Frm.F. Woodlot	0
2.2 Plantation 1	22 Frm.F. Fw.Pl.	0
2.3 Plantation 2	23 Frm.F. Other	0
3 Forest Land-Industrial		
3.1 Natural Forest	31 Prod.F. Natural	81259.38
3.2 Plantation 1	32 IFP	28373.22
3.3 Plantation 2	33 Non F. Estate	14222.97
4 Forest Land-Environmental		
4.1 Natural Forest	41 Prot. F. Natural	23994.81
4.2 Plantation 1	42 Prot. F. Pl.	0
4.3 Plantation 2	43 Prot. F. Other Pl.	0
5 Other Land		
5.1 Potential Agric.	51 Scrub	26640.00
5.2 Potential For.	52 Other Grassl.	19576.71
5.3 Unproductive Land	53 Other built-up	2579.76

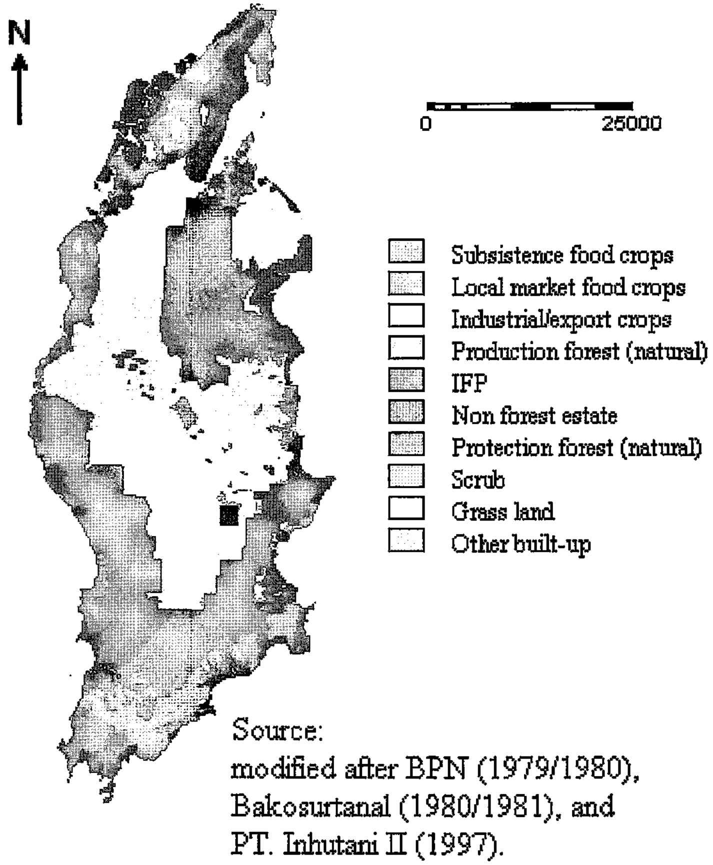


Figure 4.1 Land use classification of Pulau Laut according to APM categories

4.3.2 Spatial data inputs to run the APM-spatial

The APM-spatial was developed in GIS-ILWIS software and in this research the model will be adapted to the new situation in the study area, i.e. Pulau Laut. For this purpose, modifications of the model are required, including the modification of inputs and the syntax of the program. The map factors as inputs for the APM-spatial in this research are as follows:

- *General map*, containing information about existing agricultural land, forest land and other land in the study area.
- *Forest map*, containing information about the different types of forests in the study area.
- *Village map*, containing information about village boundary areas in the study area.
- *Slopdis map*, containing information about distances from slopes.

- *Roaddis map*, containing information about distances from existing roads.
- *Draindis map*, containing information about distances from existing rivers.

These input maps are presented in Appendix 3. Besides the spatial inputs, attribute data are also required, namely village populations and their densities, the order of priority for land transfer to agricultural area, and the simulation period. The inputs are to provide the basic assumptions for the model and also the value for every pixel. Each pixel gets a friction value depending on slope, distance from agricultural area, distance from the existing road network, distance from rivers, priority for land transfer, population density and population growth.

The assumptions employed in the APM-spatial are as below.

1. Agricultural land expansion starts from the boundary of existing agricultural land and spreads out towards the scrub and forest areas. The extent of the spread in each of the land use classes depends on the friction value.
2. Different land use classes can change at the same time, unlike in the APM-numerical where a certain land use type needs to be completely converted before the next type, according to priority, starts to be converted.
3. In general, the rules adopted are the following:
   - The steeper the slope, the higher the friction value and the slower the agricultural land expansion.
   - The greater the distance from agricultural areas, roads and rivers, the higher the friction value and the slower the agricultural land expansion.
   - The higher the value of the land transfer priority, the higher the friction value and the slower the agricultural land expansion. Note that the highest priority means the lowest priority value.
   - The higher the population growth, the higher the starter value and the faster the agricultural land expansion.
   - The higher the population density, the higher the starter value and the faster the agricultural land expansion.

4.3.3 Calibration of the APM-spatial

Before implementing the APM-spatial, it has to be established whether the model will give the same results as the APM-numerical. According to Jørgensen (1994), the aim of calibration is to improve parameter estimation by determining values that best match model outputs with actual data. In calibrating the APM-spatial, the focus is directed to comparing the results of the trends in agricultural development resulting from the APM-numerical with those resulting from the original and the modified APM-spatial. The original APM-spatial calculates the agricultural expansion by using the growth formula of the average population growth (i) during the simulation periods, i.e., $P_t = P_o(1 + i)^{\wedge t}$. The modified APM-spatial calculates the agricultural expansion by using the following formula (see Section 3.4.3 of Chapter 3 for details):

$$D_{agric} = (PA_m * (G_{GDP}/G_{pmc})^n) + (PA_c * (G_{GDP}/G_{pcc})^n) + (PA_m * (G_{pop}/G_{psc})^n).$$

As the APM-numerical considers only the permanent agricultural activity, for calibration purposes the original and the modified APM-spatial will also consider the same agricultural activity. The calibration uses data from the study area of Pulau Laut, South Kalimantan, Indonesia, and simulates the expansion of the agricultural area for 50 years. The result of the calibration shows that by the end of the simulation period (year 2030), the original APM-spatial projects the agricultural area to be 22,427 ha. This is 2,592 ha (10%) less than predicted by the APM-numerical. The modified APM-spatial predicts 25,148 ha of agricultural area or 129 ha (0.5%) more than predicted by the APM-numerical. The general rule of thumb in forestry accepts 5% deviation from the truth. Hence, following these calibration results, in order to simulate the expansion of the agricultural area, the modified formula will be used in the simulation of land use change.

4.3.4 Simulation results

Moderate scenario

The moderate scenario of the APM-spatial uses the average growth factors of Table 4.2 to simulate the land transfer to agricultural area from 1980 to 1997 and from 1997 to 2030. The average population growth is 1.47%; the average GDP is 4.16%; the average subsistence food crop is 1.10%; the average local market food crop is 1.62%; and the average industrial/export crop is 2.23%. The amount of land transferred to the agricultural area in 17 years (1980-1997) is 9,157 ha (obtained from 5,747 ha of scrub, 1,098 ha of production forest and 2,312 ha of grassland). In the situation of 1997-2030, the land transfer to agricultural area is 31,135 ha (obtained from 11,503 ha of scrub, 7,125 ha of production forest and 12,507 ha of grassland. Hence, from 1980 until 2030 there will be 40,292 ha of land transferred to agriculture (see Figure 4.2).

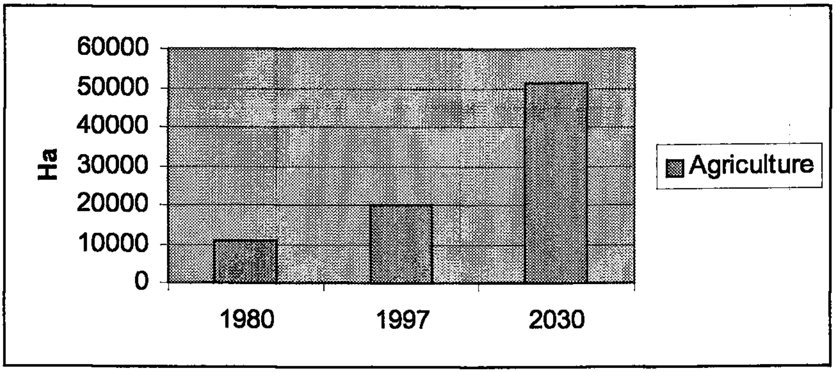


Figure 4.2 Trends in agricultural development from 1980 to 2030 according to the moderate scenario

Optimistic scenario

The optimistic scenario of the APM-spatial uses the average growth factors of Table 4.3 to simulate the land transfer to agricultural area from 1980 to 1997 and from 1997 to 2030. The average population growth is 1.07%; the average GDP is 4.34%; the average subsistence food crop is 1.70%; the average local market food crop is 1.91%; and the average industrial/export crop is 2.23%. The amount of land transferred to the agricultural area in 17 years (1980-1997) is 6,400 ha (obtained from 4,119 ha of scrub, 721 ha of production forest and 1,560 ha of grassland). For the projection of 1997-2030, the land transfer to agricultural area is 25,253 ha (obtained from 11,042 ha of scrub, 4,936 ha of production forest and 9,275 ha of grassland). Hence, from 1980 until 2030 there will be 31,653 ha of land transferred to agriculture (see Figure 4.3).

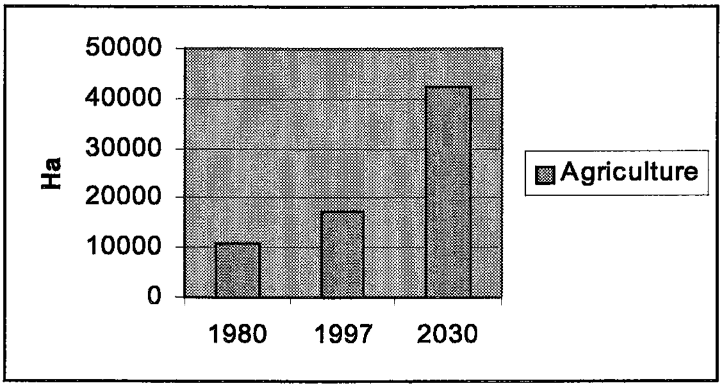


Figure 4.3 Trends in agricultural development from 1980 to 2030 according to the optimistic scenario

Pessimistic scenario

The pessimistic scenario of the APM-spatial is run according to the average growth factors of Table 4.4 to simulate the land transfer to agricultural area from 1980 to 1997 and from 1997 to 2030. The average population growth is 1.76%; the average GDP is 3.97%; the average subsistence food crop is 1.50%; the average local market food crop is 0.98%; and the average industrial/export crop is 1.57%. The amount of land transferred to the agricultural area in 17 years is 10,424 ha (obtained from 2,692 ha of scrub, 1,272 ha of production forest and 6,460 ha of grassland). In the situation of the next 33 years' projection, the land transfer to agricultural area is 43,313 ha (obtained from 15,554 ha of scrub, 13,635 ha of production forest and 14,120 ha of grassland). Hence, from 1980 until 2030 there will be 53,737 ha of land transferred to agriculture (see Figure 4.4).

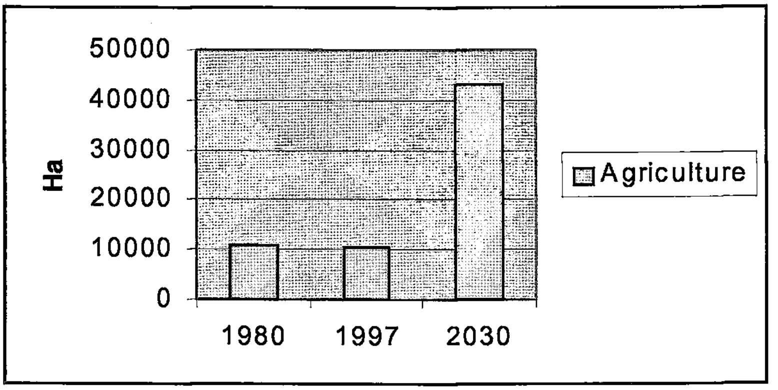


Figure 4.4 Trends in agricultural development from 1980 to 2030 according to the pessimistic scenario

Summary of the results

To summarize the overall simulation, Figure 4.5 shows the maps of the results from the three scenarios. Figure 4.6 compares the areas transferred to agricultural land in the scenarios. Note that in Figure 4.2 to 4.6, the area needed for new IFP land is not yet taken into account. In the pessimistic scenario, new IFP project area will use more production forest lands than the other two scenarios.

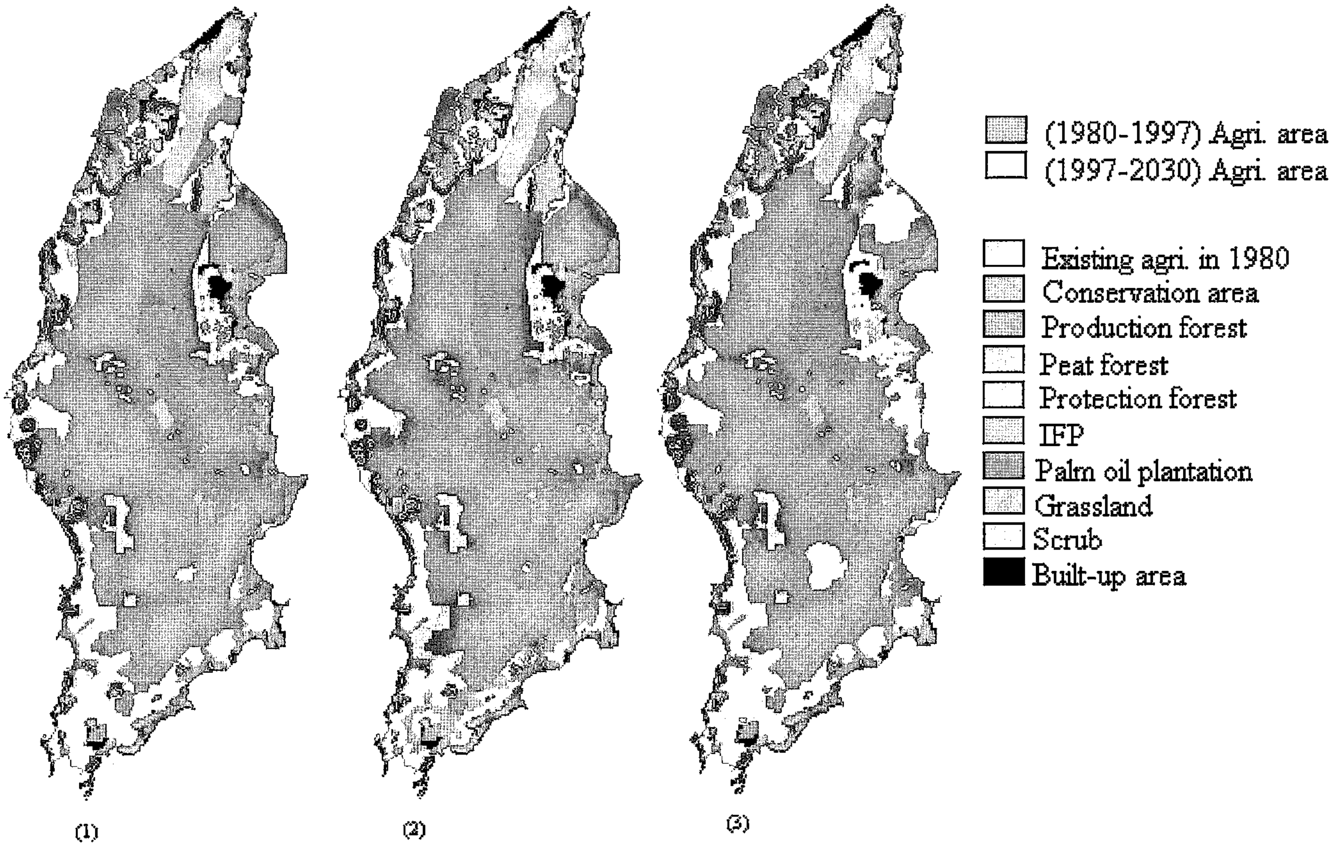


Figure 4.5 The simulation results of agricultural expansion from the moderate scenario (1), the optimistic scenario (2), and the pessimistic scenario (3)

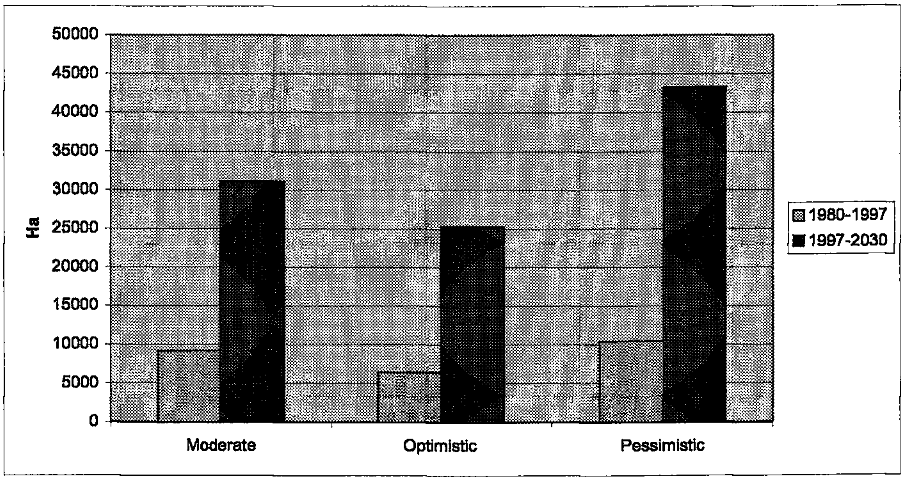


Figure 4.6 Comparison of transferred areas in the scenarios

4.3.5 Employment in the implementation of the IFP project

Although IFP development takes place on forestry land and local people have (in most cases) no legal rights to that land, it is unlikely that the land will be devoid of human habitation. Even badly degraded land is likely to be used for some form of agriculture or animal husbandry. These prior claims of local inhabitants will need to be taken into account. There are several basic possibilities for dealing with the local people on the land granted to the IFP project, namely (MOF, 1994):

- move them forcibly;
- transmigration to other localities;
- employ them as labor on the IFP project;
- enclave their land and ignore them;
- provide compensation;
- a mixture of the last four options.

None of the first five above options would probably ever be a total solution. There is a need to reach a compromise between the local people and the IFP project so that both sides can live together and benefit from the development. The local people could be an important source of labour (both skilled and unskilled) for the IFP project. The IFP project could be a major employer for local people as well as a provider of infrastructure requirements in the form of roads, school, market, etc. If one side of the relationship feels that they are not benefiting, then problems will occur that could seriously undermine the success of the IFP project. A very bad relationship with local people can result in labour disputes, fire and other long-term problems.

It is government policy in Indonesia to try to distribute the benefits of IFP development equally among all segments of the population, including the forest dwellers. It is therefore of great importance that the IFP concession holders seek the right balance between their commercial priorities and the needs of the people within their concession (MOF, 1994). In many situations, the potential IFP areas already have resident rural populations. In this case, IFP development will result in a significant social impact. This will relate especially to land use rights and the potential of IFP development to provide social benefits, particularly employment. The reaction of the local people depends very much on the land loss they have experienced and the alternatives open to them to continue their farming and other businesses.

The Ministry of Forestry (MOF, 1994) indicates crisis periods in the relationship between an IFP project and the local people. First, the compensation for taking over the land from local people has always caused distress and confusion. The second crisis will come after several years, when the opportunities for local people to develop their farms are restricted through lack of land. In the latter case, the IFP project should make special efforts to include unemployed local people in developments and in the employment structure, even at the expense of more productive workers (the transmigrants). In addition to this, the IFP project should exclude from its plantation area the nearby area needed for food supply.

In 1991, the Directorate of IFP of the Ministry of Forestry conducted a socio-economic survey to grasp the perception of the local people towards the development of IFP projects in four project areas, i.e. Sanggau (West Kalimantan), Pleihari (South Kalimantan), Pulau Laut (South Kalimanatan) and Gowa Maros (South Sulawesi) (Groome Pöyry, 1991). Employment and improved road access are the most important positive benefits perceived to come from future IFP developments in all areas (see Table 4.5). Other positive perceptions or anticipated possible benefits from IFP development include:

- village electrification;
- better access to entertainment facilities;
- the possibility that funding for health and education will be enhanced;
- an improvement in agricultural extension services.

The perceptions on negative aspects vary considerably from area to area as follows:

- In Sanggau and Pleihari, the loss of cropping land is most important.
- In Pulau Laut, the most important aspects are, first, the possible increase in population because of the further development of transmigration projects. This situation, in turn, will reduce the possibility of extending the agricultural area. Second, the development of the IFP project has used lands that have already been utilized by the local people for their agricultural activities.

- In Gowa Maros, the possible loss of future grazing land is the most important threat.

A small-scale survey was done by the author during the second fieldwork in the study area (the IFP project of Pulau Laut) and included 25 respondents (local people and transmigrants). They were interviewed regarding their perceptions towards the development of the IFP project (Table 4.6). The perceptions of all 25 respondents were positive regarding better road networks/access, business opportunities and better social facilities provided by the IFP project. The perceptions of 15 respondents were positive regarding possible employment in the IFP project and those of five respondents were positive regarding agroforestry opportunities in the project area. Negative perceptions related mostly to the possible loss of existing agricultural lands and the loss of opportunity to open new agricultural lands (18 respondents), as well as to the absence of compensation for the land taken by the project (seven respondents). The perceptions of five respondents were negative regarding the reduction of income from natural forest resources.

Commitment to the IFP programme brings responsibility for some continuity or work for employees. A plantation project involves many skills and requires managers, supervisors, mechanics, machine operators, administrative and clerical staff, medical staff and both skilled and casual labor. FAO (1978) indicates that the development of the IFP project often requires the enlargement of the existing forest service and, in some cases, the creation of a new management section to execute the planned project. The personnel required in such a section includes professional forest managers, foresters, technical assistants and various supervisor grades. As the plantation area develops, there will be a steady demand for additional staff and it will be necessary to plan the provision of facilities for the various grades of staff to be trained in plantation management and operations. As labor will be required to develop skills in silvicultural work, in nursery work and, in some cases, in mechanization or irrigation, it will be essential to provide adequate training.

Table 4.5 Perceptions towards IFP development

Perceptions	Sanggau	Pleihari	Pulau Laut	Gowa Maros
		-Ranking on 1 to 5 scale- (1= very important; 5= not important)		
Average ranking of positive perceptions/expectations				
• Future employment	1.79	1.47	1.48	1.63
• Better roads/access	1.74	1.45	1.60	2.02
• Agroforestry opportunities	1.97	1.92	2.56	1.84
• Fuelwood from thinnings	2.71	2.13	3.46	2.14
• Business opportunities	3.18	2.87	3.27	1.70
Average of positive perception	2.28	1. 97	2.47	1.87
Average ranking of negative Perceptions/expectations				
• Possible loss of cropping land	2.21	3.61	4.37	4.97
• Possible loss of grazing land	3.51	3.74	4.31	2.53
• Possible increase in population	2.88	4.55	4.21	2.67
• Removal of secondary forest	2.88	4.00	4.33	3.72
Average of negative perception	2.87	4.00	4.33	3.72

(Source: MOF, 1991)

Table 4.6 Perceptions of the local community in Pulau Laut towards the IFP project (n=25)

Positive perceptions	Agreeing respondents	Negative perceptions	Agreeing respondents
Better road networks/access	25	No land compensation	18
Business opportunities	25		
Better social facilities	25		
Future employment	15	Loss of agricultural lands	7
Agroforestry opportunities	5		
		Income reduction from natural forest	5

(Source: Author's field survey, 1997)

From the two social surveys of IFP project development, a similarity can be drawn with the positive perceptions of local people in Pulau Laut, i.e. better road/access provided by the IFP project is the most appreciated. Other positive perceptions have shifted in their acceptance by the local people, e.g. future employment provided by the IFP project has shifted from first place in the previous survey to become less appreciated in the result of the later survey. This might be considered an indication that it is difficult for the people to obtain jobs within the IFP project. Rather, the existence of the IFP project seems to have been the agent of economic development in the area, especially in stimulating the development of small-scale industries and trading (for instance the furniture industry and basic needs trading).

The Ministry of Forestry (MOF, 1994) has projected 6.7 million ha of IFP to be planted by the year 2030. If this target were to be achieved, then 7 million jobs would be created. In the case of the IFP project of Pulau Laut, job numbers can be predicted for each activity as in Tables 4.7 and 4.8 below.

The major silvicultural system applied in the IFP project of Pulau Laut is clear cutting to establish fast-growing species plantation. A line planting system has been applied for trial planting, using local commercial species (*Shorea* sp.). The clear-cutting system applied in scrub/secondary forest and grassland requires more laborers than the line planting system. The line planting system is applied only in secondary forest where the existing small trees are kept for their succession towards the high forest stage.

With the assumption that the IFP project of Pulau Laut will establish 2,000 ha per year of fast-growing species plantation, if the plantation takes place in scrub or secondary forest, the yearly required number of laborers will be 1,255 persons. If the plantation takes place in grassland, the labor requirements will be 759 persons per year (see Table 4.7). Plantation activities in grassland require fewer laborers because a mechanical system is applied in site preparation.

Comparing with the clear-cutting system, Table 4.8 reveals the number of laborers required if the IFP project implements the line planting system. In this case, some 759 persons are required every year. In all situations of plantation establishment (in scrub or secondary forest), the site preparation operation takes the largest number of laborers, followed by the planting and tending operations.

The labor force potential in each of the villages is shown in Figure 4.9. The labor force potential is divided into five classes (very low, low, moderate, high and very high). These classes are obtained from weight factors, i.e. the multiplication of population growth and population density of each village. These weight factors are necessary to make classes of village potential for providing labor. The weights are: <1 (very low); 1-5 (low); >5-10 (moderate); >10-15 (high); and >15 (very high). The result of this classification shows that among the 60 villages there are three villages that have a very high potential to provide a labor force. Two villages are classified as "high potential", and five villages as "moderate potential". The rest of the villages are classified as "low" and "very low potential" for labor force.

Table 4.7 Total labor requirements per year for fast-growing species establishment

Operation	Output man-days per ha	Area (ha)	Total man-days required	Working days	Labor requirements (persons)
Site preparation					
(Scrub/secondary forest	38.00	2,000	76,000	150	507
Grassland)	0.80	2,000	1,600	150	11
Planting	20.00	2,000	40,000	100	400
Tending	21.87	2,000	43,740	150	292
Nursery	4.19	2,000	8,380	150	56
Total labor requirements = 1,255 persons in scrub/secondary forest; 759 persons in grassland					

Table 4.8 Total labor requirements per year for local commercial species establishment

Operation	Output man-days per ha	Area (ha)	Total man-days required per annum	Working days	Labor requirements (persons)
Site preparation					
(Secondary forest)	35.00	2,000	70,000	150	467
Planting	10.00	2,000	20,000	100	200
Tending	6.00	2,000	12,000	150	80
Nursery	4.19	2,000	8,380	150	56
Total labor requirements = 803 persons					

As shown in Tables 4.7 and 4.8 above, the labor requirements for the development of the IFP project in Pulau Laut make little impact on meeting the employment needs of the local people. If the maximum number of required laborers is taken (1,255 persons), it represents only about 1.4% of the total population of Pulau Laut in 1995 (87,593 persons). However, if only the 14 villages near the IFP project area are considered, then the employment opportunity represented by the IFP project increases by about 9%. Assuming that the labor forces of the 14 villages are some 40% of the total population, then the labor requirements increase by 22%, which can be said to be a significant impact on employment.

Accordingly, the establishment of a new IFP area should consider the neighboring villages rather than the potential status of the villages for providing a labor force. This is because, to a certain extent, the distance of the settlements from the IFP project area can be compensated by good access and a good transportation system and/or by project housing facilities.

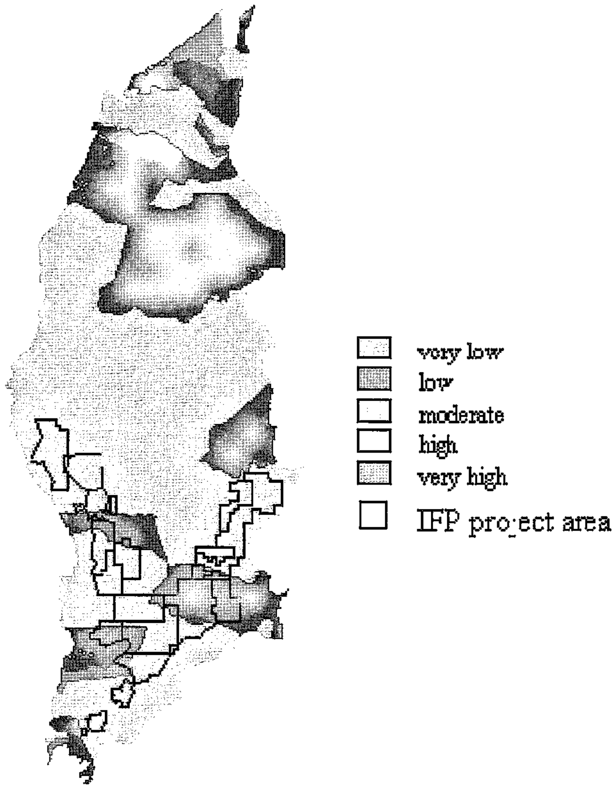


Figure 4.7 Labor force situation at the village level

In the case of the IFP programme, the Ministry of Forestry recognizes several employment systems. These are (MOF, 1994):

- *Employ daily laborers only.* This is an acceptable system of employment provided it is only a supplementary form of income for local people. This implies that the local community has alternative employment and are not totally dependent on daily wages from the IFP project. This is also a good option for people outside the immediate IFP area who want to work on only a temporary or seasonal basis.
- *Contract system.* This involves the use of sub-contractors. A sub-contractor is paid a fee to clear a fixed area of forest. In turn, the sub-contractor pays the members of his team on the same principle. This system is often popular with local people when their own local leaders become the sub-contractors. This system allows them to work in their traditional work groups under their own

management. It is also a flexible system, which allows them to regulate their own work time.

- *Perkebunan Inti Rakyat (PIR).* The example of PIR is taken from non-forestry estate. It is a widely accepted system of non-forestry plantation management in Indonesia. Smallholders are provided with seeds, herbicides and extension workers from the IFP project and they plant the tree crops on their own land. In return, they sell their timber back to the company at fixed prices. The system has the potential for plantation developments outside forest areas. It could also be a particularly good model in areas of relatively high population density.
- *Share cropping agreements.* Under this system, villagers, either individually or on a group basis, are allocated plots of land for forest plantations. The villagers plant and cultivate the trees and the company harvests the trees – the profit being shared between the company and the villagers. This form of profit sharing was reportedly popular among richer villagers and local entrepreneurs and there is great demand for it. However, IFP managers find it a rather inefficient way of cultivating their estates.
- *Buffer zone management.* This system works well in Java and is based on groups of people being given areas in plantation buffer zones to manage as small plantations and to interplant with food crops. This system would be poor compensation for people in Sumatra or Kalimantan who have many alternative forms of income from their own farms. However if this system could be combined with permanent tenure, e.g. enclave the buffer zones and allocate the land on a family or group basis, then it would probably become an attractive option for many local people and also for forest pioneers who might be attracted to the area.
- *Local transmigration.* This system is applicable in the situation where the local economy is badly affected by the IFP project or where the local area is extremely poor. The system includes the provision of food lots, tree lots and guaranteed employment on the IFP project for the local people. The local people are locally resettled in the neighborhood of transmigrants from different islands. Despite the relatively high costs of such a model, it is a popular system with local people and helps to overcome some of the worst aspects of IFP intrusion into local community agricultural land.
- *Outgrowers scheme.* This scheme involves an agreement with landowners. The company will plant trees on their land, the landowners just acting as guards of the land. When harvested, the costs of all inputs are deducted from the sale price and the net profit is divided between the landowner (30%) and the IFP company (70%). This is quite a useful scheme for the productive use of waste or unproductive land but it does not encourage the local farmer to improve his capabilities to cultivate and manage timber trees.

- *Tumpangsari (Agroforestry).* This system allows the farmers to make use the planted areas of IFP project during the early growth period of IFP. Tumpangsari can only be a partial answer to the loss of cultivated land because of the limited time before the cover crop shades out an agricultural production. Tumpangsari is very important for the outgrowers scheme or any smallholder forests where the farmer has total control over the land.

The employment models currently used and suitable for the IFP project of Pulau Laut are: employ daily laborers, the *borongan* system (contract system), local transmigration and *tumpangsari* (agroforestry). The nature of tumpangsari provides the possibility to tighten a positive relationship between the IFP company and the local people. The system creates a conducive platform for maintaining and evolving the local people's sense of mutual benefit towards the IFP project. At present, the implementation of the system in the project area of Pulau Laut is still on a small scale. Since the system allows the farmer to make use of the IFP project area for a certain period, this means reducing/diminishing land use conflicts, and the company should widely apply the system.

4.4 Implementation of the economic viability sub-model

To execute the conceptual sub-model of economic viability, the management goal of the IFP project should be revisited. It is as follows: "Forest lands must be managed in a way that will maintain and improve the timber productivity capacity to ensure maximum long-term financial returns to the company. This management goal must be achieved without damaging the other uses of forest land." The planning of a financially sustainable and economically profitable project includes the decisions on land allocation for the IFP project. The investment criterion of land expectation value (LEV) is used in this sub-model. The LEV calculates the present value of all future incomes as if the project is repeated for an infinite number of times.

4.4.1 Production phases and length of rotation

Wood production in plantation forestry is commonly based on short, medium and long rotation crops. This is due to the age (and the size or growth rate) of a tree that has relevance for the type and quality of the product desired. For example, for a particular species, young trees may be good for pulp and not good for sawn timber (warp, bend, collapse when dried); old trees may be good for sawn timber but not good for pulp (too high density, too much extractive content, i.e. colored substances that require expensive chemicals to remove). Pulp, fuelwood and small poles normally have been grown on short rotations (6-10 years), sawn timber on medium rotations (11-30 years) and veneer or cabinet timber on long rotations (30+ years). The Master Plan of Forest Plantation (MOF, 1991)) recognizes four production phases:

- 1-5 years (very short). Examples are many, with many possible species that provide early and rapid biomass production, grown for a wide variety of products such as domestic fuelwood and charcoal, some kinds of pulp, fodder leaves, etc. Genera and species used are very numerous, e.g. *Calliandra calothyrsus*, *Gliricidia sepium*, *Leucaena leucocephala* and *Eucalyptus citriodora*.
- 6-10 years (short). Examples include industrial fuelwood and charcoal, most kinds of pulp, small poles, some low-grade sawn timbers, some types of reconstituted wood products such as fibreboards and particleboards, etc. Well-known genera planted for these purposes include *Pinus*, *Acacia* and *Eucalyptus*.
- 11-30 years (medium). Examples include many sawn timbers, large poles, etc. Well-known genera planted include those used in short rotation plus *Shorea* and *Dipterocarpus*, among several others.
- 30+ years (long). Examples include veneers and sawn fancy and cabinet woods from *Tectona*, *Dipterocarpus*, *Santalum* and others.

For the purpose of scenario building in executing the sub-model of economic viability, only short and medium rotations will be used. These are the rotations relevant to the company objectives. The short rotation will be used for establishing fast-growing species in scrub and grasslands with the clear-cutting system. The medium rotation will be used in logged-over production with the line planting system.

The data on the production of the main species in the IFP project of Pulau Laut are projected by the company (cited from PT Inhutani II, 1985, and Boorliant, 1995) as in Table 4.9.

Table 4.9 The increment volume of the major planted species

Species	Land cover type	Rotation (year)	Increment volume (m^3/ha.yr)	Volume (m^3/ha)
Acacia mangium	Scrub	8	20.84	166.72
Albizia falcataria	Scrub	8	32.32	258.56
Acacia mangium	Grass	8	5.14	41.12
Albizia falcataria	Grass	8	21.10	168.80
Shorea sp	Logged-over forest	30	0.83	25.00

4.4.2 Financial analysis model

The aim of financial and economic analysis is to determine and quantify the costs and benefits of development projects in order to facilitate certain decisions which have to be made throughout the project cycle (European Commission, 1997). Financial analysis involves examining the activities and resources flows of individual entities (e.g. an industrial or commercial firm, public institution, etc.) or groups of entities (e.g. farmers, retailers). Economic analysis involves examining the flows of resources among groups of entities (e.g. entities involved in a project, sub-sectors, national or regional economy) and their impact on society as a whole. This research will only look at financial analysis from the objective of a single company and its financial gains.

The financial appraisal model is built on the production system of different land cover types by applying costs and prices to the various operations and putting them in an operational management framework for financial appraisal. The appraisal is executed based on production parameters and corresponding investment and production cost requirements. Yields depend on species and type of production management.

Cost evaluation
To estimate the required costs per hectare for the IFP project establishment, physical quantity requirements per hectare of each operation/activity, physical inputs, and supporting infrastructure requirements need to be determined. The physical quantity requirements include man-days for planting and maintenance, machinery hours for land preparation and harvesting, etc. The physical inputs include the amount of fertilizer, herbicide, seedling, etc. The supporting infrastructure requirements include access roads, building construction costs, vehicles, workshops, housing, etc.

In this model, costs per hectare are evaluated based on the cost for one rotation of the major planted species, namely: eight years for *Acacia mangium* and *Albizia falcataria* and 30 years for *Shorea* sp. Data on required costs were obtained from the MOF's standard unit costs of IFP establishment, PT. Inhutani II (1985), Boorliant (1995) and personal communication with a resource person from PT. Inhutani II and staff of the MOF.

Revenue evaluation
To calculate the revenues, the quantity of production (yields) for each species is required. Based on Table 4.9 above, estimated yields of the IFP project can be calculated as shown in Table 4.10 below. Information on log prices and

exploitation costs are obtained from PT. Inhutani II and the Regional Forest Office (Kanwil) of South Kalimantan.

Table 4.10 Yields per hectare

Species	Volume (m^3/ha)	Log price (Rp) (1997)	Exploitation cost (Rp)	Stumpage value (Rp/ha)	Revenue (Rp/ha)
Acacia mangium (Scrub)	166.72	96 000	46 000	49 500	8 266 500
Albizia falcataria (Scrub)	258.56	72 000	46 000	25 500	6 604 500
A. mangium (Grass)	41.12	96 000	46 000	49 500	2 029 500
A. falcataria (Grass)	168.80	72 000	46 000	25 500	4 309500
Shorea sp (Log. over)	25.00	750 000	46 000	703 500	17 587 500

Investment criteria

Several discounted investment criteria will be reviewed, i.e. net present value (NPV) and annual income, benefit-cost ratio (B/C ratio) and land expected value (LEV).

NPV may be interpreted as the present worth of the income stream generated by an investment (Gittinger, 1982). NPV takes the benefits and costs into account over the whole lifetime of the project. The decision rule for NPV is: accept all projects with a NPV ≥ 0, reject if < 0. These projects give a return that is equal to or higher than the discount rate that has been applied in calculating the NPV. Two notes can be made about NPV (Filius, 1997):

- The NPV does not – in a sense – take into account the amount of the investment. A project that takes a small investment, and therefore gives a small NPV, is not necessarily less profitable than a project that takes a large investment and therefore gives a larger NPV.
- The NPV can have a bearing on projects with a different life span. A project with a long life can have a higher NPV than one with a short life, but the latter can be financially more attractive: it can again be implemented afterwards. A series of projects with a short life and a low NPV for each project can give a higher NPV than one project with a long life.

Annual income is obtained by dividing the NPV by the lifetime of the project.

B/C ratio is calculated as the ratio of discounted benefits and discounted costs. The decision rule is: accept all projects with a B/C ratio ≥ 1, reject if < 1. According to Gittinger (1982), the B/C ratio is convenient because it easily gives information about the amount by which costs could rise or benefits decrease without making the project unattractive. A weakness of this criterion is that it is not clear what to reckon among the benefits and what among the costs (Filius, 1997).

LEV calculates the annual value or the present value of all future incomes as if the project is repeated an infinite number of times. According to this criterion, a project is acceptable if its annual value or LEV is greater than zero (Filius, 1997). LEV solutions for all-aged stands have been available only since 1980. The LEV approach has been applied by the Forest Service of the United States Department of Agriculture for its management decision framework of the Winnowing simulated all-aged stand prescriptions (Hall and Bruna, 1983). As the objective of the company in establishing the IFP project is to gain maximum long-term financial returns, the decision criterion can be interpreted as maximizing LEV.

Setting land priority for the IFP project

In order to set the order of priority for land allocation for the IFP project, the financial appraisal using the above-mentioned investment criteria will be applied respectively for IFP establishment in scrubland, grassland and logged-over production forest. The discount rates that are going to be used in the appraisal are 2%, 10% and 15%. These rates are commonly used for financial analysis in the forestry sector in Indonesia. The choice of the discount rate not only determines whether a project is accepted or not, it also influences the ranking of the projects. The impact is especially felt in the situation of long-term investments and large initial costs. A problem with the discount rate is that in the forestry sector it is rather low or even negative (Filius, 1997). That is why in the Indonesian situation a subsidy scheme has been set aside to help the IFP project implementor to overcome the problem of long-term profitability. Those three different discount rates eventually provide sufficient justification to take a decision from the perspective of the IFP implementor.

Table 4.11 shows the financial analysis for IFP project establishment in scrubland. For all discount rates, the LEV (50 years lifetime) for *Acacia mangium* and *Albizia falcataria* give positive results. Other investment criteria also show positive results for all discount rates. These results give the decision maker an overview to the effect that establishing IFP project in scrubland with *A. mangium* and A. *falcataria* will ensure a profitable return for the company.

Table 4.12 shows the financial analysis for IFP project establishment in grassland. A positive LEV value (280017.86 Rp/ha) in this analysis is provided only by *Albizia falcataria*, using low discount rate (2%). Other investment criteria show positive results only with the discount rate of 2%.

Table 4.13 shows the financial analysis for IFP project establishment in logged-over production forest for *Shorea* sp. The results also show that only with the discount rate of 2% is the project accepted. However, based on other criteria (NPV, B/C ratio, and annual income) the establishment of an IFP project with *Shorea* sp. in logged-over production forest is more acceptable. Accordingly, the order of priority of land for spatial simulation in the sub-model of economic viability is:

- scrubland;
- logged-over production forest; and
- grassland.

Table 4.11 Financial analysis of IFP project establishment with fast-growing species in scrubland (Rp/ha), based on data from the IFP project of Pulau Laut (continued on next page)

		SCRUB AREA			
		Discount rate			
Year	Item	0%	2%	10%	15%
Costs					
0	Nursery	89, 659	89,659	89,659	89, 659
0	Land preparation	406,000	406,000	406,000	406,000
0	Planting	212,948	212,948	212,948	212,948
0	Field survey	115,950	11,595	11,595	11,595
0	Annual plan	15,100	1,510	1,510	1,510
0	Infrastructure/facilities	230,363	230,363	230,363	230,363
1	Annual plan	1,510	1,480	1,373	1,314
1	Administration	245,673	240,760	223,317	213,736
2	Tending	133,685	128,471	121,520	116,306
2	Annual plan	1,510	1,451	1,247	1,142
2	Administration	245,673	236,092	202,926	185,729
3	Tending	56,502	53,225	42,433	37,178
3	Annual plan	1,510	1,422	1,134	994
3	Administration	245,673	231,424	184,500	161,653
4	Tending	48, 499	44,813	33,125	27,741
4	Annual plan	1,510	1,395	1,031	864
4	Administration	245,673	227,002	167,795	140,525
5	Tending	65,328	59,187	40,569	32,468
5	Annual plan	1,510	1,368	938	750
5	Administration	245,673	222,580	152,563	122,099
6	Tending	56,860	50,492	32,069	24,564
6	Annual plan	1,510	1,341	852	652
6	Administration	245,673	218,158	138,560	106,131

Table 4.11 (continued)

		SCRUB AREA			
		Discount rate			
Year	Item	0%	2%	10%	15%
	Costs				
7	Annual plan	1,510	1,315	775	568
7	Administration	245,673	213,981	126,030	92,373
8	Annual plan	1,510	1,288	705	494
8	Administration	245,673	209,559	114,729	80,335
	Total costs	3,290,413	3, 098,879	2,540,264	2,299,690
	Revenues				
8	Harvesting				
	A. mangium	8,266,500	7, 051,324	3,860,455	2,703,145
	A. falcataria	6,604,500	5, 633,638	3,084,301	2,159,671
	Investment criteria				
	NPV				
	A. mangium	4,976,087	3,952,446	1,320,191	403,456
	A. falcataria	6,604,500	5,633,638	3,084,301	2,159,671
	B/C ratio				
	A. mangium	2.51	2.28	1.52	1.18
	A. falcataria	2.01	1.82	1.21	0.94
	Annual income				
	A. mangium	622,011	494,056	165,024	50, 432
	A. falcataria	825,562	704,205	385,538	269,959
	LEV (50 years' lifetime)				
	A. mangium		6,999,247	1,344,747	404,598
	A. falcataria		9,976,412	3,141,669	2,165,785

Table 4.12 Financial analysis of IFP project establishment with fast-growing species in grassland (Rp/ha), based on data from the IFP project of Pulau Laut (continued on next page)

GRASSLAND						
			Discount rate			
Year		Item	0%	2%	10%	15%
	Costs					
0		Nursery	89,659	89,659	89,659	89,659
0		Land preparation	825,000	825,000	825,000	825,000
0		Planting	212,948	212,948	212,948	212,948
0		Field survey	11,595	11,595	11,595	11,595
0		Annual plan	1,510	1,510	1,510	1,510
0		Infrastructure/facilities	230,363	230,363	230,363	230,363
1		Annual plan	1,510	1,479	1,373	1,314
1		Administration	245,673	240,760	223,317	213,736
2		Tending	133,685	128,471	121,520	116,306
2		Annual plan	1,510	1,451	1,247	1,142
2		Administration	245,673	236,092	202,926	185,729
3		Tending	56,502	53,225	42,433	37,178
3		Annual plan	1,510	1,422	1,134	994
3		Administration	245,673	231,424	184,500	161,653
4		Tending	48,499	44,813	33,125	27,741
4		Annual plan	1,510	1,395	1,031	864
4		Administration	245,673	227,002	167,795	140,525
5		Tending	65,328	59,187	40,569	32,468
5		Annual plan	1,510	1,368	938	750
5		Administration	245,673	222,580	152,563	122,099
6		Tending	56,860	50,492	32,069	24,564
6		Annual plan	1,510	1,341	852	652
6		Administration	245,673	218,158	138,560	106,131
7		Annual plan	1,510	1,315	775	568
7		Administration	245,673	213,981	126,030	92,373
8		Annual plan	1,510	1,288	705	494
8		Administration	245,673	209,559	114,729	80,335
	Total costs		3,709,413	3,517,879	2,959,264	2,718,690
	Revenues					
8			Harvesting			
		A. mangium	2,029,500	1,272,496	947,776	663,646
		A. falcataria	4,309,500	3,676,003	2,012,536	1,409,206

Table 4.12 (continued)

GRASSLAND					
		Discount rate			
Year	Item	0%	2%	10%	15%
Investment criteria					
	NPV				
	A. mangium	-1,679,913	-2,245,382	-2,011,488	-2,055,043
	A. falcataria	600,087	158,125	-946,728	-1,309,483
	B/C ratio				
	A. mangium	0.55	0.36	0.32	0.24
	A. falcataria	1.16	1.04	0.68	0.52
	Annual income				
	A. mangium	-209,989	-280,673	-251,436	-256,880
	A. falcataria	75, 011	19,766	-118,341	-163,685
LEV (50 years' lifetime)					
	A. mangium		-3,976,268	-2,048,901	-2,060,861
	A. falcataria		280,018	-964,337	-1,313,190

Table 4.13 Financial analysis of IFP project establishment with fast-growing species in logged-over production forest (Rupiah/hectare), based on data from the IFP project of Pulau Laut (continued on next page)

Logged-Over Production Forest						
			Discount rate			
Year		Item	0%	2%	10%	15%
	Costs					
0		Nursery	44,830	44,830	44,830	44,830
0		Land preparation	781,000	781,000	781,000	781,000
0		Planting	284,725	284,725	284,725	284,725
0		Field survey	11,595	11,595	11,595	11,595
0		Annual plan	1,510	110	1,510	1,510
0		Infrastructure/facilities	115,182	115,182	115,182	115,182
1		Annual plan	1,510	1,480	1,373	1,314
1		Administration	196,103	192,181	178,258	170,610
2		Tending	133,685	128,471	110,424	101,066
2		Annual plan	1,510	1,451	1,247	1,142

Table 4.13 (continued)

Year		Item	Logged-Over Production Forest — Discount rate 0%	2%	10%	15%
	Costs					
2		Administration	196,103	188,455	161,981	170,610
3		Tending	56,502	53,225	42,433	37,178
3		Annual plan	1,510	1,422	1,134	994
3		Administration	196,103	184,729	147,273	129,036
4		Tending	48,499	44,813	33,125	27,741
4		Annual plan	1,510	1,395	1,031	864
4		Administration	245,673	227,002	167,795	140,525
5		Tending	65,328	59,187	40,569	32,468
5		Annual plan	1,510	1,368	938	750
5		Administration	196,103	177,669	121,780	97,463
6		Tending	56,860	50,492	32,069	24,564
6		Annual plan	1,510	1,341	852	652
6		Administration	196,103	174,139	110,602	84,716
7		Annual plan	1,510	1,315	775	568
7		Administration	196,103	170,806	100,601	73,735
8		Annual plan	1,510	1 288	705	494
8		Administration	196,103	167,276	91,580	64,126
	Total costs	3 230 190	3,068,348	2,585,385	2,399,456	
	Revenues					
30		Harvesting				
		Shorea	17,587,500	9,708,300	1,002,488	263,812
	Investment criteria					
		NPV	14,357,310	6,639,952	-1,582,898	-2 ,135,644
		B/C ratio	5.44	3.16	0.39	0.11
		Annual income	586,250	323,610	33,416	8,794
	LEV (50 years' lifetime)		2,303,884	-1,859,266	-2,274,624	

4.4.3 Spatial simulation of the economic viability sub-model

The existing IFP project area in Pulau Laut up to 1997 was 28,373 ha. The initial plan of the project required 50,000 ha for profitable IFP. To simulate the allocation of the remaining required area, the results of the sub-model social acceptability for the projection of 17 years' (1980-1997) agricultural area expansion will be used for information on existing land use in 1997. The allocation of the new IFP project area from the perspective of the company's objective will accordingly be simulated for the moderate, optimistic and pessimistic scenarios. Following the results of the financial analysis (Section 4.3.2), the company prioritizes scrubland as its first choice, followed by logged-over production forest and grassland. The search for the new IFP project area is started from the existing boundary of the IFP project area towards these lands in order of priority.

Simulation results

The simulation result of the economic viability sub-model for new IFP project areas is presented in Figure 4.8. The new areas are obtained from 11,584 ha of scrub, 4,758 ha of production forest and 5,301 ha of grassland. The result shows that more grassland is used for the IFP project than production forest. This situation is because the physical factors of the area (slope, distance from road and river) provide a high friction value.

The optimistic scenario uses the result of 17 years' projection of agricultural area expansion from the optimistic scenario of the sub-model social acceptability for the reference map. The new areas of this scenario are obtained from 10,294 ha of scrub, 5,517 ha of production forest and 5,875 ha of grassland.

In the pessimitic scenario, the result of 17 years' projection of agricultural area expansion from the pessimistic scenario of the sub-model social acceptability is used for the reference map. The new areas are obtained from 9,690 ha of scrub, 5,658 ha of production forest and 6,291 ha of grassland.

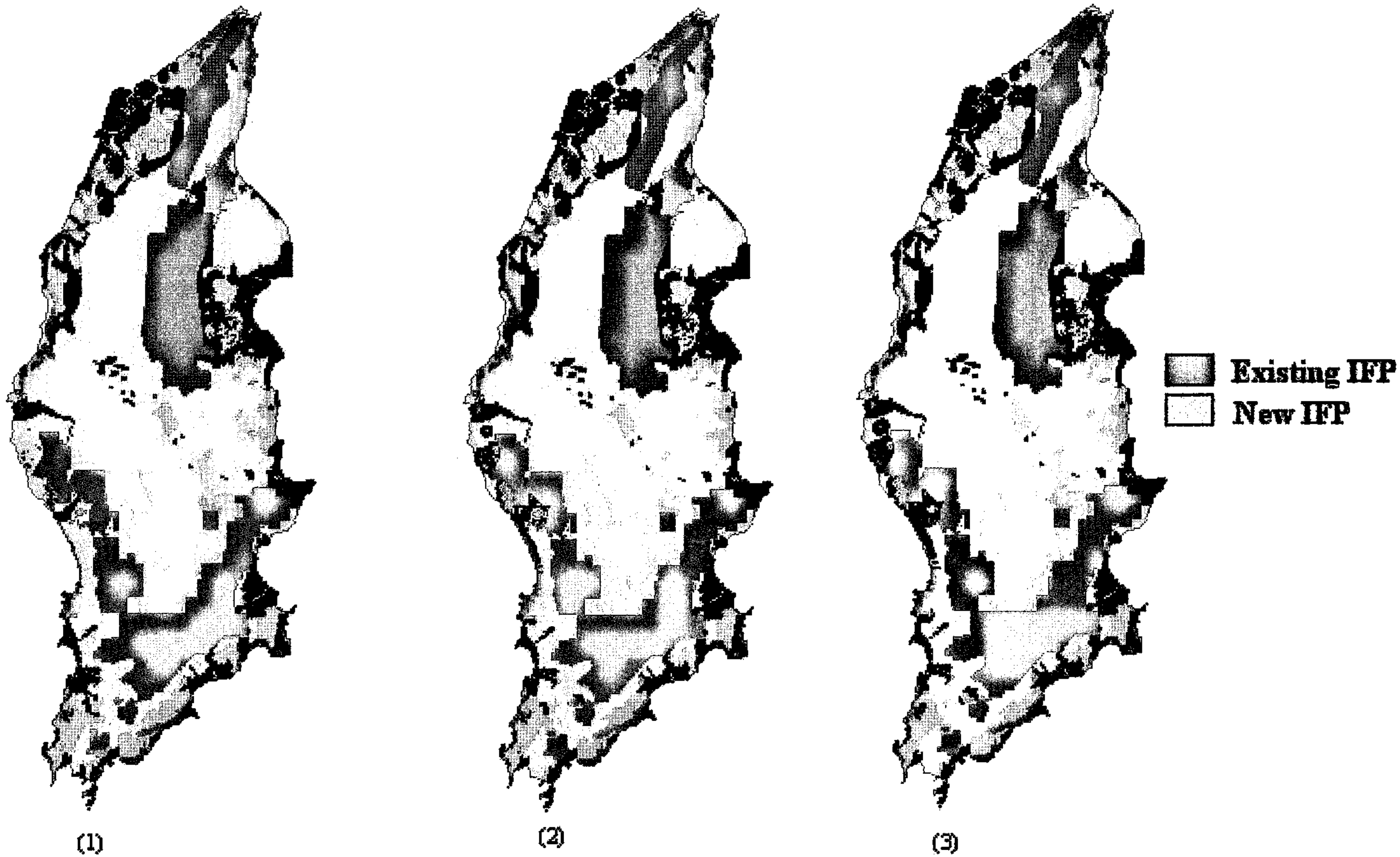


Figure 4.8 New IFP project areas according to the moderate scenario (1), the optimistic scenario (2), and the pessimistic scenario (3)

Summary of the results

The result of the sub-model economic viability is summarized in Figure 4.9. The figure shows the comparison of land use types that are transferred to the new IFP area. The use of scrub for the IFP project area is higher in the moderate scenario than in the other scenarios. In the pessimistic scenario, the use of production forest and grassland is higher than in the other scenarios

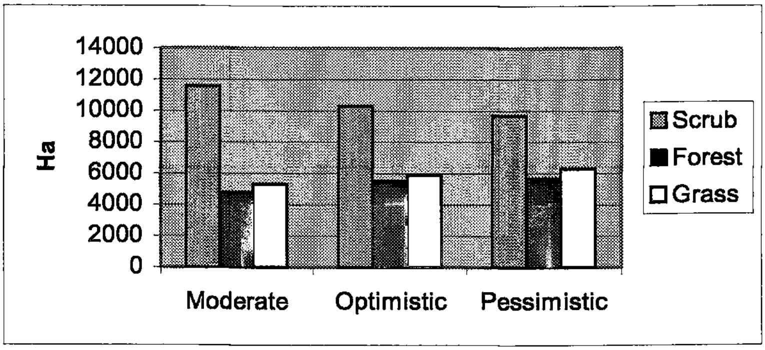


Figure 4.9 Transfer of lands to the new IFP area

4.5 Implementation of the ecological soundness sub-model

Principle 2 of the ITTO *Guidelines for the establishment and sustainable management of planted tropical forests* mentions that provisions for the establishment and sustainable management of planted forests must be considered in the context of an integrated land use plan for national economic and social development. Thus, planted forests should normally only be established on lands that are known to be capable of supporting all aspects of their long-term management and utilization without land degradation. The creation of plantations must be balanced with the need for protection of the site and the environment, the conservation of biological diversity of all types, the needs and aspirations of the present people and the potential demands of future generations (ITTO, 1993).

To cope with the above-mentioned principle, the sub-model of ecological soundness will indicate lands that have positive functions for conservation purposes. To simulate the allocation of lands for ecological purposes, the results of 17 years' projection (1980-1997) of agricultural area expansion from the sub-model of social acceptability will be used as reference maps. Fragmented forests, as the negative effects of agricultural expansion, and existing protected areas will also be used as the basic spatial information to run the sub-model of ecological soundness. In this sub-model, ecological evaluation deals with assigning value to areas for conservation purposes.

4.5.1 The ecological importance of Borneo

Recognized as Kalimantan Island by Indonesia, the island of Borneo is shared with Brunei Darussalam and Malaysia. MacKinnon et al. (1996) mention that two thirds of all species occur in tropical regions, and probably half are confined to rain forests. Borneo supports the largest expanse of tropical rain forest in the Indomalayan realm. With 267 species (155 endemic) of the family of Dipterocarps, Borneo is a center of diversity for Dipterocarps, the most important group of commercial timber trees in South Asia, and source of most of the valuable timber exports from Kalimantan, Sabah and Sarawak. Among the Indonesian islands, Borneo is second only to Irian Jaya in terms of species richness for plants, mammals, birds and reptiles (Table 4.14). The whole island of Borneo is a major center for biodiversity and a priority area for conservation. Borneo covers less than 0.2% of the earth's land surface, yet one in twenty-five of all known plants are found here as well as one twentieth of all known birds and mammals. There is a high level of floral endemism, with about 34% of all plant species, and 59 genera unique to the island. Borneo has 37 species of endemic birds and 44 endemic land mammals.

Furthermore, MacKinnon et al. (1996) reveal that Borneo's biological diversity is now threatened by poorly regulated development and non-sustainable harvesting of the island's rich natural resources, especially timber. About 60% of the island still remains under forest cover, but deforestation, due to poor agriculture and to logging practices, is proceeding at an alarming rate. The habitats most threatened by these developments are the more accessible lowland forests, where species richness is greatest.

Concerning the ecological importance of the island, environmentally sound forest management activities should always be applied. In practice, in most developing countries such as Indonesia, the consideration for ecological purposes will not be the first priority. The notion of development is often used as an excuse by the decision maker to practice the maximum yield principle in exploiting the resources. A balance between economic and ecological purposes for natural resource utilization is a situation still to be achieved.

Table 4.14 A comparison of biotic richness throughout Indonesia

Island	Plants		Mammals		Resident birds		Reptiles	
	Species	% Endemic	Species	% Endemic	Species	% Endemic	Species	% Endemic
Sumatra	820	11	221	10	465	2	217	11
Java and Bali	630	5	113	12	362	7	173	8
Borneo	900	34	221	19	358	10	254	24
Sulawesi	520	7	127	62	289	32	117	26
Lesser Sundas	150	3	41	12	242	30	77	22
Moluccas	380	6	69	17	210	33	98	18
Irian Jaya	1 030	55	125	58	602	52	223	35

(Source: McKinnon et al., 1996)

Endangered and protected species and their habitats in Pulau Laut

In accordance with the environmental impact assessment (EIA) regulation, the IFP company (PT. Inhutani II) has conducted an environmental survey in Pulau Laut (PT. Inhutani II, 1996). It indicated the presence of some endangered and protected plants and wildlife in Pulau Laut.

The survey revealed that in the northern and central parts of the island, where logging operations (Sub-Unit Logging of Mekarpura) are taking place, the forest condition is generally still supporting the habitat for wildlife. This is especially the case for protected forests and areas where the crown cover is still high. The presence of endangered and protected species in protected areas is higher than in other areas.

Forest management activities that cause the opening of the forest area will have their impacts on endangered tree species and wildlife. These activities are tree felling and land clearing, road network establishment, and site clearing for base camps and log ponds/yards. Road network establishment will have more impacts than the other activities, especially contributing towards forest fragmentation. The forest gaps along the road network will hamper the movement of the endangered monkey, Owa (*Hylobates muelleri*), from tree to tree (see Figure 4.10), and will also have an impact on the dominance of birds from the interior over exterior bird species.

The EIA study indicated five observation points of habitats for endangered and protected wildlife and seven observation points for protected trees, which need to be maintained in their natural condition. The study did not indicate the extent of these areas. In order to simulate the required appropriate area for plant and wildlife habitats, the theory of island biogeography is applied. The points for the reserve habitats, i.e. the distance from the spots, for the purpose of simulation in this research are fixed within a radius of 2 km, following the buffer zone requirements developed by Van Lavieren (1983 in MacKinnon and MacKinnon, 1986). As a general rule, the conservation value of an area is a function of its size. In principle, the area must be of a size and form sufficient to support entire ecological units or viable populations of flora and fauna. The result of the distance calculation from the habitat spots is presented in Figure 4.11. The resulted reserve habitat should then be read as the minimum required area.

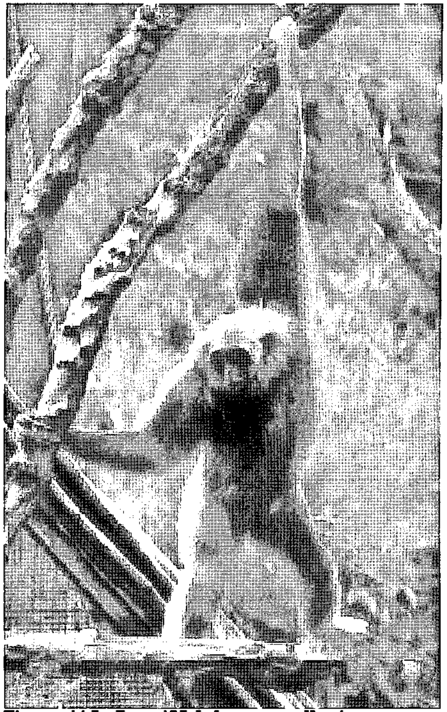


Figure 410 Owa (*Hylobates muelleri*), the endangered monkey

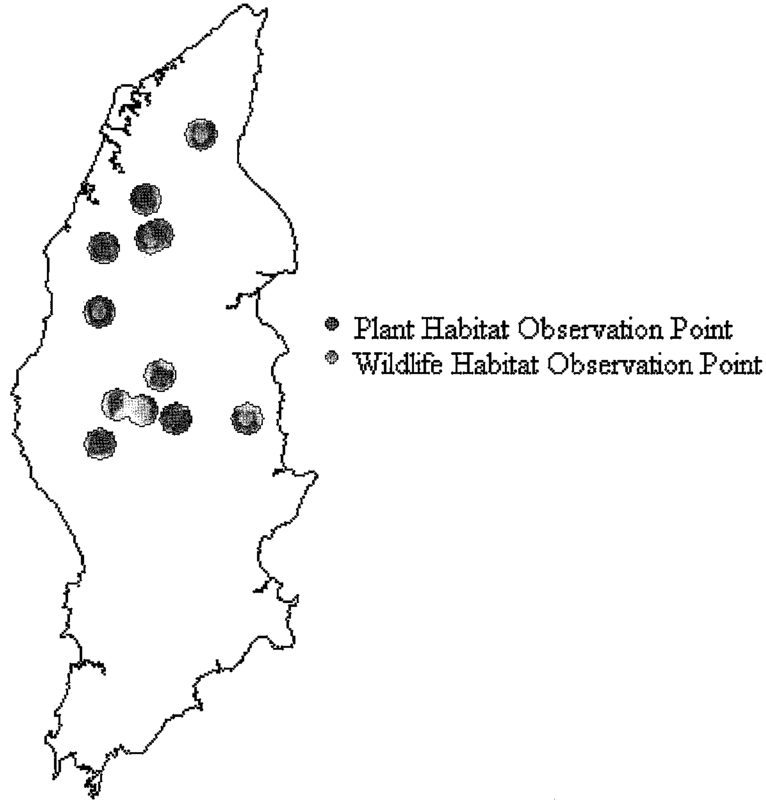


Figure 4.11 The location of observation points for plant and wildlife habitats. The red dots indicate radius 2 km distance from habitat spots.

Protective beds along river and road networks

In this research, the protective beds along watercourses and road networks are fixed at 200 m distance from the existing rivers and roads inside the forest areas. Differentiation in distances according to classes of rivers and roads for ecological purposes cannot be done because the information is not available. Both the existing rivers and roads and their 200 m distant protective beds are presented in Figures 4.12 and 4.13. The protection of areas along rivers and roads not only protects these sites, but also creates ecological corridors between sites and habitats, essential for animal and seed movement, and sustaining biodiversity.

The fragmented natural forest

The fragmented natural forest areas, as the result of 17 years' agricultural expansion (1980-1997), are used to determine the protective beds along the river and road networks in the forest land. The beds of 200 m distance along the rivers and roads inside the natural forest are protected. For this purpose, the maps of the fragmented forest areas will be superimposed on the maps of the protective beds from river and road networks.

Figure 4.12
The protective beds from the rivers

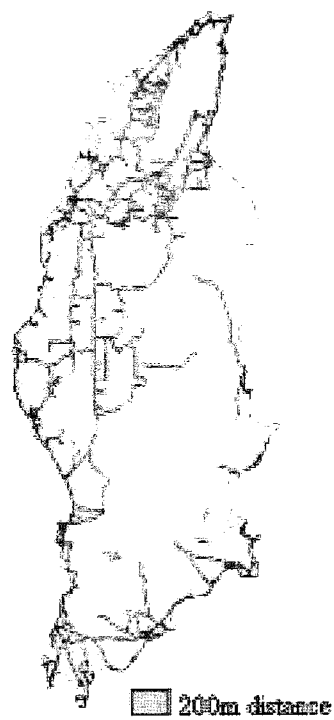


Figure 4.13
The protective beds from the Roads

4.5.2 Spatial simulation of the ecological soundness sub-model

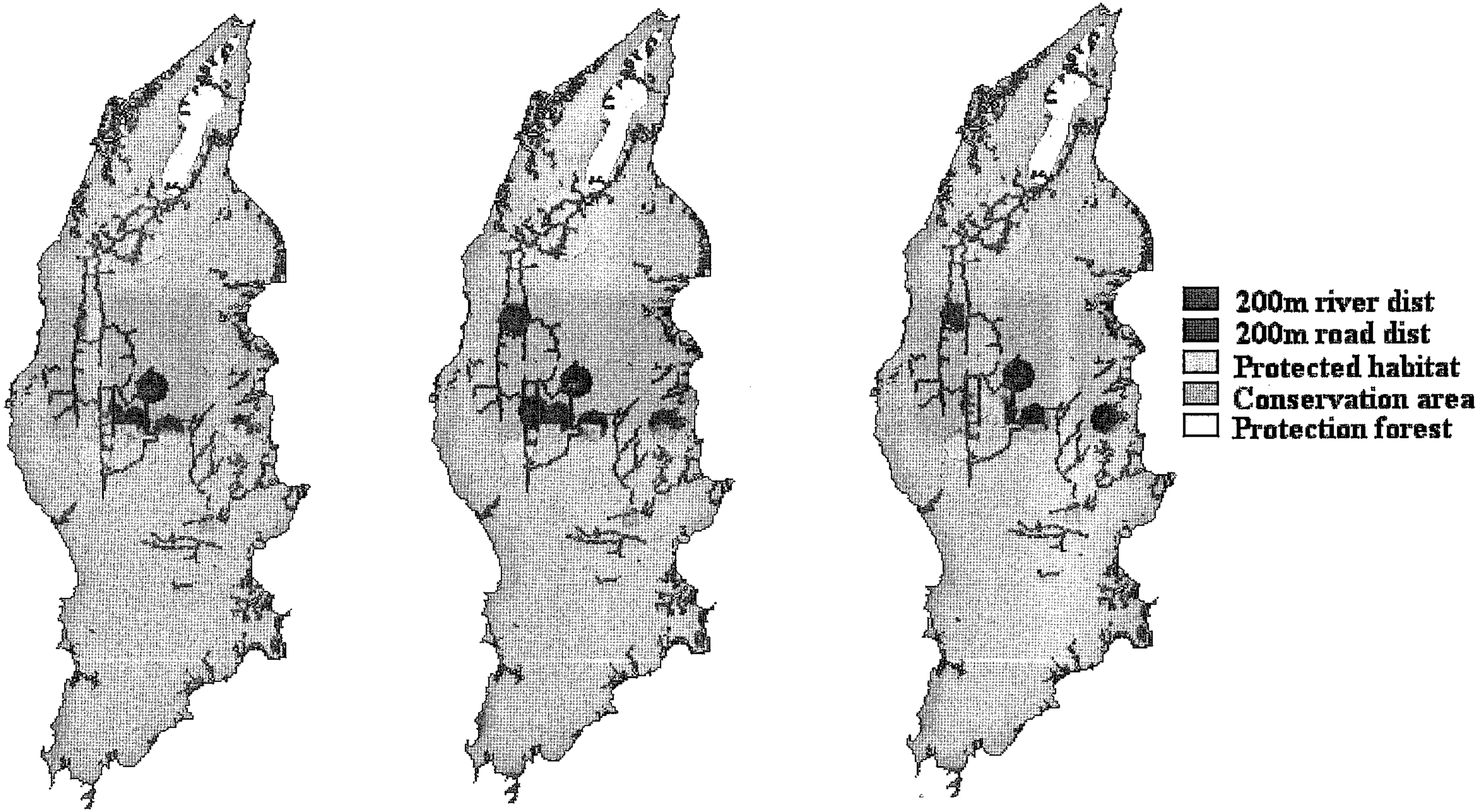
To simulate the allocation of areas for ecological purposes, areas for habitat protection and protective beds along the river and road networks in the forest land are set aside. The total protected area is obtained by means of superimposing the maps of habitat sites, fragmented forest and protective beds of river and road networks, and the forest land use by consensus map (TGHK), which contains information about protection forest and conservation areas for tree species. Ravines (lands with slope exceeding 40%) are included in the protection forest in the northern part of Pulau Laut. The rest of the areas have slope classes less than 40%. The results of the simulation are presented in three different scenarios, namely: moderate, optimistic and pessimistic.

Simulation results

The simulation results of the ecological soundness sub-model is presented in Figure 4.14. In the moderate scenario, the area set aside for the ecological site is 41,667 ha. This area is composed of 14,801 ha of protective beds along the river network, 11,632 ha of protective beds along the road network, 9,922 ha of protected habitat, 403 ha of tree species conservation area, and 4,909 ha of protection forest.

In the case of the optimistic scenario, the ecological site is 41,880 ha. This area is composed of 14,903 ha of protective beds along the river network, 11,743 ha of protective beds along the road network, 9,922 ha of protected habitat, 403 ha of tree species conservation area, and 4,909 ha of protection forest.

The pessimistic scenario results in an ecological site of 41,572 ha. This area is composed of 14,753 ha of protective beds along the river network, 11,585 ha of protective beds along the road network, 9,922 ha of protected habitat, 403 ha of tree species conservation area, and 4,909 ha of protection forest.



(1) (2) (3)

Figure 4.14 Ecological sites: moderate scenario (1), optimistic scenario (2), and pessimistic scenario (3)

Summary of the results

From the results of the three scenarios, there are no big differences in the size of required ecological sites. This means that, in principle, any of the scenarios might be chosen in the land allocation decision making process. More importantly, it means that even if the pessimistic scenario becomes true, this will not pose a threat to nature conservation, if protective beds are respected. In practice, this condition is not likely to be met. In fact, the sub-model of ecological soundness might be particularly useful for the Government in order to establish conservation forest area. Figure 4.15 below summarizes the results of the sub-model ecological soundness.

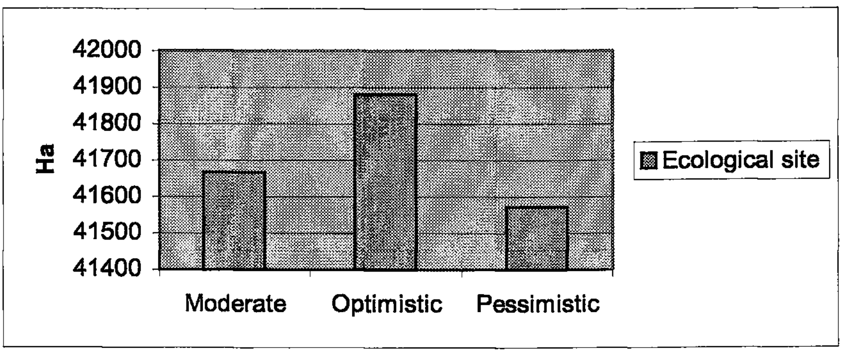


Figure 4.15 Ecological sites resulting from the three scenarios

4.6 Conflict resolution of land allocation: IFP land allocation DSS

Land use policies are the basic guidelines or rules that determine the allocation of a given land use to a particular planning unit (Rodriguez, 1995). The outputs of each sub-model have identified the preferred land use from one point of view. The IFP land allocation DSS is the integration of the sub-models to obtain aggregate land use policy satisfaction for a specific use on a given part of land. The DSS provides land allocation alternatives, which enable the IFP manager to exercise choice and select the preferred/satisfying land option for the IFP project against other possible uses of land. Whether and how to involve representatives from the other stakeholder groups in the decision making will be touched upon in Chapter 5.

Opinion discrepancies regarding preferred land use planning among the stakeholders in the IFP development (local people, the IFP company and the Government) can be identified by overlaying the maps resulting from each of the sub-models. By overlaying the maps, areas of land use agreement and disagreement among the stakeholders can be mapped. Land use agreement can be achieved when the land use options selected by the stakeholders coincide with their opinions and do not conflict with one another. On the other hand, land use disagreements occur when opinions on a unit area indicate stakeholder conflicts. In this disagreement situation, a compromise regarding the conflict unit areas must be reached through a compatibility process. In this process, the stakeholders' opinions are confronted with the established land use policy formulation for conflict resolution of land use planning in the study area of Pulau Laut. The areas of disagreement are the focus for simulating a preferred land use for the IFP project development. Some possible methods for conflict resolution are suggested in this section.

4.6.1 Land use opinion discrepancies among the stakeholders

Areas of disagreement according to the three scenarios (moderate, optimistic and pessimistic) of the sub-models are identified by overlaying the result maps of each scenario. The map of the agricultural expansion area of the moderate scenario is overlaid with the maps of the same scenario from the sub-model of economic viability and the sub-model of ecological soundness. The same procedure is applied for the optimistic and pessimistic scenarios. The results of these overlay procedures are presented in Figures 4.16.

The identified areas of disagreement represent the conflict:

- between agricultural area and IFP area (conflict soc_econ);
- between agricultural area and ecological site (conflict soc_ecol);

- between IFP area and ecological site (conflict econ_ecol); and
- between agricultural area, IFP area and ecological site (conflict soc_econ_ecol).

In the moderate scenario, the area of disagreement amounts to 17,509 ha out of the 86,093 ha of all simulation result areas. The disagreement consists of 81% of the conflict soc_econ area, 17% of the conflict soc_ecol area, 1% of the conflict econ_ecol area and 1% of the conflict soc_econ_ecol area. In the situation of the optimistic scenario, the area of disagreement is 11,890 ha out of the 83,329 ha of all simulation result areas. This involves 78% of the conflict soc_econ area, 18% of the conflict soc_ecol area, 3% of the conflict econ_ecol area and 1% of the conflict soc_econ_ecol area. In the pessimistic scenario, the area of disagreement amounts to 18,996 ha out of the 97,952 ha of all simulation result areas. This encompasses 75% of the conflict soc_econ area, 22% of the conflict soc_ecol area, 2% of the conflict econ_ecol area and 1% of the conflict soc_econ_ecol area.

Table 4.5 shows the total areas of disagreement for all scenarios. The moderate scenario results in the smallest area of disagreement for ecological purposes. The optimistic scenario gives a better chance for local people to expand their agriculture area. This situation is reasonable because better economic growth in the optimistic scenario allows the local people to improve agricultural productivity and, in return, will minimize the expansion of agricultural area. The pessimistic scenario results in the smallest conflict area for the IFP company, whereas conflict between the agricultural area and the ecological area increases.

The areas of disagreement represent places where a compromise is needed in regard to stakeholders' opinions, and the formulation of land use policy must be carried out to reach a satisfactory compromise for appropriate land use allocation. Rodriguez (1995) mentions that agreement must be achieved, preferably by consensus, between the interest groups. This provides the allocation decisions with more credibility and stability because the land users themselves are supporting the plan. Imposing a particular land use plan without taking into account the land users, their expectations, needs, and ideas about land use allocation and the organization of their living space has often resulted in failure.

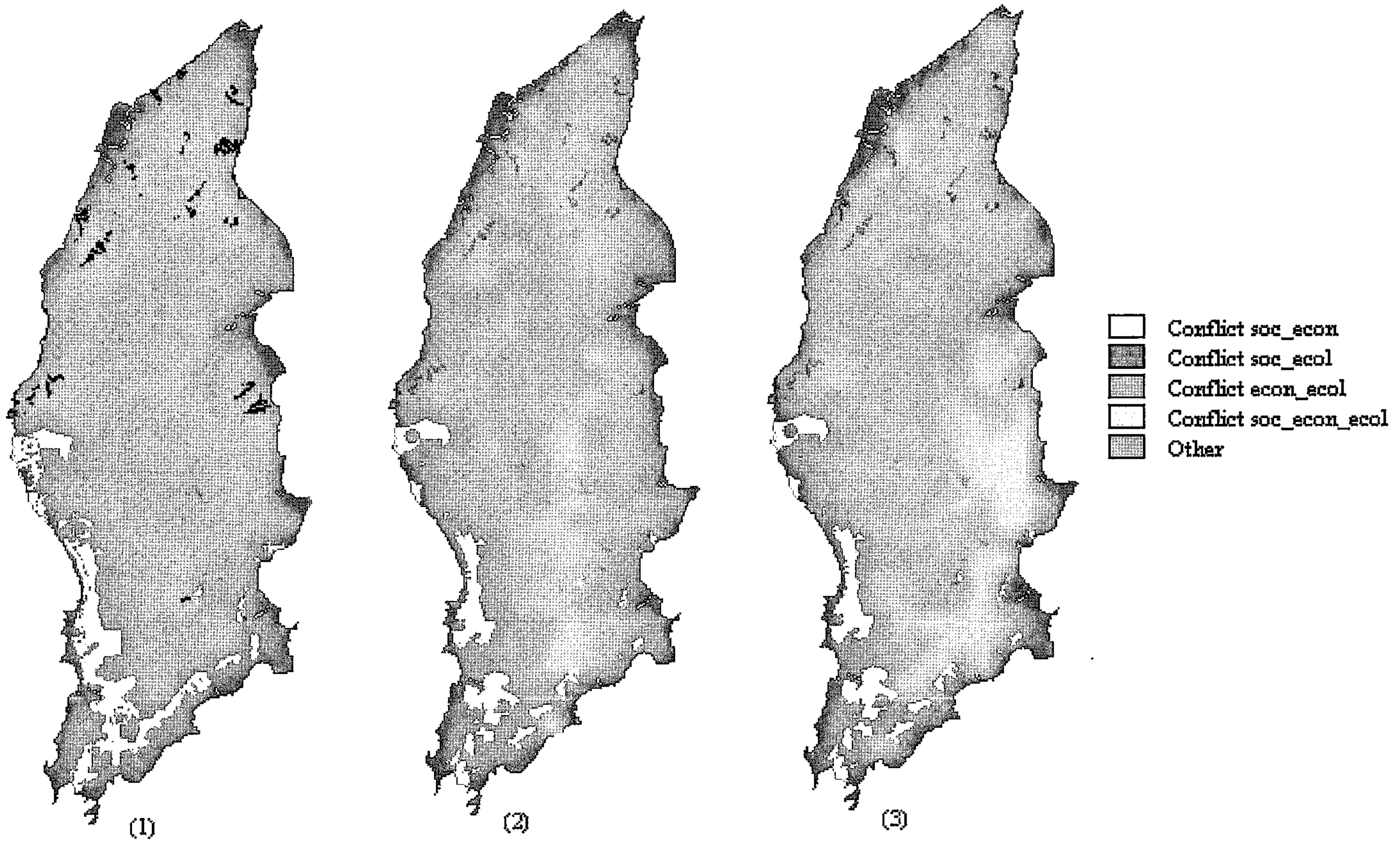


Figure 4.16 Land use opinion discrepancies according to the moderate scenario (1), the optimistic scenario (2), and the pessimistic scenario (3)

4.6.2 Land use conflict resolution

In order to provide the IFP manager with strong arguments for negotiating his/her IFP land allocation plan with other stakeholders, land use policy formulation proposes to resolve the opinion discrepancies that occur in the area of disagreement. For this purpose, the Land Use Planning Information System (LUPIS) procedure is adopted. LUPIS is a computer program designed to implement a land use planning procedure in Australia (Ive and Cooks, 1983). LUPIS is flexible enough to be adapted to other land use planning situations. It is particularly suited to strategic planning, i.e. general land use allocation, although many tactical planning applications, i.e. management planning, have used LUPIS (Ive et al., 1989).

LUPIS supports the targeting and resolution of conflict between stakeholders by means of generating land use policies, namely:

- *Commitment policies* allot a land use to specific units, excluding all other uses.
- *Exclusion policies* exclude a land use which is not allowed or not feasible within the planning conditions.
- *Preference/avoidance* policies are influenced by users through the votes they give to each individual policy.

On the basis of two reference maps, i.e. land suitability and TGHK (forest land use by consensus) maps of Pulau Laut, land use policies or consensus rules are formulated to resolve disagreement. These two maps are presented in Figures 4.17 and 4.18.

Commitment policies

1) Allot agricultural land use to units that are already under this use.
2) Allot IFP land use to units that are already under this use.
3) Keep under natural conditions those units already classified as ecological sites.

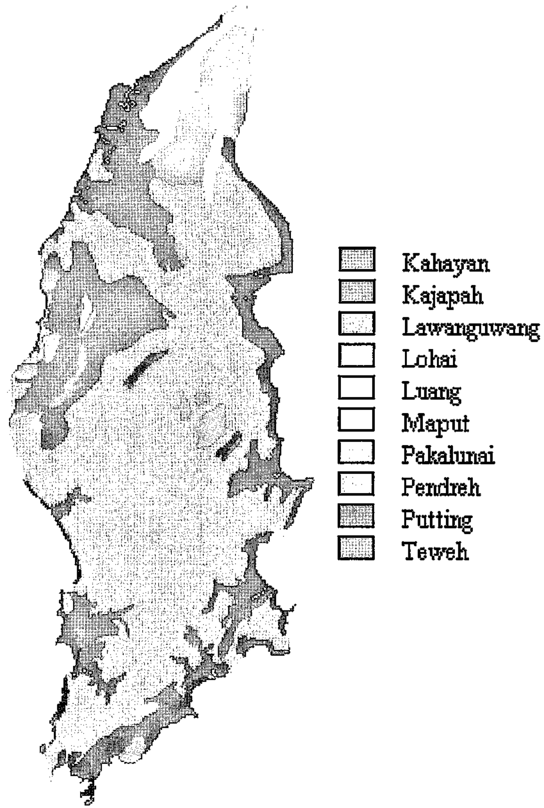
Exclusion policies

1) Exclude agriculture if the land is not suitable.
2) Exclude agriculture if the units belong to production forest.
3) Exclude agriculture if the units belong to ecological sites.
4) Exclude IFP land use if the units belong to ecological sites.
5) Exclude IFP land use if the unit is suitable for agriculture and outside the production forest.

Preference/avoidance policies

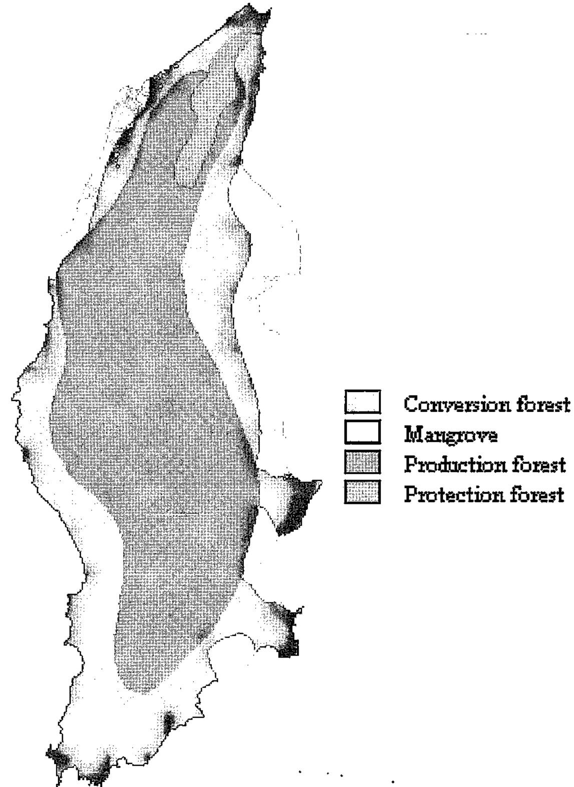
1) Give preference to IFP development in units not suitable for agriculture and outside production forest.
2) Give preference to IFP development in units suitable for agriculture but currently not used for agriculture.

The results of applying the formulated land use policies to the area of disagreement are presented in Figures 4.19. Resolving the area conflicts by using the policies results in sharing non-ecological conflict areas (conflict 1-2) between agricultural and IFP areas. All ecological sites will be kept as they are. In the moderate scenario, out of an area of disagreement covering 17,509 ha, 3,714 ha (21%) are allocated for the IFP area. In the case of the optimistic scenario, 21% (2,463 ha) of the area of disagreement (11,890 ha) is allocated for the IFP area. The pessimistic scenario gives 22% (4,109 ha) of the area of disagreement (18,996 ha) for the IFP area.



Source: RePPProt (1987)

Figure 4.17 Reference map: land suitability (see also Table 4.15)



Source: Badan Planologi Kalsel (1981)

Figure 4.18 Reference map: forest land use by consensus (TGHK)

Table 4.15 Legend for land suitability map

Land System	**Landform**	**Lithology** (dominant rock type or mineralogy)	**Soil Association** (texture of top soil/subsoil)	**Climatic Range** (mm/year)	**Suitability** (for APM agriculture)
Kahayan (khy)	Coalescent Estuarine/riverine Plains	Alluvium, recent estuarine-marine (saline) Alluvium, recent riverine (fresh) Peat	Fine/fine Fine/fine Peat/fine	1600-3900	Suitable
Kajapah (kjp)	Inter-tidal mudflats under mangrove and nipah	Alluvium, recent estuarine-marine (saline)	Fine/fine	1600-3900	Not Suitable
Lohai (lhi)	Long, narrow-crested, steep-sided ridge systems	Sandstone, Mudstone	Mod.fine/mod.fine	1800-4200	Not Suitable
Luang (lng)	Ultrabasic/basic mountains	Peridotite, Serpentinite, Basalt Shale, Mudstone, Sandstone	Mod.fine/fine	1700-300	Not Suitable
Lawanguwang (lww)	Undulating sandy terraces	Alluvium, recent riverine (fresh)	Mod.fine/mod.fine	1600-4100	Suitable
Maput (mpt)	Asymmetric, non-oriented sedimentary hills	Sandstone, Shale, Mudstone, Marl	Mod.fine/fine	1600-4400	Not Suitable
Pendreh (pdh)	Non-oriented sedimentary mountains	Sandstone, Conglomerate, Shale	Mod.coarse/medium	1800-4400	Not Suitable
Pakalunai (pln)	Non-oriented, non sedimentary hills	Dolerite, Basalt	Mod.coarse/mod.fine	2800-3300	Not Suitable
Puting (ptg)	Coastal beach ridges and swales	Alluvium, recent marine (beach sand, gravels)	Mod.coarse/mod.coarse	1600-3200	Not Suitable
Teweh (twh)	Hillocky plains with steep parallel ridges	Sandstone, Shale, Mudstone, Marl	Mod.fine/mod.fine	1800-4400	Suitable

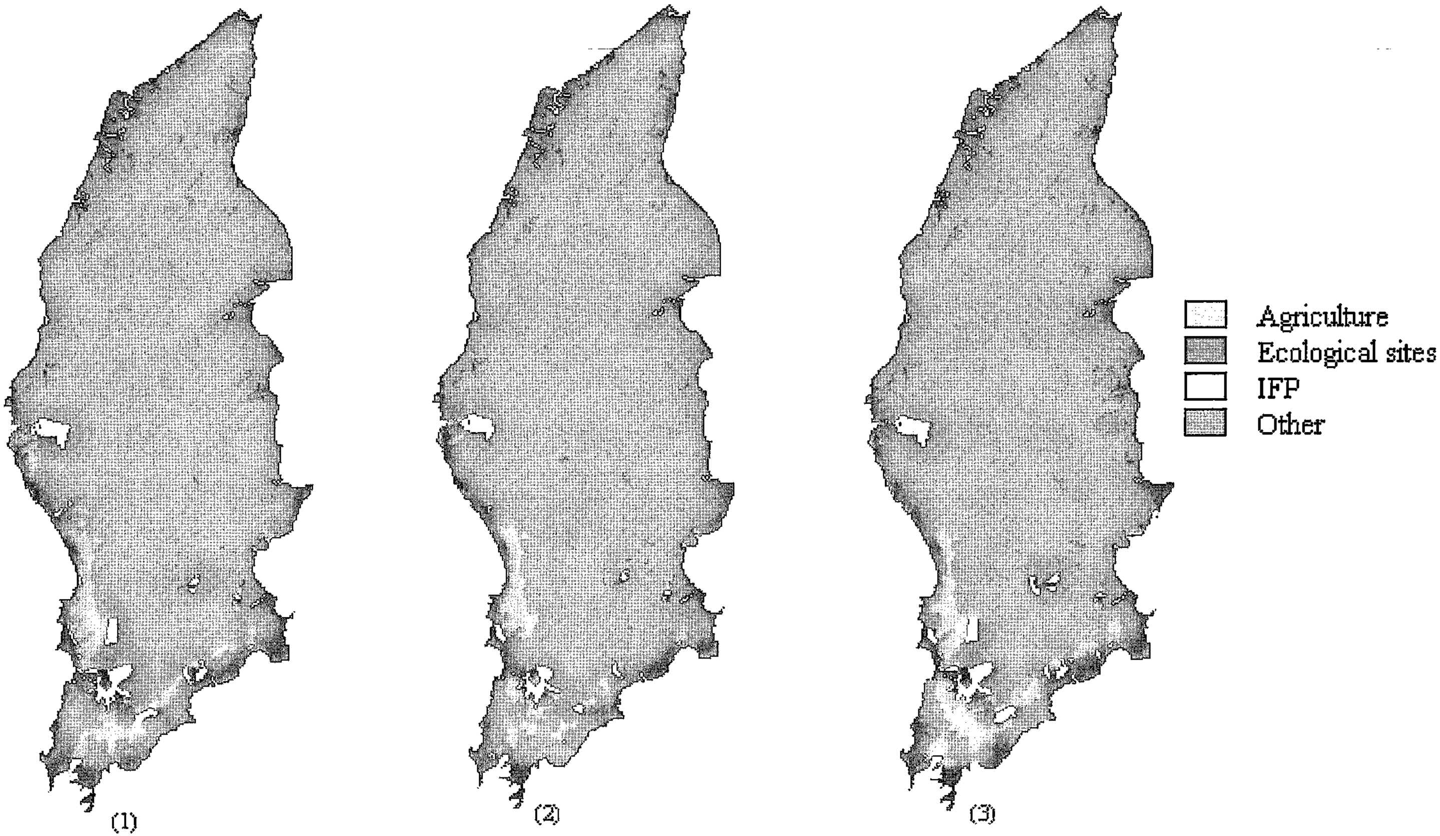


Figure 4.19 Land use conflict resolution according to the moderate scenario (1), the optimistic scenario (2), and the pessimistic scenario (3)

4.6.3 Participation by other stakeholders

The IFP manager can use the results of the simulated disagreement on land use opinions and their potential conflict resolution as a platform for discussion with other IFP stakeholders to reach a consensus on preferred and accepted land use planning. In the discussion process, the rights and power trade-off among stakeholders will take place. Fairness and equity of the process are important to achieve a more sustainable land use plan. By means of projecting local people's needs for agricultural expansion, future conflicts can be anticipated and future generations' needs are incorporated. This maximizes the current and future benefits from the agreed land use plan.

Currently, in the allocation of land for IFP project development, the participatory decision making process is nearly always neglected by the IFP project authority. The project's orientation towards short-term benefits and the desire to overlook the possible turbulence of land use conflict that potentially exists causes this. The IFP authority used to use its power to acquire land for plantation, which created friction. Conflicts between the IFP company and the local people took place in many IFP project locations. To avoid conflict, the IFP company must realize its social responsibility. According to Bartol and Martin (1991), organizational social responsibility refers to the obligation of an organization to seek action that protects and improves the welfare of society along with its own interests. Views differ on the degree to which business and other organizations should consider social responsibilities in conducting their affairs. But in this case, it is to the company's own best interest to act in a socially responsible manner.

4.6.4 Simulated IFP land allocation plan

After identifying the areas of agreement and disagreement, there are two main possibilities open to the IFP manager to result in satisfactory choices for his/her IFP land allocation planning:

- take only the discrepancy areas into consideration and exclude them from the search process for the new IFP project area;
- implement the result of conflict resolutions and search for the remaining required new IFP project area.

With both options, there are many possibilities to simulate the preferred land use allocation scenarios, e.g. based on the results of the moderate, optimistic and pessimistic scenarios.

The IFP land allocation DSS enables the fulfillment of the above-outlined IFP land allocation planning. An alternative IFP land allocation is to give an example of how the need for a total of 50,000 ha for the IFP project area of Pulau Laut will be fulfilled after compromising and accommodating the other stakeholders' objectives. From the previous search for land for the IFP project, after disagreement and conflict resolution processes, the total acquisition of land (including the existing 28,373 ha of IFP project area) is 36,588 ha of IFP project area.

From the result of conflict resolution of the moderate scenario, the availability of conflict-free area targeted for the IFP area is 6,661 ha of scrub, 47,826 ha of production forest and 3,680 ha of grassland. Using the sub-model of economic viability, the new areas for an alternative IFP land allocation will be searched. The result of the simulation is shown in Figure 4.20.

In this new alternative, the setting of IFP land allocation consists of 28,373 ha of the existing IFP project, 8,214 ha resulting from non-conflict areas and conflict resolution areas, and 13,515 ha of newly searched IFP area (obtained from 154 ha of scrub, 12,919 of production forest area and 442 ha of grassland). The available scrub area (6,661 ha) and grassland (3,680 ha) cannot maximally be allocated for the IFP area because of their locational factor, particularly the distance from the existing IFP project area. The new area for IFP establishment will concentrate in the production forest area. This means that the clear-cutting silvicultural system will not be applied. The line planting system applied in this forest area will ensure an environmentally sound plantation forest management.

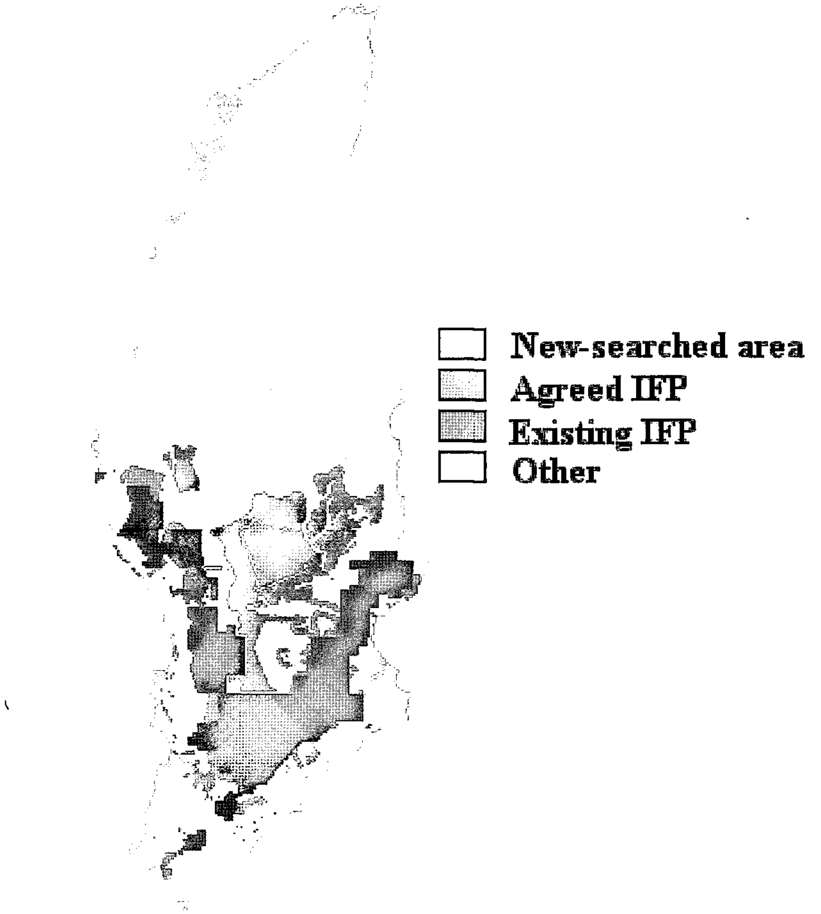


Figure 4.20 New alternative of IFP project area

4.6.5 Management strategies to implement the IFP land allocation plan

Management strategies are of importance for the success of the land allocation plan implementation, especially when there are opinion discrepancies in the area concerned. Management strategies will also strengthen the bargaining position of the IFP manager in the discussion to reach land use consensus.

The IFP manager may run several iterative processes during the discussion to modify his/her proposal for IFP land allocation. Tools such as GIS will help the manager to get quick answers to queries from the discussion. However, such GIS tools alone will not guarantee the success of the IFP land allocation plan implementation. A set of management strategies, large-scale action plans for interacting with the environment in order to achieve long-term goals, specific to the area of concern, must be formulated.

Formulating management strategies is not an easy task because of the wide range of aspects that must be encountered. Still, some main issues that commonly put constraints on conflicting land use in the development of IFP projects, can be highlighted, namely: land legal status, social and environmental obligation, and sustainable profit of the IFP company.

Land legal tenure

The Ministry of Forests (MOF, 1998) acknowledges that in the past 25 years of national development programmes, there has been a significant adaptation of policy formulation, influenced to some extent by global trends in forestry and according to the environmental agenda. The forestry sector is widely falsely interpreted as being merely a timber business. Perhaps, this is true in the case of man-made forests in many temperate countries. In the tropics, forestry almost everywhere is related to human needs, and forest land becomes a center of conflict among many stakeholders.

Present land use is the primary socio-economic criterion to determine the availability of land for IFP project development. Land can be made available for the IFP project if the people who are presently using the land are prepared to change their present land use. According to the MOF (1991), a considerable amount of forest production land is already used by the rural population for subsistence farming and cash crops. These people have no legally recognized tenure to the land they occupy, although in many instances traditional rights or rights by occupation are claimed. The IFP manager must take these issues into consideration as the IFP project involves use of the land all of the time; hence, it permanently reduces the possibility for the local people to expand their agricultural area.

Legal land tenure would ideally determine how the IFP manager should make decisions. There are, however, several types of applicable laws that refer to forest land, i.e. certified land tenure, TGHK, and traditional (*Adat*) rights. Certified land tenure represents the official land status or legal ownership bounded by law. Still, certified land tenure might be made available for the IFP project through buying or compensation. TGHK, which is based on Forestry Act No.5 1967, designates the official use of forest land.

Traditional rights to land are not based on legal ownership. They usually deal with existing land use, acknowledged by the local community as their inheritance. Most social land use conflicts in the framework of IFP development are related to neglect of the traditional rights of the local people or improper compensation for the people's land. The IFP manager should define a "win-win" solution to solve the problem of traditional land rights.

Social and environmental obligation

Indonesia has committed itself to the global concern about protecting the environment. A number of environmental measures have been introduced and reflect the awareness of the importance of maintaining a standard quality environment vis-à-vis forest resources. At present, the way of looking at the concept of forest utilization has changed from sustainable yield to sustainable development, and from merely a company's financial gains to the incorporation of social and environmental benefits.

Social development and environmental protection are activities considered to be the role of the Government through the MOF. Clear and practical standards must be set as to what land is intended to be allocated for these purposes. Meanwhile, as the agent of development, the IFP company also has an obligation towards social development and environmental protection.

In recognition of the importance of local people's dependence on forests as a livelihood resource, people's participation in forest management is one of the major forestry development objectives in Indonesia. People's involvement in forest-based activities might be attained through the provision of job opportunities and business opportunities. Statistically (MOF, 1993), primary forestry activities such as logging and planting are not so significant in providing job opportunities as they absorb less than 1% of the total national labor force. However, the picture is more impressive when forest-based industries' contribution to employment is also accounted for.

Consequently, besides encouraging more job opportunities, the development of the IFP project should improve the quality of living for the surrounding people. This can be achieved through the provision of social facilities, such as the installation of drinking water, electricity, better road accessibility, health care and credit schemes for small-scale business. While the IFP manager may have a particular concept of his/her organization's social responsibilities, this concept takes on practical meaning only when the manager actually responds to these social responsibilities.

Bartol and Martin (1991) state that organizational social responsiveness refers to the development of organizational decision processes whereby managers anticipate, respond to, and manage areas of social responsibility. Two processes are usually essential in developing organizational social responsiveness. First, it is necessary to establish methods of monitoring social demands and expectations in the external environment. Second, it is important to develop internal social response mechanisms such as committees and departments that handle issues related to social responsibility.

Recognizing the importance of environmental protection, the IFP manager should be able to bring in his/her proposed IFP land allocation to screen out land for environmental purposes, such as land with high biogenetic diversity, fragile or critical ecosystems, or high soil erosion risks, and land in need of rehabilitation. The IFP manager should also be able to explain the result to the local people and make them understand the importance of protecting the environment.

Sustainable profit of the IFP company

While the IFP company has explicit responsibilities in both social development and environmental protection, in reality the IFP company is mainly concerned with minimizing its expenses, which makes it difficult to effectively process social and environmental decisions. Obviously, the social and environmental decisions are important for reducing, if not eliminating the obstacles posed by both nature and the affected people, and hence minimizing the social and environmental costs. Apparently, sustainable profit of the IFP company is affordable.

In other cases, plantations have been established but not adequately planned. Plantation forests have successfully reached maturity only to find that there were no markets for the species that were grown (ITTO, 1993). There is, therefore, real need to ensure that the establishment of industrial tropical timber plantations does not lead to the over-production of particular species or categories of forest products. Such a situation can have economic consequences, so that the IFP projects will lose their chance of financial gain.

Chapter

5

Discussion

This chapter discusses the extent to which the research objectives and research questions have been met and answered. The contribution of the model to model forest management, the reflect on forest enemy (i.e. forest fire incidence), reflection on the concept of sustainable IFP land allocation, and the reflection on the development of spatial decision support systems, will also be discussed. The other discussions focus on the applicability of the model in other situations and the generality of the research results. Finally, recommendations for further research are elaborated.

5.1. Have the objectives of the research been met?

As outlined earlier in Chapter 1, this research is intended to achieve three specific objectives. To which extent has each of these objectives been met?

Objective 1:
To develop sub-models of sustainable IFP land allocation, namely: economic viability, ecological soundness and social acceptability

To allocate the land in sustainable manner, the development of the sub-models in this research is intended to accommodate the perspectives of the stakeholders in the framework of the IFP development. During the execution of the fieldwork, the main stakeholders and their respective objectives were identified. This identification provides a foundation for the development of the sub-models in a GIS environment.

The objectives of local people have been translated into the need of the people for agriculture land and employment. These two objectives have been accommodated in the sub-model of social acceptability. The existing APM-spatial model has been modified to enable simulation on agricultural land expansion for the period of 50 years. Three different scenarios were introduced, namely: moderate, optimistic, and pessimistic scenarios, to provide different angles of discussion on the matter.

The scenarios differ in their assumption about the growth factors of population, gross domestic product and crop productivity. The resulting simulations of agricultural expansion can be used as an input for the other sub-models. The need of local people for employment in the IFP project has also been calculated each year. The potential villages that can supply labor have been spatially analysed resulting in different categories of villages, ranging from low to high in their capability to provide workers.

The objective of the IFP company for financial gain has been dealt with, the sub-model of economic viability. With respect to the land acquisition priority for the IFP project, a financial analysis, using land expectation value (LEV), has been carried out, resulting in three kinds of land cover types, namely: scrub as the first priority, followed by production forest and grassland. The result of the financial analyses were used as inputs into the spatial analyses using the same three scenarios as before, to allocate land for the IFP project area. The results of the three scenarios might be used to anticipate a wide range of possible conflicts over land with other stakeholders' interests.

The objective of the Government for protecting the ecological values of the area has been structured in the sub-model of ecological soundness. In this sub-model a practical approach has been taken to enable mapping of areas that must maintain their ecological function. The existing government regulations together with theoretical basis were used for setting criteria for ecological sites. Here also, the same three different scenarios were used to allocate the ecological sites.

Where the data requirements are concerned, the sub-models were developed, using variables that can be obtained relatively easily. In this sense, the sub-models, and the DSS will be operational quickly, and applicable in a variety of locations. However, the quality of the results of the DSS are dependent on the quality of data inputs. In conclusion, it can be said that objective 1 has been met.

Objective 2:
To integrate the sub-models into a generic IFP land allocation DSS.

The integration of the sub-models is meant for reconciliation of stakeholders' objectives. A procedure has been developed for IFP land allocation DSS enables identification of disagreement areas between the stakeholders and to resolves the disagreement into acceptable alternatives of land allocation. This integration provides a flexible means to put the stakeholders' objectives in balance. An iterative process of IFP land allocation can be carried out with the DSS. This land use policy is used as a tool for the bargaining process between the stakeholders.

Two points, however, have not been addressed yet. The first is to develop a friendly user interface of the DSS. The second and most important one is that within the confines of this research it has not been possible to test the DSS in practice with the actual stakeholders.

Objective 3:
To appraise the DSS through a case study in an IFP project of a state-owned forestry company in Pulau Laut, South Kalimantan.

Throughout Chapter 4 and 5, the implementation of the IFP land allocation DSS has used the data from the IFP project of Pulau Laut. The result of the DSS can help the IFP manager to choose among alternatives of IFP project areas in Pulau Laut. Anticipation of land use conflict and its resolution can also be seen using the available data. It can be concluded that from the point of view of information systems development, the DSS works.

5.2 Answers to the research questions

Research question 1:
How can the stakeholders' objectives be accommodated in the sub-models?

The answer to this question is that aggregated, technically fairly simple models from the three stakeholders' three main perspectives, in combination with a common GIS interface, are adequate representations of them. A sustainable land allocation for the IFP project area can be achieved by accommodating the stakeholders' objectives in the IFP development. The advanced technology in GIS creates greater possibilities to integrate various attributes of spatial information. The strength of the GIS in spatial analysis enables the sub-models of this research to provide spatial information that represents the objectives of the stakeholders. The GIS procedure outlined in Chapter 3, 4 and 5 answers the research question: "how can the stakeholders' objectives be accommodated in the sub-models?".

Research question 2:
How can the principles of sustainable development be incorporated in the sub-models?

The concept of sustainability is widely discussed in this dissertation and used as the umbrella for developing the IFP land allocation DSS. Zonneveld's approach

(Zonneveld, 1990) on sustainable development provides the foundation to design the DSS on the basis of sustainable development. Three pillars of sustainability: social acceptability, economic viability, and ecological soundness have been used to represent the respective IFP stakeholders and develop them into the sub-models. Zonneveld observes that sustaining desired ecosystem conditions requires management goals and actions that fall within the intersection of the three pillars.

Research questions 3:
Considering the different perspectives of the stakeholders, how can the sub-models be integrated for effective problem solving in IFP land allocation?

The sub-models' integration has benefited from the formulated land use policy that is based on practical and theoretical approaches. The land use planning information system (LUPIS) procedures have facilitated the implementation of the land use policy in a GIS environment. Superimposing the results of each scenario of the sub-models enables identification of disagreement areas between the stakeholders. At a later stage, the land use policy was used to reconcile the different views of the stakeholders on land allocation. An adequate level of abstraction was afforded for sub-models integration. Otherwise, too detailed data requirements will disable the DSS to be implemented in practice. As far as the general problems encountered in IFP development are concerned, this study focused particularly on allocating the areas for IFP development.

5.3 Practical suggestions for using the DSS

The implementation of the IFP land allocation DSS will guide to the IFP manager how to follow a normative decision making model; this is prescribing how the manager *should* make decisions. The development of alternatives can be facilitated through the use of four principles frequently associated with brainstorming:

- *Don't criticize ideas while generating possible solutions.* Criticism during the idea-generation stage inhibits thinking. Also, because discussion tends to get bogged down in criticizing early ideas, only a few ideas are generated.
- *Freewheel.* Offer even seemingly wild and outrageous ideas. Although they may never be used, they may trigger some usable ideas from others.
- *Offer as many ideas as possible.* Pushing for a high volume of ideas increases the probability that some of them will be effective solutions.
- *Combine and improve on ideas that have been offered.* Often the best ideas come from combinations of the ideas of others.

With the complexity of land allocation problems in his/her hands, the IFP manager will benefit from the sub-models to structure/systemize the problem. With the resulting simplification of reality, the model, and combining this with his/her mental models of reality in making decisions, the manager can cope effectively with the complexity of the problem. Akkermans (1995) mentions that the real challenge is to see if the managerial mental models are improved by making them more explicit – opening them to discussion, sharing them with others and to create platforms for understanding other people's perception of reality.

The IFP manager can use the IFP land allocation DSS to simulate the many possibilities of land use scenarios. However, to be successful in the implementation, the IFP manager should initiate the development of effective institutional frameworks for conflict resolution and for efficient and sustainable land use. In this regard, an approach formulated by FAO and UNEP (1996) is wise to be followed. This approach includes: identify the stakeholders; educate and inform the local people; create a forum for negotiation; agree on the rules; and empower the people.

The identification of the stakeholders was carried out in this study. However, the representatives of stakeholders must be chosen for negotiation. For the local people, most probably, the representatives will include the head of the village, some informal leaders, and members of non-governmental organizations (NGO). For the Government, the representatives should preferably include local forest officers and local government officers. For the IFP authority, the manager should be accompanied his staff that are well known by and acceptable to the local people. To educate and inform the local people, the IFP manager needs to inform them about all aspects of the resource and its sustainable use, and on relevant economic, organizational and legal matters. This is particularly important to ensure that stakeholders partake equally in negotiations. At local level, a forum for negotiation may consist of a physical meeting place. Solutions reached through negotiation need to be embodied in an agreed resource utilization plan. This may be a set of rules or by-laws, a treaty or a similar instrument to which all parties agree. The IFP manager must realize that individuals and communities often have no power to intervene, contribute or make their opinions known. In order to tap the knowledge, enthusiasm and energy of local communities, they must be empowered to make and implement decisions.

5.4 Applicability of the IFP land allocation DSS

The degree of robustness of any model developed to solve a particular problem will determine the degree of usefulness of the model. In the context of a DSS, in which a model is one of its components, Beulens (1995) observed that robustness means that the system must be able to cope with changing problems, priorities, objectives and constraints. Robustness also means that the system must be able to cope with changing planners and organizational procedures.

With these scenarios, the real-world problems are simulated. Hofstede (1992) observes that, be that as it may, simulation can be very relevant to automated systems for supporting planning problems. Obviously, the value of such decision support is dependent upon the validity of the simulation model, that is, the extent to which it correctly models the behavior of the aspects of the real system that it is intended to describe. In an unpredictable real-world situation, a simulation model can at best be used for tentative purposes. Fortunately, even if it does not yield reliable predictions, a simulation model can be useful. Repeated simulation runs can generate an insight into the robustness of a plan.

In this section, the applicability of the IFP land allocation DSS will be discussed in relation to its capability to support provincial land use planning and its scientific contribution to modeling forest land management. The assessment of the robustness of the model will be undertaken by comparing the IFP manager's mental model in allocating land with the IFP land allocation DSS and checking the validity of the latter model by using remotely sensed data.

5.4.1 Reducing effects of forest fragmentation

Forest fragmentation results from patchwork conversion and the development of the most accessible and/or more productive sites, leaving the remaining forest in stands of varying size and degrees of isolation (Harris, 1984). Isolation of forest patches is caused by human activities such as logging, conversion to agriculture, and road construction. The resulting forest fragments are surrounded by agriculture, urban landscapes, plantation forest, secondary forests or wastelands. In general, forest fragmentation can be expected to cause local extinction of original forest species, and fragmented forests will contain fewer of the original forest species than continuous forests (Zuidema, et al., 1996).

In the context of the regional development of Pulau Laut, land use planners must consider the ever increasing population that often disturbs the natural ecological balance. In the case of IFP project development, in which the purpose is to increase forest productivity, the natural vegetation that previously has supported local people's needs will now be partly used for the project area. This imposition of the proposed plantation will deprive communities of part of this supply and increase pressure on the remaining forest resources. In order to mitigate this impact, the IFP project authority must provide access to local people for collecting plantation residues, such as waste from prunings and thinnings. The IFP authority must also establish an agroforestry scheme that allows local people to make use of the IFP project area for temporary agricultural activity.

Obviously, the IFP land allocation DSS can help the land use planners or conservationists to formulate strategies for environmentally sound action plans. The agricultural expansion will have consequences for the fragmentation of the remaining forest land. The result of the simulation on forest fragmentation from the IFP land allocation DSS, besides its ecological emphasis, will also be of particular use to provincial forest land use planners to overview possible consequences of changes in forest land use.

5.4.2 Existing IFP project area versus simulated IFP project area

Ideally, to check the robustness of the IFP land allocation DSS, the results of its simulations must be brought back to the IFP manager of Pulau Laut to grasp his/her idea about the applicability of the results against real practices. Or, a field survey for updating the existing land uses and forest potential could be conducted to match IFP project establishment criteria. The robustness of the model is enhanced by confronting the inputs and outputs of the model with experienced IFP managers, from which implicit constraints might be comprehended.

In this section, the sub-model of economic viability is used for simulating the allocation of the IFP project area. The result of the simulation is then be compared with the existing planted area (Figure 5.1 and 5.2). This comparison aims to produce a picture of the extent to which the developed IFP land allocation DSS is representing the mental model the IFP manager has used in allocating land for the IFP project.

As described earlier in Chapter 1, until 1997 the progress of the Semaras IFP project establishment in Pulau Laut reached 28,373 ha. This area was allocated on 2,069 ha of scrub, 14,268 ha of production forest and 12,036 ha of grassland. Using the sub-model of economic viability of the IFP land allocation DSS, the IFP project area of 28,373 ha has been simulated. The simulated area was obtained from 15,056 ha of scrub, 12,901 ha of production forest, and 416 ha of grassland (see Figure 5.1).

To obtain the spatially matching and non-matching areas between the existing and simulated IFP project, the maps of the two areas were crossed (Figure 5.2). About 19,438 ha (68.5%) of the simulated area matched the location of the existing IFP project area. The main discrepancy between the existing and simulated IFP area lay in the use of grassland. The existing IFP project area used 42.4% of grassland while the simulated IFP area used only 1.5%. The existing IFP project area also used more production forest than the simulated IFP area. In practice, IFP implementors prefer to use production forest as the existing timber can be exploited to provide an extra benefit. In the simulated IFP area, scrub had been placed as the first priority to be used for land allocation (see the elaboration of the economic viability sub-model in Section 4.4 of Chapter 4). This was the reason why the simulated IFP project area used 53.0% of scrubland while the existing IFP project area used only 7.3%.

The compactness of the plantation blocks in the existing IFP project area contributes to the presence of 31.5% of non-matching areas. The blocks of the plantation were designed in such a way that the compartments inside the blocks were adjacent to each other. With this plantation layout, units that are supposed to be excluded (disagreement areas) will also be used for plantation. The sub-model of economic viability works according to the weights of the spatial data inputs (slope, road and river). The sub-model excludes the disagreement areas, i.e. areas that were allocated for agricultural activities and ecological purposes.

The allocated lands of the IFP project areas resulting from the sub-model of economic viability depend on the setting of land priority. The priority of land in the simulated IFP areas, which has been used for comparison with the existing IFP area in this section, has been set according to the result of LEV (land expected value) assessment in the sub-model. With the flexibility in setting land priority, the sub-model of economic viability alone can be useful for the IFP manager to screen the availability of the areas that will provide profits to the company.

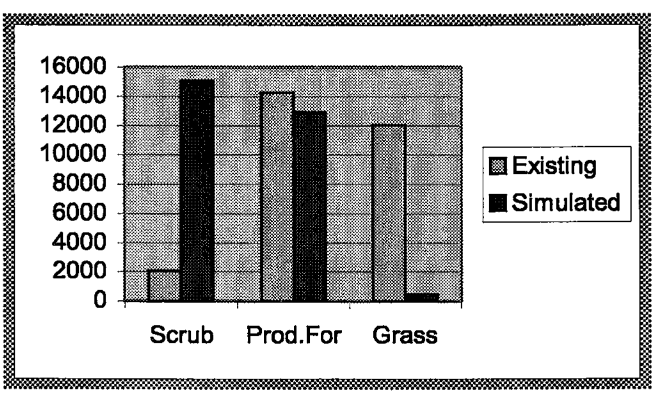


Figure 5.1 Existing IFP land area in hectares compared to IFP land area simulated through the sub-model of economic viability (Semaras IFP project of Pulau Laut).

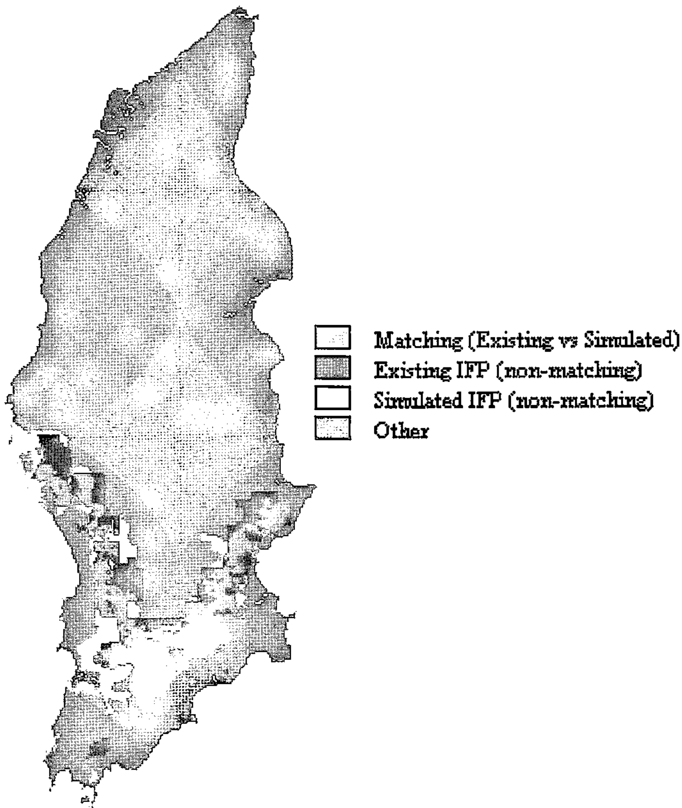


Figure 5.2 Matching existing IFP project area with simulated IFP project area

5.5 Contribution of the IFP land allocation DSS to modeling forest land management

Future land development, especially land allocation for IFP project areas that can meet the objective of sustainable development, is proposed using the IFP land allocation DSS. By simulating different development scenarios, the IFP managers, and also land use planners, can use the model to support their planning process or decisions on land use planning. The IFP land allocation DSS provides an operational means for implementing the concepts of sustainable development by using GIS.

The IFP land allocation DSS can also be used to evaluate land allocation planning to see how far the actual land development deviates from the land allocation generated by the model. The land allocation scenarios developed with the IFP land allocation DSS can provide some guidelines for future land use planning. The result of running the model with different land development scenarios will also allow the IFP manager to avoid social problems due to land use conflicts, and wasteful allocation of land resources.

Policy makers, scientists and the public in general are increasingly concerned about tropical deforestation, which is reaching almost one percent each year (Angelsen and Kaimowitz, 1998). The IFP land allocation DSS can contribute towards strengthening the methodological development of deforestation modeling. Factors that lead to deforestation, such as population growth, economic growth, agricultural productivity and accessibility, are already taken into account in the IFP land allocation DSS.

Kaimowitz and Angelsen (1998) have reviewed 140 economic deforestation models, described their assumptions, methodology, data and main results, and assessed their strengths and weaknesses. They also identified promising areas for further research, e.g. research will probably be more productive if it concentrates on household- and regional-level studies, instead of national and global studies as is currently the case. Furthermore, most of these models lack an explicit spatial dimension; thus they cannot answer the question "where?".

The spatial approach of the IFP land allocation DSS, which is based on GIS techniques, will therefore be useful for further research on deforestation. With GIS techniques, it has become much easier to create models that analyze land use in a spatially explicit context and combine social, economic and ecological spatial aspects.

5.6 Reflection on a forest enemy: forest fire incidence

When implementing the IFP land allocation DSS in different situations during IFP project establishment, local problems can be expected to occur. A prominent social problem identified during the research fieldwork in the study area of Pulau Laut took shape as arson directed at the forest plantations, which caused huge losses, not only in terms of the company's investment but also in terms of its credibility and positive perceptions. This resulted in constraints and threats towards the Government, who, in response, now encourages the IFP programme to stimulate wider acceptance by society/stakeholders. Harmonizing the relationship between the IFP company and the local people appears nowto come first in national development priorities.

Above all else, land degradation is the key effect of the unsustainable use of forest resources the increasing numbers of local inhabitants. Young (1998) shows that the direct and indirect causes of land degradation are linked by a chain of cause and effect, sometimes called a causal nexus (Figure 5.3).

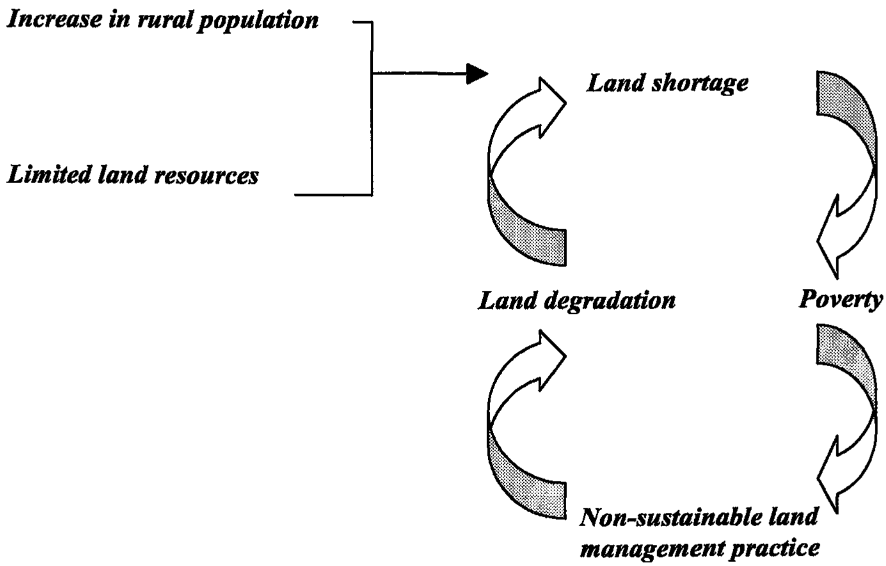


Figure 5.3 Population, poverty and land degradation (Young, 1998)

The driving force behind land shortage is an increase in rural population under conditions of limited land resource, leading to smaller farms, lower production per person, increasing landlessness and, in consequence, poverty. Land shortage and poverty together lead to non-sustainable land management practices, the direct causes of land degradation. Poor or landless farmers have no alternative but to clear forest, cultivate steep slopes, overgraze rangelands, make short-term, unbalanced fertilizer applications, or in the case of shifting cultivation, shorten fallow periods. These non-sustainable management practices lead to land degradation, causing lower productivity and lower responses to inputs. This has the effect of increasing the land shortage, thus completing the vicious circle.

The magnitude of fires

Obviously, fire is one of the worst enemies of the forest. In 1997, forest and brush fires raged across Indonesia causing tremendous damage to the environment, such as the spread of choking smog from Australia to Thailand. Fire is a great destroyer and results in not only a lot of damage to the forests, in the form of economic and ecological losses, but also the nation's loss of credibility. It is known that most forest fire accidents are caused by people who use fire in land clearing or land preparation for crop plantation (rubber, palm oil trees), timber estates, agriculture, etc.

The recent fires have also resulted in critical levels of transboundary air pollution, not only for some 20 million people in Sumatra and Kalimantan but also for populations in the neighbouring countries, i.e. Malaysia, Brunei, Philippines, Singapore and Thailand.

The fires are blamed partly on the El Niño Southern Oscillation (ENSO) weather phenomenon. But the freak weather only magnifies existing problems. Environmentalists argue that the underlying cause is poor forest management, where rain forests are recklessly logged or cleared for agriculture. The forests of Southeast Asia, just like those of the Brazilian Amazon, were especially vulnerable to fire in 1997 because of a terrible drought brought about by changing global weather patterns. El Niño occurs regularly in the Pacific. For reasons scientists do not yet understand, prevailing winds that usually push warm surface water from the coast of South America towards the middle of the Pacific fail every few years. The result is unusually wet weather in coastal areas of North and South America and unusually dry weather in Southeast Asia (WWF, 1997).

However, the periodic large-scale fires in natural or modified natural forests on mesic and even hygric sites, which happened in recent decades during anomalies of El Niño, were caused by man. During the past three decades, fires in logged-over and pristine natural forests, plantations, scrub and grassland in Borneo and Sumatra have expanded to ecologically, economically, and socially disastrous proportions. The decline in vegetation, the various types of far-spreading emissions and the profound changes in soils, hydrology and radiation and thermal climates in the burnt landscape have caused great suffering and local, regional and global concern (Bruenig, 1997).

Fires have been blazing all over Sumatra and Kalimantan throughout El Niño years, namely 1982-83, 1991-92, 1994-1995, and now 1997-98. The 1982-83 El Niño is well known globally because it resulted in serious forest fires that razed some 3 million ha in Kalimantan.

Sowerby and Yeager (1997) mentioned that the degree and type of fire damage are dependent on a variety of factors, including fire intensity, soil and habitat type, and degree of disturbance. Secondary forest, ladang (forest temporarily cleared for cultivation) and grasslands are all very vulnerable to combustion and more likely to suffer a high degree of fire damage, because of the presence of considerable quantity of combustable material.

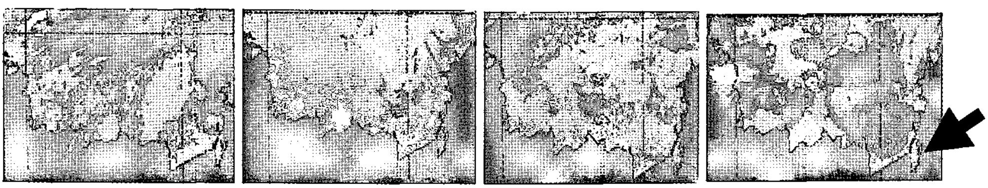
Official reports from the Ministry of Forestry (MOF, 1998) stated that the burnt areas in 1997 (up to the end of November) of about 165,352 ha consisted of:

a. 10,921 ha of protection forest land;
b. 123,527 ha of production forests (including 44,465 ha of IFP areas); and
c. 30,904 ha of nature reserves and national parks.

WWF (1998) reported, however, that satellite imagery indicated that the areas burnt or on fire totaled between 500,000 ha and 600,000 ha.

Source of ignition in the study area

Incidents of forest fires in Kalimantan in 1997 damaged the plantation in the study area (the IFP project of PT. Inhutani II in Pulau Laut, South Kalimantan). The IFP authority declared that the burnt area was about 2,000 ha. The fires started in the beginning of the drought season in July, and further developed until November. The development of the forest fires in the study can be seen from the NOAA imageries below (Figure 5.4).



7 July 21 September 31 October 11 November

- red dot is hot spot; indicating the Pulau Laut island, the study area

Figure 5.4 The development of hot spots (fires) during the drought season in 1997 in the study area (Source: personal communication, 1997*)[*]

During fieldwork in October and November 1997, the author analyzed the incidence of fires and the source of ignition. It was determined that the fires in the study area were deliberately caused by people who had grudges against the IFP plantation authority. The rich picture below describes the problem situation in the study area (Figure 5.5).

The village community in the study area consists of the local people and the transmigrants that have been in-migrated under the government scheme from densely populated islands, mostly Java Island, to work for the IFP project. There is an imbalance in the treatment of village communities by the Government and the IFP project authority. The transmigrants receive more and give less than the local people. The Government provides land and housing to the transmigrants, while the IFP project authority provides facilities such as electricity, drinking water and credits. Local people receive job opportunities from the IFP project. Unlike the transmigrants, the local people are not guaranteed jobs in the project. They have to compete among themselves and with the transmigrants. From interviews with the

[*] NFI project, MOF.

people living close to the IFP project, the conclusion was drawn that the local people felt they were being thrown off their own land. This conflict between the local people and the IFP project authority is indeed the root cause of fire ignition in the study area.

Fire is a serious threat to the productivity and environmental quality of any forest and must therefore be taken seriously. Principle 38 of the ITTO *Guidelines for the establishment and sustainable management of planted tropical forest* mentions that fire risks may increase as both living and dead biomass accumulates during the course of a planted forest's development. In some areas, fire risk may also increase during the life of a single rotation of the planted forest, in response to climate change associated with the global warming (ITTO, 1993).

Fire risk and fire management requirements will generally increase with the size of the planted forest estate. ITTO guidelines recommend that fire management plans should at least allow for a communication strategy for forest users and adjacent residents for periods when restrictions on public access or behavior are required due to either high fire danger or other fire management purposes (ITTO, 1993).

Fire risk can be reduced by maintaining good relationships between the IFP project authority and the local people through implementation of the company's social responsibilities. In plantation management, land ownership, occupation, and understanding the attitudes and interests of the people are important aspects because they affect the probability of man-made fires.

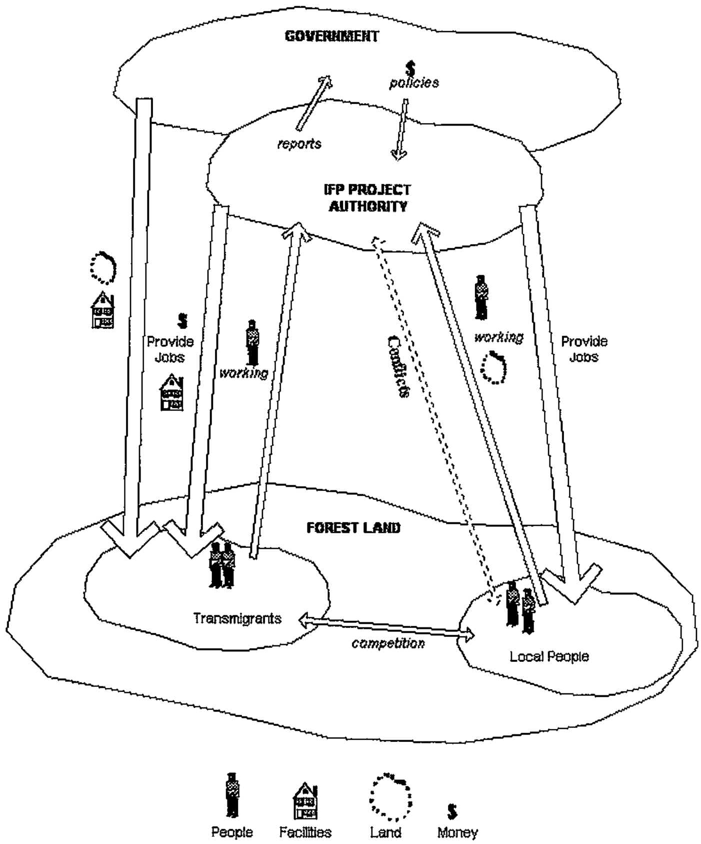


Figure 5.5 A rich picture of the social problem situation in the study area

5.7 Reflection on the concept of sustainable IFP land allocation

As usually happens in real life when some important aspects of our well-being are neglected, a crisis of some sort brings on a sudden awakening and a great rush to correct the blunder. A world-wide environmental awareness movement burst upon the scene during the two-year period from 1968 to 1970 and suddenly, it seemed, everyone became concerned about population growth, population, preservation of natural areas, and food and energy consumption, etc. Then the term "sustainability" was introduced, although it had long been a basic concept in land resource management (Odum, 1993; Young, 1998).

To operationalize the concept of sustainability in the development of the IFP land allocation DSS, three pillars of sustainable development – social acceptability, economic viability and ecological soundness – were adopted in this research. With these three pillars, sustainable use of forests can be seen to encourage value-added forest products from forest lands in a way that allows local income levels to increase. This allows forest management to be self-sustainable from an economic viewpoint. The measure of sustainability in the system boundary should be in the range of manageable and simple but effective variables.

When the Brundtland Commission report (Brundtland, 1987) is revisited, it is found that Brundtland is excellent in addressing two pillars: first, producing more with less (related to ecological soundness, e.g. conservation, efficiency, technological improvements and recycling); second, reducing the population growth, and redistribution from over-consumers to the poor (related to social acceptability). The Brundtland Commission left the other pillar (economic viability) fuzzy, so putting their concept into practice is a difficult task.

How do we see whether the sustainable development concepts work in practice? The four wing model of sustainable development (Dieren, 1998) shows the way (Figure 5.6).

The Four Wing Model

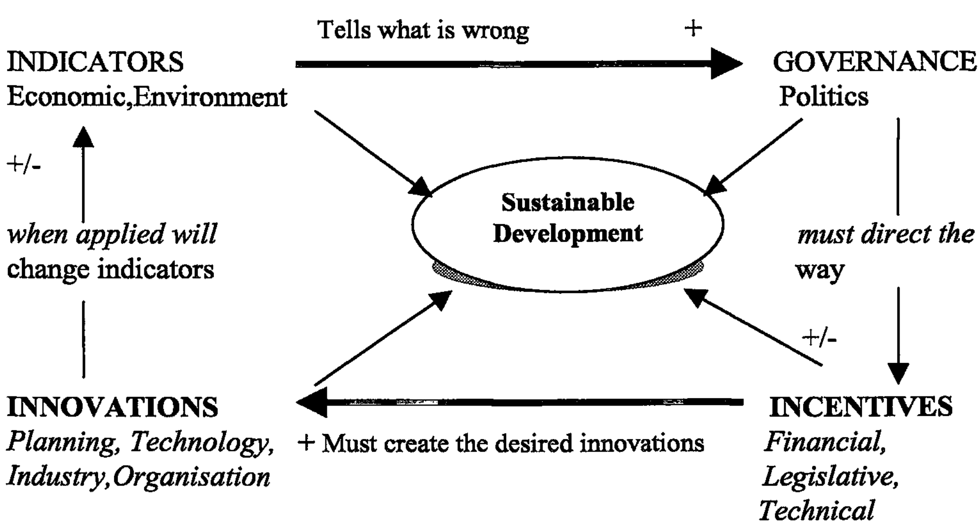


Figure 5.6 The four wing model of sustainable development (Dieren, 1998)

In the context of IFP land allocation, the four wing model explains that if the IFP project in its implementation results in degradation of environmental quality and loss of profits, indicators for necessary improvements are provided. The Government (policy maker) must then take the necessary actions to put the development on the right track. These actions include the provision of incentives, namely: financial, legislative and technical. With these incentives from the Government, the IFP company should be innovative in planning its plantation establishment, plantation technology and timber industry, as well as in strengthening its organization. If all of these innovations are successfully applied, sustainable development indicators will show improvement. However, if government policies fail to cope with the encountered problems, there will be no improvement in the indicators.

Finally, the IFP manager must be aware of what is going on in the discussion of sustainable development outside his/her system boundary. For instance, at present CIFOR (Center for International Forestry Research), based in Bogor, Indonesia, is developing criteria and indicators for sustainable development of forest management (CIFOR, 1997). Hopefully, the result of CIFOR's work will complement many efforts to operationalize the concept of sustainable forest management.

In my opinion, to be successful in allocating land for IFP project areas, the manager must take advantage of interactive land use management, a new approach to sustainable land resource planning and management that focuses on maximizing stakeholder objectives. This approach stresses three things (FAO and UNEP, 1996): information, involvement and joint decision making by all stakeholders. When people are informed and involved, they are halfway to being satisfied. When they participate in decision making, they are three quarters of the way to being satisfied. When they understand that they have negotiated the best result possible, they are almost always satisfied. When they are part of a development partnership, they are usually enthusiastic and more than satisfied.

5.8 Reflection on the development of spatial decision support systems

To the end of my research period, I have not developed a complete operational DSS with a user-friendly graphical interface, but if it were done the following are some observations on the matter.

The effectiveness of decision making in IFP land allocation can be improved by applying the model with the help of GIS techniques. The techniques provide opportunities to deal with the nature of IFP development, an intensive management in which voluminous and volatile information is required. Effective decision making in IFP land allocation is possible with a spatial DSS if the dimension of the system is directed towards analytical and practical approaches. Hence, political, social and organizational aspects encountered in the framework of IFP development are incorporated. Stakeholders involved in the planning process of IFP development are identified and assessed and their views are presented in the form of maps produced by GIS techniques, which help stakeholders understand their own opinions in a spatial context. The spatial component plays an important role for the stakeholders to choose their preferred land, e.g. for local people who are constrained in distances they can move, because of their own physics, plus locational factors such slope, etc.

User-interface

The philosophy behind the efforts to make a spatial DSS available to decision makers is that results from the system would be available quickly, without the need to consult other experts. If a DSS is going to be used by the IFP managers or policy makers rather than researchers, the system must be easy to operationalize and understand, and it must help them to evaluate the consequences of policy change. The local people should also be considered as a user of the user-friendly DSS. However, because of their limitation in using an advanced technology, members of NGOs that involve in the village development might help them to work with the DSS.

In dealing with an IFP manager who does not have access to advanced technology in DSS, system developers must consider the "user friendliness" of the system. Hence, the user-interface component of the DSS must be developed based on the behavior of the decision makers. The system's user-interface should be easy enough for decision makers to input their concept of a decision space and problem, even if they do have only limited knowledge of the scientific foundation of the model. For decision makers, the DSS interface is the only access point to the database and models. In dealing with spatial decision making, the quantity of data is huge and the models are complex, so a sensible interface design is foremost in making the system user-friendly. Adapting Watson and Wadsworth's words (1996): "if the user-interface is too complicated, the user may become confused; if the user-interface is too simple, the user may become frustrated."

Furthermore, in the process of making decisions, the decision makers often have new ideas about the problems encountered, or the decision environment changes. The user-interface of the DSS should provide a facility for an information feedback channel to accommodate new data requirements, objectives and constraints. This channelling facility enables the operators, the modeling experts and the programmers to modify the system in a fast and easy way.

Model base and database

The core approach in developing the intended spatial DSS approach is the integration and interfacing of the three sub-models (social acceptability, economic viability and ecological soundness) and associated data requirements. The combination of the three sub-models, i.e., the IFP land allocation DSS, gives the spatial DSS the ability to analyze policy options. While the IFP land allocation DSS has been developed for forest plantation development and is applicable at a country-wide level, the structure of database and data repository in its spatial DSS must be flexible enough to accept a variety of inputs and relationships between spatial and attribute information.

Since the spatial DSS deals with the spatial dimension of the problem encountered, its use for IFP development basically incorporates field-based methodology in which emphasis is put on effective spatial data gathering for model inputs. In this case, combining remotely sensed data and field surveys validate the alternatives provided by the spatial DSS. Figure 5.7 shows the field-based GIS methodology to develop an appropriate spatial DSS.

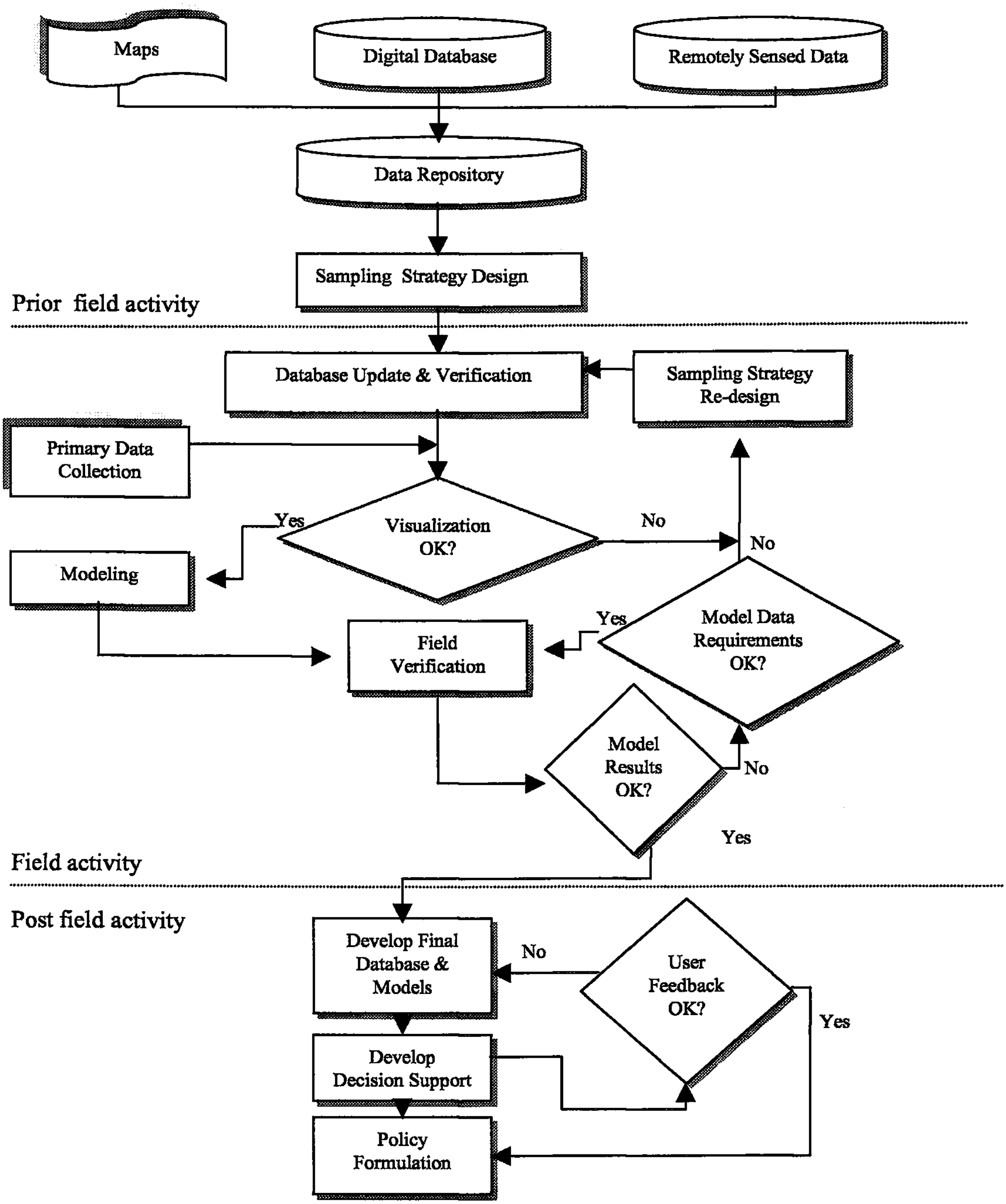


Figure 5.7 Integrated spatial DSS: field-based GIS (modification from Carver, 1995)

5.9 Supporting provincial land use planning

The approaches used in the development of the IFP land allocation DSS in this research may be applicable for supporting other land use planning activities, e.g. provincial land use planning. The figures of projected agricultural expansion, the IFP project area and protected area will help the regional authorities to structure the problems encountered in land use planning.

Often, land conversions are found to occur at the wrong time and locations. Most of the competition for space between man and nature shows up in the conversion of land into agriculture, aquaculture, infrastructure, urban development, industry and unsustainable forestry.

The demands for arable land, grazing, forestry, wildlife, tourism and urban development are mostly greater than the land resources available. In the developing countries, these demands become more pressing every year. According to FAO (1993), the population dependent on the land for food, fuel and employment will double within the next 25 to 50 years.

As the size of the area, the number of people involved and the complexity of the problems increase, so does the need for information and rigorous methods of analysis and planning. FAO (1984) outlines five main types of information needed to assess the social consequences of changes in forest land use as follows:

- *Present needs and functions.* What role does the existing forest land have in supplying the present needs of local (including migratory) communities? Examples are needs for fuelwood, domestic timber, fruits, roots, medicines, grazing, hunting, fishing, shifting cultivation, religious or social functions.
- *Future demands.* What future changes in needs are anticipated? Examples are increasing demands for fuelwood and grazing land.
- *Institutional rights.* What legal or customary rights to the use of forest land exist? What are the possibilities, if any, of changing these?
- *Effects of land use changes.* How will proposed land use changes affect these present and future needs? Where a loss is unavoidable, what alternative measures can be taken to provide for the needs?
- *Acceptability.* Will the proposed changes be acceptable to, or adoptable by, the local communities?

Economic growth is, of course, desired, because it makes people already well-off even better-off. But, for many economists, the real argument for growth by improving the lot of the poor requires redistribution to them from the better-off. The better-off are likely to resist attempts at redistribution, which will be a source of conflict (Common, 1996). When different groups occupy the same environment from which they derive their needs, the potential for conflict increases dramatically as pressure on the resource base increases. This underscores the social factor that needs to be considered in evaluating land management practices, viz. the potential for conflict as a result of different stakeholders having different objectives for a particular resource, and whether systems of conflict resolution are in place, characterized by equity, justice and participation, to deal with such conflict (Smyth and Dumanski, 1993).

Harmonizing provincial land use

Rapid land use changes have been witnessed in Pulau Laut since the economic boom in the mid-80s until just before the economic crisis that started in mid-1997. The substantial loss of fertile agricultural land and forest resources due to the unsustainable practice of agriculture activities has changed the landscape of the island. The concerns of the local government in achieving sustainable development are, among others, the rapid encroachment on the forest resource by shifting cultivation, the illegal cutting of timber, and agricultural practices on the valuable conservation area, such as peat or mangrove forest.

Decisions on land use should not be based merely on land suitability but should also consider the extent to which the use of a certain area is critical for a certain purpose. FAO (1993) recognizes that planning has to integrate information about the suitability of the land, the demands for alternative products or uses, and the opportunities for satisfying those demands on the availability of land, now and in the future. Therefore, land use planning is not sectoral. Even where a particular plan is focused on one sector, an integrated approach has to be carried down the line from strategic planning at national level to the details of individual projects and programmes at district and local levels.

Attempts to harmonize the use of land in the island must be directed towards ensuring equity between generations and efficiency in land use. At present, a rational use of the land resource is guided by regional spatial planning prepared under the co-ordination of the Bappeda (the Regional Development Planning Board). However, there is a general lack of educated staff, operational procedures, instruments and a monitoring system in the implementation of the guidelines so that conflicts among land users do continue to exist. In this sense, it is important to acknowledge the "problem ownership" so that each of the parties involved in the process of provincial land use planning will be able to figure out their objectives and their responsibilities.

The IFP land allocation DSS provides capabilities to support provincial land use planners in projecting agricultural land expansion. Projected agricultural land demand for a certain time horizon will help the land use planner in arranging sustainable land use allocation. The provincial government will also be supported by the DSS in its policy making. Information on agricultural expansion, for instance, will be of useful for the Government to formulate its agricultural policy, and is particularly related to the agricultural intensification programme to push the agricultural productivity.

Projection of agricultural land need is also related to the transmigration programmmes. Transmigration is Indonesia's programme of moving millions of people from the overcrowded islands of Java, Madura, Bali and Lombok to settlement areas in the outer islands of Sumatra, Kalimantan, Sulawesi and Irian Jaya. Transmigration will result in accelerated population growth and demand for agricultural land in the allocated area. The establishment of settlement areas for the transmigration programme obviously involves clearing forest. In addition, this clearance of forest, together with other deforestation activities such as shifting cultivation, will cause fragmentation of forest in Pulau Laut.

5.10 Generality of the results

On the land allocation decision making process of IFP development

In carrying out an IFP project, the IFP manager deals with strategic, tactical and operational decision making. At the same time, the international forestry community is asking for more concern towards the principle of sustainable development in any forest management practices. These premises underlie the general objective of the research towards the improvement of the decision making process in land allocation of the IFP project area. The decision on land allocation is fundamentally the major problem of the IFP implementor in ensuring the smoothness of IFP implementation.

The factors that influence the decision making in IFP land allocation are contingent upon macro-economic and societal development, namely economic development, population growth, demands on agricultural areas, level of pollution, quality of ecological areas, land availability for development, and the level of investment that affects the economic development. The allocated forest land for the IFP project area can be viewed as a compromise between the objectives of the stakeholders. If proper land allocation decision making is to be achieved, the decision maker must understand the complexity of the problems encountered and break them into logical sub-problems.

On the sustainability approach of the IFP land allocation DSS

The concept of sustainability is widely discussed in the literature and the definition of sustainability varies. Some of the definitions can be found in this study. All definitions agree that sustainability will never be perfectly achieved. The measure of sustainability should be in the range of manageable, and simple but effective variables. This philosophy defined the factors in this research, namely: agricultural land expansion and job opportunities (social views); sustainable financial gains (economic views); and habitat and protection area (ecological views). Sustainability in the context of social views deals with the appropriate relationship between the IFP company and the local people. Sustainability in the context of economic views deals with a time line in which a steady state is reached at the end of the first plantation rotation within the established time frame (in this case 50 years). Sustainability in the context of ecological views deal with singling out the forest area from IFP land allocation for the purposes of ecological protection.

On the IFP land allocation DSS

The results of this research provide important guidelines for the development of a spatial decision support system for sustainable IFP land use allocation. The model base, the *IFP land allocation DSS*, provides the means for balancing the objectives of the IFP stakeholders in order to resolve land use conflicts. Using the IFP land allocation DSS, the IFP manager can perform an iterative process to find the preferred (satisfying) choices of lands, because the model offers the possibility to enter upon various simulations as well as aggregated simulations.

5.11 Recommendations for further research

This research should be continued with the development of an operational spatial decision support system for IFP land allocation that can be used country-wide. However, the allocation of land for IFP development encounters complex aspects that are impossible to cover in the framework of this PhD research. Hence, on the basis of this research, some areas of further research and development should receive priority:

- Model validation is one of the most difficult parts in model development. In most cases, it leaves room for argument. The validation of the model in this research needs to be further worked out before the model should be widely applied.
- Application of the model in different localities is meant to test the applicability of the model. Different localities provide different inputs to the model, so that the robustness of the model can be measured. This should include testing of the sub-models results in practice with the actual stakeholders.
- Integration of forest fire models into the IFP land allocation DSS will strengthen the model's capability to solve practical problems of IFP development. Forest fire is a repetitive occurrence in Indonesia and effective means to overcome this problem have not yet been found. The result of research into forest fires will be of interest to forestry policy making. In the development of an IFP project where huge investment has been allocated, fire incidence will constitute a particularly large loss for IFP implementors. Hence,

support from the IFP company towards the research on forest fires may well be expected. The use of remotely sensed data in the DSS for fires detection and analysis need to be observed.

- Research on the information-sharing alliances in the context of IFP development will be of useful in the sense that fulfilment of data requirements and data quality determines the quality of information provided by the DSS. The data producers and consumers identified in this research need to be further elaborated to the extent of their roles and mechanism of the sharing.
- The establishment of a negotiation platform for IFP land allocation is an important element for the implementation of the DSS. Identification of stakeholders involvement in the related land resource management will be valuable for the establishment of the platform suitable for IFP development. Researches on how to empower local people are also important in this context.

Abstract

A land allocation model for sustainable industrial forest plantation (IFP) development is elaborated in this research. The model provides the foundation for a spatial decision support system (DSS) that deals with analytical and practical problem solving in IFP land allocation in Indonesia. The model consists of three sub-models: social acceptability, economic viability and ecological soundness. To implement the model, GIS-based procedures were established and data from the case study area, Pulau Laut, South Kalimantan, Indonesia, were used. The development of the model aims to support decisions on land allocation for IFP projects.

Although the Government targeted land, classified as unproductive, for IFP development, and also empowered IFP companies by a formal decree to establish the IFP projects, IFP development has experienced many problems. IFP companies, by their nature, concentrate on achieving financial profits. Social problems, notably claims for land by local people, however, were found to be of such importance that not addressing these would put the entire enterprise at stake. Companies, thus far, are not equipped to properly deal with these social problems. In addition, there is the need for the companies to also incorporate the environmental and ecological necessities, when allocating land. In order to arrive at a sustainable enterprise, the companies should find areas for IFP development that give high profits, but within the social and ecological constraints and possibilities.

The concept of sustainability is widely discussed in this thesis and is used as guide for developing the IFP land allocation model. Sustainability is addressed through a number of manageable and simple variables. These variables are expected to explain most of the occurring variation in sustainability. The Mintzberg et al. model of decision making phases is used as a tool to analyze the decision making process in IFP land allocation.

Allocation of land for IFP project development is understood as finding an accommodation between the objectives of various stakeholder groups. The identified IFP stakeholders that should participate in the land allocation decision making are: the local people, the IFP company and the Government. The allocated land for IFP development is considered as a compromise between the determinants of economic viability, ecological soundness and social acceptability. From the IFP company point of view, the problem can be described as how to render the company's objectives compatible with those of other stakeholders. This compatibility should satisfy and not violate the stakeholders' objectives.

To implement the conceptual model of land allocation, three scenarios were developed, i.e. a moderate, an optimistic and a pessimistic one. These scenarios differ in the size of the used growth factors of the population, of the GDP and of the agricultural productivity. The implementation of the model starts with simulating the allocation of land according to the objective of the social acceptability sub-model, i.e. the projection of expected agricultural expansion. This information is subsequently used to run the economic viability and the ecological soundness sub-models. The sub-model of economic viability allocates the land for the IFP development that gives maximal financial benefit to the company. The sub-model of ecological soundness allocates the land required by environmental needs.

The identification of conflict areas and the resolution of the conflict itself, are achieved through the integration of the three sub-models. In the integration, a policy formulation for consensus building is established, to indicate the priority of land for a certain use. The IFP company can use the information on the conflict areas and their possible resolution as a platform for discussion with other IFP stakeholders, in order to reach consensus on preferred and acceptable land use. The IFP company may use the outcome to modify the input for the model, and re-run the model during the discussion to adjust the proposal for IFP land allocation, until consensus is reached.

The approach used in the IFP land allocation model in this research may also be applied for supporting other land use decisions, e.g. land use planning at provincial level. The information on areas of projected agricultural expansion, other land uses, and on protected area will help the provincial authorities to structure the problems encountered in land use decision.

This research consists of building the model and testing it on field data. A necessary next step is to have the stakeholders actually work with the model in the case study area and other areas.

Samenvatting

In dit onderzoek wordt een landtoewijzings-model uitgewerkt voor de ontwikkeling van duurzame industriële bosplantages (IFP). Het model legt de basis voor een systeem van ruimtelijke beslissingsondersteuning (Decision Support System, DSS) bij de analytische en praktische oplossing van problemen bij IFP landtoewijzing in Indonesië. Het model omvat drie sub-modellen: sociale acceptatie; economische levensvatbaarheid; en ecologische kwaliteit. Om het model toe te passen werden op GIS gebaseerde procedures opgesteld, en zijn gegevens gebruikt van het studiegebied Pulau Laut, in Zuid Kalimantan, Indonesië. De ontwikkeling van het model beoogt het ondersteunen van beslissingen bij de toewijzing van land voor IFP projecten.

Hoewel de Indonesische overheid land, dat als onproductief geclassificeerd is, toewees voor IFP ontwikkeling, en daarnaast de IFP bedrijven middels een formeel decreet machtigde om IFP projecten tot stand te brengen, heeft de IFP ontwikkeling vele problemen gehad. IFP bedrijven richten zich door hun aard op het behalen van financieel gewin. Sociale problemen, in het bijzonder claims voor land door de lokale bevolking, bleken echter zo belangrijk te zijn, dat het niet daarop in gaan het gehele project in gevaar zou brengen. Tot dusver zijn de IFP bedrijven niet uitgerust om adequaat met deze sociale problemen om te gaan. Daarnaast is er ook nog de noodzaak voor bedrijven milieu en ecologische noden betrekken bij hun landtoewijzing. Om tot een duurzame bedrijfsvoering te komen dienen bedrijven land te vinden voor IFP ontwikkeling dat financieel profijt geeft, echter binnen de sociale en ecologische beperkingen en mogelijkheden.

Het concept van duurzaamheid wordt breed besproken in deze thesis, en wordt als gids gebruikt bij de ontwikkeling van het IFP landtoewijzings-model. Duurzaamheid wordt benaderd door middel van een aantal beheersbare en simpele variabelen. Deze variabelen worden geacht het grootste deel van de optredende variatie in de duurzaamheid te verklaren. Het model van Mintzberg et al., dat een aantal beslissingsfasen onderscheidt, wordt gebruikt als middel om het beslissingsproces in IFP land toewijzing te analyseren.

Toewijzing van land voor IFP projectontwikkeling wordt gezien als het vinden van een schikking tussen de doelstellingen van de verschillende groepen belanghebbenden. De geïdentificeerde IFP belanghebbenden die dienen te participeren in de beslissingen over land toewijzing, zijn: de lokale bevolking, de IFP onderneming en de overheid. Het toegewezen land voor de IFP ontwikkeling wordt beschouwd als een compromis binnen de bepalende factoren van economische levensvatbaarheid, ecologische kwaliteit en sociale acceptatie. Vanuit het standpunt van de IFP onderneming gezien, kan het probleem worden beschreven als de vraag hoe de doelstellingen van de onderneming in overeenstemming te brengen met die van de andere betrokkenen. Deze overeenstemming dient tegemoet te komen aan de doelstellingen van de belanghebbenden, en er niet mee te botsen.

Teneinde het conceptuele model van land toewijzing toe te passen, werden drie scenario's ontwikkeld, te weten een gematigd, een optimistisch en een pessimistisch. Deze scenario's verschillen in de grootte van de gebruikte groeifactoren van de bevolking, van het GDP en van de landbouwproductiviteit. De toepassing van het model start met het simuleren van de land toewijzing overeenkomstig het doel van het sociale acceptatie sub-model, i.e., de projectie van het benodigde uitbreiding van het landbouwareaal. Deze informatie wordt vervolgens gebruikt om de economische en de ecologische sub-modellen te laten werken. Het economische sub-model kent land toe voor IFP ontwikkeling dat het maximale profijt geeft aan de IFP onderneming. Het ecologische sub-model wijst land toe voor ecologisch belangrijke noden.

De identificatie van conflictgebieden, en de oplossing van het conflict zelf, worden bereikt via de integratie van de drie sub-modellen.. In deze integratie wordt een beleidsformulering voor het bereiken van consensus vastgelegd om de prioriteit aan te geven van land voor een bepaald gebruik. De IFP onderneming kan de informatie over conflictgebieden en hun oplossing, gebruiken als een platform voor discussie met andere IFP belanghebbenden, teneinde consensus te bereiken over geprefereerd en acceptabel landgebruik. De IFP onderneming kan de uitkomst gebruiken om de input voor het model te wijzigen, en het model opnieuw te laten draaien gedurende de discussie, teneinde het voorstel voor landtoewijzing aan te passen, totdat consensus is bereikt.

De gehanteerde benaderingen in het IFP landtoewijzings-model in dit onderzoek kunnen ook gebruikt worden als ondersteuning bij andere besluiten over landgebruik, bijvoorbeeld bij landgebruiksplanning op provinciaal niveau. De informatie over geprojecteerde gebieden van landbouwuitbreiding, van land voor ander gebruik, en land als beschermd gebied, zal de provinciale bestuurders helpen de problemen in de besluiten over landgebruik te structureren.

Dit onderzoek omvat de opbouw van het model, en het testen ervan met behulp van veldgegevens. Een noodzakelijke volgende stap is de belanghebbenden met het model te laten werken, in het studiegebied en daar buiten.

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Appendix 1 Indonesian Archipelago

Figure A1 Situation map of the study area: Pulau Laut, South Kalimantan, Indonesia

Appendix 2 Skeleton tables and their relationships of the general data model of IFP land allocation

province	(p_name, p_area, p_numpl)
district	(d_name, d_area, d_gdp, d_numpl, p_name)
sdistrict	(sd_name, sd_area, sd_numpl, d_name)
village	(v_name, v_area, v_numpl, pop_num, sd_name)
river	(ri_num, ri_type, ri_length, ri_dcls, ri_area)
river-sdistrict	(ri_num, sd_name)
road	(ro_num, ro_type, ro_length, ro_dcls, ro_area)
road-sdistrict	(ro_num, sd_name)
wbody	(wb_num, wb_type, wb_dcls, wb_area)
wbody-sdistrict	(wb_num, sd_name)
lunit	(lu_num, land_cover, suit_class, lu_area)
lunit-sdistrict	(lu_unit, sd_name)
slope	(sl_num, sl_class, sl_area)
lunit-slope	(lu_num, sl_num)
ravin	(ra_num, ra_area)
lunit-ravin	(lu_num, ra_num)
lvalue	(lv_num, lv_area)
lunit-lvalue	(lu_num, lv_num)
soil	(so_num, so_type, so_area)
lunit-soil	(lu_num, so_num)
protect	(prot_num, prot_area)
lunit-protect	(lu_num, prot_num)
cost	(cos_num, cos_value)
lunit-cost	(lu_num, cos_num)
benefit	(ben_num, ben_value)
lunit-benefit	(lu_num, ben_num)
agric	(ag_num, ag_area)
lunit-agric	(lu_num, ag_num)
subcr	(sc_num, sc_area, sc_prod)
agric-subcr	(ag_num, sc_num)
induscr	(ind_num, ind_area, ind_prod)
agric-induscr	(ag_num, ind_num)
marketcr	(mar_num, mar_area, mar_prod)
agric-marketcr	(ag_num, mar_num)
ifppro	(pr_name, pr_area, lu_num)
ifpcom	(co_name, co_act, pr_name)
plantact	(lab_num, co_act)
employment	(lab_num, lab_type, act_num)
plblock	(bl_num, bl_area, pr_name)
compt	(cp_num, cp_area, bl_num)
subcompt	(scp_num, scp_area, cp_num, tr_num, sp_name)
treatment	(tr_num, tr_type, date_treat)
species	(sp_name, date_plant, spc_num)

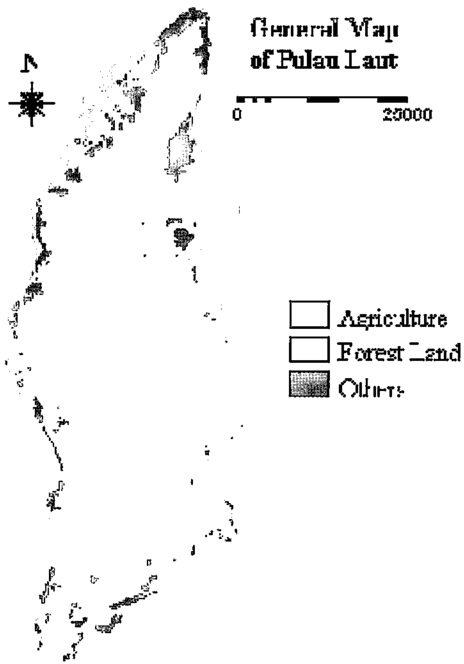

Figure A2 General map of Pulau Laut

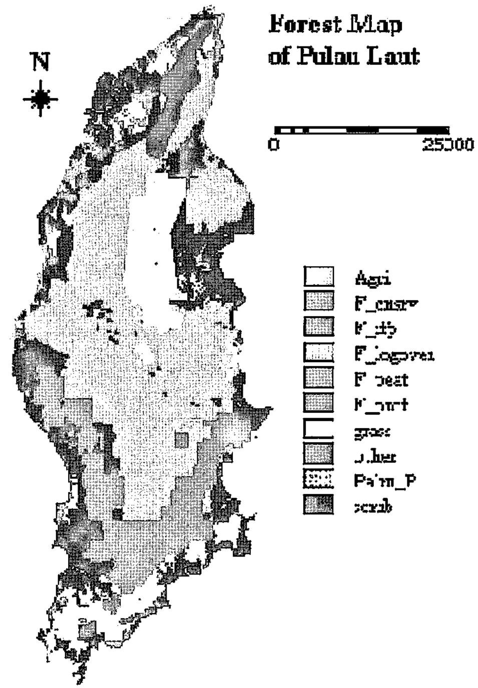

Figure A3 Forest map of Pulau Laut

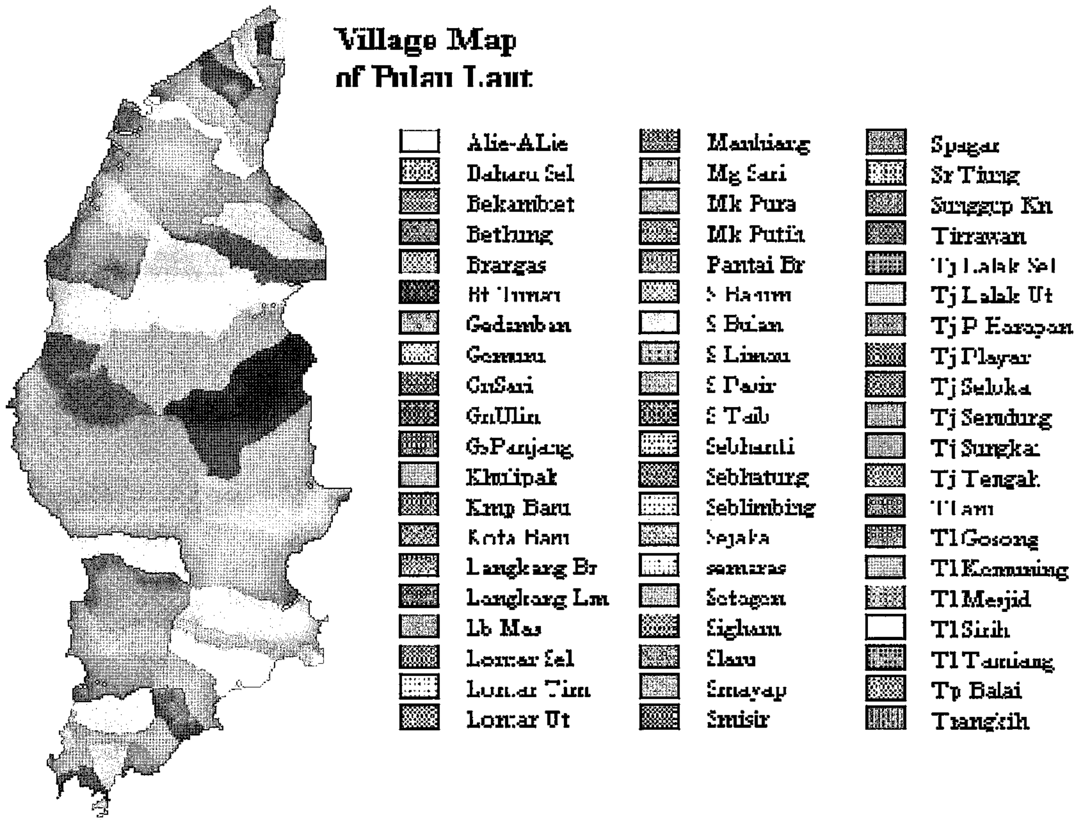

Figure A4 The Boundary of villages in Pulau Laut

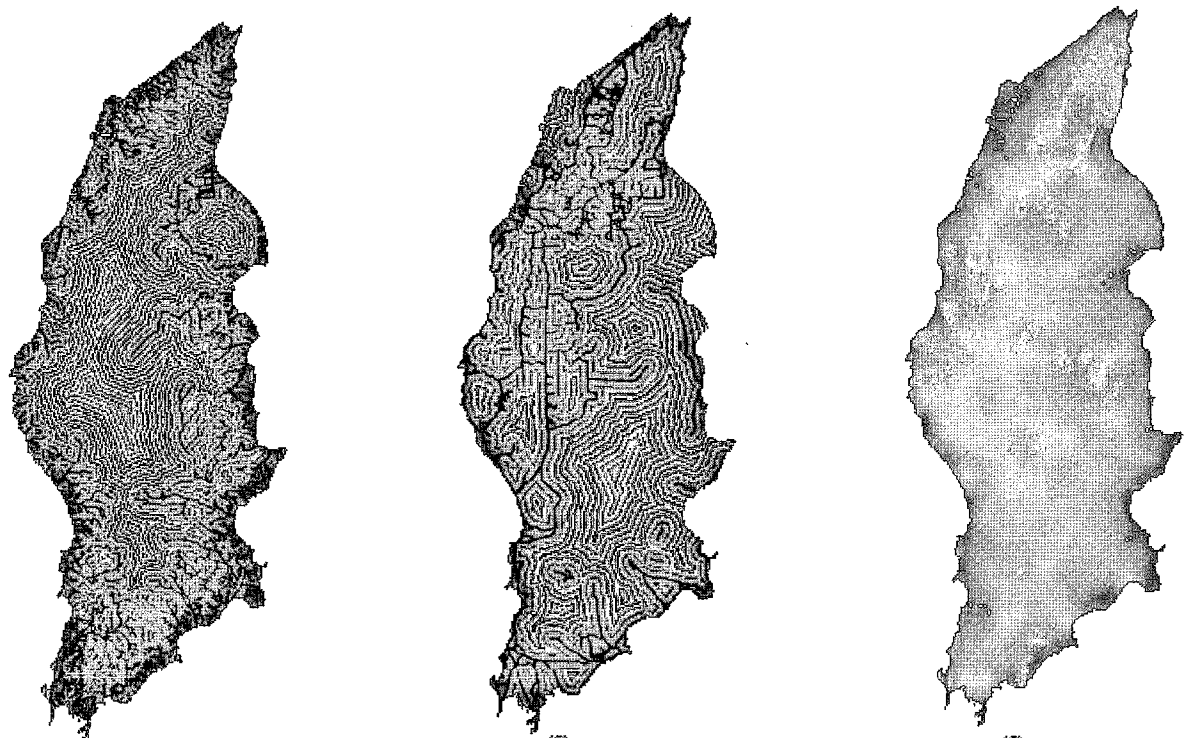

Figure A5 Distance maps: river distance (1), road distance (2), slope distance (3)

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Biography

Tetra Yanuariadi was born in Samarinda, East Kalimantan, Indonesia, on 6 January 1963. He obtained his 'Insinyur' (Ir.) degree in forestry from the Faculty of Forestry, Mulawarman University, in his home-town in 1985. He then received a postgraduate diploma and MSc degree 'with distinction' in forest survey from ITC in the Netherlands in 1989 and 1991, respectively. He has been working for the Bureau of Planning of the Ministry of Forestry and Estate Crops of Indonesia since 1986. In his career, he has served in various capacities, e.g., head of the reporting and evaluation section, and head of the national forest planning section, and has also been involved in a number of working groups for forestry policy formulation. He has participated in several international and local short courses and workshops, e.g., rural project planning at the Australian National University in Canberra, Australia; the FAO workshop on TFAP in Bangkok, Thailand; environmental study in Japan; and a national development planning course at the University of Indonesia, in Jakarta, Indonesia.