Environmental Knowledge and Resource Management: Sumatra's Kerinci-Seblat National Park

vorgelegt von
Diplom-Geographin
Silvia Werner
aus Rinteln

Vom Fachbereich 7 – Umwelt und Entwicklung
der Technischen Universität Berlin
zur Erlangung des akademischen Grades

Doktorin der Naturwissenschaften
- Dr. rer. nat. -
genehmigte Dissertation

Promotionsausschuß:

Vorsitzender: Prof. Dr. Volkmar Hartje
Berichter: Prof. Dr. Johannes Küchler
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Tag der wissenschaftlichen Aussprache: 23. Juli 2001

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Environmental Knowledge and Resource Management: Sumatra’s Kerinci-Seblat National Park

by Silvia Werner

Abstract

This study is concerned with the problem of communication between stakeholders in nature conservation and resident peoples. The major obstacle in nature conservation is a lack of understanding concerning the point of view between the parties involved, especially when it comes to the perception of nature. This work promotes an investigation of both the natural environment as well as traditional ecological knowledge and management systems as a basis for mutual understanding, to enable a more successful communication and problem solving.

The background for this approach is the experience of both nature conservation and development projects, that all extension endeavours are futile, if they don’t take local needs and priorities into account. This means for national parks, that they are prone to encroachment, as long as their boundaries result from external determination without local consent. The latter can only be achieved, however, when good communication about the environment and its utilisation is possible.

For this purpose villages on the eastern lowland fringe of the Kerinci-Seblat National Park (KSNP) have been studied as a case study. Part of the investigation identified the major components of the agricultural landscape and related management practices. As the main constituents are shifting cultivation and forest gardens, the study furthermore focussed on the structure and composition of the upland farming system as well as its botanical and pedological properties.

To complement this natural scientific analysis, local soil and plant knowledge was documented, as well as farmers’ criteria for agricultural site selection. Furthermore, utilisation and perception of the primary forest bordering local upland fields were investigated. The purpose was to assess the role and importance primary forest has for the villagers, as well as related customary rights.

The final aspect of this approach was to find out about current involvements of local people in KSNP planning, establishment and management. Their resulting perception towards their involvement and the protected area itself was then documented. The research results enable a problem analysis concerning how the neglect of local perspectives and needs triggers problems, which could be prevented by mutual understanding of the stakeholders’ respective perceptions. To provide an instrument for more successful communication leading to acceptable conservation agreements between local people and conservationists is the purpose of this study.

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Abbreviations

BAPPEDA	Badan Perencanaan Pembangunan Daerah (Agency for Regional Development)
BAPPENAS	Badan Perencanaan Pembangunan Nasional (National Planning Board)
BILA	Yayasan Bina Kelola (local NGO)
BKSDA	Balai Konservasi Sumber Daya Alam (Natural Resources Conservation Office)
CRA	Continuous Rural Appraisal
DBH	Diameter at Breast Height (120 cm).
FORDA	Forum Daerah (WALHI forum at provincial level)
GOI	Government of Indonesia
ICDP	Integrated Conservation and Development Project
Keppres	Keputusa Presiden (Presidential Decree)
INTAG	Directorate General of Forest Inventory and Land Use Planning
JKPP	Jaringan Kerja Pemetaan Partisipatif (Participatory Mapping Network)
KOMMA	Kelompok Mahasiswa Mencintai Alam (local NGO)
KSNP	Kerinci-Seblat National Park
LCO	Local Community Organizer
LIPI	Lembaga Ilmu Pengetahuan Indonesia (Indonesian Institute of Sciences)
LKMD	Lembaga Ketahanan Masyarakat Desa (Village Development Council)
LMD	Lembaga Musyawarah Desa (Village Deliberation Council)
LP3D	Lembaga Penelitian dan Pengembangan Desa, Jambi (Institution for Research and Rural Development)
LPWP	Lembaga Pengkajian Wilayah dan Pendesaan, Bengkulu (Institution for Regional and Rural Research)
m a.s.l.	Meters above sea level
NBAP	National Biodiversity Action Plan
NTFP	Non-Timber Forest Products
NGO	Non-Governmental Organisation
Pemda	Pemerintah Daerah (Regional Government)
PHPA	Direktorat Jenderal Perlindungan Hutan dan Pelestarian Alam (Directorate General of Forestry Protection and Nature Conservation)

PPA	Pusat Pengembangan Agrikarya, Padang (Centre for Agricultural Development)
PPL	Penyuluh Pelaksanaan Lapangan (Field Extension Worker)
PRA	Participatory Rural Appraisal
Repelita	Rencana Pembangunan Lima Tahun (five-year development plan)
RePPProT	Regional Physical Planning Program for Transmigration
Sarko	Sarolangun-Bangko, a regency within Jambi Province.
TEK	Traditional Ecological Knowledge; local knowledge
TEKMS	Traditional Ecological Knowledge and Management Systems
TGHK	Tata Guna Hutan dan Kesepakatan (Agreed Functional Forest Classification, i.e. forest land-use plan)
VCA	Village Conservation Agreement
VCF	Village Conservation Facilitator
VCWG	Village Conservation Working Groups (*Kelompok Masyarakat* ICDP-TNKS)
WALHI	Wahana Lingkungan Hidup (national network for environmental NGOs)
WARSI	Warung Informasi Konservasi (Clearing House for Conservation Information - Forum of twelve NGOs from the four provinces in which the KSNP is located.
WWF	Worldwide Fund for Nature

Glossary

Abundance	Presence of a certain botanical species within vegetation, expressed as density, frequency or dominance.
Adat	Customs
Agroforestry	"Agroforestry is a collective name for land use systems in which woody perennials (trees, shrubs, etc.) are grown in association with herbaceous plants (crops, pastures) and/or livestock in a spatial arrangement, a rotation or both, and in which there are both ecological and economic interactions between the tree and non-tree components of the system" (Young 1989:11).
Bupati	regent, government officer in charge of a regency
Cagar Alam	Nature Reserve
Camat	Subdistrict head
Cassiavera	*Cinnamomum spp*., Lauraceae. Close associate of *C. zeylanicum*, true cinnamon, and also cultivated for its aromatic bark.
Clones	Trees grown from stumps budgrafted with wood taken from a particular high-yielding tree.
Datuk	Honorary title for the oldest male of a Minangkabau clan
Density	Absolute numbers of a certain plant species per defined area.
Desa	Village, administrative unit, headed by a kepala desa (village head)
Diameter	Tree diameter in centimetres, measured at breast height (DBH).
Dominance	Dominance concerning the basal area of tree species within a determined vegetation plot (cm^2/area and in % of total).
Duku / Langsat	Bot.: *Lansium domesticum*, Meliaceae, common Indonesian fruit tree
Dukun	Indigenous medical practitioner, shaman
Durian	Bot.: *Durio zibethinus*, Bombacaceae, highly priced common Southeast Asian fruit tree
Dusun	Hamlet, administrative unit
Frequency	Relative number of a certain botanical species within a defined vegetation plot.
Height	Vegetation height in metres
Hukum adat	Customary law
Hutan Pelestarian Alam	Nature Conservation Forest

Hutan Suaka Alam	Nature Sanctuary
Jengkol	Bot.: *Pithecellobium jiringa*, Leguminosae, tree. Seeds of beans eaten raw or cooked as vegetable.
Jungle rubber	Rubber gardens under traditional management, mixed with secondary vegetation.
Kabupaten	Regency, administrative unit; headed by a *bupati* (regent)
Kecamatan	Sub-district, administrative unit; headed by a *camat* (sub-district leader)
Kepala adat	Customary leader
Kepala desa	Village head, government official
Ladang	Upland field currently under annual crops, mainly upland rice mixed with vegetables
Manggis	Bot.: *Garcinia mangostana*, Clusiaceae, engl.: mangosteen, common indonesian fruit tree
Merantau	Practicing circular migration.
Musyawarah	Lit.: discussion, deliberation. Traditional Indonesian pattern of problem-solving: All parties concerned sit together and discuss a problem until solution is found, which is accepted by everybody.
Petai	Bot.: *Parkia speciosa*, Leguminosae, tree. Seeds of beans eaten raw or cooked as vegetable.
Propinsi	Province, administrative unit; headed by a gubernur (governor).
Rambutan	Bot.: *Nephelium*, Sapindaceae, common indonesian fruit tree.
Selected seedlings	Grown from seed material gathered from specially established seed gardens including a chosen range of already improved seedling trees.
Smallholding	Any agricultural enterprise that is largely family operated (McHale 1965: 37).
Suaka Margasatwa	Game Reserve
Taman Nasional	National Park
Taman Wisata Alam	Nature Recreation Park
Taman Hutan Agung	Grand Forest Park
Unselected seedlings	Trees grown from seeds gathered from unimproved trees (although these seeds may be selected from a particular better performing tree).

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1. Introduction to the Study

Indonesia represents one of the world's six countries with the highest biodiversity, including also Brazil, Colombia, Mexico, Zaire and Tanzania. Within the Indonesian territory 25% of all fish species, 17% (1,519) of the bird species, 16% (870) of all described reptiles and amphibians, 12% (515) of the world's mammal species, 10% (24,375) of the world's flowering plants and 33% (250,000) or more of all insect species, 121 of them swallowtail butterflies are abundant (World Bank 1993: 1). Indonesia ranks first for all mentioned categories of species richness in Asia, and first worldwide for mammals and swallowtail butterflies, third for reptiles, fourth for birds, fifth for amphibians and seventh for flowering plants (The British Council 1996: 1). Nearly ten percent of the world's tropical forests are accommodated within Indonesian borders, ranking third in rainforest area only after Brazil and Nigeria. These three countries harbour almost 50 % of the world's evergreen tropical moist forest. Being an island state consisting of 1,500 islands, Indonesia also harbours a great wealth of marine resources. The coral reef area within the Indonesian archipelago is the largest in the Indo-Pacific Ocean.

Like in all tropical countries, the ecological riches of Indonesia suffer from exploitation and many of the species are threatened or already close to extinction. To protect its valuable biological resources, Indonesia established 366 conservation areas in all major habitat types and still is working on demarcating further typical ecosystems as protected areas. The segregation of forests, however, has not been adequate for the conservation of biodiversity. Integration into suitable cropping systems like rubber agroforests can provide refuge for species whose protected habitat is to small to ensure their survival (Penot 1997: 6). As a framework for the identification of conservation areas and for the implementation and enforcement of the protection status, the Indonesian legal system has enacted several laws and regulations. Up to now, however, institutional and policy constraints still inhibit successful implementation of the Indonesian conservation strategy. One of these constraints is the lack of community participation in conservation, resulting in conflicts over boundaries and land use restrictions within the reserve (World Bank 1994: 4). The collision of local people and conservation agencies is not a uniquely Indonesian problem, it occurs all over the world where nature reserves have been established in ecosystems with human use potential.

Due to, among others, increased gazettement of protected areas and population growth in the second half of this century, conservation managers have faced increasing conflicts with local populations. It became apparent that the traditional approach of protecting a reserve through a system of guards, laws and restrictions that had been applied, was not practicable. Starting with the UNESCO

Biosphere Conference in 1968, the idea was developed that achievements in nature conservation should also contribute to the welfare of the local people. (Aumeeruddy 1994: 4).

The Kerinci-Seblat National Park is not only important for the protection of the enormous biodiversity it contains within its area, but it also protects some of the main watersheds of the Island of Sumatra. Three main Sumatran water catchment areas have their springs within the territory of the protected area: the Musi, the Batang Hari and the rivers that drain to the west coast. The Musi and the Batang Hari flow through the lowlands of Riau and Jambi and determine the fate of thousands of hectares of irrigated rice fields. A total of three million inhabitants and about seven million hectares of agricultural lands in the provinces of Jambi, West Sumatra, South Sumatra and Bengkulu depend for its irrigation on waters originating from the KSNP (Radja 1994: 19). During the last decades, floods have become increasingly frequent in these downriver areas, as well as landslides in the foothills of the Barisan range, wherein disturbances to the ecosystem of Kerinci's forests have a significant part. A reconnaissance-level survey of the vegetation and tree flora of the KSNP indicated, that intense deforestation is taking place in and around the park. Already in the early 1990s, only 3 % of the region's lowland rain forest remained intact, leading to an enormous loss of biological diversity restricted to this ecosystem (Laumonier 1994: 249). The main reasons for forest destruction are neither ignorance nor carelessness, but the poverty of some and the greed of others according to Radja (1994: 22 pp.).

Like most protected areas, the Kerinci-Seblat National Park in Sumatra was not created in an unpopulated environment. People have lived in and around the currently defined park area for a long time. However, since Dutch colonial rule the rights of the local people to their traditional resource base have not been acknowledged unambiguously by the national government. Traditional patterns of resource use do not fit into the Indonesian national pattern of resource exploitation, which is based on Dutch law and concepts of natural resource management. People are expected to farm a limited piece of land in a permanent manner, while land that is not permanently used and managed as well as primary forest is supposed to be without an owner and therefore to fall under state authority. In reality, traditional resource use is seldom limited to a permanent plot for the cultivation of annual crops plus a garden planted with tree crops.

People in areas with other soils than those developed on fertile volcanic ash often practice shifting cultivation, with a high percentage of their land lying fallow to restore soil fertility or to represent an in-kind bank account whereupon one can draw when there is a need for money due to crop failure, unexpected expenditures, school fees, marriages and the like. The forests bordering their villages represent not only a potential land resource, but also a place for gathering (medicinal plants, building material, handicraft, food) and a source of income (rattan, latex, resin) for the local people.

Figure 1: The Kerinci Seblat National Park

Source: WWF 1996c and Simplex 1990

Areas designated as state land therefore have often been used by local communities for a long time and claimed as customary land. If these lands are allocated to other uses by national authorities, like protected area creation, timber exploitation, transmigration and plantation development, this generally means a loss of traditional use zones. When local people did not participate in the new land allocation and also were not compensated for their loss, they usually considered this process as unfair and did not accept it. Especially concerning protected area development, however, the acceptance of the reserve by local people is a precondition for its successful conservation.

For the Kerinci Seblat National Park a park management concept recently has been developed, involving several government agencies as well as national and international NGOs. Kerinci-Seblat is the biggest national park in Sumatra, including a wide range of unique ecosystems. Covering a huge area and being located in relative remote territory, major conservation activities have not yet focused on the densely settled enclave in the upland valley around Sungai Penuh. Up to now, little investigation has been carried out on the situation of most villages in the outer border area. Many of the villages are very remote and field staff for park supervision can only visit any given village infrequently. Therefore the sustainability and integrity of the KSNP territory very much depends on the willingness of local people to accept the protected area and to participate in its conservation.

1.1 Conceptual Framework

1.1.1 Objective

This work is concerned with the problem of the integration of nature conservation with resident peoples. Within this study, several villages in the outer park border area of the KSNP have been investigated to develop a methodology of how park managers (or people concerned with natural resource management in general) and local people may be able to communicate more effectively about the environment and the management of natural resources.

A park is created in the intimate surroundings of local communities. How do the local people react? Will there be implications for local people's activities on the park? How can park and surrounding communities coexist in harmony? These questions certainly occur to every resource manager concerned with the establishment of nature reserves. To answer these questions, of course, there has to be communication with local people living in the park border area. People have to participate in park development and border delineation and they have to be compensated for the loss of their access to resources.

It is not enough, however, if the aims and targets of nature conservation are presented to the local people. The scientific concept of national parks and biodiversity conservation probably is rather foreign to traditional communities who themselves have a different conceptualisation of nature. To communicate effectively about nature conservation, those responsible for park management also have to develop an understanding about how local people see and manage their environment, about their Traditional Ecological Knowledge and Management Systems[1] (TEKMS). Furthermore, to communicate with local people about nature, those concerned with national park management also have to have an understanding of the natural environment local people live in. Those who do not know about plants or soils themselves might not be able to ask the right questions to elicit local peoples' knowledge. Biologically unsophisticated researchers are not well equipped to determine what portions of the information they obtain are new, important, already well known or implausible (Johannes 1993: 36). These considerations led to the development of the research methodology applied in this study.

One part, to assess the TEKMS of traditional villages in the border area of the Kerinci-Seblat National Park, involved analysing the upland farming system both ecologically and in terms of the management practices applied. To grasp the logic behind a local classification, we have first to understand the relevant part of the natural environment, starting with applying the scientific classification (Müller-Böker 1988: 103). The serial stages from young fallow to the various stages of secondary forest were identified. Vegetation composition and vitality were then connected with the intensity/frequency of utilisation of the respective stage. Also the variation of vegetation composition of the different succession stages according to bedrock material, soil properties and geomorphology was examined. Furthermore, the different soil types present and their soil physical and chemical properties were investigated.

As a counterbalance to the scientific analysis, the traditional ecological knowledge of the local people was elicited, as well as the pattern of resource use based on that knowledge. Also the relationship between the people and the protected area was investigated. Important aspects were how the people perceive the protected area, utilization patterns, and how they have been included in park planning, establishment and protection.

1.1.2 Human Ecology for the Study of Human - Environment Interactions

The dual approach of making a scientific analysis of the agroecosystem on the one hand and analysing traditional land use practices, resource use patterns, local ecological knowledge, people's attitudes and legal concepts, on the other hand, enables a comparison between scientific analysis and the farmer's rationale of resource use management (Aumeeruddy 1994: 5). The appropriate framework to study the impact of local agricultural systems on the environment as well as the

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1 The term "Traditional Ecological Knowledge and Management Systems' (TEKMS) was introduced by Johannes (1993).

TEKMS creating the local agroecosystem is a human ecological one. Human ecology is defined by Rambo (1984a: 45) as a perspective to study people's relations with the environment. It is a conceptual framework for applied research on agricultural and rural development to help both natural and social scientists in employing a systems viewpoint on both human society and nature. The basic concept of human ecology is "that human social systems and ecosystems have an interactive relationship, so that the structure of society is modified by its relation to the environment, just as the structure of the ecosystem is influenced by human activities" (Rambo and Sajise 1984: 2). According to Rambo and Sajise, studying traditional ecological knowledge as a subject of ethnoecology allows an investigation of the flow of information in ecosystems using a human ecological perspective. I do not, however, agree with the concept of Rambo (1984a) and Rambo and Sajise (1984), who model social systems and ecosystems as two different organisms, which are merely related within the respective system, with both systems only connected through flows of energy, material and information as well as through processes of selection and adaptation. I suppose, however, that the components of both systems are also related with all components of the other system, more in the sense of Conway (1984: 34), who includes people and their social, cultural and economic activities within the boundaries of the agroecosystem (but also the urban ecosystem, of course). I suggest further that Traditional Ecological Knowledge and Management Systems (TEKMS) represent the sphere of interaction between the environment and the social system and therefore the medium for the flow of information, energy and material (see figure 1). Therefore, consequently, the study of TEKMS would be the best tool for human ecological research to study these system interactions. This could focus on the study of TEKMS to see how social systems are related to the environment or the study of TEKMS to find out in what way environmental systems are influenced by human use.

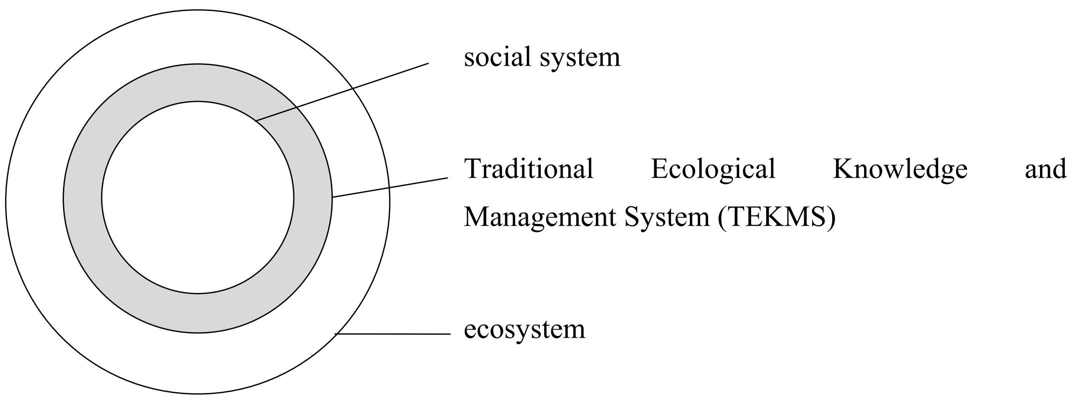

Figure 2: Traditional Ecological Knowledge and Management Systems as the sphere of interaction between social systems and ecosystems

This model further develops the concept of Netting (1965: 283), who models productive technology and knowledge as “the area of human activity which impinges directly on the environment”. Being a cultural ecologist, Netting’s work is based on the principles of cultural ecology, which investigates the “the adaptive processes by which the nature of society and an unpredictable number of features of culture are affected by the basic adjustment through which people utilize a given environment” (Tax 1953: 243[2]). The focus of cultural ecology here is on society and culture as their means of *adaptation* with traditional techniques and knowledge as a part. It is not concerned with the effects of culture, of TEKMS on the environment nor on the process of *interaction* as a whole, all of which are included within the human ecological perspective employed here.

Modern science has developed more and more towards specialisation of the respective disciplines, so that scientists educated in one discipline often do not know much about other disciplines and tend to view nature as consisting of distinct entities, too. Rural development problems, however, demand integrated solutions, and specialists’ knowledge about a certain aspect of the problem will remain insignificant unless it can be linked to the general context. Especially in rural areas environmental problems are always an expression of a disturbed relationship between the community at large and their environment. Therefore an effective solution demands an assessment of the environmental situation, of the social system, but above all, of the TEKMS. Agricultural planners and extension workers have to understand the local TEKMS to communicate with the local population and to find appropriate solutions.

1.1.3 Traditional Environmental Knowledge (TEK) for Natural Resources Management

Up to now, very limited attempts have been made to use traditional ecological knowledge in natural resource management. According to Gadgil and Berkes (1991: 132), many ‘rules of thumb’ developed by traditional resource managers and enforced by social and cultural means are in many ways as good as scientific prescriptions. Scientists most concerned with folk knowledge systems were generally anthropologists and ethnographers, while natural scientists usually were less open towards folk ecological knowledge systems. The study of local ecological knowledge primarily is a subject of ethnoecology, a subset of ethnoscience. The approach of ethnoscience is an ethnographic one. The prefix ‘ethno’ in ethnoscience “refers to the system of knowledge and cognition typical of a given culture” (Sturtevant 1964: 99). Ethnoecology refers to the study of how traditional groups conceptualise their environment, i.e. how they organize and classify their knowledge of nature and

[2] As cited in Netting 1965: 81.

related ecological processes (Rambo and Sajise 1984: 15, Brosius *et al*. 1986: 187 pp.). Most of the studies concerned with ethnoecology, however, are limited to the description of traditional ecological folk taxonomies, mainly biological ones. Rambo and Sajise (ibid.), however demand that "ethnoecology research in principle should also be concerned with understanding the totality of folk knowledge about ecosystem structure and functioning". Vayda and Rappaport (1968: 481) also call for an elicitation of local peoples' rules concerning appropriate behaviour towards the perceived environmental phenomena. Brosius *et al.* (1986: 189) suggest a comparison of the local people's ecological worldview with that derived from scientific ecology.

Box 1: Definition of Traditional Ecological Knowledge (TEK)

TEK is a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. Further, TEK is an attribute of societies with historical continuity in resource use practices; by and large, these are non-industrial or less technologically advanced societies, many of them indigenous or tribal (Berkes 1993: 3).

Many studies from diverse geographic areas from the Arctic to the Amazon showed, that indigenous people have their own systems of managing resources (e.g. Conklin 1954a, Posey 1985). Natural scientists, however, until now rarely have been concerned with TEK (see box 1 for a definition). They generally "dismiss the knowledge gained by indigenous people during centuries as anecdotal and unsubstantial. However, their own specialized knowledge is based typically on studies carried out over much shorter periods of time under conditions where being wrong does not entail the risk of going hungry" (Johannes 1993: 37). The following example described by Rambo and Sajise (1984: 15) illustrates the importance of a consultation of local farmers' ecological knowledge in natural resource planning: When scientists investigated the rates of soil erosion on traditional farmers fields in the mountain area of northern Luzon, the Philippines, they found that the taro fields, which were located on some of the steep hillside plots, suffered the highest losses. On suggesting that farmers should stop taro cultivation, the scientists had to learn from the people that taro was the only crop likely to survive the typhoons that devastate northern Luzon every few years. If the farmers had followed the advice of the scientists, erosion might have been temporarily reduced, but the farmers would have been without food after the next tropical cyclone. TEKMS always represent the ecological adaptation of a given society to their environment.

Concerning the question of which discipline should investigate TEK, Johannes (1993: 36) suggests, that TEK "should be recorded and evaluated by people who possess an appropriate background in biology, ecology and resource management, and in the social sciences, which provide the appropriate skills for translating information from one culture and language to another and for addressing the social frame of reference".

1.1.4 Earlier Research

Because the purpose of this study is to promote TEKMS as an important instrument to improve communications between local people and park management, it involves different research approaches. These include an analysis of local participation in KSNP planning, establishment and protection, traditional land use, botanical and pedological properties of upland farming and local environmental knowledge in the research area. While the possible usefulness of TEKMS for agricultural development was mentioned by several authors, their application in nature protection promoted here is a novel approach. Also the combination of an analysis of resource use, TEKMS and the environment itself is not common. Usually, studies focus on only one, or rarely, two aspects. Therefore the following section integrates the respective parts of this study into the earlier research existing.

Studies on Local Participation in Conservation Planning, Establishment and Protection

Nature conservation is predominantly a field of practice rather than theoretical discourse. Like rural development projects, conservation projects are mainly externally funded and in most cases jointly managed between international conservation agencies and local governments. Because the international agencies often have their own research department, or are at least intensively involved in current research discussions, the implementation of new concepts usually happens quickly.

While the call for community participation in rural development has been made by a large number of authors since the 1960s, the demand for the inclusion of local people within conservation endeavours is a more recent phenomenon. Park management has emphasized – and in most areas it still does – a policing role aimed at excluding local people that was sometimes characterized as the "fences and fines" approach (Wells and Brandon 1992: 1). Under this policy communities next to protected areas bore substantial costs resulting from lost access, while receiving little in return. The 1980 World Conservation Strategy paid tribute to these concerns, emphasizing the importance of linking protected area management with the economic activities of local communities[3]. The discussion on sustainable development during the early 1980s picked up that issue, as did the 1982 World Congress on National Parks in Bali. The latter first called for the inclusion of local people in protected area planning and management, recognizing that a successful long-term management of

[3] IUCN 1980, in: Wells and Brandon 1982: 2.

protected areas depends on the cooperation and support of local people (ibid.: 2). These concerns found their practical realization in the concept of Integrated Conservation and Development Projects (ICDPs), originating from a joint study of the World Bank, USAID and the U.S. affiliate of the WWF in 1989.

The major method to involve local communities in ICDPs, Participatory Rural Appraisal (PRA), exists since the time of the Integrated Rural Development Projects (IRDPs) of the 1980s. A new tool for alleviating conflicts between villagers and protected areas is participatory mapping, which has been used for village resource mapping and zonation since the early 1990s (e.g. Momberg *et al.* 1996).

Currently efforts persist to adjust ICDPs sufficiently with the local context to make them work. It has become clear, that mere "functional participation" (Pretty 1994[4]), where people have to meet predetermined objectives of the project, does not work out. Similarly, the "participation for material incentives" (ibid.) usually does not outlive the duration of the project, making it unsustainable. Advocates of local participation now emphasize the necessity for involving resident communities right from the beginning of the project (Uphoff and Buck 1997: 9) and for a continued involvement in strategic issues throughout the project (Pimbert and Pretty 1995: 25).

The major alternative approach to ICDPs currently debated is the co-management[5] of protected areas, as advocated by Berkes (1995) and IUCN and WWF (1998). The term describes a situation where "some or all of the relevant stakeholders in a protected area are involved in a substantial way in management activities" (Borrini-Feyerabend 1996: 8). Because of this shared authority and responsibility as well as a pattern of "interactive participation" (Pretty 1994[6]), hopes are, that these locally-negotiated conservation projects are more sustainable in the long-term. The major feature of co-management of protected areas is, that no pre-specified project design is applied, but rather a joint learning process. The existence of local vested interests in and control over natural resources is supposed to guarantee that the ecosystem is used in a sustainable fashion, although biodiversity conservation might have to be compromised to a certain extent (West and Brechlin 1991: 399, Barber 1996: 25, Miller 1996: 8, Uphoff and Buck 1997: 20).

Partnerships for resource management already exist in various forms in several countries, like Zimbabwe (Miller 1996) and the Indonesian province West Papua (Mandosir and Stark 1993). The advocates of co-management, however, are also aware of its limitations. The approach is not

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[4] As cited in Pimbert and Pretty 1995: 26.

[5] Also referred to as collaborative management, participatory management, joint management, shared-management, multi-stakeholder management or round-table agreement.

[6] As cited in Pimbert and Pretty 1995: 26.

applicable in areas, where a fast ecological deterioration has to be prevented. In these cases, more restrictive conservation approaches are recommended (Borrini-Feyerabend 1996: 9).

Studies on Traditional Land Use in and around the KSNP

The agricultural systems and related land use practices have been studied most extensively in the Kerinci-enclave and less so in the surrounding lowlands of the park. The focus here has mostly been on the *cassiavera*-based agroforestry systems (e.g. Ardha 1974, Belsky 1991, Savouré 1991, Aumeeruddy 1994). Due to the profitability of cassiavera production as well as existing population density, this is also the area where pressure on the park boundary is highest. Additionally, several studies are concerned with the rubber smallholder economy, where research has been carried out in various places of the Central Sumatran lowlands (e.g. Thomas 1965, Barlow and Muharminto 1982, Barlow and Jayasurija 1986, De Foresta 1992, Gouyon *et al*. 1993, Penot 1995 and 1999).

Ecological Studies in the Research Area

Prior ecological studies of the research area can be divided into general mapping endeavours, and research of a limited area in the frame of a particular project. The geology of the Indonesian Islands, including Sumatra, has been described in the most detailed manner in van Bemmelen (1949). Sumatra's geomorphology has been covered in a monograph by Verstappen (1973). An overview of the ecosystems of Sumatra has been provided by Whitten *et al*. (1987). A complete mapping of the actual vegetation of the island was carried out by Laumonier (1983) and Laumonier *et al*. (1986 and 1987). This complete botanical inventory has been preceded by several botanical studies on a smaller scale as well as vegetation maps by van Steenis (1939 and 1958). The results of a complete pedological mapping of Sumatra have also been published. The island is subdivided into several mapping sheets, each of which is supplemented with an explanatory booklet (Suparto *et al*. 1990, Sukma *et al*. 1990, Wahyunto *et al*. 1990 for the KSNP-region).

More detailed studies of the environment of the KSNP and its surroundings include the botanical inventories of Laumonier (1994a), Gillison *et al*. (1996) and WWF (1996). Extensive research on soils has been carried out in the surroundings of the Sitiung field research station at the boundary between Jambi and West Sumatra (e.g. Subagjo 1988, Colfer *et al*. 1989, Arya *et al*. 1990, Arya *et al*. 1992).

Studies on TEK and Local Resource Management

In 1989, Hecht and Posey (p. 177) regretted the scarcity of research tackling indigenous soil management, which would be very important for understanding native settlement patterns and for developing stable land use systems. They also were surprised of the lack of ethnopedology in studies of indigenous science, which would be very important given the central role of soil resources in subsistence. In general, the documentation of TEK within ethnographic studies of farmer societies had already started in the first half of the 19th century. These studies, however, frequently were not systematic explorations of that field but rather listed or described classification schemes and names for environmental features, like local soil types, animals or plants (e.g. Watson 1928, Malinowski 1935, Richards 1952, Malcolm 1953, Conklin 1954a,b, Ollier *et al.* 1971, Adewole Osunade 1988).

Later followed classifications/taxonomies that focus on the system of classification, frequently attempting to correlate a local taxonomic structure to universal folk taxonomy or technical (soil, botanical, etc.) taxonomy (e.g. Berlin 1973, Berlin *et al.* 1973, Morris 1976, Headland 1981, Hunn 1982, Berlin 1992, Siderius and Mafalacusser 1998). In the last decade, however, the number of publications on traditional ecological knowledge increased due to the realization that local agriculturalists commonly are well informed about the environments they manage. Ethnological studies on agricultural systems also more frequently included local notions on environmental features (e.g. Inoue and Lahije 1990). More important than the scientific documentation of TEK, however, is its integration into agricultural and other development projects. Recently, also utilitarian studies developed, moving away from pure description to suggesting practical uses of local knowledge in development issues (e.g. Dialla 1993, Bellon and Taylor 1993, Sandor and Furbee 1996, Habarurema and Steiner 1997). To evaluate how well the local soil classification system, for instance, discriminates between objective properties of soils, the respective authors employed laboratory results pertaining topsoil physical and chemical properties.

An example where these suggestions have been transferred successfully into practical use is the manual for the identification and management of "*The soils used for rice production in Cambodia*" (White *et al.* 1997). By linking local knowledge with modern methods of describing soils and organising information, the target was to provide a framework for research on soils and the extension of technologies (White *et al.* 1995: 1). The resulting classification system generally accounted for more variation than the soil groups of a previous classical soil map (Oberthür *et al.* 2000: 24). This manual proves very useful, because there is clearly a need at the local level for extension workers to communicate agronomic soil information to farmers. The commonly used U.S. system "Soil Taxonomy", on the other hand, is not very well understood by most scientists and represents a complete mystery to most agronomists as well as a foreign language to farmers. It is therefore not appropriate as a working tool for agronomists or extension workers (Murta 1995: 47). Nevertheless, although the soil manual is based on local soil categories and translates them into scientific descriptions, the principles behind local soil classification are not mentioned. The manual therefore remains a tool for one-way communication, i.e. scientific extension to the farmer. To base extension on existing environmental knowledge and resulting agricultural practice, these need to be translated, too. Understanding TEK and related agricultural practices can benefit agricultural development by providing an environmentally sound and culturally acceptable basis for technological change in agriculture (Sandor and Furbee 1996: 1502).

Although now several studies exist on local environmental classifications, little has been written on how these are influencing natural resource management, like enhancement of soil fertility, soil erosion and its control and conservation of soil/water in farming (Talawar 1996: 11). Other aspects, like the matching of differently demanding crops with soils of varying fertility, however, has already been noted by some authors (e.g. Hecht and Posey 1989, Adewole Osunade 1992, Bellon and Taylor 1993, Dialla 1993: 17).

While the importance of traditional knowledge for development is increasingly mentioned in the development literature, its possible role of for nature conservation has not yet found much recognition (Wells and Brandon 1992: 33). Several authors in the field of development and conservation mention the possible role of traditional knowledge in general or TEKMS in particular for protected area management (e.g. Marks 1991: 356, Johnson 1992: 12, Aumeeruddy 1994: 20, Pimbert and Pretty 1995: 30). The problem of its practical integration within conservation projects as well as the communication between development experts and local people have yet to find proper coverage.

Recent Research Activities in the Area

Research on TEKMS and local participation is carried out in several research institutions and universities in the region. Noteworthy, among others, is the Indonesian Resource Centre for Indigenous Knowledge (INRIK), located at Padjajaran University in Bandung, West Java. The Institute is part of a network of 37 indigenous knowledge resource centres in 27 countries worldwide. The network between these centres is facilitated by the Centre for International Research and Advisory Networks (CIRAN) in The Hague, The Netherlands. In Southeast Asia, two other centres in the Philippines are part of this network, one of which is part of the International Institute of Rural Reconstruction (IIRR) in Silang, Cavite. The main focus of INRIK’s research is on medicinal plants, the mapping of customary lands, and the study of traditional agriculture and related local techniques.

Within Indonesia, two international research centres, among others, are concerned with the topic. The first one is CIFOR, a policy and research organisation with activities in 38 countries, conducting socio-economic, policy and technical research on forest issues all over the world. One main focus of current research is local participation in sustainable forest management. In this context the research program "Local People, Devolution and Adaptive Co-Management of Forests" focuses on the development or identification of a set of models, institutional arrangements, methods, tools and strategies to enable local communities to achieve more sustainable and equitable management of forest resources and human well-being in a multi-stakeholder environment. This also includes the study of indigenous technical knowledge. The second international research institute, which like CIFOR is based in Bogor, West Java, is ICRAF, whose main focus is research on agroforestry systems worldwide. Research programs work, among others, on the evaluation of promising local agroforestry systems as well as the dissemination of a choice of management options for a range of shrub and tree species. Although trials and evaluation are undertaken in cooperation with the concerned farmers, the integration of TEKMS is not mentioned. Another research program is concerned with the identification of the driving forces of poverty and resource degradation and assessing the possibility of improvements through the integration of trees within the agroecosystem.

1.2 Methodology

The study is meant as a contribution to human ecology. Being an interdisciplinary field, this usually implies the use of several steps and different methodological approaches. The integrated approach applied here involves methods from botany, pedology and the social sciences. The elicitation of TEKMS belongs to sociology, where it can be considered a part of knowledge research. This study is a contribution for the documentation of local knowledge, which is likely to be transformed or lost in the course of future developments. The pedological and botanical analysis of the upland farming system employs a natural scientific approach and belongs under the rubric of ecosystem research. The investigation of local peoples' participation in park planning, establishment and management uses methods from participation analysis, which itself is an instrument of policy analysis. A solution for the conflicts of interest between local people and other stakeholders in nature conservation depends crucially on the ability of these parties to communicate with each other. Therefore the conclusions within the last chapter concerning the use of TEKMS finally are meant as an input for the disciplines of communication and planning.

1.2.1 Selection of Research Sites

The first step within this research was to select representative villages in the park border area. They needed to be comparable concerning their general environmental conditions and agricultural production patterns, but were distinct regarding their size, infrastructure linkage and access to services. The reason was that the environmental impact of land use patterns should be assessed in the context of the 'development' of an area, which generally implies the range of alternatives from which people can make choices.

Three villages have been selected, two of them in Jambi, one in West Sumatra province. Before the formal research, each village was visited briefly, at first, to decide whether it suits the general preconditions as a research site concerning main ecological conditions and land use, but most important, to consult with the villagers and the village head (*kepala desa*), to ask if they would agree if I stayed in their village for some time to study certain aspects of the environment, traditional knowledge and land use system. During these meetings I explained the objective of the research, what would happen to the information collected and the kind of research that would be carried out.

All investigated villages were situated in the eastern lower hill forest zone (following the altitudinal zonation of Laumonier 1994: 237) at about 300-350 m a.s.l. The agricultural pattern was similar, namely rice and rubber cultivation, partly supplemented by other tree crops like cassiavera. However, there were also clear differences concerning the agricultural, ecological and economic situations of the villages as well as their infrastructure. The first village, Pemunyian, is very isolated. The village has only been linked to the main road (Trans-Sumatra-Highway) by a logging road for 10 years. There is no public transport to the village, no market in or near the village and also other facilities are very limited. The farmers produce upland rice for subsistence and rubber for sale.

The second village, Dusun Birun, is located on the road leading from Bangko to Sungai Penuh. Public transport is frequent, a small market is held once a week in a village several kilometres away. The people own rainfed rice paddies and also rubber gardens. For several years, however, the main agricultural activities have been focused on the production of cassiavera. Therefore paddy rice production is neglected and rice for subsistence is either produced within the young cassiavera-plantations, or rice is bought, because the production of cassiavera is more profitable than the production of rice.

The third village, Lubuk Malako, is located in the District of Sangir, Regency Solok, Province West Sumatra. The Solok regency represents an administrative area of West Sumatra with a high population density and many villages bordering or reaching into the KSNP and therefore it is the territory where nature conservation is most difficult in that province (Radja 1994: 4) The District of Sangir is bordering the Kerinci - district of the province of Jambi. Regular public transport to the capital of the province (Padang) and to the capital of the Regency (Solok) exists daily. Once a week a market is held in the village. Basic public and private services are present, as well as several stores. Since early 1994 the village has been provided with electricity, which was not present in the other two villages. The farmers are cultivating irrigated wet rice and rubber. Starting in 1992 the rice fields have been irrigated by a government-sponsored technical irrigation system. The steady water supply allows two harvests per year; therefore there is no more upland rice production in Lubuk Malako since the technical irrigation system was built.

Concerning ecological factors, the main difference is related to the geological bedrock material. The village land of the first village is situated on acid volcanic and granitic rocks, the second village on metamorphic rocks and the third one on volcanic material (lowland) and metamorphic rocks (hill areas). The research area will be described more detailed in section 2.

1.2.2 Investigation of the Upland Farming System and Related Management Practices

The research at the village level consisted of several parts. As a framework to analyse human-environmental relations, the upland farming system of each research site was investigated. Traditional agricultural practices by the local population were studied through guided field walks on the one hand and elucidated through qualitative interrogations by using a standard questionnaire on the other hand. In accordance with the respective topic, open or closed questions were employed. In all three locations an opportunity sample of 36 to 40 respondents was used plus one specific interview of the village head about the general agricultural conditions of the village. The interviews were conducted in Indonesian and Minang. The number of interviews was not modified according to the number of inhabitants, because the major focus of the investigations was qualitative in nature. If I had aimed at covering a certain percentage of the inhabitants, the very different village sizes would have caused very small numbers of respondents in some villages and very large ones in another, leading to an incomparable database.

Leading questions concerning local land use and related practices have been:

1. How is the structure and composition of the agricultural landscape?
2. What do the people cultivate for subsistence and for cash income?
3. What kind of agricultural practices are applied?

Although the questions of the interviews had been pre-tested in one village before conducting the final interviews, several difficulties in questioning occurred. Concerning the impact of agriculture on the protected area, people were very reluctant to answer the question about how much land they already have opened in primary forest. The reason is, of course, that there already is a conflict between local people and the forest department concerning the opening of fields in forest lands. The people therefore were afraid of government sanctions, if openly admitting their conversion of primary forest. Besides, farmers would also not admit how much land they owned. Local people usually don't have formal land titles, but their land under cultivation nevertheless is subject to taxation. On questioning, the number and size of fallow lands and 'sleeping' rubber gardens therefore generally would not be mentioned. Another reason, however, also could be that immature or unused gardens would be more likely to be forgotten in an interview than actively producing gardens, as was found by Colfer *et al*. (1994: 15). Lacking the time for measuring every single field and garden, exact figures on land ownership and on forest conversion could not be obtained. The data on size of village land, land use distribution and average land ownership were obtained from village statistics. The data, however, seemed not always to reflect the real size of used land and actual land use distribution.

The farmers in the study area cultivate upland rice by means of shifting cultivation or irrigated rice, mainly for home consumption, but surpluses of paddy cultivation might also be sold. For cash income, rubber is grown, planted together with fruit trees and sometimes coffee in traditional mixed rubber gardens. Recently, cassiavera has been gaining importance as a marketable crop. The land use systems are described in detail in chapter 4. That section also is concerned with which plants are traditionally used from the primary forest, and which plants may not be used.

1.2.3 Botanical and Pedological Study of the Land Use System

In reference to the target of the study and the methodological framework, the next step was to investigate how these land use practices shape the natural environment. The questions that guided me were:

1. What is the structure and composition of the upland farming system?
2. How is the natural environment shaped by shifting cultivation?
3. What are the interactions between the different environmental factors of the upland farming system, in particular soils and vegetation?

The structure and composition of the traditional land use systems was assessed through guided field walks. The land use system is partly based on shifting cultivation, where major parts of the agricultural area consist of different fallow stages. Older rubber gardens are interspersed with secondary growth, and in accordance with their age also represent successional stages. Because the focus is on upland farming, within the study only the ecology of rubber gardens and the secondary vegetation were analysed. As a basis for understanding both the local environment as well as local people's environmental knowledge, rubber gardens and secondary vegetation as the major components of the land use systems have been studied botanically and pedologically. Within every village, botanical and pedological inventories have been made within 14 to 16 different vegetation types.

The different stages of vegetation succession have been identified and the change in species structure and composition with fallow development was shown. Also the pedological composition of the upland farming area as well as the variation of vegetation according to different soil types and soil physical and chemical properties were studied. Vegetation dynamics and soil development of the land use systems were investigated through common scientific methods. The botanical and pedological properties of the upland farming systems are discussed in chapter 5.

The age of the secondary vegetation usually was determined by key-informants as well as by general growth characteristics. Being based on the key informants' experience and practice, information seemed to be reliable. Some old fallows could be dated very exactly by relating the year of their cultivation with other major events, like a big drought during a certain year, or a road being built.

Also land use histories for the respective sites were obtained from local people. For some sites, brought under cultivation only recently, people remembered easily, whereas for long-cultivated sites this was somewhat difficult. The factor of different land use histories may be responsible for part of the differences between sites of similar age.

Site Selection

The course of succession was studied within secondary vegetation and rubber gardens in the eastern lowland border area of the Central Sumatran Kerinci-Seblat National Park. I attempted to sample vegetation of the same ages for secondary forests and traditional rubber gardens to be able to compare the impact of management on their structure, composition and biodiversity. A difference in inherent soil properties has to be excluded first, before different vegetation plots of different ages may be compared (Harcombe 1980: 10).

To assess the variation of secondary vegetation in accordance with its age as well as soil types, sample areas were selected accordingly. For secondary vegetation, sites were chosen aged 1, 2, 3, 5, 7, 10 and 15 or 20 years, the latter depending on availability. For being able to assess the impact of soil type differences on vegetation structure and composition, I attempted to sample complete vegetation series on all soil types available.

In general, unmanaged secondary vegetation older than 20 years was seldom found, because vegetation of that age was usually cut down again for making upland fields. The rarity of old secondary forest is common in all of Sumatra (Laumonier 1997: 8). The oldest unmanaged secondary forest found was a 42-year old site in Dusun Birun. Older vegetation studied was all old rubber gardens. To assess further the course of succession in old secondary vegetation, inventories were also made in rubber gardens, which reached ages of 50 years and more. Young rubber gardens were generally cleared regularly, so only a few cases were investigated for comparing disturbed with undisturbed succession.

Vegetation age was determined through information about the cultivation history of the respective sites. Because shifting cultivation is carried out in groups of several families per area, times of the last cultivation are generally remembered well. For plots older than ten years, the age was estimated. In some cases, the exact age could be determined, however, because people remembered certain occasions which occurred the year the area was cultivated.

Botanical Inventory Method

For the botanical inventory, different methods have been employed in accordance with the age of the vegetation. In secondary regrowth and rubber gardens aged ten years and older, rectangular plots have been made, employing different sizes based on the height and diameter of the vegetation of each age as well as on the number of plant individuals per sample area.

In these sample quadrates made in a homogeneous representative part of the vegetation (*sensu* Mueller-Dombois and Ellenberg 1974: 38), all trees above 10 cm DBH were measured in diameter and height. Due to the relatively small size of the different vegetation units, i.e. rubber gardens and former upland fields, one sample plot per vegetation type was considered sufficient. In ten small quadrates within, totalling 20 % of each plot, all plants between 1 cm and 10 cm DBH were listed (trees, shrubs, ferns, grasses, lianas, palms, but no epiphytes). The same was done for vegetation below 1 cm DBH for 10 % of the whole plot.

For vegetation of 20 years and older, plot size was 1,000 m², a size also employed for the analysis of old-growth tropical complex agroforestry systems by other authors (e.g. Küchler & Zonneveld 1988: 56, Gouyon *et al*. 1993: 187). Due to smaller tree size and higher numbers of trees per area, for 10 and 15 year old vegetation, a plot size of 200 m² and 400 m², respectively, was considered sufficient.

Young fallow plant communities up to the age of about 7 years consist of very dense vegetation with a high number of stems per area. Making vegetation plots where every single tree is recorded and measured therefore is a rather difficult endeavour without destroying the vegetation to be sampled. For that reason, no vegetation plots were made. Instead I used transects of ten to 70 meter length, depending on vegetation age. Along these transects, all occurring species were recorded one meter to the right and one to the left. Of each plant recorded, the respective cover percentages were assessed (*sensu* Braun-Blanquet). The Braun-Blanquet method combines estimation of cover (dominance) and abundance (Kreeb 1983: 61). In the lowest degree abundance plays a role and in the highest cover is the only criterion (Küchler & Zonneveld 1988: 55). By this approach the relative role each species plays within the economy of the stand is investigated (de Rouw 1991: 164). Although the application of phytosociological methods in tropical rain forests has proved to be difficult, they can be applied successfully in less complex and more restricted environments, like secondary forests. There it is much easier to recognise associations (Laumonier 1997: 7 pp.).

Soil Inventory Method

To assess the relationship between soil conditions and vegetation as well as to compare the former with indigenous soil classifications soil samples were also taken within each vegetation plot. Concerning the first aim, the author wanted to investigate possible differences between soils under vegetation of different age and vice versa, to find out, if the vegetation on different soils was distinct concerning composition, vitality and biodiversity. By this, one could also eventually observe if the soils at reportedly frequently used locations were different to those reportedly only used once or a few times since the plots were opened from primary forest. These results were to be compared with local soil classifications, which were applied in selecting sites for vegetation plots.

For an *in situ* ecological evaluation of the soil a 1 m long auger was used and a field manual[7] employed, site environmental factors were assessed, as well as the horizonation of the soil and the characteristics of these. The soil physical factors appraised include texture, structure, moisture, intensity of rooting, bulk density, potential rooting space, pore volume, air capacity, usable field capacity and permeability. Soil colour was determined through a Mansell soil colour chart. The USDA soil taxonomy (Soil Survey Staff 1997) served as key for the nomenclature.

For texture and chemical analyses topsoil samples were collected from a depth of about 0-15 cm; in accordance with the depth of the A-horizon. The samples were air-dried, ground and sieved for subsequent analyses. The following chemical properties were evaluated by laboratory

[7] Compiled by the Institute of Ecology, Branch for Regional Soil Science, of the Technical University of Berlin, following the FAO system (1974) and the Bodenkundliche Kartieranleitung (1982).

investigations: organic matter: nitrogen and carbon, reserve phosphate and -potassium, plant-available phosphate, exchangeable cations: calcium, magnesium, potassium, sodium, sulphur, effective cation exchange capacity of the soil and base saturation, soil acidity: exchangeable aluminium and pH methods (see annex 1 for the detailed soil scientific methodology).

1.2.4 Survey on Traditional Ecological Knowledge

The terms traditional knowledge, indigenous knowledge, folk knowledge, rural knowledge and ethnoscience have been used interchangeably to describe the knowledge system of an ethnic rural group that has originated locally and naturally. This knowledge, derived from the direct interactions between humans and the environment, has many dimensions, like knowledge concerning botany, zoology, linguistics, craft skills and agriculture. Its successful adaptations are preserved and passed from generation to generation through oral or experimental means (Altieri 1990: 553).

Within this study, local pedological and botanical knowledge was documented. Knowledge on other aspects of the environment is probably present, but has not been investigated in the frame of this study. Knowledge on animals like insects, birds, mammals and fish would be one part of TEK omitted here, as well as astronomical and climatical knowledge. The West Javanese Baduy tribe, for example, has been found to adjust their agricultural calendar to the movement of the stars. When the Orion belt occurs in the sky, they will open their new upland fields in the secondary vegetation, and when the Pleiades can be observed, they will plant their rice (Iskandar 1994: 30).

To understand the rationality of local land use practices, it was important not only to investigate the physical aspects of the agricultural system, but also people's way of seeing their natural environment. These considerations are very relevant in agricultural development endeavours. If local soil categories, for example, could be translated into scientific categories, states Sikana (1993: 15), it would be easier for researchers and extensionists to communicate with farmers.

Following these considerations, the research approach was based on three major questions:

1. What kind of considerations do people take concerning their agricultural endeavours?

2. How do people name and classify environmental features?

3. What concepts do people have about nature, environmental problems and nature conservation?

Traditional agricultural practices and knowledge about the environment as well as local peoples' views of environmental problems (i.e. how they perceive their environment and the influence of their own land use practices) was captured by qualitative questioning. The initial reference frame for gathering and organizing traditional ecological knowledge is taxonomic. To study traditional knowledge about local plant species, one must first become familiar with their local names

(Johannes 1993: 34). First, to analyse the knowledge of the indigenous population concerning their environment, and the behaviour resulting from this knowledge, structured interviews were carried out. Second, the correspondence between ecological folk taxonomies and those of science was investigated during field-walks together with key informants in the frame of the botanical and pedological studies.

Knowledge about plants and their uses as well as about the places these plants generally are growing was investigated. It was also checked if the people distinguish different soil types abundant in the village land of the respective village. If this was the case, they were asked further, if they know if certain crops, especially rice, grow differently on these soil types and/or in different geomorphological conditions. Traditional ecological knowledge and its relatedness to scientific approaches are discussed in chapter 6.

1.2.5 Involvement of Local People in Park Establishment and Protection

Because the purpose of this study is to provide the preconditions for better communication and understanding between local people and other stakeholders wanting to establish and maintain a conservation area, the next step within this study was to find out about the role of primary forests for the villagers, the current pattern of utilization as well as conflicts resulting from park establishment. The leading questions within this approach were:

1. How do people see primary forest (e.g. mystically)?
2. Who has - in the eyes of the people - rights to the forest?
3. How were the villagers informed about the creation of the national park?
4. What was the local peoples' reaction towards the creation of the national park?
5. How do local people participate in park planning, establishment and management?

The relationship between the people and the forest was assessed through structured interviews as part of the standardized questionnaire mentioned before. The questions included some about old stories and fairy tales about the forest or forest plants, which gives us conclusions about local peoples' perceptions of forests in general. An assessment of traditional utilization patterns and customary user rights was also done. The level and quality of participation of the indigenous population in KSNP planning, establishment and management were both obtained through questioning within the questionnaire in the three main study villages and through group discussions in several other villages bordering the park. The results from both approaches provide information about the peoples' view of the conservation area in general as well as possible conflicts of interest between their claims on agricultural land and the national goal of rainforest protection. People's perceptions of primary forest are discussed in section 3.2, whereas people-park interactions are tackled in section 3.3.

1.2.6 Synthesis

Through investigating the rationale of the local people for their agricultural practices we already have gained important information for the reasons why people apply certain practices, cultivate certain crops and do it in the way they do. This knowledge supplements an appreciation of the local peoples' perception towards forest. Therefore we already not only know the impact of the land use system on the environment, but we already understand the logical basis for the farmers' agricultural endeavours and their environmental worldview. In answering the questions mentioned above, the major precondition for more effective communication with the inhabitants of parks and their boundary area is given. This precondition enables us to proceed into an exchange with them about certain environmental features, including nature conservation.

Although TEKMS are a very important factor when it comes to national parks, the behaviour of the local people has to be discussed in a broader context. Many problems have their origin not only in local problems but stem from general conditions concerning national park management and the concept of nature protection. Therefore, also these points have to be discussed to make the answer of the final questions possible:

1. What causes people not to respect national park borders?

2. How can the conflicts between nature conservation and local people be overcome?

3. How can nature conservation and traditional land use be integrated in a way that serves both?

These questions will be discussed in the final part, chapter 7. Problems of nature conservation include more than the conflicts between local people and conservationists. The stakeholder analysis of section 3.2 provided an overview of the various interests involved in the case of the KSNP. This study cannot provide a solution for stakeholder conflicts in nature conservation in general. What is attempted here, is to suggest TEKMS as an instrument enabling, or at least easing, communications between local people and stakeholders in nature conservation.

2. The Eastern Lowland Fringe of the Kerinci-Seblat National Park (KSNP)

2.1 The Physical Environment

The Kerinci-Seblat National Park (KSNP) extends over 1,368,000 ha and represents the largest continuous area of undisturbed primary forest in Sumatra. Stretching along the volcanic Barisan mountain chain, it is located between 100°31’8’’EL to 102°44’1’’ EL and 1°7’13’’ SW to 3°26’14’’ SW, stretching nearly 350 km from south to north (figure 1). At its maximum width of about 70 km, it surrounds the densely populated mountain valley enclave, which is part of the central rift valley of the Barisan range. The enclave extends to 70 km length and 25 km width, lying at an altitude between 900 m and 1300 m a.s.l. The Kerinci valley consists of alluvial plains, harbouring also the 41 km^2 big and 110m deep Lake Kerinci. In the south the park is divided from the Lebong-valley in Bengkulu by the volcanic bar around Mt. Sumbing (2507 m) and Mt. Masurai (2935 m) and at its northern end from the lateral valley around Muara Labuh by Mount Kerinci. The park also contains more than twenty unique wetland areas, including volcanic lakes and peat swamp forests.

The KSNP is located within four administrative provinces, Jambi, West Sumatra, South Sumatra and Bengkulu. The largest portion, or 40% of the protected area, is located in Jambi province, whereas West Sumatra accounts for 25%, Bengkulu for 21% and South Sumatra for 14% of the park area, covering a total of nine regencies and 36 sub-districts (BPN 1993: 2, World Bank 1994: 6). The research region was located along the eastern lowland border of the KSNP, in the provinces of Jambi and West Sumatra. This is the foothill zone of the Barisan mountain range, having an altitude around 350 m a.s.l.

2.1.1 Geology

The Barisan mountain chain is a part of the great volcanic belt, belonging to the extensive Sunda-orogen, stretching arc-like from Burma over the Andaman Islands, Sumatra and Java to the Lesser Sunda Islands. This orogen, which results from arching and folding processes from the tertiary until today covers about one third of Sumatra.

The area subject to orogenetic processes creating the Sunda-mountain chain, however, had already been folded during the Carbon, and subsequently eroded again. These previous folding structures led to the development of various rifts, faults and breaks during the arching and folding processes (van Bemmelen 1949: 704 pp.). The most prominent break, the Semangka-graben, cuts across the whole mountain range from the northern to the southern tip of the island, dividing it into a western and an eastern half. While the graben was sagging, several volcanoes started to build up on both sides of the break and within it. Several of them still are active today, one of them within the national park (Mt. Kerinci, 3804 m). Additionally, several hot water springs can be found in the whole Kerinci-Seblat area as an indicator of volcanic activity.

Lateral faults and volcanic bars divide the Semangka-graben into several sections. The bottom of these lengthwise valleys now is covered with recent alluvial and colluvial material. The deepest part of some valley bottoms have become lakes, like the Kerinci Lake in the KSNP upland enclave around the town Sungai Penuh.

The western half of the Barisan range rises steeply from the coastal strip up to heights of 1500-2000 m a.s.l., forming the major watershed of Sumatra. The Eastern Barisan is characterized by lower and less precipitous mountains, sloping down gently to the western peneplains. The peneplains, forming the central strip of the island, geologically represent the geosyncline between the arc-like Sunda mountain chain and the Sunda-massive, which surfaces in the east of Sumatra with the Riau-archipelago, Bangka island and the Malay peninsula. This geosyncline filled with sediments of up to 1,000 m during the tertiary.

2.1.2 Topography

The KSNP is located at altitudes from 10 m to more than 1000 m above sea level. It contains several major peaks: Mt. Kerinci, an active volcano and one of the highest mountains of Indonesia (3,804 m), Mt. Pantaicermin (2,690 m), Mt. Tujuh (2,604 m), Mt Terembung (2,577 m), Mt. Rasam (2,566 m), Mt. Boleng (2,560 m) and Mt. Raya (2,543 m). East of the Barisan mountain chain the landscape slopes gently to the inland plains, while in the west the slopes down to the coast are quite steep.

Morphological processes typical for the humid tropics have formed the relief of the national park. The deeply weathered soils and high precipitation make erosion serious and landslides common. As a result, the relief is characterized by steep slopes and relatively flat valley bottoms, forming the typical ‘rolling hills’ in the lowlands and hill zones.

According to the RePPProT land systems classification, about 86% of the park belongs to the category mountainous system and only 14% or 137,000 ha are lowland hill or plains systems. There is very little level to undulating land (only 6.1% in Jambi) and much land characterized by steep to very steep slopes. 47.26% of the area in Jambi province has an inclination from 15 to 40 %, whereas 45.79% has an inclination of more than 40% (BPN 1993: 12, World Bank 1994: 6). This feature in combination with the shallowness of the topsoils and the rain regime makes the territory very sensitive towards erosion and adds to the importance of the maintenance of a permanent forest cover.

2.1.3 Climate

The climate of the island of Sumatra is humid tropical, being classified as 'Af' in accordance with the Köppen classification. In the lowlands, the annual average temperatures are 26-27° C. Daily maximums range from 30° C to 36° C, whereas daily minima are around 22° C. Typically for the inner tropics, the annual temperature range is much lower than the daily one, the former being only about 2° C. Every 100 m increase in altitude corresponds with an approximately 0.6°C decrease in temperature.

According to rainfall data from the years 1980 to 1990, the research area (regencies Sarolangun-Bangko, Bungo Tebo and Sangir) has an annual precipitation rate of almost 3,000 mm. The major rainy season lasts from October to May, whereas a relative dry season occurs from June to August. Nevertheless, all months still receive 130 to 180 mm rainfall. It rains frequently, and 20- to 50-mm rainstorms are common (Arya *et al*. 1992: 9). This means that the balance between precipitation and evapotranspiration is positive during the whole year, a decisive limit for crop cultivation. A monthly rainfall of 200 mm during the growing season is the minimum for unirrigated rice cultivation.

2.1.4 Soils

Resulting from year-round high temperatures and precipitation, the majority of the Sumatran lowland soils are highly weathered and leached. Low cation-exchange-capacities and high soil acidity coupled with shallow topsoils are a general feature of these soils. Only in areas with volcanic ash or alluvial deposits are soils of higher fertility. With increasing altitude, the weathering of soil minerals is slower due to decreasing temperature, leading to general higher soil fertility.

The dominant soil types of the eastern piedmonts of the park are highly weathered and leached red-yellow podsolic soils in the very lowland, followed by latosols of dark red colour in the hill zone. The typical soils on lower mountain slopes and valleys are young andosols and alluvial deposits suitable for agricultural production (UNDP/FAO 1981:7p, World Bank 1994: 6). Most of the soils in the lower areas of the KSNP are fine textured, well drained and highly weathered (BPN 1993: 14). Along the Bangko-Sungai Penuh road, starting near the research location Dusun Birun, volcanic tuffs occur, being highly unstable and susceptible to erosion (Laumonier 1994: 239). In the tropical lowlands, where all other soil-forming factors are relatively constant, differences between soils relate directly to parent material (Bartolome 1984: 178).

2.1.5 Vegetation

The Kerinci-Seblat area represents the biggest continuous rainforest area in southern Sumatra. In the reserve, an estimated amount of 4,000 plant species are found, some of which are very rare. Because of the great variety of altitudes present in the KSNP, it contains all primary evergreen moist forest types from evergreen lowland forest over mountain rain forest up to alpine flora (table 1). However, evergreen lowland forest below an altitude of 300 m is only represented within small areas of the park. This is regrettable, because lowland forest generally contains the highest biodiversity and primary lowland forest is also vanishing most quickly due to the impact of logging concessions and settlers. In areas where the forest has been cleared by farmers, secondary growth containing typical pioneer species like *Macaranga* and *Ficus* dominate the vegetation.

Table 1: Characteristics of the Kerinci-Seblat National Park forest formations

	Lowland Forest	***Lower Montane Forest***	***Upper Montane Forest***
Altitude	0 - 1000 m	1000 - 1500 m	> 1500 m
Location	Rawas Hulu Lakitan Along park boundaries	Higher slopes of the Barisan	Summits of the Barisan
Dominant tree families	Dipterocarpaceae Leguminosae	Dipterocarpaceae (< 1200 m) Lauraceae Myrtaceae	Lauraceae Fagaceae Ericaceae (alpine)
Characteristic tree species	Shorea parvifolia DIPT Parashorea sp. DIPT Dipterocarpus sp. DIPT Dialium sp. LEG Koompassia malaccensis LEG Garcinia sp. GUTT Durio zibethinus BOMB Bombax valetonii BOMB Terminalia copelandii COMB Octomeles sumatrana DAT	Hopea sp. Shorea platyclados DIPT Rhodamnia cinera MYRT Litsea LAUR Bacaurea EUPH Intsia bijuga LEG Pinus mercusii PIN	Cinnamomum parthenoxylon LAUR Quercus sp. FAGA Castanopsis sp. FAGA Podocarpus amarus PODO Ficus variegata MORA
Shrub and herb layer	Amorphophallus titanum ARA Arenga sp. ARECA Calamus manan ARECA Daemonorops sp. ARECA Korthalsia sp. ARECA	Areca catechu ARECA Livistonia altissima ARECA Asplenium sp. ASPL Bulbophyllum sp. ORCH Dendrobium sp. ORCH Eria sp. ORCH Pholidota sp. Lycopodium sp. LYC Colocasia ARA Nepenthes sp. NEP	Viburnum sp. CAPRI Hydrangea oblongifolia SAX Plantago sp. PLANT

Source: UNDP/FAO 1981: 11.

2.1.6 Animal Life

The park is habitat to 180 bird species including 39 endemic species, 144 mammals, seven of which are known only to occur in the park, 10 reptile species and 6 primates. Rare animals include the Sumatran tiger, the clouded leopard, the largest remaining population of the Sumatran rhino, the forest goat, the wild dog and the Asian elephant. The KSNP is one of the four habitats of the Sumatran rhino where breeding still is reported, besides The Gunung Leuser National Park (GLNP) in north Sumatra, Endau Romping in West Malaysia and southern Sabah. Other typical mammals, some of which only occur in the KSNP are the tapir, the western tarsier, the slow loris, two species of langur, the endemic Sumatran hare, the lesser Malay chevrotain, the barking deer and the sambar deer, the pencil-tailed tree shrew, the bamboo rat, three species of porcupine, the hog-nosed badger, the common otter, the common palm civet, the bearcat, the Javan mongoose, the marbled cat, the flat headed cat, the Malayan sunbear and primates like the dark-handed-gibbon, the Siamang, the banded leaf monkey, the long-tailed macaque and the pig-tailed-macaque. A common species of the park is the wild pig, which frequently disturbs fields close to the protected area (UNDP/FAO 1981, Appendix II). The bird population includes four eagle species; the Salvadori's pheasant, being endemic to Sumatra; six kingfisher species inhabiting the numerous rivers and streams of the park, five hornbill species, living in undisturbed forest with many fruit trees; the specklet piculet, a small rare woodpecker; nine bulbul species, the rare Asian fairy bluebird and the rare green magpie. The alpine shrubs of Mt. Kerinci host white-eyes, flowerpeckers and sunbirds; whereas the Bento swamps are inhabited by the common snipe, the plumed egret and the common moorhen. Other well-represented bird families include cuckoos, pigeons, babblers, flycatchers and warblers (UNDP/FAO 1981: 15 p.).

2.2 The Socio-Economic Environment

2.2.1 History

Settlement and Migration

Palaeoecological studies in Central Sumatra have found proof for forest disturbance through human activity since at least 4000 years (Morley 1982: 155). Furthermore, archaeological traces from the neolithic period have been found in that area, too (Schnitger 1989[1]). Sumatra's inhabitants are supposed to have first set foot on Sumatra in the Mesolithicum, coming from central Southeast Asia via the Malacca Straits. They entered the island from the east coast, moving inland on the main rivers like the Musi and the Batang Hari. Two major tributaries of the Batang Hari are the Batang

1 As cited in Aumeeruddy 1994: 7.

Merangin, originating from the Kerinci Lake and the Batang Sangir, having its source near Mt. Kerinci.

Because of the fertile volcanic soils and other favourable ecological conditions, the lengthwise sections of the Semangka-graben, including the Kerinci-valley, have been settled early and belong to the areas with the highest population densities in Sumatra. Over time, the Kerinci valley and its surrounding areas have been populated by several waves of migrants from adjacent areas. This resulted in a heterogeneous social organisation, being influenced by the matrilineal culture of the Minangkabau as well as from the more bilateral system of the Jambi people. As a development of the various cultural heritages, the inhabitants employ their own traditional law (*hukum adat*) connected to various realms of social life (Watson 1984, 1991[2]). Being less favourable for agriculture, the lowland areas have been only sparsely settled for a long time. Settlement at the lower mountain areas outside of the main valleys of the Semangka-graben increased in the 14th and 15th centuries, when due to increasing population pressure within these valleys people started to migrate from their cultural centres. During this process, also the lateral valleys along major and smaller rivers flowing down to the eastern lowlands became one of the main targets of these settlers. Besides the few villages on alluvial soils along the larger rivers, the peneplains have only been settled recently. Only when rubber as an economic tree crop entered Sumatra did agriculture become profitable in these areas. However, settlements are still always located near rivers, with the agriculturally used areas stretching to the hinterlands. The latter feature is common to many shifting cultivating societies in the humid tropics (Dove 1986: 8).

Political History

The area of Kerinci-Seblat was included in the Sugindo kingdom from the 9th to the 13th century. However, after Islam entered Sumatra in the early 14th century, the region became part of the kingdom of Jambi until the beginning of the 20th century.

Minangkabau people settled the Sangir regency in the 14th century AD, when in the time of the Pagaruyung Kingdom (1345-1375) two local leaders, called *datuk* (Dt. Ketumanggunan and Dt. Parpatih nan Sebatang) did not agree with the government. They moved with their followers from Pariangan and Padang Panjang among others into the Solok regency. Also people from Batu Sangkar migrated eastwards up to the Sangir area (Radja 1994: 63 p.).

Dutch colonial rule started to enter Central Sumatra only after the Dutch government took over the territory belonging to the Dutch East India Company, which went bankrupt in 1799. After the Dutch settled their territorial disputes with the British between 1814 and 1824, which had claimed the area

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2 As cited in Aumeeruddy 1994: 7.

of today's Bengkulu Province, they started to extend their sphere of influence from the former trading posts into the interior of Sumatra. While they started to enter the central part of the Minangkabau kingdom already in 1819, the more remote areas were reached much later. The Kerinci enclave, for instance, surrendered and submitted themselves to Dutch administrative rule only in 1903 after heavy fights against a Dutch military expedition sent to the territory. The impacts of the colonial rule brought about decisive changes in the local economies, especially due to the introduction of money, economic tree crops, and the accelerated flow of goods and information through the construction of roads. Dutch colonial rule ended with Indonesian independence in 1945.

2.2.2 Political and Administrative Framework

Two institutional systems are present within the villages surrounding the park: traditional institutions and, government established institutions. Traditional institutions (*lembaga adat*) feature their own traditional customary laws (*hukum adat*) and are headed by customary leaders who also have judiciary functions. The authority of traditional institutions varies from village to village, depending on the ethnic setting and the history of external influences. Their functions range from setting and enforcing social rules, organising collective action to natural resource management (Werner 1998: 12). Natural resource management may include the determination of the planting season, demarcating protected areas like watersheds, regulating the cultivation of new land as well as determining the preconditions required for opening primary forest. The more remote villages are and the stronger the influence of Minangkabau customs, the stronger are customary institutions and customary rule, especially as related to natural resource management. Customary law in lowland villages along major roads in Jambi, far from the Minangkabau heartland, on the other hand, mainly focuses on social regulations.

Government established institutions include the Village Defence Council (*Lembaga Ketahanan Masyarakat Desa*, LKMD) and the Village Development Council and Consultation Forum (*Lembaga Masyarakat Desa*, LMD), which takes decisions on development activities at the village level and is the officially recognised forum for village consultation. The governance groups, LKMD and LMD, closely cooperate in village planning. After the LKMD has set up the village development plan for the following year, the LMD ratifies this plan or decides upon changes (Werner 1998: 41). In areas with strong customary institutions there exists close cooperation between the informal, traditional and the formal, government-sponsored groups in village level planning and project execution. Village government officials also usually stem from the ranks of traditional leadership in the study area.

2.2.3 Infrastructure

Roads and Transportation System

The major road system of Sumatra was built by the Dutch colonial administration. Between 1848 and 1862 the road system in the central highlands of Sumatra was constructed, linking former isolated areas to the trading ports at the coast. Between 1913 and 1921 the Kerinci enclave was connected to the port of Padang through the building of a road along the west coast via Tapan (UNDP/FAO 1981: 4 p.). Another road between Sungai Penuh and Padang along the central rift valley via Kayu Aro has been built between 1977 and 1982. The construction of the Trans-Sumatra-Highway from Tanjungkarang via Lubuk Linggau and Muara Bungo to Medan in the early 80s very much contributed to the improvement of the north-south transportation system.

Most of the streets linking the villages surrounding the KSNP are not asphalted yet. Several villages are also not connected with roads but with rivers or footpaths. Only 15 out of 50 sample villages surrounding the park are served by public buses, another three make use of horse-drawn carts as a means of transportation, while five villages employ motorboats (BPN 1993: 7).

The road infrastructure of the villages in the research area varies. Whereas Lubuk Malakko and Dusun Birun have asphalted roads that are frequented by public transportation, Pemunyian does not. Because Dusun Birun is located at the road linking the district capital of Sarolangun-Bangko to the enclave around Sungai Penuh, the village is passed by several busses per day operating between both cities as well as the smaller towns in between. Lubuk Malakko is not located at a thoroughfare, but is itself the destination of one daily bus each from the district capital Solok and the provincial capital, Padang. Compared to these places, linked relatively well to the road network, infrastructure development in and around Pemunyian is very poor. The only road connecting the village to the outer world is a logging road, which was built in the year 1983, when the logging concession PT. Mugitriman entered that area. However, there is no means of public transportation from the main road, the Trans-Sumatra-Highway, to the village (about 40 km). There is only one villager who owns a small motorbike. Therefore it is quite difficult for the villagers to reach the local market and to receive services and information.

Health Care Facilities

Medical service is not available in most of the villages surrounding the KSNP. In 50 villages surveyed by the BPN (1993: 6) in Jambi, only one Community Health Centre (*Puskesmas, Pusat Kesehatan Masyarakat*), three Medical Clinics (*Puskesmas Pembantu*[3]) and twenty Integrated

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3 Whereas Community Health Centres (*Puskesmas*) are always staffed with doctors, Medical Clinics (*Puskesmas Pembantu*) are only staffed with nurses and are guided by the Community Health Centre

Health Service Centres (*Posyandu, Pos Pelayanan Terpadu*) were present. The medical team in the 50 villages altogether consisted of four doctors, one midwife and nine medical assistants. 32 of the 50 villages had no medical facilities or medical staff. Therefore village health care is mainly obtained through traditional medication by indigenous medical practitioners or shamans (*dukun*). In Sangir sub-district, health care facilities are more frequent. Four Community Health Centres, 12 Pusat Kesehatan Inpres and 97 Integrated Health Service Centres were present (Kabupaten Solok Dalam Angka 1992[4]).

This general picture is also representative for the research area. Both in Dusun Birun and Pemunyian there are no permanent health care facilities. In addition to traditional healers (*dukun, dukun anak*), Dusun Birun has a midwife. The next *Puskesmas*, however, is located 5 km from the village, whereas it is 40 km for Pemunyian. There is no medical service entering the village, and to call a doctor into the village is very expensive. In Lubuk Malakko, the health care situation is better, representing the more developed Sangir sub-district. Six days a week, a nurse is present in the local Medical Clinic to provide the local community with basic medical services.

Education

Educational facilities in the villages bordering the KSNP generally do not exceed primary education. Therefore the majority of the inhabitants have either attended primary school for less than the mandatory duration of six years or they have left school after the end of the primary education. There are, however, only a small percentage of illiterate persons. As a tendency, the education of the children is higher then that of their parents (BPN 1993: 5, Radja 1994: 67 p.).

In the villages of the research area, each village was equipped with a primary school, but for higher education children had to travel to other villages. In Lubuk Malakko and Dusun Birun, the nearest junior high school is located about five kilometres away, whereas for Pemunyian it is 40 km. In Pemunyian 187 inhabitants are illiterate according to village statistics. But in fact, many more people are almost illiterate. Education still is difficult in this village, which has had its own primary school since 1977. Although officially six teachers are employed for the primary school, often none of them is present to teach the pupils. During my stay of almost 3 weeks, the only teacher I met was the teacher for religion, who arrived one day before my departure.

At that time, there had been no teacher at the village school for two months. The reason for this unfortunate situation is, that the families of the teachers live outside of Pemunyian. There is also no

nearby. Integrated Health Service Centres (*Posyandu, Pos Pelayanan Terpadu*) are more focussed on health counselling and have no permanent medical staff.

4 As cited in Radja *et al*. 1994: 59.

public transportation into the village, so access is difficult for everybody. Low wages furthermore lower the motivation of the teachers, who partly might also be dependent on extra income. The teachers also have to travel to the district capital to receive their wages.

As a result, a majority of the young generation speaks no or only very bad Indonesian. The adults only speak Indonesian, if they have been away working (*merantau*). This means, that only part of the male population speaks Indonesian, because women are rarely migrant workers. In practice, this has very negative impact for the further development of the village: the residents cannot communicate with government officials or extension workers, making development programmes difficult.

Education is more advanced in both other villages. In Dusun Birun as well as in Lubuk Malakko, several respondents already had junior or even senior high school degrees, and the number of people who did not finish primary school was also lower.

Other Infrastructural Facilities

In most of the remote villages in the KSNP border area (like Dusun Birun and Pemunyian), other infrastructural facilities like clean water and electricity are not available yet. Less remote settlements are successively connected to the power supply system (like Lubuk Malakko, which was connected in 1994). Traditionally, villages in the lowland and hill zone in the outer boundary area are located along rivers, which serve as supply for potable water, as well as a place for laundry, personal hygiene and toilet. Due to increasing population density water quality decreases and diseases spread easily. Biological decomposition processes are not sufficient anymore for cleaning the water flowing from one village to the next. Therefore a clean water supply is a high priority for the villagers.

2.2.4 Population

Sumatra is inhabited by 36.5 million people, 80 % of whom live in rural areas. The average population density of Sumatra was 77 inhabitants/km^2 in 1990[5], whereas fertile, long settled paddy areas are inhabited by as many as 200, maximal 500, inhabitants per km^2. Population density in West Sumatra is 80 persons/km^2, whereas in Jambi an average square kilometre is only settled by 45 persons (Stat. Bundesamt 1994: 30). The Sangir sub-district of West Sumatra, however, where the study village Lubuk Malakko is located has an average population density of only 29 people per km^2 (Radja *et al.* 1994: 41).

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[5] The average population density for the whole country was 93.5 people/km^2 in 1990 and 99.5 people/km^2 in 1993.

Figure 3: Kerinci Seblat National Park boundary villages

Source: WWF 1996c and Simplex 1990

Between 1990 and 1995 population growth in the provinces covering the KSNP was 3.19% in Jambi, 2.57 % in South Sumatra, 3.67 % in Bengkulu, and 0.91 % in West Sumatra[6]. The population of the regencies covering the park is approximately 3.3 million, whereas the 36 sub-districts bordering the park are inhabited by approximately 1.64 million people. The population density in boundary villages ranges from 9 to 146 people per km^2. Some of the 468 villages share common boundaries with the park, containing 50 to 300 households (250 to 1,500 inhabitants).

The Kerinci valley today contains a population of about 300,000 inhabitants, representing the area with the largest population density in the immediate vicinity of the park besides Lubuk Linggau and Curup in the South of the park. Population growth in the areas surroundings the park is lowest in West Sumatra with 1.6 %, due to a long tradition of male labour migration. Within the Kerinci regency annual population increase accounts for 2.2 %, and in the other districts of Jambi province bordering the KSNP about 3 % (between 1971 and 1988) whereas the highest average increase in population is in Bengkulu with 4.4 % per year due to spontaneous in-migration and government-sponsored transmigration of poor farmers from the densely settled Java (Kerinci Dalam Angka 1988, BNP 1993: 4, World Bank 1994: 7). Because of the lack of cultivable land, many young people look for work elsewhere, however, there also still is in-migration of poor farmers from West Sumatra, Jambi, South Sumatra and Java seeking employment as share croppers or farm workers.

Of the three study villages, the smallest was Dusun Birun, having a population of only 421 people, being divided among 92 families and 63 houses. Second comes the village of Pemunyian with 815 inhabitants, belonging to 185 families and living in 126 houses. The largest village is Lubuk Malakko, having a total of 4,287 inhabitants, 784 families and 757 houses. Among the families questioned, the average family size in the research area was 4.9 for Pemunyian, 5.2 for Dusun Birun and 5.5 for Lubuk Malakko. Although this feature has not been studied in depth, it is nevertheless worth noting, that the average family size increases from the poorest village to the richest, from the most isolated to the most developed one (including the availability of health facilities). In Lubuk Malakko, as the richest village, most families live in nuclear families, whereas in both other villages an average of 1.5 families share one house. This means, two out of three families occupy their house together with another family, mainly with a close kinship relationship (i.e. extended family).

Society and Local Cultural Development

The area surrounding the park is settled by several ethnic groups, like the Minangkabau in West Sumatra, the Rejang in Bengkulu and South Sumatra, the Ipuh in northern Bengkulu, the Malays as

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6 Due to a long tradition of out-migration (*merantau*), West Sumatra has unusually low population growth figures. Population growth figures in the other provinces also include considerable in-migration due to government -sponsored transmigration projects, moving landless and other poor farmers from Java.

well as in-migrated Minangkabau in Jambi and the Kerinci people in the Kerinci regency of the Jambi province. Javanese immigrants have settled in boundary villages of Jambi and Bengkulu.

Initially settled by various ethnic groups, the people of the enclave developed their own cultural identity over times, calling themselves *orang kerinci*, people of Kerinci. The inhabitants of the study villages in the lowland border area of the KSNP, however, still trace themselves back to the communities the first settlers came from. Although the exact age of these villages is difficult to tell, this feature seems to indicate that they must be younger than the settlements in the enclave.

Lubuk Malakko, being the biggest settlement and the only one located in West Sumatra Province, is clearly settled by Minangkabau people only. The ancestors of the inhabitants came from the Minangkabau heartlands at Pagaruyung. Minangkabau culture already has been noted and described by various authors, to some extent certainly because of its rare matrilineal culture (e.g. de Josselin de Jong 1951, Scholz 1977, Abdullah 1972, Stenger Frey 1986). The distinct feature of the Minangkabau culture is its inheritance system, which divides the heritage into *harta pusaka tinggi* (lit.: high inheritance) and *harta pusaka rendah* (lit.: low inheritance). *Harta pusaka tinggi* represents the property of an extended family to which an individual family only has user rights, but it may not be sold, because its status is *tanah adat*, i.e. customary land. It is inherited from the ancestors and includes irrigated rice fields and the house as well as the houselot. *Harta pusaka tinggi* is traced down from the mother to her daughters. Men may not inherit any of it. *Harta pusaka rendah* on the other hand, represents individual property and includes all goods that either bride or groom has earned or bought themselves before their marriage as well as during their marriage. Fields opened in primary forest and bought land also fall under this category. *Harta pusaka rendah* is shared equally between the daughters and the sons. Another unique, but by now generally abandoned feature of Minangkabau culture developed from the inheritance system: In former times, after marriage the woman would stay in the house of her clan, where eventually a new part was added for her and her children. The husband only was allowed to visit his wife at night and had to leave before morning. He would mainly work at the fields of his mother and sisters, and would have an important function as uncle to educate his nephews and nieces rather than his own children, who would be educated by his wife's brother. Nowadays, however, the big traditional communal family houses have generally given way to small houses only inhabited by nuclear families or a small part of the extended family at the most. The clan is headed by the *ninik mamak*, who is the oldest brother of the mother or another of her male relatives. The *ninik mamak* would generally have to take care of cases concerning customary law like marriages, ceremonies, the division of inherited property and land disputes or other problems arising within the clan.

The people of Pemunyian, although the village is located in the Province of Jambi, are ethnically Minangkabau, originating from the bordering Province West-Sumatra. However, the language spoken in Pemunyian is already a mixture of the Minangkabau and Jambi languages. Also the customs are generally weakened after migration out of the Minangkabau heartland. For example, the inheritance system is no longer matrilineal as is typical for Minangkabau people, but the inheritance is shared equally between all children, following the Jambi culture. As there are neither paddies nor traditional communal houses in the village, there would also be no typical *harta pusaka tinggi* in Pemunyian. According to its inhabitants, the village has already existed for several hundred years (*sejak nenek moyang* - lit.: since the time of the ancestors). Because of the lack of early records, it is uncertain, how old the settlement actually is. But because the oldest traditional rubber planting near the village is said to be older than 60 or even older than 80 years, the village has to be at least that old, too. Nevertheless, rubber plantings exist in Sumatra only since the beginning of the 19th century, which means, if the village were older, it would be difficult to prove.

The village Dusun Birun also has been settled by Minangkabau people. Bengkulu Province is also reported to be a place of origin of some of the ancestors. Like Pemunyian, because the village is located in Jambi Province, the language and the culture have been influenced accordingly.

2.2.5 Economy

The mainstays of the regional economy are estate crops, timber and related processing industries, mining and smallholder agriculture. In the most of the villages in the border area of the KSNP 90 % or more of all families gain their main income through agricultural activities, especially the production of food crops and cassiavera (Kerinci Dalam Angka 1988, BPN 1993: 4, 39). Village economic status is closely linked to land quality. Upland villages endowed with rich volcanic soils can grow high value crops such as cassiavera, coffee and temperate vegetables. Villages bisected by rivers or streams are usually self-sufficient in rice, even with very low intensity cropping. Villages on hilly sites with acidic soils have little scope for the cultivation of annual crops besides upland rice for subsistence and therefore mainly focus on tree crop development. In the lowlands this is foremost rubber, but also coffee and cassiavera are cultivated in these villages. Agricultural intensification is constrained by the lack of extension services, inability to purchase inputs, lack of irrigation systems, and in many cases lack of access to markets (Schweithelm 1994: 5).

Besides agriculture as the main source of income, most farmers have side activities like farm labour on other people's fields, small trading activities and various artisan work (Radja 1994: 69). From the study villages, only in Lubuk Malakko, some families totally live on off-farm activities (4.3 %), in both other locations, all families receive at least part of their income from agriculture, including paid farm labour (table 2). Off-farm activities include teaching at the local primary school (government employees), working as midwives and various crafts. Some farmers also earn additional income by catching fish or collecting non-timber forest products, like several kinds of rattan and the fruits of the rattan *jerenang*, which are sold at the local market. In Lubuk Malakko, as the largest village, even works as drivers, tailors, food vendors and mechanics can be found, which are not present in the other villages. Nevertheless, the percentage of families having other income sources is not higher there.

Table 2: Composition of professions on the research area

	Farmers *	Traders*	Govt. employees*	Others*
Pemunyian	100 %	3.8 %	3.2 %	11.4 %[7]
Dusun Birun	100 %	3.3 %	10.9 %	7.6 %[8]
Lubuk Malakko	95.7 %	3.6 %	3.1 %	11.0 %[9]

** in % of the families* *Source: village statistics*

The village traders generally sell goods for daily needs to the villagers and buy their agricultural produce, especially rubber, cassiavera and coffee. The former again sell this produce at the near by market, where they purchase the goods for their small shops in the village.

In Sangir district, cassiavera is normally bought by traders who enter the villages and then sell the produce at the market in Padang Aro or Muara Labuh or directly in Padang. But there are also farmers who directly sell their harvests at the markets of Padang Aro or Muara Labuh. Rubber is predominantly bought by traders from outside the villages and sold directly to the processing industry in Padang (Radja et al. 1994: 86 p.). In Lubuk Malakko, local traders also sell building materials, furniture and clothes. Besides, larger traders from outside also enter the village to buy the farmers' harvests directly, either from the farmers themselves or from the local traders. Rubber and cassiavera in Dusun Birun, as well as coffee and rubber in Pemunyian and Lubuk Malakko, are bought by these large traders, who also sell goods for daily needs, clothes and kitchen appliances to the villagers.

Besides the economic activities inside the village, some farmers also practice circular migration (*merantau*). In general, most farmers prefer to cultivate their fields, where harvests are guaranteed, instead of looking for work, which provides a less secure income. Those looking for work generally do not move very far and also only carry out unskilled labour. Farmers of Dusun Birun, e.g., have migrated for work only within the province and work in garages or operate as unskilled workers. Pemunyian farmers *merantau* to near-by areas to tap rubber gardens or to larger cities of central Sumatra (Jambi, Pekanbaru) to be employed as unskilled workers. Some people, however, are said

7 Nine midwifes, two shavers, five woodworkers, one stoneworker and four handicraft workers.

8 Among others: one midwife, six skilled labourers.

9 Among others: nine tailors, three mechanics, five drivers and eight skilled labourers.

to have even *merantau* to Malaysia. Farmers of Lubuk Malakko are tapping rubber in Jambi province, *merantau* to Medan to trade or work as tailors. Youths *merantau* to Padang, the province capital, for senior high school or university education. The length of the migratory work ranges from some months to several years. Married men of Pemunyian, for example, *merantau* for tapping rubber after cultivating their *ladang* in September and return to their village before the Islamic fasting month (between late November and mid-March).

Of 50 villages within the national park and in its bordering areas, which have been investigated by the BPN (1993: 4 p.), five were categorized as very poor (income less than Rp. 250.000[10] per capita per year), 26 were almost poor (income Rp. 250.000 - 500.000 per capita and year), whereas 19 were classified as not being poor villages (income higher than Rp. 500.000 per capita and year). The income per capita varied between Rp. 163,000.- and Rp. 1,001,152.- per year. In Sangir and Sungai Pagu regency, West Sumatra, the average income of villages varied between Rp. 235,262 and Rp. 455,995 per capita, depending very much on the size of the cassiavera gardens people had (Radja *et al.* 1994: 92). Because the subsistence produce of the respective villages has not entered the calculation, the income per capita does not represent the real prosperity or poverty of a village. Farmers may have a high income due to large cassiavera gardens, but may have no rice fields, so they may be poorer in absolute terms than those farmers self sufficient in rice but having a low cash income.

Also the villages in the research area all have been classified as *desa tertinggal*, lit.: left behind, or "backward" villages. In the frame of the government-sponsored Poverty Alleviation Program *Inpres Desa Tertinggal* (IDT), from 1994 to 1997 villages falling under this category have received monetary support to function as revolving funds in order to upgrade the local economy.

Besides agriculture and handicraft, the villages surrounding the national park also have a good potential for tourism development. There are several waterfalls like the Asap Waterfall for example, lakes, like the Gunung Tujuh Lake, and caves like Goa Kasah, which represent interesting places for sightseeing, hiking and other outdoor activities. The Merangin River passing Dusun Birun offers potentials for rafting.

2.2.6 Land Use Systems

In most lowland areas surrounding the national park, the geomorphology does not allow for easy establishment of wet rice cultivation. Therefore agriculture in these areas is dominated by shifting agriculture for rice and other food crop subsistence production and tree crop cultivation, rubber, cassiavera and coffee, for cash income (cf. BPN 1993: 37). Shifting cultivation, being one of the

10 In 1993, about Rp. 2,100 averaged 1 US$ and Rp. 1,260 averaged 1 DM.

world's oldest agricultural systems, is practiced by about 240 to 300 million people in the tropics. In 1950 it still accounted for approximately thirty percent of the total agricultural area of Southeast Asia (Dobby 1950: 349), producing food for up to ten percent of the total population (Pelzer 1945: 29). In Indonesia it was estimated that about 5,554,000 farmers are engaged in shifting cultivation on an area of about 10,411,000 ha, including the old fallow of the last five years (Mubyarto 1991: 56 p.).

Scholz (1983[11]) calculated a total area of 289,000 ha used for shifting cultivation and 1,521,000 ha for paddy rice cultivation, representing 5 % and 25 % respectively of the total area used for agriculture in Sumatra. Because fallow land has not been included within the calculation, the total area under shifting cultivation is much higher. To receive the real land area under shifting cultivation, the annual upland field area has to be multiplied with the average fallow length, which is nine years in the research area[12]. Applying this kind of calculation, the total area under shifting cultivation in Sumatra would account for 34 % of the total area used for agriculture, while the area under paddy rice would only account for 18 %. Although the land area under shifting cultivation each year accounts for about 20 % of the area under paddy rice, rice produced by shifting cultivation in 1980 accounts only for 13 % of all rice produced in Sumatra (1967: 22 %; Scholz 1988: 61). This difference between land area and harvest portion is due to higher yields on irrigated fields and, partly, double-cropping.

The cultivation of economic tree crops in Central Sumatra started in the 19th century with coffee, with commercial planting enforced by the Dutch colonial government, followed by rubber at the onset of the 20th century. The introduction of coffee and rubber as economic tree crops linked the prior mainly subsistence-oriented village economies to the market, leading to monetarisation and the development of private land ownership. Increasing need for money to purchase consumer goods and pay taxes changed farmers' priorities from a mere securing of the household subsistence to a maximisation of profits and safeguarding of the family's economic base (ibid.: 80). The construction of a road system in the central highlands facilitated increased market-oriented production and information flow. Goods that formerly had to be carried could now be transported much quicker on buffalo-drawn carts. Tax obligations and the availability of consumer goods made the market economy spread quickly over the whole island.

The above-mentioned perennial crops could be integrated easily into the local agricultural system, because they are planted into the old upland ricefield, employing little extra work. Especially rubber

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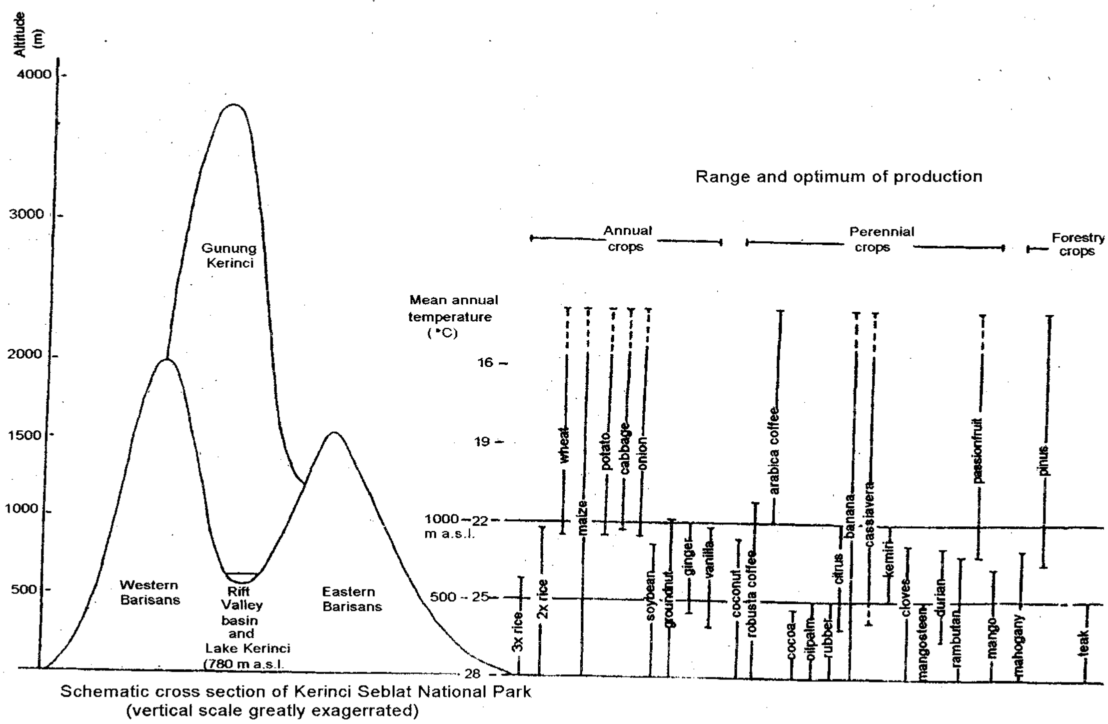
11 As cited in Scholz 1988: 9.

12 (9+1) x 289,000 = 2,890,000 (years of average fallow + actual *ladang* x annual *ladang* area) .
9 x 289,000 + 6,017,000 (total agricultural area according to Scholz 1983) = 8,618,000.
2,890,000 ha of 8,618,000 ha = 34 %.

spread quickly among Central Sumatran farmers, because it thrives well on the acid, nutrient-poor soils and can be managed flexibly. Therefore it fits perfectly into the traditional agricultural cycle, which is characterized by seasonal labour peaks during times of rice planting and harvesting. In each region, a typical economic tree crop gained dominance. Coffee was mainly planted in the highlands, rubber in the lowlands and cassiavera began to be cultivated in the Kerinci valley, where farmers earlier had been gathering products from the forests (ibid.: 27).

Figure 4: Range and optimum of production of selected crops as drafted on the schematic cross section of Kerinci Seblat National Park



Source: DHV 1993

Recently, large fallow lands and old rubber gardens in the lowlands are being converted to oil palm plantations, which are managed by plantation companies. As part of this development also smallholder estates expanded through government initiatives and with World Bank assistance for the PIR/NES schemes *(Perkebunan Inti Rakyat* or Nucleus Estate and Smallholder Scheme). Under these schemes private developers prepare plots of land for smallholders located nearby. After three to four years the operations are transferred to the smallholders, who manage the plantations under the supervision of the developing company. These companies then purchase the fresh oil palm fruit bunches from the smallholders. The area of oil palm plantations in Indonesia has increased from

106,000 hectares in 1967 to 2.5 million hectares in 1997. Most of this oil palm plantation area is concentrated in Sumatra (Casson 1999: 10, 13).

In the research area, the West Sumatran Solok regency, where the village Lubuk Malakko is located, most of the area consists of upland fields, only 24 % of the total agricultural lands are used as irrigated rice fields while 54 % are planted with perennial crops, especially rubber, cassiavera and coffee. The total area used for upland rice, is about two thirds of the size of all paddy rice fields (BPS Solok 1992[13]). In Jambi, 32 % of the non-forest lands are planted with smallholder estate crops whereas only 8 % are irrigated rice fields. This pattern derives from the hilly to mountainous topography of the area, which limits the scope for irrigated rice cultivation. Rubber gardens account for 61 % of all smallholder plantations, oil palms for 12 %, cassiavera for 7 % and coffee for 3 % (see table 3; BPS Jambi 1995: 219, 245pp.).

Table 3: Development of tree crop cultivation in Jambi

tree crop	*Jambi Province*			*Sarolangun Bangko District**		
	area (ha)	*% of area grown with smallholder tree crops*	*% annual change from 1989 to 1994*	*area (ha)*	*% of area grown with smallholder tree crops*	*% annual change from 1989 to 1994*
rubber	505,646	61 %	+ 2 %	182,254	82 %	+ 1 %
oil palms	100,061	12 %	+ 76 %	23,884	11 %	+ 16 %
cassiavera	57,887	7 %	+ 8 %	5,629	3 %	+ 32 %
coffee	26,771	3 %	- 4 %	3,588	2 %	- 4 %

* location of study village Dusun Birun Sources: BPS Jambi 1995, BPS Sarolangun Bangko 1995

In the province in general, an intense development of oil palm estates is obvious. This is less so in the Sarolangun Bangko district. Bordering the Kerinci district, as the cassiavera cultivation centre, the data show a cassiavera planting boom during recent years. The area planted to cassiavera is still small as compared to other tree crops, particularly rubber, but from 1989 to 1994 an average annual growth of 32 % has been noted (table 3). Rubber plantation size, on the other hand, remained almost constant during that time, both in Jambi as a whole as well as in the Sarolangun Bangko district. This development could also be observed in the study village Dusun Birun, as we will see in chapter 4.

13 As cited in Radja *et al*. 1994: 49pp.

Agricultural Development in Historic Perspective

Because of its remoteness, the agricultural history of the research area is not very well documented. This situation is different for the mountain valley enclave around Sungai Penuh, which had been visited early by Dutch explorers and subsequently developed to a centre for market-oriented production due to its favourable ecological conditions. The development of that area described here probably was not felt in the same intensity in the remote areas, especially concerning cash crop production. However, many developments certainly influenced the general situation in that area.

In the Kerinci valley, agriculture of the 19th century was characterised by the cultivation of paddy rice in the plains and shifting cultivation on the hillsides (Marsden 1975, Kathirithamby Wells 1986[14]). Additionally, non-timber forest products like resins and rattans were sold from the Kerinci-area and traded on the west coast (van Aken 1915: 23). In the beginning of the 20th century, the local economy became increasingly market-oriented, which was also due to the newly felt need for cash income due to the tax system imposed by the Dutch colonial administration (Belsky 1991[15]). Commercial tree crop production like coffee (1907), tea (1918), rubber and cassiavera (1930) entered the enclave, and were promoted further through the construction of a road by the Dutch in 1922, linking Sungai Penuh to the port of Padang (Watson 1984[16]). This led to a transformation of the agricultural landscape, so that more and more old upland fields were not fallowed anymore but planted with tree crops. Because the lands planted with trees were not available anymore for food crop cultivation, an increasing amount of new fields was opened in the primary forest. The change of the agricultural production pattern from mainly paddy rice production to commercial tree crops also led to a change in the social structure, especially a weakening of traditional leadership, customary rules concerning land use, land tenure as well as land acquisition.

After independence, the market-oriented cultivation of tree crops continued to be supported by the Indonesian government. The phase of accelerated economic growth of the republic in the New Order era in the 1970s and a relative increase in the price for cassiavera-bark in the 1980s led to a second wave of commercial tree planting (cassiavera, rubber, coffee, cloves) and therefore also of deforestation (Watson 1984[17]). Also the construction of the asphalt road from Sungai Penuh via Lubuk Gadang and Muara Labuh to Padang from 1977 to 1982 contributed to the accessibility of the forests in the Kerinci area and to a further expansion of cassiavera cultivation (Radja *et al.* 1994: 35). The soil erosion caused by the deforestation in the Kerinci-area, however, leads to flooding and subsequent siltation of the river downstreams (Verstappen, 1973: 66).

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14 As cited in Aumeeruddy 1994: 10.

15 As cited in Aumeeruddy 1994: 10.

16 As cited in Aumeeruddy 1994: 10.

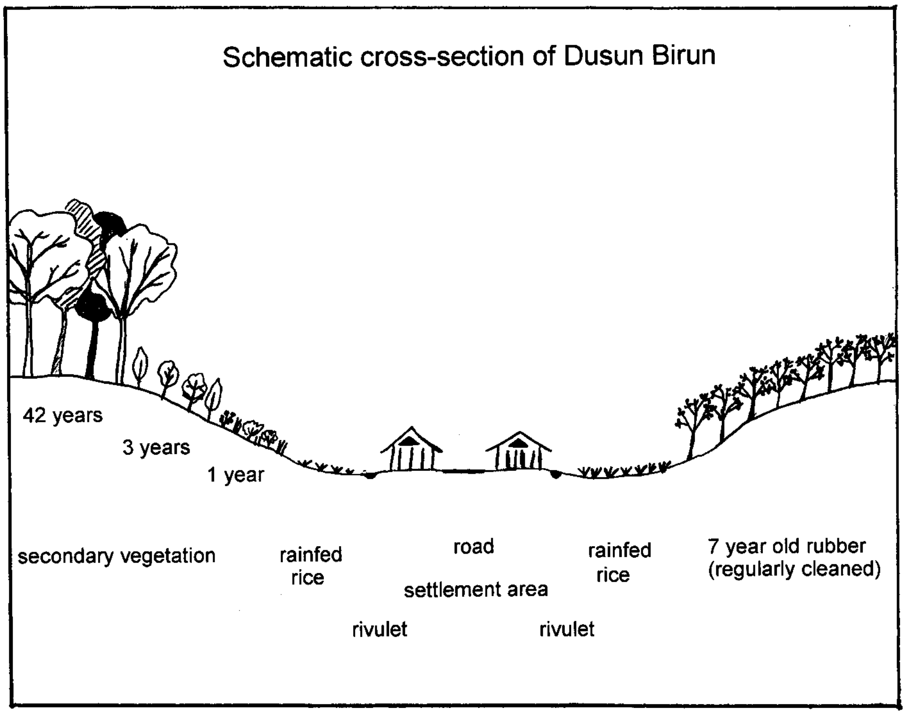
17 As cited in Aumeeruddy 1994: 10, 12.

Up to recent times, the agricultural production pattern in the enclave remained unchanged: on the valley bottom paddy rice is cultivated (17 % of agricultural land), whereas on the uplands tree crops prevail (77 % of agricultural land) (Scholz 1988: 129). Tree crop cultivation, mainly cassiavera and coffee, implies a rotational system, called *ladang*, with cycles of tree cultivation from 8 to 25 years and annual crops (upland rice, tobacco, tomatoes, onions, potatoes, etc.) inbetween. *Ladang* are located farther from the villages on the slopes of the hills and are of bigger size, about 1.5 ha. In the northern part of the enclave there are also perennial tree plantations, locally called *pelak*, located near the villages and of rather small size, 0.25 - 0.33 ha each. *Pelak* contain a wide array of used species and also several wild forest plants, representing a system that reportedly already existed at the beginning of the century (Indrizal *et al.* 1992: 51p.; Aumeeruddy 1994: 10, 26). Above all, in these agroforest gardens commercial products are produced, although fruits and vegetables for home consumption are grown, too (Aumeeruddy 1994: 23).

Research Area

Agriculture in the research area, as in the Kerinci enclave, mainly consists of rice cultivation for subsistence and economic tree crop gardening for cash generation. Due to differences in geomorphology that have been described above, some areas have been favourable for the development of paddy rice cultivation, whereas in others still upland rice prevails. Upland rice is generally mixed with vegetables and other plants for home consumption, whereas in paddy rice areas, vegetables are either planted into the homegarden or into the young tree crop garden. Villages planting upland rice generally do this by means of shifting cultivation. Tree crop gardens are established by planting the saplings into the recent *ladang*. In villages, where the primary purpose of opening a *ladang* is the establishment of a tree crop garden, vegetables and also rice may be cultivated during the first three to four years when the farmer has the time to stay in the garden. After the garden is established, it is generally not fallowed or cut down anymore, unless it becomes unproductive. Some authors speak of an ‘economically enriched fallow’ in this kind of shifting cultivation system (Raintree 1986: 5). This description, however, only holds true, when a period of annual food crop cultivation and a fallow period are involved in the cultivation cycle. When a garden is only cut down after it has become unproductive and directly replanted after, then no ‘shifting’ is involved.

Figure 5: Schematic presentation of the land-use pattern in Dusun Birun



Economic tree crops were introduced in Central Sumatra about the beginning of the 20th century. The exact date, when they entered the respective villages has not been documented exactly. Therefore the period during which the major cash crops rubber, cassiavera and coffee have been cultivated in the villages of the research area were estimated by the local village heads (table 4). According to this information, rubber is cultivated in Pemunyian since the 1920s and in Dusun Birun and Lubuk Malakko since the 1940s. Cassiavera was planted first by farmers in Dusun Birun by 1975, whereas by the mid-80s, it was cultivated increasingly and also spread to both other locations. Coffee has been cultivated longest in Lubuk Malakko (1946), which is located near Lubuk Gadang, a major local centre of coffee cultivation. In both other villages, which are not located in traditional coffee areas, coffee only began to be planted between the 1960s and the 1970s.

Table 4: Introduction of cash crops

	Pemunyian	***Dusun Birun***	***Lubuk Malakko***
rubber	since the 1920s	since the 1920s	since the 1920s
cassiavera	since about 1984	some since about 1975 increased since 1985-1990	since 1988
coffee	since the 1970s	ca. 1964-1975 (then coffee prices decreased, few coffee planted now)	since 1946

Source: Respective village heads

Before the cultivation of economic tree crops, local economies were mainly subsistence oriented. Some small cash income, however, has been gained for a long time through the sale of non-timber forest products like rattans, latexes, gums and resins. Before the introduction of cash, these products were bartered. According to Dove (1994: 385), this history of gathering forest rubber contributed to the quick adoption of *Hevea brasiliensis* by the local population. Nowadays, fluctuating prices of tree crops cause 'boom' times, where large numbers of farmers start to plant a certain crop when prices are high, leading to the transformation of the agricultural landscape in the affected areas. This happened when coffee prices were high in the 1970s, and the late 1980s to 1990s, when cassiavera cultivation became profitable.

3. Participation of Local People in KSNP Planning, Establishment and Protection

3.1 The KSNP within the Framework of Protected Area Management in Indonesia

3.1.1 Establishment of the Protected Area System in Indonesia

Stretching some 5,110 km from west to east, Indonesia comprises the biggest part of the Malaysian floristic region, one of the richest botanical areas of the world. The country extends over two of the worlds main biogeographic regions: the Oriental region, with the islands of Sumatra, Kalimantan, Java and Bali on the Sunda shelf; and the Australian region which comprehends Irian Jaya resting on the Sahul Shelf, along with the remainder of Papuasia and Australia. In between lies Wallacea, which has a mixture of elements from these two very different parts of the world. Because extending over large parts of these biogeographic regions, Indonesia also has a high amount of endemism, exceeded only by Madagaskar.

Due to being equipped with this abundance of natural resources, the protection of these riches from conversion and disturbance has early attained attention. Already in 1889, the first nature reserve was established in Indonesia, the *Cagar Alam* Cibodas (240 ha) in West Java. This protected area became successively extended by several adjoining forest areas until becoming the Gunung Gede-Pangrango National Park in 1980, embracing a total of 15,000 ha. Since the declaration of independence in 1945, by which time over 100 sites had been established, the network has expanded considerably. Together with the Gunung Gede-Pangrango reserve four other protected areas were declared as Indonesia's first five national parks on March 6, 1980. These were Gunung Leuser National Park in northern Sumatra, Ujung Kulon National Park in West Java, Baluran National Park in East Java, and Komodo National Park on Komodo Island in the East Nusa Tenggara region (Sumardja 1981: 2 pp.).

As of early 1997, Indonesia's protected area system covered 21,2 million hectares, some 11,2 % of total land area, which exceeds the recommendation of 10 % by the IUCN (Kerinci Seblat National Park 1999a: 2). Included herein are both lands that have been designated or gazetted as protected areas by the Indonesian government, as well as those that have been proposed as reserves. Besides those territories classified as nature reserves or national parks, another 30 million hectares are ranked as permanent protection forest (*hutan lindung*) for watershed and steep land conservation. As a whole, 49 million hectares of forest lands are protected by the law. Furthermore, 65 hectares of forest are classified as permanent production forests. Production forests are mainly located in lowland and hill forest, and therefore are of very high species diversity.

Table 5: Indonesian national parks by 1997/1998

Name	*Province*	*Area (ha)*
LAND NATIONAL PARKS		
1. Gunung Leuser	Aceh and North Sumatra	1.094.692
2. Siberut	West Sumatra	190.500
3. Bukit Tigapuluh	Riau and Jambi	127.698
4. Kerinci-Seblat	West Sumatra, Jambi, Bengkulu, South Sumatra	1.368.000
5. Berbak	Jambi	162.700
6. Bukit Barisan Selatan	Lampung, Bengkulu	365.000
7. Way Kambas	Lampung	130.000
8. Ujung Kulon	West Java	122.956
9. Gunung Gede - Pangrango	West Java	15.000
10. Gunung Halimun	West Java	40.000
11. Bromo-Tengger-Semeru	East Java	50.276
12. Meru-Betiri	East Java	58.000
13. Baluran	East Java	25.000
14. Alas-Purwo	East Java	43.420
15. Bali Barat	Bali	19.003
16. Gunung Palung	West Kalimantan	90.000
17. Bentuang-Karimun	West Kalimantan	800.000
18. Bukit Baka – Bukit Raya	West Kalimantan, Central Kalimantan	191.090
19. Tanjung Puting	Central Kalimantan	415.040
20. Kutai	East Kalimantan	198.629
21. Kayan-Mentarang	East Kalimantan	1.360.500
22. Gunung Rinjani	West Nusa Tenggara (Lombok)	40.000
23. Kelimutu	East Nusa Tenggara	5.000
24. Komodo	East Nusa Tenggara	173.300
25. Bogani-Nani-Wartabone	North Sulawesi	287.115
26. Lore Lindu	Central Sulawesi	229.000
27. Rawa-Aopa-Watuhomai	Southeast Sulawesi	105.194
28. Manusela	Moluccas	189.000
29. Wassur	Irian Jaya	308.000
30. Lorentz	Irian Jaya	2.505.600
MARINE NATIONAL PARKS		
31. Kepulauan Seribu	Jakarta	108.000
32. Kepulauan Karimun-Jawa	Central Java	111.625
33. Bunaken – Manado Tua	North Sulawesi	89.065
34. Taka-Bone-Rate	South Sulawesi	530.765
35. Kepulauan Wakatobi	Southeast Sulawesi	1.390.000
36. Teluk Cendrawasih	Irian Jaya	1.453.500
TOTAL		**14.382.668**

Source: Statistik PHPA 1997/1998, in: Kompas 14. 6. 1999: 20.

Indonesia has established a total of 375 conservation areas, including 36 national parks (table 5). Within these territories, 80 terrestrial and 49 marine areas are of highest preservation priority. The conservation sites cover all major habitat types. 36 of 80 'critical reserves', however, have not been protected yet. This includes the Indonesian wetlands, which have received inadequate coverage in the existing network according to the Asian Wetland Bureau. One probable cause is the insufficient information regarding their conservation value. Any new allocation of tropical lowland forest areas to conservation will be difficult due to their economic value and accessibility (WCMC 1992: 6).

Many of the Indonesian conservation areas are not being well protected or even exist on paper only (MacKinnon 1997: 37). By 1996, only 12 national parks had an active presence by Directorate General of Forestry Protection and Nature Conservation (*Direktorat Jenderal Perlindungan Hutan dan Pelestarian Alam*, PHPA). The rest were either "paper parks" or nominally and temporarily looked after, on behalf of the government, by international NGOs such as the World Wide Fund for Nature (WWF[1]). The other 344 protected areas within the national system receive virtually no protection in the form of personnel and facilities from PHPA (The British Council 1996: 23). Section 3.2.1 will be concerned with the causes for this situation. To prevent a degradation of the existing protected area system notwithstanding limited facilities available, PHPA needs to focus on establishing safe boundaries, creating zoning of uses and assuring the security of the respective conservation area and its resources (The British Council 1996: 31).

3.1.2 Development of the Legal Framework for Nature Conservation

Reserves were originally established on the basis of two colonial government ordinances, of which the Nature Protection Ordinance of 1941 (Natuurbescherminge Ordannantie; Staatsblad No. 167) rescinded the earlier Nature Protection Ordinance of 1932 (Staatsblad No. 17). At that time, only Nature Reserves (*Cagar Alam*) and Game Reserves (*Suaka Margasatwa*) were provided for (WCMC 1992: 1).

Today, the Indonesian legal framework for nature conservation consists of four principal laws and several ministerial decrees. The Basic Forestry Law No. 41 of 1999[2] (replacing the Basic Forestry Law No. 5 of 1967) describes the purpose, supply, availability and use of forests in the interests of community development. It also regulates the protection of conservation areas and the relationship between the state and the people regarding forest ownership and use. The law provides for

[1] In 1996, the WWF had an active program in close cooperation with PHPA in 11 national parks and a comparable number of nature reserves.

[2] Undang-undang nomor 41 tahun 1999 tentang Kehutanan.

conservation, protection and production forest. Conservation forest is divided into three categories: Nature Sanctuary (*Hutan Suaka Alam*), Game Reserves (*Suaka Margasatwa*) and Nature Conservation Forest (*Hutan Pelestarian Alam*) (Tunggal 2000: 7). The latter category is a new addition not present in the earlier forestry law. The respective categories and their management are described further in particular government regulations.

Box 2: Historical development of laws and regulations for nature conservation

1932	Nature Protection Ordinance (old)
1941	Nature Protection Ordinance (old)
1967	Basic Forestry Law No. 5 (old)
1982	Environmental Management Law No. 4
1982	National Conservation Plan
1990	Conservation of Living Natural Resources and their Ecosystems Act No. 5
1992	Spatial Management Law No. 24
1999	Basic Forestry Law No. 41

The colonial legislation mentioned above was replaced in 1990 through the Conservation of Living Natural Resources and their Ecosystems Act (UU No. 5 of 1990). Within this ordinance the regulation for punishment for destruction of the protected forest was established with a maximum of ten years imprisonment and a fine of Rp. 200.000.000,-. The law was based on the Presidential Decree on Protected Areas from 1990[3]. It distinguishes between Nature Sanctuaries (Nature Reserves / *Cagar Alam* and Game Reserves / *Suaka Margasatwa*) and Nature Conservation Areas (National Parks / *Taman Nasional,* Nature Recreation Parks / *Taman Wisata Alam* and Grand Forest Parks / *Taman Hutan Agung*). These designations, which are equally applicable to terrestrial and marine reserves, provide differing degrees of legal protection. This ranges from nature reserves and the core zones of national parks, where no human activities are allowed, to Nature Sanctuaries and Game Reserves, whose utilisation of natural resources is described within particular government regulations (Tunggal 2000: 14). The Act also makes provision for existing protected areas to be established as biosphere reserves under the Unesco Man and the Biosphere Programme, recognizing the concepts of "core zone", "utilization zone" and "buffer zone" (Barber *et al*. 1995: 55).

Gazettement, alteration and declassification of protected areas is by decree of the Minister of Forestry and Estate Crops. Concerning the criteria for the selection of protected areas, a Special Document was issued in 1980 by the Minister for Agriculture[4]. This was followed by the

3 Keppres nomor 32 tahun 1990 tentang Kawasan Lindung.

4 Surat Khusus (SK) Mentan No. 837/Kpts/Um/II/1980 tentang Kriteria Kawasan Lindung.

Environmental Management Law No. 4 of 1982, which states the basic provisions for the management of living resources by linking environmental management to the improvement of human welfare. Furthermore the law provides for the assessment of environmental impacts of development projects. It defines conservation as "...the management of natural resources, which ensures their wise utilization, and, in the case of renewable natural resources, ensures their continued supply by constantly maintaining their value and variety". In 1983 the Department of Forestry established the Agreed Functional Forest Classification (TGHK), as a functional classification of Indonesia's forest lands[5]. To coordinate the sustainable management of the sea, land and air resources in a spatial context at the national, regional and local level, the Spatial Management Law No. 24 of 1992 was enacted. This law is elaborated in the spatial management plan[6] of the respective provinces. The two functional land classification systems have been integrated in their implementation since 1993.

As a framework for the identification of areas with unique ecosystems and high species diversity within the countries seven major biogeographic regions, Indonesia has adopted a National Conservation Plan (FAO 1982). The plan was developed in the frame of two successive UNDP/FAO project providing technical assistance in conservation planning for the Directorate of Nature Conservation, the Nature Conservation and Wildlife Management Programme from 1974 to 1978 and the Development of National Parks Programme from 1978 to 1982[7]. Criteria for the demarcation of protected areas within the plan are species richness, endemism, habitat range, management and socio-economic benefits.

Although Indonesia's domestic legal framework for nature protection is well developed, it lacks sufficient implementation regulations. One example is the lack of regulations for buffer zones or areas adjoining protected areas in general, which has lead to land use in park surroundings detrimental to nature conservation. Also, the overlapping of national law with customary law causes conflicts (see section 3.2.4). The poor implementation of the Indonesian legal conservation framework is as well caused by a lack of commitment to, or participation in, nature conservation by important segments of the national polity and economy, whose activities frequently have a direct negative impact on the environment (sections 3.2.1 and 3.2.5). The gap between the underlying legal structure and its actual implementation and enforcement results in existing law having been

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5 The TGHK (*Tata Guna Hutan dan Kesepakatan*) comprises the following categories: protection forest, conservation forest, production forest and conversion forest (production forest that may be converted to other uses).

6 The spatial classifications according to the spatial management plan (*Rencana Tata Ruang Wilayah Propinsi* / RTRWP) are: protection forest, forest land cultivation area and non-forest cultivation area.

7 Activities in the frame of the first project were mainly field surveys and the preparation of management plans, whereas the second resulted in a National Conservation Plan (FAO, 1981-1982).

applied only to a very limited extent to stop or punish infractions (The British Council 1996: 16 p.). The lack of an agency with the capacity and the authority to rationalize and prepare appropriate implementing regulations prolongs this situation.

3.1.3 Administrative Structure of Indonesian Protected Areas Management

Under the Nature Protection Ordinance of 1941, the Directorate General of Forestry, beneath the jurisdiction of the Ministry of Agriculture, was put in charge of protected areas. As a part of the Directorate General of Forestry, the Directorate of Nature Conservation and Wildlife (PPA) was established in 1971 and given responsibility for establishing and managing protected areas. In 1981, the Ministry of Forestry[8] was given full ministerial status and subsequently assumed complete responsibility for the management of the national forest estate. PPA then became the Directorate General of Forest Protection and Nature Conservation (PHPA), being responsible for the management and stewardship of the protected area system, including the planning and designation of all protected areas, and the planning and supervision of protected forests. Within the four different directorates of PHPA, the Directorate of Nature Conservation and the Directorate of National Parks and Recreation Forest are concerned specifically with terrestrial and marine protected areas (WCMC 1992: 1 p.).

At the provincial level, PHPA is represented by the Natural Resources Conservation Office (*Balai Konservasi Sumber Daya Alam*, BKSDA) under the authority of the Provincial Forestry Office (*Kantor Wilayah Kehutanan*), headed by a representative of the Minister of Forestry and Estate Crops. The BKSDA work in association with the Regional Planning Boards (BAPPEDA), which are ultimately responsible to the provincial government. They are supported by *Sub-Balai Konservasi Sumber Daya Alam* (SBKSDA) within each regency, with an additional office for each national park. Its director reports directly to the Directorate of National Parks and Recreation Forest through the provincial forest department. Provinces soon will get larger authorities, including concerning nature conservation, if a new regulation on regional autonomy will be enacted. While any endeavours still have to be based on national laws, provinces then may determine conservation areas, as well as their pattern of utilization, development, maintenance, restoration, supervision and management[9].

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8 In 1999, the responsibility of the ministry was enlarged into Ministry of Forestry and Estate Crops.

9 According to the draft of the government regulation about the authority of the government and the authority of the provinces as autonomous regions (*Rancangan Peraturan Pemerintah No. ..., tahun 2000, tentang Kewewenangan Pemerintah dan Kewewenangan Propinsi sebagai Daerah Otonom*).

The responsibility for the designation of conservation areas rests with the provincial authorities through the Agreed Functional Forest Classification (TGHK), the National Species diversity Action Plan and, based on land systems classification, the Regional Physical Planning Board for Transmigration (RePPProT[10]). The government authority responsible for survey and demarcation of protected area boundaries in the field is the Directorate General of Forest Inventory and Land Use Planning (INTAG). Enforcement of protected area legislation is carried through by PHPA together with local law enforcement agencies. The territory adjoining the conservation area is managed by regency authorities and supervised by provincial authorities. To coordinate planning and development activities in areas surrounding national parks, the National Planning Agency and the Ministry of Forestry and Estate Crops have founded a national forum. Further agencies sharing competence for matters of species diversity conservation are the Ministries of Agriculture, Environment, Home Affairs, and the Indonesian Institute of Science (LIPI).

3.1.4 Participation in International Conservation Agreements

The growing, worldwide recognition of the importance of Indonesia's natural riches is indicated by the many international programs and activities focussing on the country as a centre of species diversity. As its official response to these species diversity challenges, Indonesia participates in a number of international conservation-related conventions and programmes.

World Heritage Convention. On 6 July 1989 it accepted the Convention concerning the Protection of World Cultural and Natural Heritage. Four protected areas and cultural artefacts have recently been nominated for the inclusion on the World Heritage List. These are Borobudur and Prambanan (Cultural Heritage sites) as well as Ujung Kulon and Komodo (Natural Heritage Sites).

ASEAN Convention. As a contracting party to the ASEAN convention, three sites have been designated: the Gunung Leuser National Park and the Kerinci-Seblat National Park in Sumatra as well as the Lorentz National Park in Irian Jaya.

Man and Biosphere Programme. As a participator of the Unesco Man and the Biosphere Programme (MAB), Indonesia has, to date, established seven international biosphere reserves for the conservation of the important ecosystems and genetic resources they contain. MAB-reserves in Indonesia include Siberut, Gunung Leuser, Cibodas, Tanjung Puting, Lore Lindu, Kayan-Mentarang and Komodo.

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[10] In order to provide a natural resource database for transmigration planning allowing for being able to avoid repetition of problems associated with poor site planning, RePPProT, a joint cooperative venture between the Indonesian and British governments, has been completed (WCMC 1992: 5).

International Biodiversity Convention. In 1994, Indonesia ratified the Convention on Biological Diversity, which it had signed as one of the first countries in 1992 following the Rio Earth Summit. In 1995, Indonesia hosted the Second Conference of the Parties (COP II). Resulting, the country has international and legal commitment to both monitor and inventory its species diversity. To become operative, the convention requires national action, which is represented by the National Species diversity Action Plan (NBAP), issued in 1991. As a framework for the fifth and the sixth five year development plan (Repelita V and VI) and for the 25 year development plan, the NBAP outlines priorities for conservation action and indicates funding priorities and mechanisms to strengthen Indonesia's species diversity conservation strategy. The principal targets of the NBAP are the reduction of the loss of terrestrial and marine habitats of primary importance for species diversity and the expansion of species diversity data and information to policy makers and the public as well as the fostering of the sustainable use of resources. The plan recognises that "the integrity of conservation areas cannot be maintained without providing alternative resources and income-generating opportunities to local people who are directly dependent upon resources from those areas"[11]. `According to the World Bank (1994: 1 p.), the

> "successful implementation of this plan will require reform and strengthening of policies, institutions, and legal arrangements, improved intersectoral cooperation; identification of research, education and training and personal needs; participatory project development with full consultation with local institutions and communities; and a full economic evaluation of the costs and benefits of species diversity conservation and utilisation."

Further conventions Indonesia participates in are the *UN Convention on the Law of the Sea* (UNCLOS) for the preservation of marine resources, the *Ramsar Convention*, relating to the conservation of important wetland ecosystems, as well as the *Convention on International Trade of Endangered Species of Wild Fauna and Flora* (CITES[12]). Under current circumstances and institutional arrangements, however, the challenges of species diversity conservation in Indonesia are unlikely to be adequately addressed. According to the NBAP, causes of species diversity degradation include population growth, forest conversion, disregard of traditional land tenure rights and management systems, encouragement of transmigration programs, pollution and sedimentation, over-exploitation of particular species, policy inadequacies and poor coordination among government agencies relating to conservation[13] as well as the ineffective or inadequate transfer of

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11 Bappenas 1993 in: Barber *et al*. 1995: 2.

12 In 1979, Indonesia became the first country in Southeast Asia to join CITES, which is administered by IUCN on behalf of the United Nations Environment Program (IUCN 1982: 318).

13 Especially including the Ministries of Public Works, Transmigration and Population, Agriculture, Marine Exploration, Interior, Tourism and Arts, Settlement and Regional Development, the Provincial Forestry Services and the Provincial Planning Boards.

knowledge and understanding of conservation (The British Council 1996: 13 p.). The following section as well as section 3.2 will be concerned with the causes of some of these problems.

3.1.5 Institutional and Policy Constraints within the Indonesian Protected Area Management System

The Directorate General of Forest Protection and Nature Conservation (PHPA) has the responsibility for developing and managing Indonesia's protected area system, but lacks any real authority for environmental protection. One reason for this, is that it is only a relatively minor and under-supported Directorate-General in a Ministry, which has as its primary responsibility management of the logging of Indonesia's forests. PHPA's work is not well supported throughout the government structure, including its own Ministry of Forestry, reflecting the overall lack of knowledge and commitment to conservation. Existing formal agreements of cooperation with other ministries have yet to lead to significant joint activities. Although decision makers in the agencies concerned may recognize the necessity for collaborate actions, they are reluctant in relinquishing their control. This results in natural resources still being treated and managed as isolated entities and conservation measures to be detached from programs in the fields of agriculture, rural development, public works, and energy development (The British Council 1996: 25, 31 pp.).

In the implementation of its protected area management system, PHPA is facing several constraints, being based on insufficient institutional capacities and a lack of political regulations in certain fields. Major constraints in the field include insufficient trained and motivated personnel and a frequent absence of clearly and accurately defined protected area boundaries, resulting in many parks lacking the personnel and facilities needed to maintain them as viable areas for species diversity conservation (WCMC 1992: 4).

The main bottleneck, which is having a negative influence on the capacities of the responsible agencies in park management and enforcement, is the inadequate funding and staffing of PHPA. Despite progressively increasing government budgets and international investment programmes, management has been unable to keep pace with the increased workload demanded by an expanding protected areas network. Furthermore, the existing budget is not spread proportionally upon all protected areas. Some parks receive little or no investment support, whereas others obtain a disproportionate amount of the financial means. The park development budget, reflecting the Indonesian government's intention to upgrade the park's infrastructure and management capabilities, ranged from Rp 1.0 to 1.4 billion between 1991 to 1994 (US$ 0.64 / ha), financing project activities such as biological inventories, boundary demarcation and infrastructure development. Gunung Leuser National Park in northern Sumatra has an area of almost 1 Mio.

hectare, and a budget of Rp. 300 Mio. (US$ 37.500[14]) per year. According to the head of the park conservation subsection, this sum would essentially only suffice for one-fifth of the area (Kompas 14.6.1999: 18).

Connected to this feature, PHPA has also an acute shortage of trained and skilled technical and management staff, especially at the regional offices. The background of PHPA personnel in general lacks any education in nature conservation. This situation is consolidated through a current freeze on the recruitment of additional civil servants. Besides, staff motivation is poor due to low salaries and a very narrow promotion path to higher ranks (The British Council 1996: 27). Caused by the deficiency of field officers, the enforcement of park boundaries has been limited. The insufficient staffing of regional offices can also not cope appropriately with the pressure on the park area through poaching and land conversion. The number of forest rangers occupied in KSNP do not provide a patrolling presence commensurate with the size of the park and the scale of infringements, and therefore prevents PHPA from exercising real control over the protected area (World Bank 1998: 6, 8, MacKinnon 1997: 49). The Team for the Protection of Special Forests (TPHK, *Tim Pengamanan Hutan Khusus*), which is responsible for the security of protected forests, has no field posts and is only represented up to the sub-district level (Radja 1994: 105). Because of the shortage in field personnel, the park authority is dependent on the support of the local government for law enforcement.

Another bottleneck is that boundary delineation has been impeded by out-of-date or inaccurate mapping data, including the lack of local-level range information. This fact raised numerous conflicts over the placement of boundaries and the status of a given area within the forest zone (Fisher and Mulyana 2000: 125). Regional and national mapping carried out by other agencies and NGOs, however, is partly available and should be used to supplement the PHPA database (The British Council 1996: 26). The bottlenecks in the administrative system and the empowerment of the agencies in charge are inhibiting the implementation and enforcement of the park conservation strategy. For a successful management of the protected area these obstacles should be tackled adequately.

3.1.6 Development of the Legal Status of the KSNP

The Kerinci-Seblat National Park is the third largest land national park (*taman nasional*) in the Indonesian archipelago. KSNP is the second national park established in Sumatra, the first being

[14] BI middle rate of 3.5.2000: 1:8.000.

Gunung Leuser National Park (GLNP) in the northern part of the island. GLNP, however, through being a part of another floristic region, differs considerably from KSNP.

Park establishment. From 1921 to 1926 the Dutch colonial government imposed a protection status upon several forests in the area being the KSNP today. In 1929 the forests of Mount Indrapura were declared as a nature reserve with an area of 15.530 ha. The protection status of these forest reserves was sustained by the Indonesian government after independence in 1945. In 1980 the nature reserve Mount Indrapura was extended to 211.285 ha and several other forest areas in the Kerinci area were also declared or proposed as conservation areas. The area of Kerinci-Seblat was suggested as a national park after extensive field surveys by FAO and PHPA in the late 1970s and early 1980s.

In 1981 a management plan was proposed by UNDP/FAO to strengthen the conservation status of the reserve. Arguments for the importance of the conservation of the forests of Kerinci according to UNDP/FAO (1981: 2, 26) were at first the mere size of the reserve, because large connected rain forest areas have become more and more scarce in Sumatra. The protected area is a vital habitat for many endangered mammals, birds and plants and the diversity of ecosystems within the protected area is very high, including tropical moist forests of almost all altitudes and even alpine flora. Besides, the forests have an inestimable value for protecting the watershed area of several major rivers in Sumatra, the largest being the Musi and the Batang Hari, ich whose downriver areas they are safeguarding seven millions of hectares of agricultural land from floods and water supplies to an estimated 3.5 million people (MacKinnon 1997: 48). Corresponding to UNDP/FAO (1981: 26) Kerinci-Seblat furthermore has a great amount of potential for tourism as well as for conservation education.

Based on the management plan of the FAO developed in the frame of the National Conservation Plan (FAO 1982), the Minister of Agriculture in mid-October 1982 issued a ministerial decree[15] during the 1982 World Congress on National Parks in Bali, Indonesia, proposing the Kerinci-Seblat National Park with a size of 1,484,650 ha, including 300,000 ha of lowland forest, being located within four administrative provinces, Jambi, West Sumatra, South Sumatra and Bengkulu. This initial proposal included 17 gazetted and planned wildlife and nature reserves, adjacent protection forests, and connecting areas between these separate territories[16].

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[15] Surat Keputusan Menteri Pertanian no. 736/Mentan/X/1982 tanggal 14 Oktober 1982.

[16] Comprises the following: Cagar Alam Bukit Tapan (Tapan Forest Nature Reserve), Cagar Alam Gunung Indrapura (Mount Indrapura Nature Reserve), Cagar Alam Indrapura (Indrapura Nature Reserve), Suaka Margasatwa Bukit Gedang Seblat (Gedang Seblat Game Reserve), Suaka Margasatwa Bukit Kayu Embun (Kayu Embun Forest Game Reserve), Suaka Margasatwa Rawas Hulu Lakitan (Rawas Hulu Lakitan Game Reserve), Hutan Lindung Bajang Air Tarusan (Utara) (Bajang Air Tarusan North Protection Forest), Hutan Lindung Batang Marangin Barat/Menjuta Hulu (Batang Marangin West/Menjuta Hulu Protection Forest), Hutan Lindung Bukit Regis/Hulu Sulup (Regis Forest/Hulu Sulup Protection Forest),

In 1985, the park was reduced to 1.25 million ha through revisions on the forest consensus map (TGHK). Because areas with an inclination of less than 40 % should be excluded from the park to be used for agricultural or plantation purposes, the Ministry of Forestry began developing a new management plan in 1991 that further reduced the park area to slightly more than 1 million hectares (Bappeda 1991: 17). In 1992 a "consensus" boundary was agreed to by the Ministry of Forestry, provincial governments and logging concession-holders, within which the park shrunk to 996,850 ha, about 66 % of the area proposed in 1982 (Barber *et al*. 1995: 22). Through these excisions most of the species-rich lowland and hill forest areas became excluded from the protected area (World Bank 1994: 37). Several areas belonging to the KSNP before were then granted to forest concessions and plantation companies. This move clearly indicates the primacy of economic interests to the protection of species diversity and typical ecosystems. These border revisions, however, severely reduced the habitat of the large mammal species, such as the tiger, elephant, tapir and rhino, so that their long-term protection could be endangered. Some excised areas have since been reallocated to the park, bringing it to its current size of just under 1.4 million hectares. Part of the excised territories, however, were not reclaimed as part of the park, but became reclassified as limited production and protection forest. Much of KSNP's species diversity value still resides within its buffer zone in the lowlands (Kerinci Seblat National Park 1999a: 4 p.). In 1999, the park boundaries became "gazetted", i.e. legalized, after demarcation and mapping had been finished. By this, the park authority finally obtained the legal authority to prosecute people who encroach upon park resources (Kerinci Seblat National Park 2000: 1). The boundary has been planted with the areca nut palm, whose fruits provide income for the local population and which is easily visible both from a distance and from satellite imagery (World Bank 1998: 7).

Process of border delineation. The delineation and mapping of the approximately 3.000 km long park boundary was finished by the end of 1998. Facing problems with encroachment upon the territory of the KSNP, the national and the regional government had to develop certain strategies. Because a considerable amount of settlements existed within the park boundary, a first step was to reconsider the boundary delineation that had been laid down within the decree of the minister for agriculture in 1982 and to exclude those area from the park territory, which already had become converted to agricultural lands. Not all settlements were newly founded in the course of

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Hutan Lindung Gunung Sumbing/Masurai Protection Forest), Hutan Lindung Kambang/Batanghari I/Bayang (Kambang/Batanghari I/Bayang Protection Forest), Hutan Lindung Sangir Ulu/Bantang Tebo/Batang Tahir (Sangir Hulu/Batang Tebo/Batang Tahir Protection Forest), Hutan Lindung Batang Merangin Timur (Batang Merangin East Protection Forest), Cagar Alam Danau Gunung Tujuh (Proposed Lake Tujuh Nature Reserve), Cagar Alam Kambang/Batanghari I/Bayang (Proposed Kambang/Batanghari I/Bayang Nature Reserve), Suaka Margasatwa Sangir Ulu (Proposed Sangir Ulu Game Reserve), Suaka Margasatwa Sangir Ulu/Batang Tebo/Batang Tabir (Proposed Sangir Ulu/Batang Tebo/Batang Tabir Game Reserve), Hutan Lindung Bukit Gedang Seblat (Proposed Gedang Seblat forest southern extension) encroachment during the recent cassiavera-boom, but many had been existent since or maybe before the time of Dutch occupation. Unfortunately, for the supervision of the total border length, only 100 forest rangers are employed. Limited in number and ill equipped, they have little power to stop encroachment and illegal logging (Wiryono 2000: 7).

Criteria for border delineation within Jambi province were evaluated by a team formed from the organisations connected with the KSNP management. The part of the team responsible for the investigation of physical and socio-economic aspects was supervised by the Agency for Regional Development (BAPPEDA), whereas the part in charge of the buffer zone was supervised by the Regional Office for Agriculture (BPN 1993: 18). In the Kerinci enclave, the proposed buffer zone covers approximately 50.000 ha and consists primarily of secondary vegetation or cassiavera trees mixed with a variety of other plantation crops and vegetables (WCMC 1991: 5). According to the original course of the KSNP border, twelve villages were located within the national park. These settlements belong to the Kerinci and Sarko regencies, and are located in the highland of the Barisan range. The five villages within the Kerinci regency have already become resettled in accordance with the Special Document of the Regent from Dec. 12, 1988 about the acknowledgement of village eradication[17] (BPN 1993: 7). Many resettled families, however, returned to their village of origin later (Perbatakusuma *et al*. 1991: 4).

In 1991, the National Body for Land Affairs carried out a study to evaluate criteria for the drawing of the border and to redraw the border, in such a way that agricultural use zones still inside the park by now should be excluded at most from the park area (BPN 1993). Criteria for the border delineation should be preferably natural features, such as rivers, river intersections, ridges and summits. If possible, also fixed points should be employed such as triangulation points and quarter points. There should be no more enclaves within the national park besides the main enclave of the Kerinci valley around Sungai Penuh, which has 280.000 inhabitants. Areas with slopes above 40 % inclination, soils with an effective depth of less than 60 cm, areas prone to erosion and forested areas bordering the national park, especially in the area of the enclave, should become included within the KSNP. These criteria also became reference for the Provinces West Sumatra, South Sumatra and Bengkulu for the delineation of the KSNP border within their territory.

In the frame of completing the course of the border in Jambi province, 62,940 ha which had partly already become converted to agricultural utilisation, were excluded from the protected area, whereas 57.220 ha of primary forest have been added to the park territory, which effects a net loss of 5.720 ha. Through this process, ten villages, which formerly had been located in the national

[17] S.K. Bupati No. 501 tanggal 12 Desember 1988 tentang Pengakuan dan Penghapusan Desa di Propinsi Jambi.

park, became excluded[18] (BPN 1993: 18 pp.). Also the operational areas of timber concessions were to be included into the protected area if certain conditions were given. In the case of the operational area of the timber concession being located within the headwaters of the tributaries of certain rivers[19], if the slopes were dominated by inclinations of more than 40 %, if the precipitation exceeded 2500 mm per year, if the soils were easy erodible or in case of the area being the habitat of rare protected plants and animals (after BPN 1993: 23).

Park management. The new Indonesian conservation law of 1990 (Law no. 5) strengthened the national park status. This resulted in the development and implementation of integrated conservation and development plans, supported at the international level. In 1984 the KSNP office was established in Sungai Penuh, the principal town of the park's enclave. In 1990 the WWF opened its Kerinci bureau, supporting the local Forest Conservation Department (PHPA) in its park management efforts. The KSNP was also declared as a Southeast Asian Cultural Heritage Site in the year 1991 (Radja *et al.* 1994: 20). The Indonesian government has identified the KSNP as a priority area for investment in the National Species diversity Action Plan, because of its high global and national species diversity value and the fact that many of the ecosystems in the park are under severe pressure from a range of external threats.

Within each department concerned with the management and protection of the KSNP, programs were developed to prevent encroachment upon and fragmentation of the park. There were, however, several critical points within these government programs, which, though not restricted to the management of KSNP, represent a rather general problem. At first, they frequently represent a complex of sectoral activities that are not integrated into a single program, but carried through by the respective agency in charge only. Each department tends to create projects within its own sphere of responsibility rather than to strive for cooperation and integrated approaches with other involved agencies. This is due to every agency having its own targets and planning mechanisms (Wardoyo *et al*. 1997: 45). The forest department, for example, focused on resettlement of families living within park boundaries and to enforce border delineation. The agricultural department aimed at improving the agricultural production pattern to increase farmers' income, prevent land degradation and encroachment upon the park territory. This lack of coordination lessens the effectiveness of every single activity and implies a waste of human and financial resources. The second point is that

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[18] Kerinci regency, Gunung Kerinci subdistrict: Batu Hamper, Sungai Betung Mudik, Sungai Betung Ilir, Suko Pangkat and Renah Pemetik.

Sarko regency, Jangkat subdistrict: Tanjung Kasri, Lubuk Mantilin, Renah Alai and Rantau Kermas.

Sarko regency, Tabir subdistrict: Air Liki

[19] Batang Tebo, Batang Ule, Batang Bungo, Batang Pelempat, Batang Tabir, Batang Merangin, Batang Tembesi, Batang Asai and Lengkup.

government programs often are limited to firmly outlined project activities which allow little adaptation or alteration according to the local conditions. This working-according-to-the-plan concept fails to allow for long-term planned programs with proper preparation and follow-up.

A new approach to protected area management, increasingly applied in Indonesia, are Integrated Conservation and Development Projects (ICDPs). They combine conservation - mostly inside the park - with development - mostly outside the park. Whereas former conservation approaches were mainly restricted to the reserve itself, ICDPs aim to meet the needs and aspirations of resident peoples within and around these areas (Miller 1996: 11).

> "The distinctive feature of ICDPs as conservation strategies is that rural residents are induced to surrender access to, or curtail illegal offtake of, native species and their habitats in exchange for alternative sources of income and sustenance, or for the provision of direct compensation, infrastructure, or social services associated with improved standards of living" (Barrett and Arcese 1995: 1073).

By mid-1997, there were roughly 20 ICDPs in various stages of planning and implementation in Indonesia, with KSNP being one of them. The ICDPs in progress cover parks with a total area of 8,5 Mio. ha, 40 % of the country's conservation estate (Kerinci Seblat National Park 1999a: 2). A precursor to the ICDP approach is the Unesco 'Man and the Biosphere'-concept, which promotes an integrated approach to protected area management. It is recently applied in seven protected areas of Indonesia (see chapter 3.1.4). The 1982 World Congress on National Parks in Bali adopted the need to include local people in protected area planning and management, calling for increased support for communities next to parks. This was part of the efforts to link conservation and development in the discussion of sustainable development of the early 1980s (Wells and Brandon 1992: 2 p.). The ICDP-concept first commonly appeared through a joint study initiated in 1989 of the World Bank, USAID, and the U.S. affiliate of the WWF to address global issues of conservation management. The study developed out of the experience dealing with integrated approaches to conservation, much of it derived from the International Biological Program of the 1950s and '60s.

KSNP was chosen as an ICDP site because of its global species diversity importance, and also because the range and complexity of the threats facing the park could not be dealt with by a conventional management approach (Kerinci Seblat National Park 1999a: 5). Current initiatives of the Indonesian government for the management of the KSNP and other protected areas through ICDPs, if not lagging behind their ambitious objectives, could be a promising step towards a development of an improved and more comprehensive system of protected area management in Indonesia. The aims of the ICDP should be achieved through improving national park management and planning linked to rural development activities in boundary villages by means of institutional strengthening, building of institutional capacity and improving of livelihoods.

The rural development component of the projects should be a means to achieve nature conservation, not a purpose in itself. A general problem of ICDPs are the linkages between projects' development components and conservation objectives – or the lack of them. Many development activities can increase local incomes, but will they also enhance the conservation of biological diversity? Although the ICDPs attempt to provide substitutes for resources, to which access has been denied, it is unclear whether compensation and substitution can remove the incentives to exploit. Even more critical is that benefits are directed toward actual or potential agents of park depletion, not the ultimate sources of demand for the resources (Wells and Brandon 1992: 30 p.).

Promoting development activities that not only improve local living standards, but also lead to strengthened park management is a difficult task for ICDP managers. In cases where ICDP projects treated people as passive beneficiaries, they often have no stake in and therefore no commitment to the activities being promoted. These projects were not successful in achieving their goals (ibid.: 47). People who have a stake in the project, on the other hand, are less likely to derail it.

Despite people being better off through development measure, it does not necessarily result in them refraining from illegal exploitation of a nearby park. Strengthening guard patrols and imposing penalties is, therefore, still necessary. Proposed activities should also not be so lucrative as to attract new settlers to the protected area. Improved land use zoning and channelling of productive investments and social services away from the park boundaries could be of further help (Sanjayan *et al.* 1997: 14, 16).

Like most approaches to conservation and development, ICDPs also have their critics. Constraints mentioned related to ICDPs echo those that led to Integrated Regional Development Projects' loss of popularity: they are considered costly, complicated, and not producing the results expected (Uphoff and Buck 1997: 1). Lengthy planning mechanisms result in long implementation delays, possibly leading to loss of interest among the affected communities and other stakeholders. Changing circumstances can also make the detailed plans redundant, wherefore it is often "more efficient to spend less time planning (or even working to existing plans), to be more adaptable during implementation, and to start with small initiatives and build up as different strategies are tried, tested, and modified" (MacKinnon 1997: 59).

The ICDP carried through in the KSNP is jointly funded by the Global Environmental Trust Fond (GEF) and the World Bank (World Bank). It aims at a sustainable management of the park's species diversity and the maintenance of permanent forest cover in the remaining buffer zone[20] concession areas as well as at enhancing the livelihoods of poor households living near the park to prevent

[20] While in biosphere reserves the buffer zone lies within the protected area, in ICDPs buffer zones surround the reserves.

further encroachment and intrusion into the park (Kerinci Seblat National Park 1999a: 2). The project, which started in mid-1996 after a 6-year preparation period, is scheduled for 6 years. It consists of four main components, namely park management, area/village development, integrating species diversity in forest concession management and project monitoring and evaluation. The scheduled project period, however, will need extension, as experience with ICDPs has shown that long periods are needed to elicit local participation and foster a partnership (Wells and Brandon 1992: 64, Sanjayan *et al*. 1997: 19).

3.2 Stakeholders within KSNP and Surrounding Areas

The focuses of this chapter are the diverging interests of the various stakeholders in the park area and its surroundings as well as the resulting problems for KSNP establishment and management. Stakeholders' activities partly pose direct threats to the integrity of the protected area, such as human encroachment, logging, mining, estate development and road construction. Conflicting land use objectives such as those of national and local government, the conservation administration, and local people living within and around the reserve itself are frequently the cause of park management problems in Indonesia (WCMC 1992: 4). The presence of these conflicting interests are made possible or at least are amplified through several weaknesses in the framework as well as in the administration of the park and buffer zone management, based on institutional and policy constraints within the Indonesian protected area management system, as described in chapter 3.1. In the following, the different stakeholders present in and around the KSNP and the interactions between them will be explained.

3.2.1 The Indonesian Government and its Regional Representations

Political level priorities. Up to now, nature protection is not yet a high government priority. When short-term economic interests or other development priorities come into conflict with conservation efforts, the economic perspective almost invariably dominates. This feature is enhanced by the highly vertical organization of the Indonesian government, with each Ministry having its own reporting channels and agenda. Within this administrative structure, nature conservation is the sole responsibility of the Directorate General of Forest Protection and Nature Conservation (PHPA), wherefore other agencies, notwithstanding their frequent significant negative impact on the environment, do not feel a need to become involved in it (The British Council 1996: 17). A better integration and coordination of the policies of all agencies involved in land use planning in national parks and its surrounding areas would be necessary to prevent, that current initiatives to protect the reserves are not jeopardized by activities of other departments pursuing different objectives (World Bank 1994: 4). Nevertheless, there is little consensus about the institutional changes required within the government to foster coordination among the sectoral agencies needing to be involved in ICDP efforts (Barber *et al*. 1995: 3). When, after the implementation of the Law on Regional Autonomy (Law Nr. 22 of 1999), the regencies will be in charge of local nature conservation, new conflicts are prone to emerge. Because regents are mostly not well informed about environmental matters and, therefore, most certainly will prioritise economic interests, the management of national parks in their jurisdiction neither seem interesting nor profitable to them (Kompas 14.6.99: 20). For that reason, district governments increasingly demand that parks contribute to the regional income (Wiryono 2000: 7). In the future, regional development strategies will be important in their impact on the environment. Possible effects may involve, that forest-clearing is made profitable, or that the local industry is capable absorbing workers (Helmuth 1999: 1283).

Intra-government diverging interests. Also conflicts between national, provincial and regional interests might impede conservation goals. An example is the planning of several roads by provincial authorities transsecting the KSNP. The new roads threaten to fragment the reserve into seperate blocks, posing a threat to park integrity by disrupting animal migration and the flow of genetic resources (World Bank 1994: 38). New roads also offer ready access to formerly difficult-to-reach markets, which may encourage previously remote communities to increase their forest harvesting and cultivation of cash crops (MacKinnon 1997: 47). In KSNP, the excessive encroachment for cassiavera cultivation will almost certainly proceed along any new road built through the Kerinci highlands. MacKinnon (ibid), therefore, suggests considering rerouting roads to avoid areas of high species diversity value and undisturbed forest.

For the province and region, infrastructure development and its resulting economic benefits have higher priority than nature conservations with its indirect and less tangible advantages. The national park management does also not receive the necessary support for the management of the KSNP buffer zone from related regional governments, which might have different perceptions concerning the need for nature conservation and KSNP (Wardoyo *et al*. 1997: 46). A harmonious integration of protected areas into larger, regional spatial and land use patterns, having species richness conservation as a major goal, would therefore be necessary (The British Council 1996: 32). Otherwise, KSNP remains "an embattled island isolated within a sea of resource exploitation concessions, new human settlements and expanding access roads" (Barber *et al*. 1995: 25).

The policy contradictions in the above road development case indicate again the lack of cooperation between different government agencies. Also, within the Ministry of Forestry and Estate Crops these contradictions may occur when, for example, a logging plantation development concession is awarded in areas designed as national park. In Gunung Leuser National Park of northern Sumatra, conflicting intra-government decisions at different administrative levels have resulted in the deforestation of large areas. West Sumatra and Bengkulu, for example, would like to develop the area around the parks for tree crop plantations by supporting road construction through and around the park, whereas Jambi rather appreciates the conservation value of the park due to its proneness to flooding (Kerinci Seblat National Park 1999b: 2). Hopefully, the further development of implementing regulations of the Law on Regional Autonomy will contribute to resolve conflicts between national, provincial and regency interests and to settle protected area boundaries in a way that both conservation and community development goals can be achieved. Also between regions, different priorities occur.

Competences at regional level. At the provincial and regional level, the major constraints for an efficient park management are that spheres of competence within administrative units, as well as between different administrative units, are not defined clear enough. Although exchange mechanisms between authorities at the different administrative levels exist, they frequently do not function and remain formality (Wardoyo *et al*. 1997: 45). A transparent regulation of the jurisdiction of each office would make cooperation between agencies more easy and efficient. Concerning the management coordination of protected areas and their surroundings between the provincial administration and the Ministry of Forestry and Estate Crops, up to now no official regulation exists. This lack of coordination causes problems for the protection of reserves spread over several provinces and districts (World Bank 1994: 9). Even within the Ministry of Forestry and Estate Crops itself, the vertical coordination and the coordination between the different sub-offices at regional level is not yet optimal, which can cause the failure of operations. The frequent absence of office heads in certain districts also discourages the coordination between the different agencies (Radja *et al.* 1994: 105 pp.). Furthermore, management plans of national parks are not linked yet to provincial or regency spatial plans, or no integrated management plans exist at all. Promising initiatives, however, are the recent incorporations of conservation and protection activities into local government regulation and programs in the provinces Jambi and South Sumatra, as well the districts Kerinci, Sarolangun-Bangko and Musi Rawas (Kerinci Seblat National Park 2000: 1).

3.2.2 Environmentalists

The strongest lobby for nature protection in Indonesia in general and the KSNP in particular certainly is represented by national and international NGOs as well as by representatives of international governments. The lobby manifests itself within several international treaties for nature conservation, to many of which Indonesia also is a contracting party (see chapter 3.1.4). In many cases, however, participation in the treaties lack legal and practical follow-up measures at the national level. International NGOs and governments, who would like to see Indonesia's environmental riches protected as a global heritage, try to convince the Indonesian government through financial and institutional support correspondingly. Indonesia often gladly received this assistance, but due to economic interests, legal and practical enforcement remains limited (see chapter 3.2.1).

In KSNP, several local NGOs join the WARSI network cooperate with the World Bank and the WWF as well as representatives of the Indonesian government for a joint park management (see chapter 3.1.6). As already mentioned for the general picture, however, the presence of several diverging stakeholder interests in that region, conservation measures lack the political support of all government agencies concerned to actually prevent infringement and achieve successful conservation of KSNP.

3.2.3 Commercial Stakeholders in the Park's Surroundings

Another category of stakeholders is represented by the various commercial endeavours adjoining the KSNP. The park is surrounded by timber concessions, estate crop areas, mining concessions and transmigration settlements. Most of the surrounding forests not slated for logging are allocated for clearing and conversion to non-forest uses. These stakeholders and their allies frequently try to extend their concession area into the protected zone by legal means or otherwise.

Logging. Natural production forests being recently logged or which have already been exploited are found in a 2 km to 20 km wide belt around the KSNP. Some areas are covered with lowland vegetation and habitat types not represented within park boundaries (World Bank 1993: 15). Seventeen logging concessions belonging to 12 companies border almost the full length of the park boundary in Jambi and Bengkulu. The timber concessions mainly stretch over lowland and hill forests, which are extremely rich in species diversity. Several hundred hectares of the KSNP became reclassified as production forest in 1985 and the following years, only to be added again to the park in the late 1990s. Nearly 70 % of these areas lie in hill systems that meet official government criteria for watershed-protection forest (Barber *et al*. 1995: 26). Almost all concessions have already logged their whole area, so that undisturbed forest now only remains on very steep hills. The concession areas are leased for 20 years to private sector logging companies. They have to comply with the regulations of the Indonesian Selective Logging System, allowing them only to cut trees of more than 50 cm diameter.

The control of the concession area by the forest administration is still too low and ineffective, so that overlogging and encroachment upon the park territory was not prevented. Among other reasons, this is also caused by the lack of personnel, transportation and other equipment facilitating an effective control system. Encroachment upon the territories of protected areas by logging concessions, therefore, has become a common problem in Indonesia (Rulianto and Andari 2000: 100). Also, the supervision of the *modus operandi* of the timber concessions has been inadequate, so that logging practices have been extremely destructive both to the forest and to watershed values (World Bank 1994: 8). Road construction and maintenance in particular, as well as prevailing management practices in general, are causing severe soil erosion and a consecutive siltation of rivers. In order to ensure sustainable forest management practices in the park buffer zone, the ICDP-KSNP supports independent concession monitoring (Kerinci Seblat National Park 1999a: 4).

Mining. Eight gold and coal mining concessions are currently located in the KSNP and its surrounding areas. One concession is located completely on park territory, five are present in the border area and two have their operational area adjacent to the park boundary. Many of these mining companies are still in the explorational stage and it is not certain yet whether economically viable resources will be found (World Bank 1994: 8). The ICDP allows exploration to continue for five years. If no viable deposits are found during that time, the concessions will be cancelled without compensation (Barber *et al*. 1995: 28).

In some areas, particularly in Bengkulu, traditional gold mining practices are continuing within the park. The processing of the gold results in mercury being released into the waterways, which harbours serious health risks for animals and humans (Kerinci Seblat National Park 1999b: 2). Besides, underground mining causes the collapse of trees, rockslides from higher elevations as well as pollution through litter discarded in the area (WARSI 1994: 25). The Rupiah depreciation due to the Indonesian economic crisis has boosted export incentives for minerals, having potentially important impacts on forests cover (Sunderlin 1999: 14).

Estate development. In many areas of Indonesia, large scale monoculture plantations planted with palm oil, rubber and fast growing timber species developed in response to global demands have resulted in displacement of traditional villages (Moniaga 1993: 7). In the KSNP border area, tea plantations have been established since the 1920s. More recently, oil palm, cocoa and rubber plantations have been developed near the park. Additional estate-crop development is planned for the lowlands of Bengkulu to the west and Jambi to the east of the park. In theory, these plantations provide employment in the park buffer zones, but wages are so low that local people generally prefer other work (Barber *et al*. 1995: 28).

The estates also have an indirect effect by displacing local communities who then open agricultural land within the park. Poverty is no longer the main cause of deforestation. Big plantation projects are more likely to contribute to deforestation than are small farmers (Helmuth 1999: 1283). In seven villages in the Central Sumatran province Riau[21], for example, shifting cultivators cleared a maximum 200 ha of primary forest (and approximately 1.400 ha of all types of forest) in 1998. The two oil palm projects present nearby, however, were about to convert 14.000 ha (Angelsen and Resosudarmo 1999: 10).

Theft of forest products. Another pattern of forest utilization is the illegal exploitation of timber and non-timber forest products such as wild game from the reserve. These practices have been intensifying since the onset of the Indonesian economic crisis, which started in 1998 (Wiryono 2000: 7). According to the WWF[22], also in the boundary areas of KSNP encroachment and illegal logging has intensified since the onset of the Indonesian economic crisis in 1998. This is a general feature in Indonesia, taking a serious toll on conservation areas and protected forests. A third to half of national park managers believe illegal logging by local people has increased during the crisis (Sunderlin 1999: 9 p.).

The authoritative support illegal logging is receiving in Indonesia is indicated by the fact that illegally cut timber is supplied with "official" documents, so it can enter the domestic market without problems. Only rarely do reports enter the news about the interception of shiploads due to the invalidity of their documents. Resulting, the Indonesian timber processing industry statistically produces much more output than the official amount of logged wood should allow for. According to figures from the *Indonesia-UK Tropical Forest Management Program*, the combined log consumption capacity of the plywood, sawn wood as well as pulp and paper industries is currently on the order of 75 million cubic meters per year. The official harvest according to the figures of the Ministry of Forestry and Estate Crops, however, averaged just below 25 million m^3 per annum over the last few years. This indicates that these industries have obtained between one-half and two-thirds of the logs they consume from illegal and presumably unsustainable sources (Purnomo 2000: 4). The ministry also confirmed that illegal logging produced about 30 million cubic meters of timber in 1999. This means that the amount of wood originating from illegal logging exceeds those from legal concessions. At an average value of US$100 per cubic meter raw logs, this means losses of about US$ 3 billion for the Indonesian state. This sum is equivalent to 64 % of the new credits from CGI (*Consultative Group on Indonesia*) for the year 2000 (Kompas 19.2.2000: 10).

In Kerinci-Seblat, according to the WWF (see previous footnote), businessmen mainly use local people as an instrument for the logging operations. As an adaptation to the supervision of forestry officials, the logging activities are generally carried out in the middle of the night. Theft of forest

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[21] Bordering Jambi and West Sumatra in the north and east respectively.

[22] Personal communication Mr. Mas'ud, WWF-Project Manager for ICDP-KSNP in Sungai Penuh, 10.5.2000.

products is not carried out by local peasants, but frequently by people from outside the area. Also, those who are exploiting the resinous wood *gaharu* or hunting protected animals are often hired by certain people from the city, or at least there are already special places at the market, where the stolen goods can be sold (Indrizal *et al.* 1992: 97 p.). Especially in famine seasons, local people have always turned to the theft of forest products (Bappeda 1991: 10). The forest goat and deers are trapped for their meat, while the banded leaf monkey is sold stuffed for indoor decoration. Macaques, where they damage crops, are poisoned, while the common palm civet is caught and sold as a pet (UNDP/FAO 1981: 23 p.). Local villagers also sell several bird species. Commercial hunters target deer, tapir, the Sumatran Rhino (for its horn), and the Sumatran tiger (for its bones – a valuable ingredient in many Chinese medicines – and its skin) (Barber *et al*. 1995: 24). The key to combat encroachment according to the WWF ICDP-KSNP director, Mas'ud, is law enforcement. The position of PHPA would basically suffice as it is. Getting the culprits should also be easy, as there is usually only one road or river leading to the area of illegal timber exploitation[23].

However, even the forest police admitted to being unable to stop the illegal loggers. These would usually turn up in large groups, which would assault the patrols when confronted by them. This kind of daring behaviour, ignoring every authority, is untypical for Indonesia and hints again towards a strong backing of these groups. Representatives of the Department of Forestry and Estate crops have named groups from the Indonesian military to back up illegal logging in national parks (Rulianto and Andari 2000: 100). In Jambi, the armed forces, police, regional government and forestry service are involved in the illegal timber exploitation of the province's national parks, including KSNP. During routine operations of the forest police, the activities resume again after a few hours. Every day, 400-500 trucks of 5-7 m^3 illegally logged timber each are said to enter the plywood, moulding and sawmill industry around Jambi city. On the way there from the logging area, the trucks pass seven to eight security posts (Thahar 1999: 19). In the North Sumatran Gunung Leuser National Park the theft is said to involve timber barons as well as the military and police, plus even conservation authorities, acting to take advantage of a power vacuum (Sunderlin 1999: 10). In the Sangir sub-district, Solok regency, West Sumatra, the area of a former concession bordering the KSNP is heavily exploited for the remaining timber, inhibiting a regeneration of the logged forest. The forestry officials and the regional government do not dare to stop this exploitative practice because, again, members of the armed forces are said to support the local people in their logging activities and even transport the logs on their trucks (Radja *et al.* 1994: 108

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23 Personal communication 10.5.2000.

pp.). Furthermore, a total of 27 illegal sawmills operate along the KSNP boundary[24]; their activity also receives official protection.

3.2.4 Local People Living in and around the Park

Of the 486 villages having common boundaries with the park, some 134 have agricultural lands opened within the park area and acute boundary disputes exist (table 6, see also fig. 3). Most villages range between 20 and 30 square kilometres, and have populations of several hundred to more than a thousand persons (Schweithelm 1994: 4). Encroachment upon the park stems from three different sources: First, from local people living outside the park, cultivating cash and subsistence crops. Second, from local people living within agricultural enclaves inside the park, and third, from sharecroppers who live outside the park, cultivating cassiavera on slopes along roads that transect the park. People gain access to the park boundary area through a well-established provincial and regency road network and through gravel and dirt tracks that bisect the park (World Bank 1994: 7 pp., 39). Encroachment is worst on the slopes above the Kerinci enclave, along the three main access roads and, to a lesser degree, on the external boundaries of the reserve (WCMC 1991: 7). The encroachment problem might be worsened, if current road development plans would be realized, possibly causing a “chain reaction”[25] of major disturbances.

Table 6: Distribution of villages adjoining the park

Province		***Number of villages***	
	Total	***Entering park area***	***%***
Jambi	298	62	47
West Sumatra	105	27	20
Bengkulu	39	35	26
South Sumatra	26	10	7
Total	468	134	100

Source: WWF Kerinci and Bappenas 1994, quoted in: World Bank 1994: 7

The encroachment upon the territory of the KSNP steadily increases in area (table 7). By mid-1998, the total area estimated to be under cultivation within KSNP was recorded as 38,415 ha. This figure consists of areas where families are resident (1,085 families cultivating 1,665 ha) and cultivated areas (mainly tree crops) where the encroachers reside outside park boundaries (36,750 ha tended by 25,973 families) (World Bank 1998, Annex 2: 1). These lands are mainly planted to cassiavera,

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[24] According to the World Bank consultant Paul Japsen, as cited in Kompas, 25.3.2000.

[25] DHV 1993, in: Barber *et al*. 1995: 28.

while annual clearing for smallholder shifting cultivation does not exceed 1,500 ha (Barber *et al.* 1995: 24).

Forest land conversion has not been combated effectively due to a lack of personnel and transportation within the responsible agencies. Since the onset of the Indonesian economic crisis in 1998, encroachment upon the KSNP territory has been even more rampant (Wiryono 2000: 7). This feature originates in a lack of law enforcement and a power vacuum, because the economic and political crisis undermined the authority of the state (Angelsen and Resosudarmo 1999: 4).

Table 7: Encroachment and enforcement activities in financial year 1997/1998 by district (Kabupaten)[26]

	Kerinci	***Sarolangun Bangko / Bungo Tebo***	***Musi Rawas***	***Rejang Lebong***	***Bengkulu Utara***	***Pesisir Selatan***	***Solok / Sawah-lunto***
Number of prosecutions	6		4			1	
Sawn timber seized (m^3)	11.164		13				
Illegal logging (ha)	273	36.5	19	47.5	36	99.85	
Area (ha) encroached (resident cultivators)	161		1,723		1,504		
Area (ha) encroached (non-resident cultivators)	11.132	105		953.5	814	1,253	679.5
Chainsaw confiscations	9						

Source: World Bank 1998, Annex 2: 1

General causes for farmers expanding into primary forest land are manifold. One reason is that the course of the border was not clear until recently in many areas; another, that economic reasons force the peasants to cultivate more land. Also, general information about the national park and its uses and functions is low among the rural population (Radja *et al.* 1994: 95). In the following section the different patterns of local forest utilization and conversion will be described.

Cassiavera cultivation. Farmers who are opening new fields within primary forest at altitudes higher than 300 - 400 m a.s.l. generally plant their fields with cassiavera, one of the main and highest priced cash crops in the region. The Kerinci enclave, in particular, has grown heavily during the last decades. As a tendency, the price gained for agricultural products increases more slowly than the price of other needs and services; this process also forces the farmer in the enlargement of his agricultural land or to sell his produce earlier. Many farmers from traditional villages, who open fields in the primary forest, don't move there themselves but employ contract workers. These farm

[26] The greater number of incidents in Kerinci and Musi Rawas is believed to reflect greater enforcement efforts in these districts (World Bank 1998, Annex 2: 1).

labourers come from West Sumatra, Java or Jambi, however there are also local peasants cultivating land owned by people from outside. This production pattern allows farmers to expand their agricultural activities beyond the size of land which he and his family are able to cultivate themselves (Indrizal *et al.* 1992: 84 p., 126 p.).

However, not only small farmers are engaged in cassiavera cultivation. Because of its profitability, even government officials, members of the army and people originating from Kerinci who have already become successful abroad are also investing in cassiavera cultivation (ibid.: 110). Population growth, in-migration and rising needs pose a steady pressure for expansion, leading first to the creation of temporary camps and shelters near the new fields, which are generally located in the forest far from the village. In the course of time, these settlements become permanent and develop into villages. After the new settlements have been established, they also attract further migrants from other areas, also looking for arable land (ibid.: 55, 78 pp.).

Shifting agriculture. According to the local people, a new *ladang* or upland field is generally made within secondary vegetation because undisturbed primary forest is already too far away from the village. In general, shifting cultivators prefer secondary forests above primary forest for a prospective swidden because "the clearing of primary forest requires much more man power for a given area and demands a longer drying period before burning can take place" (Conklin 1954b: 137). The low weed pressure, on the other hand, is considered an advantage of fields opened newly from primary forest by the farmers (Behrens 1989: 93), as is the abundant nutrient provision by the burnt biomass (Marten and Vityakon 1986: 204).

The KSNP boundary zone, like in many other areas in Indonesia and other countries with tropical rain forest, primary forest areas, which have become accessible by a logging road system, is entered by entrepreneurs and local farmers (cf. Gouyon *et al*. 1993: 195). The forests therefore cannot regenerate as intended after having been logged according to the Indonesian selective logging system in that area, but becomes converted into agricultural use through shifting cultivation.

3.2.5 Conflicts Resulting from Contradictions between Customary Land Rights and National Law

A frequent conflict in Indonesia is the divergent view of local people and the government concerning the ownership status of a certain piece of land. Since Dutch colonial rule, forest land is considered property of the state, falling under the authority of the forest department. This is the case in most Southeast Asian countries - "governments claim exclusive ownership over most forests and coastal waters, whether or not people are already living and working there and whether or not governments have the capacity to actually manage them" (Barber 1996: 15). As defined in the

Indonesian basic forestry law, all forested land that is not under actual cultivation, although it might be fallowed, belongs to the state. According to customary law, the family having opened a piece of land in primary forest will be it's rightful owner, even if it consecutively lays fallow and is not planted with crops. A person has user rights to a piece of land, as long it is under cultivation. When the land is fallowed, it automatically returns to the extended family. Though not under actual cultivation, fallow lands are neither unmanaged and unused by the rural population, nor 'lying idle', as state officials perceive it. Fallow lands are an important source for medicinal plants, handicraft and building material as well as for food plants such as fruits and vegetables. Primary forests are also often used for non-timber forest products by local communities and therefore considered communal property located on communal lands (*tanah adat*). This usually concerns the forested areas between two adjacent villages, whose borders are determined by customary law, or the area traditionally used for hunting and gathering.

Restricting patterns of traditional use. Local people feel treated unfairly if they are not allowed to collect trade products such as rattan lianas in the forest concession areas. The people have traditionally always collected various items in the primary forest, some for own use or consumption, some for sale. Because there are very few crops or products, which can be sold by the villagers, they feel severely hurt by this regulation. For the past 25 years, anybody wanting to collect rattan intended for sale in the concession area must get a permit first. The permit is issued for 3 or for 6 months and must be paid. According to an official of the National Park Office the permit is very cheap, but according to the local people it costs several hundred thousand Rupiah (i.e. > 50 US$). Although this amount seems to be an over-estimation, it is possible that the local people are sometimes charged more than the actual fee, which might not be known to them.

Acknowledgement of traditional land rights. The contradictions between customary and national land rights have produced a long story of conflicts between shifting cultivating communities and the forest authority. Both claim to be the rightful owner of the land, but the latter generally lose out and have successively become the national scapegoat for forest destruction. Forestry agents tend to threaten the local communities with punishments, if they don't change their land use practices. This frightens and angers the peasants. They do not understand why, on the one hand, people from outside may extract huge amounts of wood, or plant wide areas of land but, on the other hand, they should not even be allowed to take some trees or open a small field to have enough to eat. Farmers might also be driven off their land to make place for government-sponsored transmigrants from outside. This simply does not make sense to the local people.

The introduction of continuous cultivation systems such as irrigated rice fields, and later, tree crop gardens, lead to the development of permanent, inheritable user rights and finally, private land ownership. The problem is, however, that most people in boundary villages live and farm on *adat* land, having no official certificates proving their ownership. Land certificates are expensive and require time-consuming bureaucratic procedures. The lack of them, however, makes families vulnerable to loss of land through park boundary adjustment, commercial logging or tree crop estate development (World Bank 1994: 8).

In general, the Indonesian government only recognizes forested lands planted to tree crops as being under use and therefore may be rightfully claimed as customary lands. If fields planted with tree crops later are claimed by the government or commercial owner, farmers are entitled to financial compensation (*ganti rugi*). This rule, however, has adverse ecological effects, because it pushes people to plant tree crops on as much land as they can, particularly in cases of increasing land pressure (cf. Gouyon *et al*. 1993: 193, Colfer 1994: 18). Also, Gunawan and Abdoellah (1994: 14) note in their study on East Kalimantan that logging activities in or near traditional village lands may create some kind of 'competition' and conflict between local people and concessionaires. The forestry officials are well aware of that practice, blaming it on the lack of education and stubbornness of the peasants. A common policy to alleviate that problem is the relocation of infringing settlements.

Historically, Indonesia's land use laws are based on the Basic Agrarian Law from 1960, which itself is grounded explicitly on customary law *(hukum adat)*. The Basic Agrarian Law again is based on the agrarian law introduced by the Dutch colonial minister De Waal in 1870. The law regulated land property rights, including regulations concerning the sale and lease of land. All land that was claimed by the local population according to customary law was not allowed to be sold to foreigners, whereas all other land was declared as belonging to the state. Unfortunately, ambiguous formulations within the Basic Agrarian Law lead to applications disrespecting traditional ownership (cf. Moniaga 1993: 7):

> Adat law applies to the earth / or land, water and the air as long as it does not contradict the national and state interests, based on the national unity with Indonesian socialism and also other related regulations within this law and others, all in respect to the religious laws (Basic Agrarian Law No. 5 / 1960, Article 5).

Also in many other countries with part of the population being traditional societies, traditional land ownership is not recognized in accordance with the customary law of the respective societies e.g. Ecuador (Macdonald 1993), the Philippines (Bennagen 1993) and Kenya (Matampash 1993).

Due to the unclear position of customary law against national law, inadequate attention has been paid to mechanisms for compensating affected parties when traditional land or natural resource use rights are surrendered in the broader national interests of species diversity nature conservation. Expert legal analysis of customary land tenure and the areas of conflicts with government interests are needed for each conservation area. Besides an accurate assessment of the conflicting interests in each area of boundary and resource use conflicts, practical measures for law enforcement and for compensation of local people are necessary for cases where conflicts cannot be resolved (The British Council 1996: 16, 24). Recently, the Bureau of Lands has issued potentially groundbreaking "Guidelines to Resolve Adat Communal Rights Conflicts", which will spell out criteria for the recognition of customary common property rights[27].

3.2.6 Diverging Stakeholders' Interests

In Indonesia a high level of diverging interests exists among different stakeholders who wish to maintain forest land as it is and those who wish to use the forest for other purposes, such as economic tree crop and timber plantations (Kartodihardjo and Supriono 2000: 10). Also in the area and surroundings of KSNP the different interests of the respective stakeholders regarding land utilization patterns inevitably leads to conflicts. The common constraint most of them feel is that the protected area legally inhibits their targeted use of the forest and its land. Nevertheless, because of the weak lobby and law enforcement of nature protection in Indonesia, non-conservative interests frequently gain supremacy. Both nature of the local economy and location of the park present formidable conservation obstacles. The long and narrow shape of the park adds to its vulnerability to fragmentation (MacKinnon 1997: 48). The following section describes existing stakeholder conflicts and how they are currently managed.

Government-farmers. One major factor causing conflicts between government and farmers, the legal contradictions, has been mentioned in the former section. In practice, this has severe implications for nature conservation. In KSNP, the conflict already took off in the colonial era. In 1929 forest reserves were established surrounding the Kerinci valley and the use of forest lands became prohibited the by the colonial administration. Upon this, the local population responded with massive planting of cassiavera gardens to mark their territory and a highly developed concept of private ownership of land and resources linked to the introduction of commercial crops (Watson 1987, in Aumeeruddy 1994: 33).

Also the national government invented several regulations to prevent uncontrolled agricultural expansion into the protected area. Because the agricultural production pattern demands for an opening of new fields, these prohibitions caused heavy unrest among the farmers. Clashes between peasants and the forest guards occurred frequently. These kinds of conflicts are typical when long-standing land use patterns suddenly face government restrictions and are considered illegal (Fisher

27 Fay C and Sirait M 1999. Reforming the reformists: Challenges to government forestry reform in Post-Suharto Indonesia. Unpublished manuscript. Cited in: Sunderlin 1999: 18.

and Mulyana 2000: 124). The foresters act in accordance with their duty, whereas the peasants defend their traditional rights implying that land is a gift from God which anybody may posses. There is also some kind of adaptation of the farmers to the threat posed by the forest guards; namely by paying bribes to the officials, so they keep a blind eye on the farmers' activities. Another strategy of the peasants to avoid confrontations with the forest guards is through opening fields in the middle of the forest at places invisible from roads (Indrizal *et al.* 1992: 96 p.).

One approach to tackle the problem of encroachment upon the protected area by local people and immigrants has been resettlement programs. Poor households are encouraged to join voluntary resettlement schemes, financed by the local government. However, this measure is less effective because the amount of people newly encroaching upon the area is still higher than the amount of people who got resettled successfully (Bakosurtanal 1990: 15). Therefore it became obvious that unless the friction between peasants and conservationists is not resolved, there will be no safety neither for the park boundary nor for adjoining forest lands.

Unfortunately, there is still a lack of understanding on behalf of government agencies of what factors really trigger encroachment and how to overcome them. Usually, only local people's poverty and insufficient education about the benefits of nature conservation are mentioned. Resulting, information measures and the creation of income opportunities are already considered remedies to achieve nature protection. The roles of land tenure conflicts and diverging local perceptions, or even the presence of other stakeholder interests and political priorities, are not considered. This approach puts the whole blame for environmental degradation on the local people all over again[28], which is one major reason why nature conservation has been blessed only with limited success in Indonesia.

Nature conservation-economic interests. Probably the most important stakeholder conflict endangering the integrity of the park occurs between those pursuing economic interests versus those advocating nature conservation. Most local governments do not recognize the importance of the park, which provides no direct revenues for them. On the other hand, they receive local taxes from cassiavera and other tree crops grown in the park. Subsidies from the central government have been suggested to make them more supportive of park management activities (Kerinci Seblat National Park 1999a: 5).

> "The ecological and environmental benefits of protected areas and natural forests are almost never fully recognized or acknowledged, yet such benefits as the protection of watersheds and soils and the conservation of genetic resources may far outweigh the 'costs' in lost development opportunities" (MacKinnon 1997: 46).

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[28] Several papers presented during a symposium on "Rainforest Protection and National Park Buffer Zones" in Jakarta, 7.2.1991, organised by the Directorate General of Forest Protection and Nature Conservation and DHV/RIN Consultancies.

There is plenty of encroachment of logging concessions, commercial plantations, mining companies and the like upon the park territory. The blame for forest conversion and loss of species diversity has always been put solely on the rural population, probably because of a fear to hurt the economic interests of more powerful stakeholders. The forest service (*Dinas Kehutanan*), which, with its forest police, should safeguard the forests of illegitemate exploitation, is often unable to combat the theft of timber and non-timber forest products sufficiently due to a lack of personnel, communication and means of transportation (Bappeda 1991: 10, Kompas 14.6.99: 20). There is also still a need for clear procedures for conflict resolution, such as in matters related to the exploration and extraction of minerals and oil in protected areas (The British Council 1996: 24).

If there would have been a political goal to prioritise species diversity conservation, at least within those areas declared as reserves, these problems would have been addressed consequently and there would be a stricter control of plantation development as well as logging and mining practices in areas surrounding parks. Furthermore, the law enforcement agencies would have been equipped with sufficient funds and staff to be empowered for effectively enforcing the park boundary and to manage and monitor the park and its surroundings; and certainly there would have been more decisive steps to ensure an optimal cooperation and coordination between all agencies involved through an elaborate system of laws and regulations. But, understandably, the national priority had been on economic development during the last decades, wherefore the management and legal enforcement of protected areas was left behind.

Role of ICDP-KSNP. Contributing to the resolution of stakeholder conflicts in KSNP, the ICDP component concession management has assisted the Ministry of Forestry and Estate Crops to manage and stabilize the remaining lowland forest areas in the boundary zone through a review and reallocation of the concession areas adjoining the park as permanent forest production management units. Within this process, the Ministry identified areas of high species diversity or watershed conservation value to be left unlogged within the concession or returned to the park. Furthermore, the project provides technical assistance through training, surveys, monitoring and independent audit of forestry conservation practices.

An incorporation of species diversity conservation into the regulatory guidelines for interprovincial spatial planning and regional planning practice at national as well as at provincial level is necessary for successful nature protection. Before the onset of the ICDP-KSNP there had been no initiatives yet to coordinate regional development efforts to relieve pressure on the park (MacKinnon 1997: 48). The ICDP-KSNP assists the Ministry of Planning (BAPPENAS) and the Ministry of Home Affairs, Regional Planning Directorate (BANGDA) in reviewing the related regulatory system for planning as well as interregional spatial planning for the four provinces covering the park, and strengthening the regional and spatial planning capacity of provincial and regency planning agencies (BAPPEDA) for the nine regencies covering the park (World Bank 1994: 12 p.).

The ICDP aims at including all parties involved in planning, execution and coordination of the KSNP management to improve their cooperation and participate actively in a common management approach. To qualify all stakeholders fulfilling their respective role and function within the project, several services, especially in consulting and extension, as well as funding to upgrade existing facilities, are provided. For the success of the project, however, it is vital that all parties commit to the common management plan, and that they are enabled and use their ability to fulfil their respective role and function. Monitoring and supervision is applied to prevent stakeholders from neglecting their responsibilities or prioritising other vested interests, which could be disadvantageous to a fruitful project implementation.

Conclusions. Considering the complexity of the different stakeholder interests, finding an easy and quick solution is certainly impossible. Long, intensive and genuine communication is necessary to arrive at a win-win solution. Still, without strong institutions for nature conservation and an appropriate education (and salary) for its personnel, without sufficient legal regulations and enforcement, all that communication will not bring the envisioned results. Important is also an adaptation of the general development context surrounding KSNP to the park's existence. Plantations, roads, resettlement sites, mines or other intensive forms of development should be prohibited around protected areas, since these inevitably form the springboard for encroachment (Barber *et al*. 1995: 50).

3.3 Local People's Perception of Primary Forest and the KSNP

3.3.1 The Mystical Importance of Forest

Traditional ecological knowledge, which will be described in chapter 6, finds its for the Western scientist most understandable materialization in those expressions, which are similar to those in the Western world, such as ethnobiological classifications. The evaluation and perception of the natural environment, however, is also influenced by spiritual aspects (Müller-Böker 1988: 120). Traditional belief systems, including traditional ceremonies in connection with the cultivation cycle or taboos concerning human behaviour in the forests, also reflect a society's traditional regulation system for environmental management. Much knowledge in traditional societies, however, also is transmitted in the form of stories and legends, using metaphors and sophisticated local terminologies that may not be well understood by outsiders or even by younger people of that society itself (Johnson and Ruttan 1992: 52).

The peasants living in the border area of the KSNP regard the forests near their villages as being a sacred place, which belongs to the ancestors that founded the settlement. This attitude towards forests has also been detected among the inhabitants of the Kerinci enclave by Aumeeruddy (1994: 15). The people believe in the existence of spirits, which live in and guard the forest: evil spirits and tigers who will get angry and punish the people if certain taboos are not respected. Also in other traditional societies, such as the Dene in Canada, animals are often attributed with human or even supernatural qualities in folk legends (Johnson 1992: 60). Societies having a close spiritual connection generally seem to believe in the presence of goddesses and ghosts in the forests who can be offended through the wrong behaviour (e.g. in Nepal, Müller-Böker 1988: 120). While these taboos shall not be discussed here in detail, their existence proves that the attitude of the villagers towards the forest is respectful and submissive to the powers deemed owning it. This attitude becomes still clearer being aware of the fact that every opening of primary forest involves traditional ceremonies conducted by the village shaman (*dukun*). This ceremony is called *malambe* and requires several gifts, which have to be treated with a magic formula by the shaman: three leaves of the betel pepper (*sirih*), three cigarettes, incense from benzoin gum (*kemenyan*, bot.: *Styrax benzoin*), plus eventually lime and matches or either resin from the *gambir*-vine (*Uncaria sp*.) and soda. After the gifts have been prepared, they are carried into the forest which is going to be opened. Then (in Pemunyian) a small quadratic hole is dug, fenced with twigs; then the incense is burned and the shaman reads a magic formula. Or, as in Lubuk Malakko, two pieces of wood are stuck into the soil, and the gifts are placed upon it. Only after this ceremony, which takes three days, has been carried out, the trees in the prospected field may be cut down.

The purpose of the *malambe* is to ask for permission and protection of the forest spirits while opening the forest. Similarly, also in the Philippine' Eastern Visayas a traditional ceremony is carried out to ask permission from the invisible forest dwellers who, when neglected, cause bad luck (Pielago *et al*. 1987: 13). In Lubuk Malakko, however, there are already many people who do not know about *malambe* any more, and who claim that there would be no customary rules related to primary forest. However, in any case no outsider is allowed to open a piece of forest near the village as he likes. In Lubuk Malakko, people from outside have to be adopted by 'step-parents' first and then they have to pay '*pusako mudo*'[29] in form of cigarettes and bananas to the young people of the village. This formality is used to let them know that there is an outsider who is now already considered as an inhabitant of Lubuk Malakko. About how outsiders can become members of the local communities, similar procedures have been reported for the Kerinci valley by Indrizal *et al.*

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29 *Pusako Mudo*: 'young heirloom', referring to the customary heirloom of the Minangkabau. *Pusako Tuo* is the 'old heirloom', which is irrigated rice fields and the house, which traditionally cannot be sold but are inherited from the mother to her daughters.

(1992: 118): there the candidate has to make a ritual meal and invite the customary leaders so he becomes recognised by the village community as one of them, having the same rights and duties as they do. Considering this procedure, it is not very difficult for outsiders to own agricultural land in the border area of the national park. In other villages of the Sangir sub-district, a part of the people who want to open a field in primary forest ask for permission from the village head, but most people do not ask for permission at all (Radja *et al.* 1994: 70). It is criticized by the regional government that the village chief does not report the local forest conversion to the head of the sub-district, because he does not feel responsible (ibid.: 108).

In Dusun Birun, *malambe* is not known. There, anyone wanting to open a field from primary forest had to ask permission from the *ninik mamak*[30], the head of the extended family and nowadays also from the village head (*kepala desa*). Many peasants, however, did not acknowledge any traditional laws concerning the use of primary forest anymore.

Concerning the spirits that reside in the forest, most important is the tiger. He is considered as equipped with magic powers, and if his taboos are respected he can help the villagers through warning them from disasters or even assisting them in finding their way back to the village if they have lost their way in the forest. Evil spirits, such as the *bunian*, who looks like a human being but can also be invisible, may lead people into the forest so they won't find their way back. The *bunian*, living in the hills and the forests, is also responsible if the ears of the rice remain empty, because it is known to 'borrow' the rice. The rice ears look undamaged, but the seeds inside are lacking. Therefore, at the edges of the ripening rice fields, several magic plants have to be placed, so that the *bunian* is warded off. The belief in the *bunian* and the magic tiger seems to be widespread in the Minangkabau area. Also in the coastal area at the border to Bengkulu province (South Pesisir Regency) the story of these supernatural creatures has been reported (Stenger Frey 1986: 16). Some of these supernatural beliefs, such as the story of the *bunian*, could be local explanations for crop pests or even nutrient imbalances, which cannot be identified by traditional means. Magic plants to ward off the *bunian* could even be a natural means of biological control, an interesting field for further investigations.

Sacred places, such as the hill Bukit Batu Balah in Lubuk Malakko, are inhabited by the ancestors who have founded the village. At that hill a big, mossy stone is found, whose surroundings are said to be always strangely clean from litter. Around that place grow many fruit trees. Who ever comes to that location, which cannot be sought on purpose, but can only be found if one gets lost in the forest, may eat of these fruits as much as he pleases. However, it is forbidden to carry any of these

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30 *Ninik mamak*: uncle or male sibling of the grandmother, head of the extended family according to Minangkabau-customary law.

fruits home, and whoever tries to take fruits with him, will not find his way back. Holy places like this are forbidden to clear for agricultural purposes. People who have tried to cut down trees at that hill have been reported to become severely ill afterwards and never to recover again.

All these customary laws are aimed at restricting people's access to the forest, so it will not be cut down in huge areas, but only as small fields necessary for the individual use. Ceremonies before cutting down any trees indicate people's honour for the forest and its spirits, and also guarantee collective control over the resource that may not be depleted by individuals for their own purpose.

3.3.2 Acknowledgement of Forest Protective Function

Besides peoples' conviction that the forest is a holy place, which is inhabited by various supernatural creatures, as it has been discussed above, people also regard the existence of the forest as a precondition for a prosperous life and as literally being the "source of life" for the whole village. This concept is shared by many other traditional communities in forest areas, such as several Philippine tribes (Bennagen 1993: 68p.) and the Dayak of Kalimantan[31]. While, of course, local people may not have abstract concepts on species diversity, they also have important reasons to want the forest to remain prolific and undamaged.

People would not deliberately deplete or cut down the forest, because they are convinced that "a damaged forest will make our life difficult and we will live in misery". Forest has many functions for the peasants living around it. The primary function of forest is to be a productive resource and a saving account where they can draw upon in times where there is a need. Also, it is a place for the gathering of various products, both for sale and for daily needs such as rattan and medicinal plants. Last but not least, the forest is also looked upon as a land resource. This vision is shared by boundary communities around KSNP (WARSI 1994: 9).

The people believe that the forest belongs to them, and therefore it has to be protected; but it only makes sense to peasants to protect a resource if it has practical uses to them. Therefore, protection does not mean to merely admire the beauty of the ecosystem and its rich species diversity. This view results from a culture of affluence, whose life does not depend on the exploitation and productive use of that resource. How could small farmers, who can barely gain enough from their daily work to support themselves and their families, afford the luxury of protecting a resource, which is of no use to them? It would be only rational for them to cut down the forest and take the profit to improve their situation; but the forest is protected through customary regulations to regulate access to a limited resource, because the people do take the long-term view. Cutting down

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[31] Own observations.

some trees for a new field, yes, but never more than somebody is able to take care of at one time. Gathering of forest products, yes, but regulations concerning activities in the forest via taboos, so the community still holds control over the behaviour of people after they entered the forest. Sometimes, however, it is difficult to understand for communities, which have lived in a forest environment for generations, that this abundance is limited, that maybe only fragments of the original plant and animal species remain (Wells and Brandon 1992: 33).

However, since also the cutting down of small amounts of trees or the extraction of non-timber forest products from primary forest is not allowed according to the national forest law as well as according to regulations on national parks, there has emerged a conflict between the small farmers with their traditional land use pattern and the national forest authority with their claim over all forest lands. Through the creation of a national park this conflict became somewhat more distinct, because the peasants, who suddenly found themselves living in the surrounding of a protected area, were not only told not to practice any more shifting agriculture and not to open any primary forest, but they now found themselves confronted with a boundary, cutting them off from a resource which, in their worldview, was a basic part of their whole agricultural and social concept. This exclusion inflicted on the local people had several consequences concerning their attitude towards the forest as well as their agricultural practices, which will be addressed in the following point.

3.3.3 Who has the Right to the Forest?

Historically, forests surrounding villages have been used by the inhabitants of the KSNP boundary area for gathering and hunting. These forests also are also regarded as being a source of land. As it has been described above, they were not a mere open-access-zone, but a common property with access and use regulated by customary law. Bromley and Cernea (1989: iii) describe common property regimes as

> "structured ownership arrangements within which management rules are developed, group size is known and enforced, incentives exist for co-owners to follow the accepted institutional arrangements, and sanctions work to insure compliance".

As mentioned above, according to Indonesian national law, all forest lands are claimed as state property, contradicting customary law. To find out how local people perceive forest ownership in the present day - if there still are traditional land titles on the primary forest, or if they rather accept the national forest law now, the local people were asked, who according to them, has the lawful right to the forest. Considering their responses, especially in combination with the question on traditional regulations for forest protection, the outcome was very interesting.

Depending on whether the people felt that the village community is the owner of the forest near the settlement, or the state, their recognition of customary regulations differed. If the people felt that the forest belongs to the villagers, inherited from the ancestors who opened the village, their recognition of traditional laws, which have to be observed if someone wants to open forest land was generally strong; whereas in cases where the people acknowledge the authority of the government over the forest, they generally have no more linkage to traditional regulations. Those people now consider the forest officials as being the ones making the rules concerning forest conversion or conservation. But there is a severe backlash in this achievement in convincing the local people not to adhere anymore to customary law, but to acknowledge the national forest law as the rightful rule. Some respondents expressed a general incomprehension as to why they should protect the forest if it did not belong to them. In their opinion, those who own it, i.e. the Forest Department, should also be those responsible to protect it. Similar processes could be detected by Aumeeruddy (1994: 33) in the Kerinci-valley, and by ICDP (1994: 27) in the area of the village Letter W, Sangir regency bordering the Kerinci regency, where social transformations gave way to uncontrolled and destructive uses of forest resources. In the pioneer agricultural zones, the richest farmers, who entered a process of capitalisation, were now viewing the forest as nothing but a free access resource that can be used to increase their wealth. These findings are in accordance with the statement of Weber and Reveret (1993[32]), that common property resources from which the commons are excluded through means of policies prohibiting their access, are in response not regarded as common property resources to be managed locally anymore.

> "Resource degradation in the developing countries, while incorrectly attributed to 'common property systems' intrinsically, actually originates in the dissolution of local-level institutional arrangements whose very purpose was to give rise to resource use patterns that were sustainable... When local level institutional arrangements were undermined or destroyed, the erstwhile common property regimes gradually converted to open access in which the rule of capture drove each to get as much as possible before others did. While this has been referred to as the 'tragedy of the commons', it is, in reality, the 'tragedy of open access'. The dissolution of traditional local institutional arrangements has not been followed by the establishment of more effective institutions" (Bromley and Cernea 1989: iii).

Another argument of the local people for not respecting national park borders is that, according to them, even government officials are participating in timber theft and opening of cinnamon plantation on protected area territory (ICDP 1994: 41).

Local people's integrated concept of nature conservation is not in accordance with access restriction to forest products through conservation objectives. If resident communities are prohibited to use the forest in the Kerinci-Seblat National Park, local institutions no longer control the management of

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32 As cited in Aumeeruddy 1994: 33.

resources in a protected area. Resulting, the social ties between them and the forest become disturbed and the utilitarian value of the forest for the people is lost. Therefore the necessity for the people to protect the forest decreases, it becomes a resource which can be exploited and depleted, because it is not their responsibility and interest anymore to protect it. Only a resource, which is owned safely leads to long-term, sustainable use. If people feel that any investment (such as protection efforts, for example) are made in vain, the forest not being under their authority making them unlikely to reap the benefits, why should they make it? If, however, protected areas would also be useful to the local people, if they could participate in exerting control over the management of them, this negative impact could be avoided (see also Aumeeruddy, 1994: 16).

3.4 People's Participation in KSNP Establishment and Management

It has already been realised by the Indonesian National Planning Board that a successful protection of the KSNP also implies the need for integrated development programs to improve the living conditions of the rural population in the park surroundings (Bappeda 1991: 7). Also park managers increasingly feel unable to manage the protected areas based on a concept of exclusion, separating them with the local communities living in their surroundings (Kompas 16.6.99: 20). This exclusion endangers the success of project respective activities, because the latter might not be accepted by the local community. Therefore, reserve management is becoming more and more concerned with improving local welfare and recognising the important role local people can play in managing the areas they utilise and perceive as of their own through customary rights (WCMS 1992: 4).

Until now, however, integration of the local population into the process of planning and designing of project activities is very limited in nature. This is partly due to the attitude prevailing in bureaucratic circles that rural people are backwards and uneducated, making them no proper partners for collaborative planning and management. Counselling with the local population about their needs and priorities before project development, however, allows for a selection of suitable and locally desired programs and therefore for targeting scare resources at those activities improving the situation of the boundary villages in a sustained manner. The following sections are concerned with how the inhabitants of the villages adjoining KSNP have been involved in park establishment and management, as well as with their reaction towards KSNP creation.

3.4.1 Local People's Role in Park Establishment before ICDP-KSNP

First contact with the park. At the time when the Dutch colonial government imposed a protection status upon the Kerinci-area in 1929, no participative approaches involving local people were known yet, but as also supervision of the park was still limited due to lack of infrastructure, many villages near or in the park might well not have been aware of the changed status of the forest surrounding them. This situation changed slowly, when the Kerinci forests were declared a national park in 1991 by the Indonesian government. Boundaries were drawn first on the paper, afterwards demarcation started in the field. The process usually did not involve any prior consultation with the local population, both in the study sites as well as within other boundary villages (WARSI 1994: 8, 16, Barber *et al*. 1995: 22). Because map data were never "field-truthed" before, the course of the park boundary often separated the peasants from their fields, even though many villages had already existed for a long time (Radja *et al.* 1994: 108). Only some time later would PHPA officers visit the affected villages and explain to its inhabitants that the bordering forest is protected now, and that they may neither make fields in it nor take timber, game or other forest products anymore. Information provided by government agencies, however, were sometimes confusing. In one village, the Office for Estate Crops allowed a further utilization of already existing fields within the park, whereas the Forestry Service prohibited it (Perbatakusuma and Rufendi 1993: 63). In some villages, the inhabitants were even informed by outsiders, such as NGOs or researchers, about KSNP. The communities themselves, however, would have preferred to participate in boundary demarcation from the very beginning (ibid.: 42).

In many boundary villages, for the local people nothing indicated the creation of a national park around their villages, except for the sporadic visit of PHPA field officers. The latter would generally appoint a village meeting held in the local primary school, where the officials would sit in the front and the villagers would sit on the benches like schoolchildren; Then the peasants would be taught that shifting cultivation may not be practiced anymore, that it is forbidden to take anything from the forest, and if they were to see a tiger, they should by no means shoot him but directly inform the national park agency [33]. More than the half of the villagers, however, would not attend the meeting in a move of silent disapproval, pretending to be busy in the rice fields far from the village. Those who came listened quietly and eventually politely nodded their heads to the lecture of the government official. When asked if they understood, they usually answered yes, they did. Local people prefer to agree on meetings beforehand at times that are convenient to them over being summoned without former appointment. When local people feel they are not being treated with due respect, and where the importance of their cooperation has not been acknowledged, the local population turn uncooperative, thus forcing this acknowledgement, Dove (1986: 16 p.) states in a case study on plantation development in West Kalimantan.

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[33] In a village with no public transport within a day's walk.

Occasionally, some people from the village also joined extension programmes in the sub-district capital to learn how to become permanent farmers. Through such education measures, the government aims to have the participants share their knowledge with the rest of the village so eventually in the future no shifting cultivation will be practiced anymore. Unfortunately, it is not that easy. The local people are already disappointed and resentful towards the government, because they are usually not involved in decisions regarding their village, including those concerning the national park. Resulting, everybody was glad, when the government officials went home again, and hoped they won't come back soon. Then, business went on as usual.

In the Jangkat village Pulau Tengah, Sarolangun-Bangko regency, Jambi province, the village community was, for the first time, informed that a national park is going to be established near their village in 1985. At that time there was an official from the regency capital Bangko visiting the village during preparations of the general elections in Muara Manderas, the capital of the remote upland sub-district. The information about the planned park was just dropped occasionally, during a meeting whose purpose was to give directions to the village head concerning the upcoming elections. In a neighbouring village, Lubuk Pungguk, the first contact with the KSNP occurred only in 1994, when farmers encountered boundary markers in their fields, without knowing about their purpose. Up until 1997, farmers in many boundary villages were still oblivious of the park's existence (Wardoyo *et al*. 1997: 42). A similar situation has also been found in other Indonesian national parks (Barber *et al*. 1995: 49).

Conflicts with boundary demarcation. In the lowland village Dusun Birun, the village government was informed about the KSNP and the boundaries to be drawn in 1994, but was not involved in the demarcation process. The course of the border, so the villagers were told, had already been determined "from above". Also when the boundary near Lubuk Pungguk was moved, after written complaints from the village head[34], he was again informed only afterwards. The involvement of people from neighbouring Pulau Tengah as assistants for demarcation combined with the perception of the villagers from Lubuk Pungguk, that less fields and forested customary land of the former village was taken for the KSNP, lead to the perception among people from the latter settlement that Pulau Tengah had been favoured. Resulting, rifts occurred between the two villages, which had formerly an amicable relationship. Most probably, however, people from Pulau Tengah had simply been involved, because it was the most accessible village at a time where the whole sub-district could not yet be reached by car. Since finishing the boundary demarcation, there have been no

[34] The villagers through the village head appealed to the national park office to consider their complaints concerning the course of the park boundary, but there has been no reaction. Therefore the villagers also addressed their complaints to the regent, but again, received no reply. Only several months later, forestry officials from the regency came and moved the park boundary for about 300 m.

forestry officials visiting the village[1]. Also the sub-district head only reminded the villagers not to cultivate any land inside of the park boundary (Werner 1996, unpublished data). In other boundary villages, demarcation triggered conflicts within communities. Farmers, whose fields had been affected were jealous of others whose had not (WARSI 1994: 16). When the village heads were incapable of resolving the problem of farmers' fields becoming part of the KSNP, conflicts between the community and the local leadership emerged (Perbatakusuma and Rufendi 1993: 38).

Some weeks after the second boundary demarcation, the village head of Lubuk Pungguk sent a letter to the forestry service concerning the problem that, although the border had been moved, there were still many fields of the villagers inside the park, including the hamlet Koto Rawang. The reply the village head received after three weeks stated that the park and problems related to the course of its boundary would not be the responsibility of their office, but of the regent. Therefore the village head wrote a letter to the regent, sending a copy to the head of the sub-district, Bappeda and the regional forestry department. Again the regent replied that he was also the wrong addressee, and that the villagers should write to the forestry department in Jakarta, instead. When the new sub-district head was installed by the regent, the villagers asked the regent about the KSNP, but they didn't get any answer. When people from Lubuk Pungguk met with forestry officials in Koto Rawang and asked about the KSNP, they were brushed aside harshly "Don't ask that, your houses are the lungs of the world." According to the local people, the government should not treat them like that, because the government also depends on the people. This lack of responsiveness on behalf of the Indonesian government officials wasted the positive potential present in Jangkat, where the local communities were initially very willing to cooperate with the park authorities.

National vs. customary governance and forests control. Before colonial and national governments took charge of Indonesia's forests, traditional laws regulated the way communities exploited or used natural resources in rural areas. These laws generally contained just values and were a means of social control. Due to a lack of incorporation of traditional structures into the administrative system, customary control of natural resource use as well as social regulation became eroded (see box 3).

In remote areas, where customary rule is still strong, customary laws still extend on natural resource management. In the KSNP boundary zone this is still true, for example, in the upland sub-district of Jangkat. In Sarko the importance of the customary organization in community life still is very high. The strength of the customs in Jangkat partly results from the isolation and ethnic homogeneity of that mountain area, which up to recently was not accessible by road.

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[1] The road to the district capital, Muara Manderas, via Pulau Tengah and Lubuk Pungguk was only built in 1996.

Box 3: Indonesia's system of local administration

The national administrative system is structured into provinces (*propinsi*), regencies (*kabupaten*), sub-districts (*kecamatan*), villages (*desa*) and hamlets (*dusun*). The division of settlements into village units depends on administrative features, among others on the number of inhabitants, the land area and the location. A village head (*kepala desa*) is installed by the local government, having the status of a government official.

This administrative system evolved from the Law on Village Governance from 1979[2]. Aforesaid Indonesian law, however, was based on a regulation of the Dutch colonial rulers of the early 20th century, introducing a new system of village governance where the village head had to be chosen by the government. Afterwards, the government did not acknowledged anymore the legitimacy of customary governance systems.

At village level, these two structures stand in rivalry with each others since that time, causing confusion and the weakening of traditional regulations, because the *kepala desa* does not necessarily understand about customary law. Also traditional administrative units and structures were disrupted by this new division into *desa* and *dusun*.

Furthermore, the villagers trace their descent from the West-Sumatran Minangkabau and the inhabitants of adjoining Kerinci sub-district, also known for their strong traditions. Customs provide a sense of identity to the people. Many realms of daily life are governed by customary rules, e.g. social interactions, especially concerning the relationship between men and women, as well as land use practices. Herein notably is foremost the regulation of the planting season for rice, which is important for pest management. Customary organizations also allocate forest land to families who applied for it, as well as determine which areas have to be used in what fashion (paddy, plantation, forest). Within Jangkat, virtually all families are members of the customary institution. Customary regulations structure the daily life and the stringent implementation of fines contributes to the success of collective action (Werner 1998: 27, 66). According to the traditional leaders of the Minangkabau (*Ketua Kerabatan Adat Nagari*) in Subdistrict Sangir, District Solok, West Sumatra, there are customary regulations embracing customary forests, village forests and forbidden forests. Traditional leaders who damage these forests can be disowned of their title *datuk* or *ninik mamak*. Ordinary people cutting down trees in forests protected by customary laws will be fined in accordance to their ability (Radja *et al.* 1994: 110).

The advance of a dualistic structure consisting of a formal and a traditional village government through the administrative demands of the law on village governance from 1979 was prevented in Kec. Jangkat by the local people through filling formal leadership positions with traditional leaders. Village leaders and members of the LKMD and LMD are selected in accordance with their position within the *lembaga adat*. Therefore no conflicts between traditional and formal governing institutions exist in that sub-district. Moreover, formal village governments ensure the enforcement of customary rules and the implementation of *adat* decisions (Werner 1998: 42).

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[2] Undang-undang nomor 5 tahun 1979 tentang Pemerintahan Desa.

General considerations. The traditional pattern of interaction of Indonesian government officials with villagers neither involved local people in park management, nor did it focus on local needs. As indicated by the example above, however, traditional communities partly retain customary laws related to natural resource management. They also, as will be described in chapter 6, own traditional environmental knowledge and developed related management practices for the natural resources surrounding their villages. Local communities living in park boundary villages may therefore well represent proper partners for nature conservation endeavours. Moreover, the bio-integrity of conservation areas cannot be guaranteed without clear and commonly agreed upon legal boundaries. To achieve this, local communities have to participate fully in identification and demarcation. It is also the first test for a participation-based management strategy (Momberg *et al*. 1995: 16). For that reason, integrated conservation approaches, as those employed by international organizations and NGOs nowadays generally occupy a rural development component. As previously mentioned before, this is also the case in the ICDP carried out in KSNP since 1996. The pattern of involving the inhabitants of villages adjoining the park is described in section 3.4.3.

3.4.2 People's Reaction towards the Creation of the National Park

In villages where no community development activities in the frame of the ICDP have been carried out, the awareness of the concept, the goals and the usefulness of the KSNP is very low among the population. The approach of the national park agency to prevent the inhabitants of the villages in the border area of the park from encroaching upon the protected area by means of information and education did not develop communication with the local population successfully. This is due to the fact that the inhabitants of the boundary villages were neither informed properly about the KSNP, nor involved in the boundary demarcation, as mentioned in the prior section. Because no understanding and appreciation of each other's opinion has been achieved, misconceptions are common on both sides.

Traditional procedures for land acquisition. If somebody from outside wants to own land near one village in the study area, he has to be adopted by step-parents of the village community first. And if people coming from outside want to establish a new village somewhere, they have to make a ceremony, inviting the inhabitants of the surrounding villages, for good neighbourhood and mutual relationships. Also in other boundary villages, the permission of customary leaders is required (Barber *et al*. 1995: 21). According to these traditional regulations any party claiming any piece of forest near the village after the existence of the respective village, should involve the village community and allow them to take a position in accordance with their seniority in that area.

In contrast to this traditionally required procedure, it has been reported that fields belonging to farmers and already planted, have been sized by several agents, such as the developer of a huge palm oil plantation in the vicinity of Pemunyian and Lubuk Malakko, the transmigration site near Lubuk Malakko, or by logging companies, providing an inadequate compensation or no compensation at all. Resulting, the impression has developed among the local people that there are various parties wanting to take advantage of the forests near their villages, prohibiting them by one or another reason to extract forest products or to clear more forest for subsistence. For the villagers, there is no difference, who is limiting their access to land - whether it is the nature conservation agency, the forest department, logging companies, transmigration projects or commercial plantation owners are making borders. They feel deprived and frustrated that due to their being vulnerable and poor, it is always others who are reaping the benefits. The national park agency, on the other hand, probably perceives the local people as stubborn, backwards and uncooperative, not understanding the goal of nature conservation and willingly opposing to the law and to their authority by ignoring existing regulations and continuing to open new fields in primary forest.

Communication structure between park officials and villagers. After the demarcation of the park boundary in 1994, several officials from the forestry department and the PHPA have visited the boundary villages in Sarko. The aim of their visits, nevertheless, was not to give any extension or guidance concerning the park, but rather to repeat and reinforce the prohibitions related to the park. The villagers felt that the purpose of these visits was only to frighten them. Officials visiting Pulau Tengah, for example, would not get in contact directly with the villagers, or invite them to have a meeting or discussion. Instead, they would only meet with the village head alone. Subsequently, it would be the task of the village head to transmit the outcome of this meeting to the villagers. Because the local people within this communication structure are mainly receiver of commands, they feel that their interests are not considered important.

If there are problems and complaints related to the KSNP, the villagers usually talk to the village head. He collects all these complaints and then discusses them at the LKMD-meeting and at the gathering of the customary leaders (*lembaga adat*) to find a common solution. As a result of these meetings, the village leaders had already written several letters in which they formulated their problems. Besides these letters, the villagers had also expressed their complaints verbally when the head of the regional government (DPRD) visited Pulau Tengah. Although writing six letters and addressing officials personally when having the chance to do so, the villagers received no reply to any of their requests. Due to the lack of response, the villagers were getting increasingly upset.

Box 4: Local park guards, unempowered communication facilitators

Communication between the boundary communities and the park authorities should be facilitated through park guards, called *pemitra*[37], who are stationed in the respective villages. In Lubuk Pungguk, the park guard is a middle-aged man originating from the village. He has a difficult position towards both the villagers and the park authority. The park authority does not give his role much recognition, because even when the boundary was demarcated, he was not informed about it.

The park guard's duties are to check the boundary markers and to investigate, whether any farmers open new fields inside the park and damage any of the boundary markers respectively. He has to send a report every three month to the central park office in Sungai Penuh and has to provide extension to the villagers concerning the KSNP.

The *pemitra*, nevertheless, has an inner conflict about his role as an individual and as an employee. As an individual, he feels compassion towards the villagers and their problems related to the park, but as an employee, he has to be loyal towards the park authorities. He blames his inner conflict for not being able to function optimally in his job - to create a harmonic relationship between the villagers and the park authority.

Park guards are paid very poorly. In 1996, he received monthly merely Rp. 65.000, which was equivalent to US$ 28,- at that time. This is far below the minimum wage for a worker. According to the villagers, the *pemitra* should originate from their village and be elected by the community via deliberation (*musyawarah*). The person chosen of the villagers then should be recognized and employed by the park authority.

Impact of the park on local communities. The villagers feel that the park is inflicting losses upon them, because their space to move i.e. to open new fields, *ladang* as well as *sawah*, has been severely restricted. Furthermore, game animals such as deer and small antelope are damaging the fields of the farmers, but they are not allowed to kill them. This also results in a reduction of the harvest and therefore has negative repercussions on the household economies. On the other hand, income alternatives besides agriculture do not exist. Therefore, the perception, that the establishment of KSNP has hurt the people was common prior to the onset of the ICDP (WARSI 1994: 16).

Particularly in the Jambi uplands, cultural norms prescribe that a farming household is only complete when equipped with rice paddies and upland fields. The matrilineal values present in these communities compel the parents of the bride to provide upland fields as a precondition for the marriage (Wardoyo *et al*. 1997: 35). This limits the scope for alternative income orientation and maintains the pressure upon remaining forests. After boundary demarcation in Jangkat, formerly well-functioning rules for environmental protection do not function anymore due to a scarcity of land. In 1995-96, families started opening fields in areas formerly forbidden by customary law, such as river headwaters. As a result, according to the local people rivers are becoming dry and there is not enough water for the irrigation of the rice paddies. This could have serious repercussions on environmental stability in the village and downriver areas.

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[37] *Pemitra* literally means 'the one who facilitates partnership'.

Box 5: Local perception of the KSNP

After hearing a lot about the park and related problems in Lubuk Pungguk, I realized, not having asked one important question: Do people think the park does any good? Besides the problems they have, what do they think about the KSNP? When asking first: “What do you think the park is good for?”, the people initially were a bit quiet and then one after the other started to list all the good sides, such as

- the park prevents erosion and floods;
- animals have a safe place to live;
- to safeguard the sustainability of natural habitats, so there always be untouched nature and our grandchildren may still witness pristine landscapes covered with forest;
- probably the government wants to preserve some land reserve for the future.

Listening to these answers I felt very much as a schoolteacher having obedient pupils who have made their homework very well. Nevertheless, I felt dissatisfied, because I sensed that it really was no more that learned knowledge having no relationship with the villagers’ own opinion.

Therefore I asked again, saying that I also knew this official version, but I would be also interested in their personal opinion. Do they, personally, think that the park does any good?

Silence. Then, somebody brave came forward, saying: “The park has no positive impact on our village. Our agricultural lands are decreasing and our population is increasing. There is now an imbalance between the number of villagers, who depend on rice paddies and cassiavera for their living and the agricultural lands available”. All the other persons present at the discussion agreed upon this statement. No more grandchildren experiencing the beauty of pristine forests were mentioned. Anyway, what’s the use of a forest, if not to make a rice field?

Local aspirations related to the KSNP. Until mid-1997, when the study villages were last visited, there was no involvement of the local community into park management. The villagers admitted not knowing anything yet about the meaning and importance of the KSNP, but only about the prohibitions related to the park, and the fines for violating them. They would prefer an explanation on the purpose and objectives of the KSNP, so that if they become involved in the ICDP, the community would have a better understanding of it. Besides, they would like to have a real explanation from the forestry department about the KSNP and the problem of the boundary, which includes their fields within the park territory. The community would like to have a park boundary that is agreed upon by the village and the park authorities. The villagers would promise not to violate this boundary, and the customary organization and the village authorities together would be responsible to watch over it.

The local people also expressed a need for guidance from the park office on how to protect the KSNP in a way that does not inflict losses upon the farmers. According to the local communities, they should be involved by means of *musyawarah* [38] in any decision made regarding KSNP. Under

[38] Traditional Indonesian pattern of problem-solving through deliberation, involving all parties concerned.

these preconditions, the villagers would support the implementation of the ICDP. The land use pattern that has been agreed upon by the community would be enforced by the customary organization together with the village authorities. Also in other areas of Indonesia where local communities were well organized and had strong traditions of conservation, they were very interested in working with the government to protect the nature reserve. It is therefore important that government and NGO actors involve traditional leaders in the planning and socialization process of the conservation area (Fisher and Mulyana 2000: 125).

Possible contributions of local communities to KSNP management. The traditional rules for environmental management are very suitable to allow for a sustainable use of the natural resources. Where the customary organization still has a strong grip upon the local community, violations are rare, or even do not happen at all, as asserted by the customary leader. This is mainly the case in socially stable, ethnically homogenous boundary villages that have existed for several generations or more. Ethnically diverse villages that have been settled in the past few decades are generally not cohesive and must rely on village heads and formal institutions for leadership and determination of resource access rights (Schweithelm 1994: 4 p.).

Box 6: Can customary institutions save Jangkat's forests?

The new road connecting Sarko's capital Bangko with Jangkat will almost certainly bring new settlers into the region, which has fertile soils where cassiavera grows well. A similar development could occur in Jangkat as before in the Kerinci regency, where customary rule already became weakened through outside influence and social differences. Whether the process of dilution of customary institutions will be an inevitable result of the contact with 'modernity' remains an open question.

The development of the new road will make the marketing of local products easier and cheaper. This will increase the profitability of cassiavera production, which may very well put increasing pressure upon traditional rules which still limit the agricultural area owned by the individual family. If the customary leaders are not able to control access to land by locals as well as by outsiders anymore, the forests and the KSNP adjoining Pulau Tengah, Lubuk Pungguk and the other villages along the road are in danger.

The role of the local community for a sustainable use of the environment and also for preventing uncontrolled intrusion of outsiders should be acknowledged and supported by the government. Government institutions are unlikely to exceed a control like this with a similar effectiveness. For this purpose, ICDP activities included the strengthening of customary regulations relevant for nature conservation in general and the protection of the KSNP in particular. These traditional regulations also became a part of the Village Conservation Agreement (WWF 1998a: 9 p.). Strengthened local institutions may then function as local 'watchdogs' over KSNP boundary violations.

While problems are usually solved by *musyawarah* at the village level, the national ideal for conflict resolution, the involvement of villagers into higher-level decisions is still very limited. It should be desirable to reinforce and strengthen these well-functioning local communities by supporting them in the solution of the problems that cannot be solved at the local level. The lack of response to local problems in the long run can create social tensions within the community, such as between Pulau Tengah and Lubuk Pungguk, and between the community and government institutions, such as PHPA. The government would ease their own job by being responsive to local needs and aspirations. If it would provide the environment where the major problems affecting the village from the outside (such as the park) or from the inside (such as population growth and the subsequent need for agricultural extension for intensification or diversification) are managed, most of the daily problems could be handled by the villagers on their own via customary rule. If problems are being left to build up, this can have negative repercussions on social peace and therefore on the local potential to handle and manage difficulties on their own.

3.4.3 Approaches and Policies of Involving Local People in the ICDP-KSNP

ICDPs are based on the principle that conservation projects will not be successful if the local people are not actively involved in them. Without cooperation between government institutions (PHPA) and villages at the fringe or within protected areas, illegal encroachment will continue (Momberg *et al*. 1995: 4). Community based conservation works best where the local people have close and long lasting ties to the resources being exploited and customary conservation practices still play an important role (Dias and Indiani 1996: 26). Besides community isolation, cultural views about conservation and production systems, also local peoples' ability to make decisions concerning 'their' forest affect their choices to accept park boundaries and to comply with conservation agreements (Horning 2000: 118).

Pattern of community participation. Local participation within the ICDP-KSNP takes place in the form of several project activities. One of them, which is also a major target of the project in general, is the development of partnerships and collaborative linkages between communities living near the park, their local governments in surrounding districts and NGOs. Local communities also participate in species diversity conservation, boundary demarcation and protection as well as prevention of encroachment by outsiders. Improved income opportunities or social benefits are supposed to relieve pressure on the park as well as helping rural people in the boundary area to obtain secure access to natural resources they manage in the traditional use zone surrounding the park.

Rural development is facilitated by catalysers from the WWF working closely with local NGOs participating in the WARSI-network[39] in the frame of the ICDP. During the project preparation phase, the WWF has carried out a detailed survey of biophysical and socio-economic conditions and local aspirations. The WWF also funded the WARSI NGOs to provide local communities with information to solicit community ideas for improved project design. A participatory approach has been chosen for the management of rural areas surrounding the park (WWF 1998a: 3). In areas where settlements adjoin forest concessions, additionally community forestry is promoted. The NGOs also inform and instruct target groups in boundary villages, government officials and the community at large about the values of conservation. It is questionable, however, to what extent such abstract goals such as species diversity conservation, watershed protection and the safeguarding of protected animal habitats really make sense to small farmers, whose priorities generally are the feeding and the survival of their families. People should be able to relate to this information from their day-to-day experience. Education must help local people recognize that they have a stake in maintaining natural ecosystems, possibly reinforcing cultural dispositions towards conservation (Uphoff and Buck 1997: 8 p.). Otherwise it will have no impact on their behaviour and land use practices.

The WWF and WARSI work together with 109 boundary villages in ten priority clusters where species diversity is most threatened. Up until May 2000, the project had focussed on 47 villages, with further 28 following during 2000[40]. To strengthen the protection of the traditional use zone, Village Conservation Agreements (VCA) have been set up between the park management, the regional government and the local communities living in the border area. Village resource mapping and zonation through participatory mapping, a technique to strengthen resource tenure, became the basis for the VCA with the government in KSNP. This tool is helpful in fixing boundaries, for

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[39] WARSI (Warung Informasi Konservasi) is a network of conservation-oriented NGOs founded in 1992 and based in the four provinces which are part of the park, with the purpose of coordination and cooperation on problems related to the KSNP. The WARSI NGOs primarily see their role in development and conservation of the KSNP as partners of both donors and government agencies and would like to play a key role in community development, advocacy for the local people affected by development interventions and policy dialogue. The common focus adopted by these NGOs for their field activities is on an integrated approach to environmental conservation and income-generation for local communities (Elliot *et al*. 1993: 17). Although partly engaged in 'traditional' agricultural extension, WARSI has also assisted in the preparation of the ICDP helping the local people in contributing to the project design through community consultation (IBRD 1994: 10). The access to target groups, community development skills and the willingness to work in remote areas are the advantages of involving NGOs in KSNP conservation and development projects. WARSI-members: 1. *West Sumatra*: BILA*, KOMMA, Taratak, PPA. 2. *Jambi*: LP3D, Yayasan Bakti Masyarakat, Gita Buana*. 3. *Bengkulu*: LPWP*, Gemini, Sasmita, YASA. 4. *South Sumatra*: LP3M*, Karya Desa, Darma, Seminung, Wighna Manggala, WIGWAM, PKBI. (* WALHI FORDA member).

[40] 1997: 10 villages, 1998: 18 villages, 1999: 19 villages (personal communication Mr. Mas'ud, WWF-Project Manager for ICDP-KSNP in Sungai Penuh, 10.5.2000).

conflict resolution, community articulation of traditional resource use, as well as for land allocation and management (Dias and Indiani 1996: 2).

A method first applied in Indonesia in 1992 in the boundary area of the Kayan-Mentarang Biosphere Reserve, East Kalimantan, is used to map the area extent of lands under village control and management, as well as the interrelationships between village territorial boundaries and forest department maps. The important innovation within this method lies in its suitability to map historic village management areas precisely and to indicate the overlapping areas between village management territories and designated state forest (World Bank 1993: 2). These maps are therefore also useful for resolving competing interests and claims to land territories and natural resources (Momberg *et al*. 1995: 3). The maps, which are created through cooperative sketch maps, field rationalisation and GPS[41] use, and subsequently processing by GIS[42], facilitate better communication between villagers and foresters. In Kayan-Mentarang, the status of the protected area was then changed from Nature Reserve to Biosphere Reserve, in which zones compatible with traditional use are established around a restricted core area (World Bank 1993: 3 p.). In KSNP, the WWF used this method to also show encroachment beyond ancestral land claims (Momberg *et al.* 1996: 53).

Formalizing local participation. A Village Development Plan that specifies development priorities is prepared as part of the planning exercise (Schweithelm 1994: 7). The land use plan is formalized in the VCA that specifies the pattern of land use, involving a sustainable use of the natural resources by the local communities. It legalizes sustainable village access to resources inside the park and its buffer zones, acknowledges the park boundary and guarantees specified development assistance in return for cooperation in protecting the park and species diversity resources on village lands (WWF 1998b: 2). The process of the VCA needs a preparation and delivery time of three years.

The conditions in villages vary considerably, consequently so do the Village Conservation Agreements. Where customary institutions are still strong, and customary law still functioning, its relevant rules were incorporated into the VCA. This includes particularly customary rules on natural resource management such as that cultivated land in the headwaters may not be cultivated within a certain distance of the river, or that each planting season will be executed simultaneously to reduce pest damage[43]. Community members who already own fields or gardens may not open new ones unless within secondary vegetation. Furthermore, fields, which are not planted with productive

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[41] Global Positioning System, an electronic device allowing for an exact determination of location through satellite communication.

[42] Geographic Information System.

[43] VCA Rantau Kermas, Paragraph 14.

crops, become property of the village again [44]. The latter two regulations are based on the customary rule that only those families may open new fields (usually of about one hectare size), which do not yet own any, or whose gardens are already well developed. The target of the rules is preventing land grabbing. Within the protected area, however, VCAs by default have to prohibit cultivation. Fields inside the park boundary have to be given up after their crops have been harvested.

The ICDP also assisted the five regencies involved in the project to prepare a regulation that would establish the legality of the agreements after passage by the regencies' legislature (Schweithelm 1994: 7). The agreements are later finalized through the Coordinating Regency Committee, attended by several government agencies, and consecutively signed by the head of the Agency for Regional Development (BAPPEDA) and the KSNP park manager. This procedure makes the agreements to official documents of the regional government, which will be used as a reference for village development planning as well as management of national park resources within conservation projects and integrated area development (WWF 1998a: 11). Violators of the VCA will be punished both according to customary and according to national law[45]. Nevertheless, the legality and enforceability of the VCAs remains in question. Because there is no clear statement of to what kind of sanctions the communities have agreed to, there is no clear way to monitor them (World Bank 1998: 10).

To compensate local people for their lost access towards forest land, each village receives Rp. 250 Mio. for development and income generating measures in two stages, the first half after the conclusion of the conservation agreement, the second half after an evaluation of local compliance with the terms of the agreement. The purpose of this support is to enable the villagers to find alternative opportunities of income generation not dependent on the KSNP. Also in encroachment areas within the park unrelated to customary land claims, conservation agreements acknowledge limited access of village communities to forest resources in the part of these park areas that became classified as traditional use zones (Momberg *et al*. 1996: 53). The buffer zone, on the other hand, is located outside the park, including all agricultural areas within.

Implementing the VCA. To achieve the target of the conservation agreement, the WWF assists the villages with development planning. The local communities are assisted in finding a strategy for changing their pattern of income generation better compliable with species diversity conservation by a fieldworker, known as a Village Conservation Facilitator (VCF), permanently appointed to each village where conservation agreements will be or already have been set up. For this, the fieldworker tries to elicit local aspirations. He functions also as a mediator between the local

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44 VCA Rantau Kermas, Paragraph 16.

45 VCA Rantau Kermas, Paragraph 21.

community and the Indonesian government. The active involvement of the latter is crucial to obtain its support (Dias and Indiani 1996: 27). In the frame of their socialisation during their stay in the villages, the WWF-KSNP assumes, that the fieldworker will learn to understand local perceptions, including TEKMS. Besides the importance of resource ownership for local motivation, the active involvement of these fieldworkers as well as regular visits from government officials, WWF and ICDP staff maintains confidence among the people (ibid). In some cases, the fieldworkers were successful in helping villagers to understand the vital role the forest plays in their well-being. This is important, because it makes them see benefits in maintaining the integrity of the national park. In the ICDP at East Usambara Mountains National Park, Tanzania, employing village facilitators as a community outreach mechanism also worked well (Wells and Brandon 1992: 21). After villages have successfully implemented their conservation agreement and found alternative income generating measures, the fieldworkers will move to another area (Bird 1999: 4 p.).

Each VCF is assisted in the field by a Local Community Organizer (LCO) from the respective boundary village (WWF 1996b: 3). LCO are appointed by the local communities and facilitate village conservation planning together with the VCF[46]. Usually they are selected among the more innovative community members. Their tasks are to identify and organize target groups, to identify activities that serve economic and species diversity objectives, and to facilitate group decision-making. The quality of both LCO and VCF, however, varied, which sometimes had repercussions on the quality of the conservation agreement. Because all LCO and VCF receive the same training, the performance is mainly related to personal factors. Regular supervision and guidance therefore is important (Bina Swadaya 1996: 11). Occasionally, the village head appointed LCO by criteria of personal relationship rather than suitability (World Bank 1998: 9, 11, Annex 5: 4).

Alternative income-generation. Local people who are economically dependent on the park are particularly those with restricted access to land and low incomes. The LCO assist these villagers to organize themselves into groups and to choose alternative income generating activities that suit their needs and interests; the ICDP then assist these groups in proposing their activities, facilitate implementation, including help to apply for credit and arrange marketing (Schweithelm 1994: 8).

The financial assistance received by the boundary villages is supposed to be spent on infrastructure and agricultural development. Investment in agriculture, such as intensification of paddy rice production, is supposed to lower dependence on park resources by providing higher incomes from agriculture on village lands. Investment in infrastructure, such as irrigation or roads, is also

[46] VCF and LCO are trained for 10 days in (1) legal aspects of KSNP management (concerning natural resources, customary law, land rights, etc.), (2) communication skills, (3) social analysis (PRA, data collection, participatory planning, evaluation, etc.) and (4) community organizing (Bina Swadaya 1996: 4).

expected to raise incomes, while drinking water systems and other social infrastructure create goodwill among the villagers towards the park, which is supposed to provide further incentive for them to cooperate in its protection. The selection of activities would be based on the development priorities set in the village development plan, and finalized through participatory decision making coordinated by the village head and LKMD. The villagers provide labour, use credit to purchase inputs if necessary, and receive extension, expertise, equipment and construction materials by the implementing technical agency paid for by the ICDP (Schweithelm 1994: 7).

Other conservation-related economic activities carried out by the local communities under the assistance of the WWF include the development of community forestry in the park buffer zone outside the park boundary in villages adjoining forest concessions and the establishment of protected areas near the villages' rivers that equally have economic purposes (WWF 1998a: 9). This would "not only effectively increase the conservation estate by maintaining natural habitat beyond park boundaries, but could provide a model for sustainable forestry elsewhere in Indonesia" (MacKinnon 1997: 50). In the Kerinci enclave, government programmes have already focussed on planting a 'harvestable forest', where cassiavera must be mixed with a range of 11 other trees[47], which may be harvested but not cut (Potter and Lee 1998: 38). Unfortunately, the idea of using local traditions of complex agroforestry systems (*pelak*) to construct a sustainable buffer zone has not been taken up by park authorities. In cases where the areas for community forestry are allocated in former timber concession, nevertheless, the statement of Barber (1996: 17) will hold true again:

> "...most public 'forest lands' or 'fisheries' where local communities have been granted management rights by the state are in fact degraded areas in need of rehabilitation. ... Rare is the case where local communities gain – or regain – control of areas with resources that are still really valuable such as mature dipterocarp forests or productive coral reef fisheries".

To combat cassiavera cultivation inside the park, the WWF assists local people with the establishment of cooperations, who control the origin of their produce. The cooperations are then connected with traders, who pay higher prices for cassiavera from the cooperations than for those of unclear origin. In one village, the inhabitants decided to use 3.000 ha of underutilized land to plant chilli peppers. The local fieldworker arranged for the village's economic council to travel to a nearby area where the successful harvest of chilli peppers had already dramatically increased their village's income (Bird 1999: 5). For an alteration of resource use practices and pattern, however, the management regime being instituted must be in local people's interests and be perceived by them to be so (Uphoff and Buck 1997: 12). In general, this change of a village's economic base is a

[47] Such as orange, candle nut (*kemiri*), durian, avocado, sugar palm (*aren*) and areca nut (*pinang*).

long-time process. And the danger of encroachment is always lingering as population numbers increase.

Another concern is that the funds might be used up for various village development projects that are in no way linked with KSNP conservation (World Bank 1998: 10). For instance, in Khao Yai National Park, Thailand, the loans funnelled through the local ICDP working group was the major incentive for the villagers to participate. They did not perceive the planned connection between the availability of credit and reduced illegal activities in the park (Wells and Brandon 1992: 23 p.). In that case, the development assistance would rather buy compliance than contribute to protected area conservation. There is also the danger that people will think it legitimate and justified to resume their extraction of resources from within the park after the benefits ceased, if no clear connection is made to conservation objectives which are shared by the local communities (Uphoff and Buck 1997: 10). Clear criteria are therefore needed for suitable projects, which decrease peoples' dependence on the park through providing alternative income opportunities and therefore reducing the incentives for encroachment. Not in all villages, however, were people interested in exchanging their income received from illegal cutting and selling of timber for other income-generating activities. In other cases, enthusiasm for participating in the ICDP-KSNP decreased due to a delayed release of funds (World Bank 1998, Annex 5: 2, 4). Once promised, a timely release of funds is therefore important to prevent disappointing local expectations and consecutively breeding local-level disinterest or antagonism (Sanjayan *et al.* 1997: 17).

Role of local institutions. A major target of ICDP-KSNP is to stabilize land and resource use along the park boundaries. Through this VCA process, KSNP and its needs are integrated into village decision-making, with the conservation-related roles for the government village councils (LKMD) being defined[48]. According to Wells and Brandon (1992: 45), "local institutions can act as focus of mobilization among local people and as a link between local people and external organizations, whether government or nongovernmental organization". During PRA, the ability of formal and informal village institutions are identified as playing a role in the ICDP process (Schweithelm 1994: 19). To enable local communities to participate in resource management, the capacities of the LKMD in planning local area development have been strengthened. The LKMD leadership was frequently inactive and not well informed of its tasks. During both formal and informal meetings, the LKMD leaders and other prominent figures have been invited to investigate both the potentials and problems in the village, and to plan village development in accordance with local needs based on potentials and problems present (WWF 1996b: 4, 11).

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[48] Comments on draft VCAs by Anthony Whitten, 23. 9. 1996.

Additionally, new Village Conservation Working Groups (VCWG) have been created, assisted by the fieldworkers and based on consultations with the village leadership. These groups are in charge of the local enforcement of the conservation agreement and are formalized by village decree[49] (WWF 1998a: 10). The VCWGs consist of stakeholder groups representing the target groups and interest groups in the village and are functioning in coordination with the LKMD. Their leadership is recruited from influential village figures or representatives of existing community groups. Within the Irian Jayan Wasur National Park, these groups were regarded as the "most important part of the management structure for the park" (Barber 1996: 5). They channel information between local communities and the park service, serve as advocates for the villagers and enable them to become formally and integrally involved in park management. Planning decisions made by these groups will be reinforced during LKMD meetings. The VCWGs also determine the management of the productive funds received by the village in the frame of the ICDP-KSNP. The funds may be either disbursed to local level institutions or to individuals from the target and interest groups if no community groups with programs relevant for the park exist. To allow for control mechanisms, the related decision-making process must be transparent and involve all interest groups of the village (WWF 1996a: 4).

The strengthening and forming of community organizations have been the task of the Village Conservation Facilitator. Consequently, facilitated by Local Community Organizers and VCFs, the LKMD together with village government and Community ICDP-KSNP Groups in several cases have been able to amicably resolve negative interactions between the community and the KSNP (WWF 1998a: 9). There is a positive correlation between successful Village Conservation Agreements, functioning customary institutions and experienced VCFs (ibid, Annex 5: 4).

In Lempur, Kerinci regency, a local community organization consisting of the leaders from five villages has been set up based on customs (Dias and Indiani 1996: 2, 7). Through a participatory land use planning process assisted by the WWF these villages were also able to reconstruct customary environmental law for a traditional communal forest to protect their watershed. Simultaneously, the forest functions as a park buffer zone. An act of the district government[50] allows for sustainable, non-commercial use of this forest. The now-reinforced traditional institution and the district government safeguard related law enforcement (Momberg *et al*. 1996: 53). Also in

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[49] The purposes of forming these local level institutions for the ICDP-KSNP are to: (1) develop economic opportunities for the villagers compatible with conservation, (2) formulate VCAs, (3) assess and determine the community target and interest groups, (4) control and seek solutions for negative community interactions with the national park, (5) plan and control ICDP related projects at village level (WWF 1996a: 3).

[50] *Surat Khusus Bupati.*

another conservation area in Indonesia, the Riung Nature Reserve on Flores, customary groups were empowered through institution-building by a local NGO, which are now able to press for common goals across the entire reserve (Fisher 2000: 55).

General considerations. It is not yet clear how and if nature conservation in KSNP is compatible with its surrounding communities. Successful examples of integrating people's needs with those of conservation, such as in the reserves of Irian Jaya, mainly involved remote areas with traditional communities. In KSNP, pressure factors are more diverse, and the impact of outside influences on boundary villages is more distinct. Therefore, multiple questions arise: Will the Village Conservation Agreements be kept? Will both the local communities and the government deliver their respective commitments? If not, will the government, particularly PHPA, be capable of enforcement? Will the government improve the institutional and legal framework related to nature conservation? Will the government battle infringement by other, more powerful stakeholders, too?

One major factor for the success of the ICDP-KSNP is how well a cooperation between the park management and local communities can be established. The long-established top-down approach of the Indonesian government has left farmers distrustful of their development measures. Therefore, projects employing participatory approaches usually have to build trust first, and have to be careful to keep their promises. Provided that this trust can be established, local people will be more willing to contribute to a project if they feel their skills and knowledge are appreciated. How this could be achieved and how, perhaps, agreements can be found that finally work out will be discussed in chapter 7.

4. Traditional Land Use at the Eastern Lowland Fringe of the KSNP

The land use system in the research area largely consists out of two constituents: rice - mostly upland rice - production, and tree crop cultivation, predominantly rubber (table 8). The land use system upland rice - rubber is typical for the Central Sumatran peneplains and hill zones (Scholz 1988: 166), including the lower lateral valleys of the Semangka-graben where the research sites are located. Rice is produced by means of traditional shifting cultivations without any external inputs. Also for rubber production no other inputs than human labour are used. For the establishment of a new rubber plantation, still mainly natural saplings from old local variety gardens are taken. Planted into the young *ladang,* rubber is a typical crop succeeding rice on upland fields.

In higher valleys at altitudes above 500 m, like those surrounding Muara Labuh, rubber is replaced by coffee. From Muara Labuh as a local centre for coffee production, coffee cultivation extends also to lower lying lateral valleys like those along the Sangir River, where Lubuk Malakko is located.

Whereas rice production, especially where upland rice is produced, is for food subsistence, the production of economic tree crops provides cash income. Tree crops also contribute to household food security as a source of revenue if food self-sufficiency cannot be achieved by local production.

Table 8: Land use distribution in the research area

		Pemunyian	*Dusun Birun*	*Lubuk Malakko*
paddy rice		-	22 ha	800 ha
upland fields		185 ha*	250 ha	232 ha
fallow		> 1000 ha	150 ha	125 ha
rubber	local variety	n. a.	n.a.	597 ha
	high yielding variety	40 ha	-	-
cassiavera		50 ha	211 ha	86 ha
coffee		50 ha	25 ha	126 ha
customary forest		-	-	6830 ha
village forest		-	3062 ha	-
others		-	244 ha	69 ha **

* About 1 ha / fam. Source: Village statistics
** Homegardens
n. a. Data not available

The reasons which made the rubber-shifting cultivation combination popular in the Central Sumatran lowland and hill zone in the early decades of the 20th century remains the same, causing this land use system to continue in remote villages like those in the KSNP border area. In

Pemunyian, a typical example for remote villages in that area, there is no public transportation from the capital of the regency to the village. Therefore, people have limited possibility to buy agricultural inputs due to a lack of market access. This problem is accelerated by a scarcity of cash income. The farmers also have no money to buy inputs. On the other hand, land resources are still widely available to make new upland rice fields in areas that have been rarely or never used for agriculture before. Another aspect is the abundance of relatively fertile hills close to the village, where although fallow duration is short to very short, the rice harvest is said to be very good and weed pressure not too strong.

Differences between the land use systems of villages in the research area are caused by several factors, the most dominant being geomorphology and soils. This characteristic also has been noted by Scholz (1988: 206) in his work on Sumatran agricultural production systems. The extent of level areas available for wet rice cultivation influences the degree of shifting cultivation practiced and the soil fertility determines the crops planted, especially where no chemical fertilizer is used.

The Annual Cultivation Cycle

Farming activities in Central Sumatra - like almost everywhere in the world - are scheduled in accordance to the time of the major annual rainy period (table 9). Many agricultural societies throughout the world even have developed traditional calendars resulting from their recognition of the need to plan their agricultural activities in accordance with the seasonal rhythms. One example is the *pranatamangsa* calendar of Java, reflecting the seasonal monsoon cycle of the area. It has served traditional farmers in Java for centuries as a practical guide about when to start planting different crops (Daldjoeni 1984: 15). Several factors are of critical importance for successful production, the most important certainly being the availability of water. Unlike areas (or fields) where irrigation water for rice cultivation is available year-round, the cultivation of upland crops is strongly linked to the seasonality of the rains. Some communities may only depend on rainfed agriculture for certain crops, like vegetables, whereas their main income is received from irrigated rice (Lubuk Malakko) or tree crops (Dusun Birun). Villages depending on upland rice for their subsistence, like Pemunyian, have their whole annual agricultural cycle organized in accordance with the availability of rain[1]. Because the major rainy season in the area of Pemunyian lasts from October until February, the rice crop has to be planted before the onset of the rains, so the rice will have enough water during its growth period. The rice has to be planted early enough, so it can start growing before the weeds come up.

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1 The linking of the annual agricultural cycle to the rainy season is a general feature of shifting cultivator societies (cf. e.g. Gunawan and Abdoellah 1994: 8 for the Dayak of Kalimantan).

Table 9: Seasonal calendar

Month	*Pemunyian*	*Dusun Birun*	*Lubuk Malakko*
January	watching the rice fields to prevent invading pests	watching the rice fields to prevent invading pests	rice harvest
February	rice harvest	rice harvest	drying the rice harvest, pounding rice
March	drying the rice harvest, pounding rice	drying the rice harvest, pounding rice	planting annual food crops (*palawija*)[2]
April	slashing the underbrush in the rice field of the coming season	slashing the underbrush in the rice field of the coming season	weeding the *palawija*
May	cutting down the trees in the new rice field	cutting down the trees in the new rice field	harvest of *palawija*
June	- (tapping rubber)	- (tapping rubber)	planting rice
July	burning of the future rice field; 7-10 days after the burn: rice planting	burning of the future rice field; 7-10 days after the burn: rice planting	weeding rice
August	rice planting	planting rice into the *ladang* or paddy	harvesting rice
September	planting of red, hot chilli peppers and other vegetables, weeding	planting of vegetables, weeding	drying the rice harvest, pounding rice
October	weeding	weeding	- (tapping rubber)
November	planting of tree crops[3]	planting of tree crops	planting rice
December	weeding	weeding	weeding rice

During labour peaks in upland rice cultivation, usually the planting and the harvesting season, farmers usually have no time to tap rubber because the work on their rice fields absorbs all family labour. Similarly, throughout the rainy season rubber tapping is paused, because the latex collection cups fill with water. During the other parts of the rice cultivation cycle, only part of the family is preoccupied with tasks on the *ladang*. Tree crops like rubber fit extremely well in the rice cultivation cycle, because they can be tapped when people have time, and can be left if they are busy on their field (cf. Thomas 1965: 101). Rubber trees actually benefit from periodic idling, resulting in higher peak latex flows when tapping is resumed. Besides the approximately four months when farmers are busy in the rice fields, swidden labour is in surplus. "Since labour and not land is the primary factor of production in swidden societies, the productive use of this surplus

[2] Various grain legumes and vegetables (*palawija*) are planted into the rice paddy, using the remaining soil moisture of the preceding rice cultivation period. Most farmers are planting peanuts, which have a good market price.

[3] Fruit trees are planted one month after the rubber.

labour is a major economic challenge" (Dove 1993: 139). Therefore McHale (1965: 38) calls the combination of shifting cultivation and rubber planting in hilly terrain an 'ideal complementarity'. The annual crops (especially rice) - agroforestry combination is a very successful land use system, also in other areas like Java (Soemarwoto 1984: 266), Kalimantan (Weinstock 1984a, Werner 1993) and the Philippines (Belsky 1993), because the garden serves as a source for income between the rice harvests and insurance in case of crop failure.

4.1 Food Crops and Animal Husbandry

4.1.1 Rice Cultivation

Rice is the major food crop in most area of Indonesia and therefore it has always had the highest priority in government food crop programs. During the last decades Indonesia has invested considerable resources to achieve rice self-sufficiency, which resulted in a more than 50% increase of national rice production between 1980 and 1992. Nationwide, rice is produced on 10.6 million ha, accounting for almost half of the agricultural areas (Stat. Bundesamt 1994: 54). In the fertile, densely settled islands of Java and Bali, rice is mainly produced as irrigated paddy rice, whereas in the so-called outer islands like Sumatra, Kalimantan and Sulawesi major areas are managed by shifting cultivation. While on irrigated rice fields with technical irrigation two or even three harvests per year can be achieved, unirrigated upland fields are only planted once a year to rice.

The major agricultural system for rice production in the research area varies in accordance to the predominant geomorphological situation. As in other areas where shifting agriculture is practiced, irrigated rice is cultivated wherever the terrain permits, on flat lands between hill slopes (e.g. Ramakrishnan 1992: 46). Whereas in some areas like Pemunyian and Dusun Birun only small level areas exist within a major rolling hill relief, wide plains dominate other village lands, like those of Lubuk Malakko, intersected by dispersed emergent hills and ridges. The different relief is due to distinct bedrock material at the three locations. Whereas in the hilly lands of Pemunyian and Dusun Birun irrigated rice cultivation would only have been possible with major investment in terracing, given the precondition of abundant irrigation water, the geomorphological situation of Lubuk Malakko favoured the establishment of paddy rice fields. In Pemunyian and Dusun Birun, on the other hand, shifting cultivation traditionally has been the major means of rice production. Shifting cultivation is an effective system for crop production in case of lack of (or inability to buy) external inputs (lime, pesticides, chemical fertilizer) and the abundance of land. The combination of short cultivation and long fallow periods prevent soil degradation and weed pressure which farmers otherwise had to balance with fertilizer and pesticides. In Dusun Birun, however, the agricultural production system has changed during the last years. The farmers no longer make any fields for mere rice production, but rather plant mixed gardens dominated by cassiavera trees, whose harvest is used to buy rice (Werner 1997: 12).

In general, mechanisation in rice production, irrigated and upland, is very low, employing mainly traditional means of production. Field preparation in paddy rice cultivation is done by plough-oxen (Lubuk Malakko) or by "*merancak*", i.e. driving a hoard of buffaloes over the field several times, who mix the muddy soil with their hooves (Dusun Birun). Planting, weeding and harvesting are done by hand. In villages with irrigated rice cultivation, modern inputs like fertilizer and pesticides are already used. In other areas, innovations comprise only the use of motorized rice hullers instead of pounding rice by hand mortar.

Shifting Cultivation

In remote lowland boundary areas of the KSNP, shifting cultivation still is the major agricultural production system. The characteristic land use system consists of upland rice, produced for subsistence, and rubber, produced as a cash crop. In the upland fields rice is usually grown mixed with some vegetables (see table 13) and tuber crops, mainly cassava (*Manihot esculenta*).

According to Scholz (1988: 19), shifting cultivation is not related to a certain state of cultural development or caused by some "ecological forcing factor". Nevertheless, shifting agriculture is favoured by hilly or mountainous geomorphological conditions, where the lack of flat lands between the hill slopes restricts irrigated rice cultivation. Shifting cultivators often have been dubbed as being too lazy for irrigated rice production, involving strenuous maintenance and soil preparation efforts. The preparation of an upland field, from slashing the underbrush to cutting down the big trees is not less labour intensive, as stated by Scholz (1988: 20). He contradicts the statement of Boserup (1965) that shifting cultivation would be labour extensive as compared to paddy rice cultivation. If calculating the relationship between labour input and yield both systems would not be very different.

Indeed, traditional shifting cultivation is simply one possibility to provide the subsistence of farmers under certain general conditions in an optimal way from the economic point of view. These general conditions comprise lack of capital, limited access to markets, but large land resources. Shifting cultivation uses the nutrients stored in the biomass of the secondary vegetation as fertilizer, without which it would be necessary to constantly import expensive inorganic fertilizers (Ramakrishnan 1992: 40). Shifting cultivation makes optimal use of the limited resources provided, while ensuring that little harm is done to the natural environment (Driessen *et al*. 1976: 114).

In this kind of shifting cultivation system, which can be defined as 'integral' according to the definition of Conklin (1957: 2 p.), rice is still produced in the traditional way, without any input of fertiliser and pesticides. The annual production cycle, adapted to the seasonality of rains, as it has been explained above, will be described briefly in the following. Shifting cultivation as an agricultural system has been described in detail elsewhere (e.g. Conklin 1957, Harris 1971, Chin 1985, Inoue and Lahije 1990, Dove 1993).

Every year, each family opens a *ladang*, i.e. an upland rice field, of about one hectare surface area. To prepare for the rice field, at first the undergrowth is slashed (April). Some weeks later, the large trees are cut down (May). After drying during the summer-dry-period, the area is burned and planted with rice immediately (August). The rice is planted by dibble stick, with which holes of about 5 cm depth are made into the soil at a distance of about 30 cm. In every hole about ten rice seeds are put. Consecutively, vegetables are planted in between the rice. After the beginning of the rainy season, the field has to be weeded (October-November). When the rice is ripening, the field has to be watched steadily to prevent invading animals, birds or insects (January). After a growing period of 6-7 months, the rice is harvested (February; see table 9: seasonal calendar).

For upland rice, still many traditional varieties are used (table 10). They comprise sticky, glutinous rice for cakes and sweet dishes, black rice and several types of staple rice. These varieties generally are adapted to certain soil types and exhibit different water requirements. There are types for gley soil[4], for swamp soil and for especially dry circumstances (slopes and hilltops).

Table 10: Different upland rice varieties used in Pemunyian and their suitability for local soil types

local rice variety	kind of rice	suitability
padi kaciak	upland rice	black, fertile soil
padi gadang	upland rice	red. less fertile soil on slopes
padi andak kubu	upland rice	red soil
padi gading	upland rice	swamp soil
padi ande lubuk	upland rice	gley soil *(tanah lubuk*)
padi sapulut tali	glutinous rice	black soil
padi sangkak	glutinous rice	black soil
padi sapulut hitam	black glutinous rice	black soil

To optimally exploit soils of differing fertility, certain varieties have been bred which are less demanding and more enduring. Although they generally yield less, they can be used for cropping under less favourable conditions without experiencing severe crop failures, as would probably be the case if varieties adapted to fertile, black soil were planted. Also in Mexico farmers were found

4 Soils influenced by ground water.

to match maize varieties with folk soil types. High-yielding varieties normally requiring high amounts of soil nutrients were preferably planted on fertile soils, whereas intermediate and local varieties were allocated to less fertile soils (Bellon and Taylor 1993: 764, 777 p.).

Upland rice production has a different importance in the three research sites. As it could have been expected from the general features of the land use system, the percentage of farmers owning rice-based upland fields is highest in those areas where people depend most on upland rice as a staple food. In remote areas with relative low population density and abundant land resources (Pemunyian), upland fields are made by almost every family in the village, with the major target of subsistence rice production and vegetables as a by-product. Economic tree crops may be planted into the old rice field for purposes as garden establishment or as an expression of land ownership. The primary purpose of the farmer in making an upland field, however, is rice production (Werner 1997: 7).

In other places, upland rice production is not of major importance anymore. In areas with good market connection but no irrigated rice cultivation, like Dusun Birun, upland rice production is always linked to cassiavera cultivation. In these areas, the primary purpose of the upland field is the establishment of a cassiavera garden. Rice as well as vegetables are by-products for subsistence, and are planted in between the cassiavera during the first three years. In regions where rice is generally grown in irrigated paddies only (Lubuk Malakko), no more upland fields are made for the purpose of further rice production. There, too, the principal reason for the opening of upland fields is the establishment of new cassiavera, coffee, or rubber gardens. Also these gardens are mixed with vegetables, when still young, but no rice is planted. In both areas, the land-use system only has a subsistence period during the first years, but then changes to become predominantly cash-producing. The main motive for establishing an upland field is not subsistence production anymore, but the generation of a monetary income (Werner 1997: 7). Therefore it is legitimate to speak of a 'cassiavera-boom' in Dusun Birun, for 75 % of the respondents had young cassiavera gardens being still in the stage mixed with annual crops. In comparison, only 35 % of the farmers in Lubuk Malakko had young tree crop gardens, which, however, had only partly been planted to cassiavera, and partly to coffee or rubber.

The national agricultural administration generally regards mixed farming like the planting of annual food crops in the first years of cassiavera production or mixed rubber gardens as undesirable. The farmers still sticking to this land use system are deemed old-fashioned, resistant to change and ignorant of farming, whereas mixed gardens are assumed to make the land barren and to have no economic value. This perception results from a lack of understanding concerning the function of the mixed farming system (Indrizal *et al.* 1992: 40).

On average, rice harvests per hectare are about one third lower in mixed rice - tree crop gardens than in fields planted to rice only. Minimum and maximum harvests per hectare were also much lower in the latter than in the prior place. Adding the fact, that average upland field size is one third higher in Pemunyian than in Dusun Birun, it is obvious, that average rice harvests per family are much lower in Dusun Birun. Because already in Pemunyian rice harvests were not always sufficient to provide for total food subsistence, it seems that farmers in Dusun Birun would consciously rather invest in cash crop production than strive for food subsistence. This assumption is strengthened by the fact, that almost one third of the rice rainfed paddy fields in Dusun Birun are fallowed, proving the decreasing importance farmers pay to rice cultivation recently. If cassiavera gardens are already big and do not need intensive care anymore, many farmers now fallowing their rice paddies, however, planned to cultivate them again. It seems, that the imperative of shifting cultivating societies, as it had been formulated by Dove (1993: 142), that rice subsistence always comes first, is not true anymore for these changing village economies. Also Belsky (1993: 138) observed that Kerinci farmers seemed to schedule all other economic activities around the cycle of rice cultivation. Due to this feature she concludes, "for irrigated rice farmers, tree crops provide multiple products that are largely supplementary in nature". According to my observations during this study and earlier observations among the Land Dayak in West Kalimantan (Werner 1991, unpublished data), the above-mentioned assessment, which has been shared by many authors, must be revised in some areas. While rice production itself has a mythical quality on Java (Soemarwoto 1984, Dove 1988), this is not necessarily the case elsewhere. During times of difficult market access, and in areas, where this still is the case, rice production for subsistence was and is important, because local rice prices are generally high due to high transportation costs. Because, however, farmers generally act economically, rice production may well be neglected, if the production of other crops is more profitable and rice is sold in or near the village at moderate prices (cf. Cramb 1978 in Chin 1985: 239, Mackie 1986: 449, Mayer 1989: 43).

This flexible adaptation of Sumatran farmers to market prices and changes in the economy could already be observed earlier this century in the adaptation of farmers towards coffee price changes. When the coffee prices dropped in the 1930s during the world recession and the costs of basic foodstuffs rose, farmers converted their gardens into upland rice fields (Morrison 1938 in Belsky 1993: 135). In the times of coffee-boom (1973-1980), many rice paddies in the coffee-zone of the Barisan-range were fallowed, only to be cultivated again when the coffee prices dropped in the early 1980s (Scholz 1988: 163). This trend had always been observed by Deuster (1982: 92) in West Sumatra, where rising rubber prices between 1972/73 and 1978/79 led to declining rice production levels and increasing rubber tapping. Furthermore, steadily decreasing real rice prices[5]

[5] Rice price development as compared with price development of other vital goods.

during the same period were making it increasingly unattractive for farmers to cultivate rice - its price doubled, whereas the cost of living index rose 2.5 times (Deuster 1982: 92). Before the green revolution, in the early 1960s, the situation was the reverse. High rice prices in relation to rubber drove farmers to produce as much rice as possible, to reduce their dependence on market supplies to a minimum (Thomas 1965: 103). This up and down continues until today. In the 1980s again low rubber prices induced the smallholders to rest their trees and adopt their usual alternative economic strategies (Potter and Lee 1998: 35). In areas, where there is no paddy rice production, this is the collection of forest products. In many Jambi villages, particularly those far away from forests, groups of men have furthermore been hired to act as illegal loggers, sometimes in quite far away areas[6]. During the monetary crisis, which started in mid-1997, prices of export commodities first rose relatively to those of rice, triggering increased forest clearing for economic tree planting in 1998/99 (Sunderlin 1999: 6). By the end of the year 1998, however, rubber prices worsened again through the strenthening of the Rupiah (Angelsen and Resosudarmo 1999: 7).

Fallow Management

Very little active management is needed once an area becomes fallow. Favouring fruit tree saplings and other useful plants by cutting plants hampering their growth, weeding around productive fruit trees and eliminating vines when travelling through the area are the principal methods used. The secondary vegetation resulting from these management practices is diverse and has a high concentration of useful species. Domesticated tree crops, especially fruit trees, medicinal plants and rubber, planted as well as established from seeds thrown away after consumption while working in the rice field are abundant, but also a diversity of wild useful trees, herbs, lianas and shrubs are found. Several farmers even plant useful species into the fallow vegetation (see table 13). Therefore, if an area is fallowed, it does not mean, that it is unused or even useless. Besides restoring soil fertility, many crops, planted and unplanted, are used. Fallows are, in fact, often some kind of extensively used gardens. These gardens are not cared for intensively, because they are located too far away or due to labour shortage.

What seems to be useless brushland to agricultural extensionists or foresters actually is a part of a delicately balanced traditional land use system. In contradiction to prevalent views, conscientious fallow management is rather the rule than the exception, as proved by Conklin (1957), Hoskins (1984), Macdonald (1993) and Garrity *et al.* (1996). Another reason for the active management of fallow land is the demonstration of land ownership. Unmanaged fallow land has no recognized

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6 Unpublished data, 1996.

private ownership but belongs to the whole community. Also the Indonesian government only recognizes land planted to crops, be it annual or tree crops, as belonging to somebody.

The average fallow age of the secondary vegetation of the village land is nine years, as calculated from information given by the farmers [7] (see chapter 6.3.3 for factors determining fallow length). Up to now, aggressive weeds like the stoloniferous grass *Imperata cylindrica* have not spread further. Nevertheless, Nye and Greenland (1963: 123) assumed that fallow lengths of at least ten years would be necessary in Southeast Asia to keep this weed under control. Furthermore, a sufficient fallow length is also important for the regeneration of soil fertility and therefore for the stabilisation of crop yields. According to studies of Ramakrishnan (1992: 39) in North-East India, a ten-year fallow is also most efficient in terms of energy ratio and land use. Ten years is also the minimum length for a fallow being effective for weed control (ibid.: 148).

In Pemunyian, farmers stated, that an area might be used again if the trees of the secondary vegetation have a diameter as thick as a men's arm, which is reached after an average of three to four years on fertile soil. The oldest secondary vegetation, as stated by farmers and as also observed in the field, was, with rare exceptions, about 20 - 25 years. According to Laumonier (1997: 8, 129), only little secondary vegetation older than 20 years is present in all of Sumatra.

Normally, decreasing fertility and increasing weed pressure are the main reasons for fallowing. It is also proven, that short fallow lengths cause a decrease in soil fertility and an increase of certain aggressive weed species. Areas, mainly emergent hills, considered to be of higher soil fertility, are assumed to need shorter fallow periods than others. For these locations it might hold true, that they have a higher fertility because of the steady topsoil erosion. This causes less weathered lower soil horizons to be exposed. Because of sufficient nutrition, concurrence of rice and non-aggressive secondary species might therefore still be strong enough to suppress aggressive weeds, which are specialised to capture sites of low fertility.

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7 It is difficult to ask for fallow duration, because unmanaged fallow is a kind of common property. If calculating fallow ownership from the data given by the farmers, most of the farmers in Pemunyian own an average fallow size of 3.1 ha. In Dusun Birun and Lubuk Malakko only about one third admitted owning fallow of an average size of 1.5 ha viz. 3.4 ha. In any case, this amount of fallow ownership is not in accordance with the average field size as well as fallow length given by the farmers and observed in the field. The average fallow ownership per family has to be at least the average fallow length plus the actual upland field multiplied with the average *ladang* size, i.e. 12 ha for Pemunyian (9 + 1 x 1.2). One reason for the reserve on the part of the respondents might be a mixture of forgetfulness, fear for taxation, shame for their land use system and fear resulting from pressure of forest officials. Another cause is that unplanted fallow land frequently has not been divided yet between the nuclear families and still is the property of the clan or extended family. In her studies of Indonesian shifting cultivation communities, Colfer (pers. comm. 4/00) experienced the same pattern.

Paddy Rice Cultivation

In Lubuk Malakko, irrigated rice has been grown for at least 40 years, which is the age of the oldest rice field named by respondents. In 1991 the traditional village irrigation system was exchanged for a modern technical irrigation system, allowing two instead of only one harvest as before. This change led to a virtual disappearance of shifting cultivation for the means of rice production, whereas in times where only one rice harvest per year was possible, many people still also cultivated a *ladang*. In Dusun Birun, rainfed paddy rice (*sawah tada hujan*) is cultivated in the small flat areas between the hills. Unlike irrigated rice, the water supply in rainfed rice paddies cannot be regulated, causing lower harvests. Because high-yielding varieties generally demand a well-tuned water supply, in rainfed paddies still mainly traditional varieties are used. Since 1990, when the cassiavera-boom started in that village, people fallowed their rice paddies, and focussed all their attention and labour upon their cassiavera gardens. As mentioned above, Sumatran farmers tend to fallow their rice paddies during times of high prices for products of their tree crop gardens. During my visit in May 1994, however, some farmers stated they planned to cultivate their paddies again at the end of the month. In Pemunyian, a level area near the Pemunyian River was tried as a wet rice field several years ago. However, the fields were given up due to unsatisfying harvests. The land is used as a buffalo grazing ground now.

Table 11: Rice paddy ownership and management

		Dusun Birun	*Lubuk Malakko*
% of farmers owning rice paddy		50 %	97.5 %
average paddy ownership *		0.7 ha	0.7 ha
ownership status**:	bought	12.2 %	20.9 %
	inherited	77.8 %	53.5 %
	sharecropped	0 %	20.9 %
	rented	0 %	4.7 %
paddy management:			
	alone / family members	63.1 %	94.8 %
	sharecropping	5.3 %	2.6 %
	paid labour	5.3 %	0 %
	fallowed	26.3 %	2.6 %

* Based on farmers' assessment. ** In % of total paddy area.

In Lubuk Malakko, almost all paddy fields are under cultivation, whereas 40 % of the rice fields in Dusun Birun are fallowed (26 % of the respondents). In Dusun Birun, 50 % of the respondents and in Lubuk Malakko 97.5 % of the respondents own a paddy rice field with an average area of 0.7 ha (table 11). In fields, which are sharecropped generally 1/3 of the harvest belongs to the owner of the field and 2/3 to the person, who cultivates it. This feature seems to be representative for West Sumatra (Deuster 1982: 87) and most other parts of the island, except for densely settled areas. There paddy yields are generally divided 50 : 50 (Scholz 1988: 74).

4.1.2 Other Food Crops

As mentioned before, besides rice as the staple food crop, farmers generally also plant vegetables and other food crops. Vegetables generally are planted into the upland field or in the homegarden. The combination of rice with vegetables is a typical feature of shifting agricultural fields, as has been observed by several authors (Dove 1993: 137, Werner 1993: 12). Besides rice, an average of three vegetables and other annual food crops are planted into the upland field or young garden (table 12). In upland fields not mixed with tree crops, the amount of vegetables planted is highest, reaching up to nine different species. The number of vegetables cultivated decreases with the age of the garden.

Besides annual crops, perennial crops are also cultivated. Especially in Dusun Birun, where the primary purpose of the upland field is the establishment of permanent gardens, an average of more than two tree crops is planted into each *ladang*. The knowledge concerning which species are suitable to be mixed results from generations of trial and experience. Christianty and Priyono (1979 [8]) in their study of Sundanese homegardens in West Java found, that farmers had a well-developed understanding of the light needs of various species and placed them in their gardens accordingly. Besides, mixed cropping in traditional agroecosystems also works as a biological pest suppressant (Ramakrishnan 1992: 42). Irrigated rice fields are sometimes also planted with annual food crops other than rice (*palawija*), usually after the main rice harvest on fields where the supply irrigation water does not suffice for a second rice harvest.

Table 12: Cultivation of non-rice crops in upland fields

	Pemunyian	*Dusun Birun*	*Lubuk Malakko*
average number of non-rice crops planted	4.3	4.6	2.8
vegetables and fruits	4.2	2.4	2.6
tree crops	0.1	2.2	0.2

[8] As cited in Rambo 1984: 54.

Table 13: Non-rice crops planted into upland field during the last two years

local name	***english name***	***botanical name***	***Pemunyian***	***Dusun Birun***	***Lubuk Malakko***
bayam	amaranth	Amaranthus sp.	7.2 %	13.9 %	-
cabe	chilli pepper	Capsicum annum	43.2 %	15.4 %	15.4 %
duku	longsat	Lansium domesticum	-	10.8 %	-
durian	durian	Durio zibethinus	-	9.3 %	-
gando / gadun	St. Thomas bean	Entada phaseoloides	19.2 %	-	-
jagung	corn	Zea mays	24.8 %	4.6 %	3.2 %
sipadeh	ginger	Zingiber officinalis	3.2 %	-	-
jengkol	stinkbean	Pithecellobium jiringa	0.8 %	12.3 %	-
kacang belimbing		Psophocarpus tetragonolobus	-	1.5 %	-
kacang panjang	long beans	Vigna unguiculata	32.0 %	3.1 %	33.0 %
kacang tanah	groundnuts	Arachis hipogaea	3.2 %	-	20.8 %
kangkung	swamp cabbage	Ipomoea aquatica	4.8 %	6.2 %	-
katulo / pitulo		indet.	28.8 %	12.3 %	16.3 %
keladi	taro	Colocasia esculenta	0.8 %	-	-
kucai		Allium odorum	0.8 %	-	-
kundur	white gourd	Cucurbita moschata	-	3.1 %	-
kunyit	tumeric	Curcuma domestica	6.4 %	-	-
mangga	mango	Mangifera indica	-	6.2 %	-
melon	honey melon		-	-	2.0 %
mentimun	cucumber	Curcumis sativus	35.2 %	6.2 %	6.7 %
nangka	jackfruit	Artocarpus heterophyllus	-	3.0 %	-
batiak	papaya	Carica papaya	9.6 %	-	-
petai	locust bean	Parkia speciosa	-	6.2 %	-
pisang	banana	Musa paradisica	-	6.2 %	7.2 %
pucuk katu/ sayur k.		Sauropus androgynus	-	60.0 %	-
rambutan	rambutan	Nephelium lappaceum	-	1.5 %	-
rotan	rattan	ARECA	-	3.1 %	-
semangka	watermelon	Citrulus lunatus	3.2 %	-	3.5 %
terong	eggplant	Solanum melongena	21.6 %	19.0 %	54.5 %
tomat	tomato	Lycopersicon esculentum	-	6.2 %	1.5 %
ubi jalar	sweet potato	Ipomoea batatas	0.8 %	3.1 %	-
ubi kayu	cassava	Manihot esculenta	31.2 %	57.8 %	45.7 %

* in % of the respondents

A total of 18 different vegetables, two annual fruit crops, eight fruit tree species, two spices and one plant used for handicrafts were planted during a period of two years (table 13). Preferences for certain crops differed between villages, probably also due to the availability of seed material. In general vegetables were cultivated for home consumption only and not for the generation of cash income[9].

The main reason for this feature, besides transportation problems, are the unsuitability of the acid and leached upland soils for permanent dryland cultivation. As it will be seen in a subsequent chapter (6.3.1), local people already experienced that most annual food crops only thrive well on fertile ('black') soil. Apart from the rareness of fertile soil in the research area, high pest pressure (especially wild boar) also does not allow for unguarded vegetable gardens. Besides, several valuable spices and vegetables for daily consumption are also planted in the houselot to prevent predation (cf. Michon *et al*. 1986: 319 for West Sumatra).

4.1.3 Livestock

Animal husbandry clearly is not a main agricultural activity in the research area. The low reliance on livestock is a common feature of the land use systems in KSNP boundary villages (Barber *et al*. 1995: 21). Only a few people keep cows and buffaloes, mainly for rice field preparation. This is reflected by the higher amount of ownership in Lubuk Malakko, the only village with a major focus on irrigated rice cultivation (table 14).

Table 14: Animal husbandry in the research area

Village	***cows***		***buffaloes***		***goats***		***chicken***	
	%	ø	%	ø	%	ø	%	ø
Pemunyian	5.0 %	1.0	12.5 %	2.4	32.5%	2.8	92.5%	11.3
Dusun Birun	2.8 %	2.0	13.9 %	3.2	2.8 %	3.0	80.6 %	5.3
Lubuk Malakko	27.5 %	1.6	17.5 %	2.9	5.0 %	3.0	50.0 %	7.8

% Percentage of respondents owning the respective kind of livestock.

ø Average amount of animals owned.

Also relative low cash availability and difficulties in market access might contribute to the low amount of large livestock kept in the research area, especially in Pemunyian and Dusun Birun.

However, small numbers of large livestock is a typical feature for all areas of the humid tropics, caused by generally unfavourable conditions for animal husbandry. Following Scholz (1988: 28), major reasons are

* high temperatures, resulting in reduced food intake and therefore slow weight increase

9 Amounts produced were difficult to assess and varied from year to year and from family to family. To obtain exact data of the produce, weighing the harvest during one or several production cycles would be necessary.

* an abundance of diseases and parasites favoured by the humid tropical climate
* the lack of natural pastures
* the low nutrient content of the local grasses, especially that of the common *alang-alang* grass (*Imperata cylindrica*).

The prestige of local farmers in general is only to a lesser amount measured by their ownership of livestock. For paddy farmers, the major indicator of wealth is the size of their property, especially irrigated rice fields (ibid.: 29). Besides these considerations, traditional shifting cultivating societies usually do not keep larger livestock due to practical considerations: the families spend periods of the year at their often distant rice fields. This practice limits animal husbandry to those species, which can be carried with them, like chickens, or those, who can find their fodder themselves, like poultry and pigs (e.g. also on the islands of Siberut and Kalimantan, own observations; and in North-East India, Ramakrishnan 1992: 106).

4.2 Income Generating Crops

An important part of the local land use system besides subsistence food crop cultivation are tree crop gardens for cash generation. Smallholders extensively plant economic tree crops for cash purposes as an outgrowth of shifting cultivation in many parts of the humid tropics (Raintree 1986: 9). In former times, economic tree crops were not planted extensively due to market imperfections, but also because abundant primary forests allowed the gathering of various products. The increasing pressure upon primary resources and the resulting scarcity of the concerned products also contributed to the preference of shifting cultivators to plant economic tree crops on their own land (Dove 1994: 3).

In Indonesia alone, most shifting cultivators nowadays have integrated some kind of economic tree crop into their shifting cycle. In the lowlands of West Java, Kalimantan and Sumatra rubber has been integrated in the shifting cycle as a cash crop (Barlow and Tomich 1991, Dove 1993), in the Sumatran uplands coffee and in some areas cassiavera (Scholz 1988, Godoy and Bennett 1989). In East Kalimantan, the fallow is economically enriched with rattan (Weinstock 1984a), in West Kalimantan with Illippe nut (*Shorea spp*.) (Werner 1993).

The cultivation of tree crops, which are planted mainly in mixed forest gardens is well adapted to the local ecological conditions. This kind of assemblages of plants with different growth habits, canopies and root structures makes optimum use of scare available environmental factors like nutrients, water and solar radiation. As has been mentioned above, tree crops generally are planted into the old upland rice fields or are directly planted mixed with annual food crops and fruit trees. In the two provinces of the study, Jambi and West Sumatra, 24.4 % and 16.0 % respectively of the farmed land are planted to tree crops. In West Sumatra, 25 % of the area planted to tree crops is planted to rubber, in Jambi 77.3 % (Barlow and Tomich 1991: 32 p.). The average annual growth rate of rubber plantations has been about 2 % during the last 10 years (Susila 1998[10]).

4.2.1 Rubber

The usefulness of natural rubber from the tree *Hevea brasiliensis* was first discovered by the native Indian populations of the Upper Amazon, who were manufacturing a variety of rubber products for domestic use and trade in the 18th and 19th century. The earliest and principal use of rubber tree products has been for food. The seeds of the rubber tree and some of its close relatives can be consumed after prolonged soaking or boiling to remove the cyanic poison (Smith *et al*. 1992: 211). The rubber trees of Southeast Asia are descended from rubber seeds that the British gathered in Brazil in 1876 and planted in the Singapore Botanic Gardens (ibid.: 213). After rubber was introduced in Central Sumatra in the 1920s, rubber production developed to the main monetary income-oriented activity in that area. In 1906, South and Southeast Asia accounted for only 1 % of world rubber production. Only two decades later, the area's production from cultivated plantations amounted to more than 95% of the world supply (McHale 1965: 35). In Brazil, its native area, commercially viable plantations could not be established successfully due to a fungal disease, the South American leaf blight (Smith *et al*. 1992: 215).

Because the rubber plant is adapted to acid upland soils of low fertility, it needs no fertiliser input. Rubber cultivation spread very quickly in the upland areas of Sumatra and other moist tropical areas of Indonesia[11], like West Kalimantan and West Java. It was considered an 'ideal' farmer smallholder crop (McHale 1965: 36). Two-thirds of natural rubber production worldwide is used for the manufacturing of tires (Smith *et al.* 1992: 229). Besides, rubber is a major component of rubber footwear and rain gear and also used for industrial products like hoses, fuel cells, belts, foam sponge, mats, packing and tank linings (Rhines 1959: 82).

Rubber is mainly produced in the three Southeast Asian countries Malaysia, Indonesia and Thailand. These three countries account for 73 % of the world production, with Indonesia (24.5 %) being the second largest producer after Thailand (26.9 %) (Stat. Bundesamt 1995: 259). In the early 1990s 3.2 million hectares were planted to rubber in Indonesia, 2.7 million ha or 84.4 % of them by smallholders (Stat. Bundesamt 1994: 56). The area planted to rubber, however, is still expanding,

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10 In: Kartodihardjo and Supriono (2000: 3).

11 High annual rainfall (above 2,500 mm/a) with a fairly even distribution throughout the year is a necessary condition for successful rubber cultivation (Barlow and Muharminto (1982: 88). Besides, although rubber is adapted to low soil fertility, balanced fertilisation increases growth and rubber flow. Rubber does not grow well at pH above 5.5, because then leaves develop chlorosis due to immobilization of iron (Rhines 1959: 84).

predominantly through smallholder activities in Sumatra and Kalimantan. More than 1.4 million Indonesian families or about eight million persons depend on rubber production for their main income, typically owning 2-3 ha per household. Annual rubber production ranges from 1.2 to 1.3 million tons, of which more than one million is exported, generating exchange revenues of more than US$ 1 billion (ibid.: 56, 80). In 1991, smallholder rubber accounted for 75 % of Indonesia's rubber exports (Dove 1993: 136). Rubber is the largest agricultural generator of foreign exchange. It contributed to 3.5 % to the national revenue from exports (1980: 5 %), coming fourth in value to oil products, textiles and timber, and comprising 5.7 % of non oil items (1980: 19 %) (Stat. Bundesamt 1994: 80).

Before the introduction of rubber there had been almost no cash crop production in the research area, cash income was earned mainly through the sale of non-timber rain forest products like rattan, resin and aromatic gums. The possibility of combining rubber with rice production was advantageous to the farmers. Rubber provided excellent prospects of a very attractive cash income on the basis of relatively small inputs of money, capital and labour (McHale 1965: 42). Therefore farmers could now hedge against the loss of the rice crop by earning income from rubber (Thomas 1965: 102): When their rice crop failed in a given year, farmers could draw more heavily on their rubber, and when rubber prices were low, they had at least their rice crop for subsistence (Dove 1983: 93-95).

In the late 1980s rubber cultivation in the peneplains and hill zone of Sumatra covered about one fourth of the island, extending over almost 1,000 km in length and 120 km in width (Scholz 1988: 163). Especially when infrastructure and the availability of agricultural inputs were still limited, rubber was the major crop produced for sale in that region. While large-scale palmoil plantations are have been spreading quickly during the last decade, rubber still is the main economic tree crop cultivated by smallholders. However, in the course of increasing infrastructural development, especially those of roads, and a consecutive flow of information and goods, also village economies are progressively subject to change.

Ownership of Rubber Gardens

In the more remote areas, which are represented by the village Pemunyian, the village economy still is mainly based on rubber. 97.5 % of all respondents own rubber gardens, with an average total area of 2.7 ha. 70.8 % of all rubber gardens are already productive and 60 % of the respondents own productive gardens. In Lubuk Malakko, rubber garden size per family is almost 30 % lower than in Pemunyian, i.e. 1.9 ha, with only 82.5 % of the farmers owning any rubber garden. Finally, Dusun Birun has the lowest ownership rate of all villages, both concerning the garden size owned per family and the percentage of farmers owning any garden. If calculated for all households investigated, the area of productive, tapped rubber per family is only 0.2 ha, which is only about 12 % of the productive garden ownership in Pemunyian and half of that in Lubuk Malakko. According to calculations of Gouyon *et al*. (1993: 196), a total rubber garden area of three hectares “is the minimum to meet the average basic consumption needs per household under optimistic price hypotheses”. These authors found that households in the ‘frontier’ zone of Jambi owned at least 5 ha of rubber gardens. In the early 1960s, when South Sumatra was still sparsely settled, Thomas (1965: 103) also found rubber garden ownerships of 4 - 6 ha per family, with about half of it being productive.

Table 15: Rubber garden ownership

		Pemunyian	***Dusun Birun***	***Lubuk Malakko***
% of farmers owning rubber garden		97.5 %	61.1 %	82.5 %
% of farmers owning productive garden & tapping them		62.5 %	19.4 %	45.0 %
average rubber garden ownership*				
	total	2.7 ha	1.1 ha	1.9 ha
	productive gardens	1.7 ha	0.2 ha	0.9 ha
	not yet productive gardens	0.8 ha	0.3 ha	0.5 ha
	fallowed gardens[12]	0.2 ha	0.6 ha	0.5 ha
ownership status**	bought	9.1 %	2.5 %	18.7 %
	inherited	57.4 %	90.1 %	7.4 %
	opened primary forest	33.5 %	7.4 %	73.9 %

* Farmers’ assessment. Area per family owning rubber gardens ** In % of total rubber garden area

The major reason for these disparities is the importance rubber production has in the village economy. In remote areas like Pemunyian, rubber production is almost the only means for cash generation besides some gathering of non-timber forest products. As mentioned above, in areas connected by roads, like Dusun Birun and Lubuk Malakko, increased access of the local population to markets and to information also brought about changes in the agricultural production pattern. In areas where technical irrigation has been introduced, more time is committed now to rice cultivation, allowing for two instead of only one harvest per year, as was described in chapter 4.1.1.

[12] Probably not all fallowed gardens have been mentioned by the farmers. In cross-check questions several gardens were just mentioned in one of either question. One reason for this feature is that farmers tend to forget about gardens they don’t actually manage, another, that farmers often plant rubber trees in their old rice fields as an expression of their claim to that land, but the garden is too far away to be managed. It functions also as a growing ‘in-kind bank account’, which might be tapped in times of need, or inherited by the children, or might be tapped the next time the family has a rice field nearby.

However, also new crops, like cassiavera, and other cultivation practices entered the area, promising higher incomes and less risk (chapter 4.2.2).

Notwithstanding the decreasing importance rubber has in some village economies due to other means of income generation, farmers are not cutting down their rubber to plant the area with a more promising crop. Although total areas of rubber actively managed by the individual family might have decreased in certain areas, most of the farmers still try to diversify their sources of income, or, at least, their *potential* sources of income. This is reflected by several features. First, by the relative high area of rubber gardens fallowed in general (table 15) as well as by the high amount of gardens of productive age being fallowed (table 16). Besides, far away rubber gardens often are not tapped during times where families have no *ladang* nearby. Also other authors have observed, that rubber smallholders often fallow their mature rubber gardens for several years, if rubber prices are especially low (McHale 1965: 42, Barlow and Muharminto 1982: 91). Second, by the unchanged age structure of the total rubber gardens (table 16), which is expressed by the amount of young gardens. If farmers were to give up rubber cultivation for good, certainly there would be no more or at least less young gardens.

A relatively low proportion of immature to mature rubber (table 16), nevertheless, can also reflect long cultivation cycles and therefore indicate a relative abundance of land. In areas, where land is scarce, farmers rejuvenate their old gardens, whereas where land is abundant, farmers don't, but plant new ones on empty land instead. Barlow and Muharminto (1982: 95) compared five South Sumatran villages and found 16-17 % immature gardens in areas with abundant land resources compared to 38-40 % immature gardens in areas where land was scarce.

Table 16: Rubber garden age structure

	Pemunyian	*Dusun Birun*	*Lubuk Malakko*
% of gardens in productive age (≥ 8 yrs.)	78.4 %	69.7 %	76.1 %
% of all gardens tapped	63.2 %	21.2 %	47.0 %
average age of rubber gardens			
productive gardens	18 years	19 years	18 years
all gardens	14 years	14 years	13 years

In the research area, the proportion of immature rubber is intermediate to high, compared with the data of these authors, varying between 21.6 % and 30.3 %. In the remotest village, where land is relatively abundant (Pemunyian), the percentage of immature rubber indeed is lowest. The relatively high percentage in Dusun Birun, however, does not stem from shorter cultivation cycles of rubber. Since the late 1980s farmers in fact mainly established new gardens for cassiavera due to current high prices for cassiavera bark, but mixing it with rubber. Also in West Kalimantan, where there is no land scarcity, Dove (1993: 138 p.) found a high amount of immature rubber gardens (39 %). A high percentage of immature rubber gardens therefore may stand either for land scarcity or land abundance and high current planting rates. In either case it needs further investigations to determine, what factors are responsible for the current age structure.

As has been described above, also in villages where rubber is economically less important, people still plant rubber and therefore maintain a source of income which has proven to be sustainable, although less promising in the actual time. Times can change, too, so it is wise to have some backup. Farmers already have experienced that new, seemingly promising crops are not always going to provide a steady income. Some years ago, cloves were high-priced and seemed to be easy to cultivate. Many farmers almost everywhere in Sumatra planted cloves. Some time later, a disease killed most of the crops, being succeeded by a severe deterioration of the prices due to introduced central marketing regulations. Today, there are no longer any farmers planting cloves.

Management Practices

Rubber has been produced in the research area for about 60 to 90 years, which is the estimated age of the oldest rubber gardens. Up to now, almost no rubber garden planted has been cut down again. The first rubber gardens are still standing and productive, although yielding less compared with young gardens, because many rubber trees are already dead. The structure and composition of old rubber gardens is already similar to that of old-growth forest. There is, nevertheless, a lot of spontaneous regrowth of rubber within old gardens, replacing dead and unproductive trees. Because, however, rubber does not grow well under shade, the overall tapped tree population after 40 years shrinks to only 40 % of the initial number of rubber trees (Gouyon *et al.* 1993: 194).

Nevertheless, just about 13 % of all farmers admitted to cutting down old rubber gardens if latex production decreases. Those who cut down their aging gardens, stated that they did so at an average age of about 30 years. That would mean an effective tapping duration of 22 years, which is well in the time frame for rubber productivity under traditional management set by Barlow and Muharminto (1982: 90) at 15 - 25 years. Several gardens, however, also were exhausted early due to bad tapping measures. It is probably unusual that the old gardens are not cut down again, after their productivity has decreased. In other areas of Sumatra and Kalimantan, rubber is normally cut down and the area is replanted with young trees after about 40-60 years (Gouyon *et al*. 1993: 188, Werner 1993: 10).

One of the reasons the majority of the farmers refrain from cutting down old rubber gardens is that they perceived that the same number of old rubber trees would be more productive than young ones, and also their latex would be of higher quality because it contains less water. According to farmers' assessment, young productive rubber trees harvest about 25 % less than the same number of old productive rubber trees. For that reason, it is said, that an old rubber garden with 300 trees per ha still yields more than a young rubber garden with 400 trees per ha.

Another reason for not cutting down old gardens is that they might harvest less rubber, but instead a wide array of fruits and medicinal plants as well as valuable timber grow in relative proximity to the village, which otherwise can only be found within primary forest (cf. Werner 2000 on botanical composition and used species within old rubber gardens). Furthermore, land planted to tree crops represents a recognized claim to that land. Under circumstances, where traditional ownership to land is not recognized by the government, planting as much land to tree crops as possible seems to be the only way to retain ownership when pressures upon natural resources increase (cf. Gouyon *et al*. 1993: 193).

The majority of the farmers manage their rubber gardens by themselves (table 17). In Pemunyian, almost one third of the gardens are sharecropped or managed by paid labour, whereas in both other locations only some respondents rented their gardens out. As could be expected, the village where the highest percentage of gardens are fallowed is Dusun Birun, and the lowest Pemunyian. This feature stands in direct relationship to the economic importance rubber has in the village economy. In Pemunyian, where average rubber garden ownership is highest, the percentage of sharecropping is, too. The lack of other income opportunities makes sharecropping both profitable for the garden owner and the person who tap the rubber trees.

Table 17: Rubber garden management

		Pemunyian	***Dusun Birun***	***Lubuk Malakko***
rubber garden management *	alone	56.7 %	59.1 %	77.3 %
	sharecropping	26.3 %	13.6 %	3.0 %
	paid labour	2.6 %	-	-
	fallowed	15.4 %	27.3 %	19.7 %

* In % of the respondents.

For creating a new rubber garden, the rubber trees are planted into the *ladangs* while the rice plants are still small. The labour cost for establishing the new stand of rubber therefore is very low. Also no capital is needed to obtain planting material, because rubber seedlings are generally gathered beneath mature unimproved trees close to the new planting. The average amount of surviving mature trees is about 300 per hectare. This number seems to be about average to low as compared to other inventory data. Colfer (pers. com. 4/2000) had a similar estimate for rubber gardens near

Sitiung, West Sumatra. Geinitz (1984: 15) mentioned an average between 100 and 350 productive rubber trees in mature Sumatran rubber stands, whereas Dove (1993: 139) found 250-500 trees per hectare in West Kalimantan. Gouyon *et al*. (1993: 187) counted 490 rubber trees per ha in adult rubber plantings in South Sumatra, while limited regrowth and wrong tapping measures made rubber tree density in an old Jambi garden drop to only 200/ha. According to Barlow and Muharminto (1982: 98, 101), in South Sumatra 600-650 saplings are planted per hectare, reaching an average of 430 trees in mature stands.

According to the local people, rubber trees are planted in about every second rice field. Similar observations were also made by Barlow and Muharminto (1982: 96) in South Sumatra. On average, secondary regrowth within young rubber gardens is slashed regularly until an age of 5 1/2 years. More than three-fourths of the farmers don't cut down useful plants that casually grow within their gardens. Spontaneous vegetation, spared during slashing, includes mainly fruit trees, timber trees, medicinal plants, species used for handicrafts and some plants with other uses (table 19). Besides providing food, medicine and building materials, the mixing of rubber gardens with other species prevents pests often affecting monocultures. Mixed rubber gardens also harbour a high biodiversity of plants as well as of the animals feeding on these plants. The concept of distinguishing spontaneous secondary regrowth into useful und threatening components is also shared by shifting cultivators of other areas (e.g. Chacón and Gliessman 1981: 6).

Table 18: Management practices within rubber gardens

	Pemunyian	***Dusun Birun***	***Lubuk Malakko***
% of farmers cleaning their gardens regularly	95.0 %	71.4 %	76.5 %
average age until cleared regularly*	5.6 years	4.4 years	6.0 years
% of farmers not cutting down useful wild plants	92.5 %	80.6 %	57.5 %

* Frequency once a year or more.

Whether people are cleaning their rubber gardens from undergrowth and plants disturbing the growth of the young rubber trees, and the frequency with which they are doing this, depends on various factors. As expressed by table 18, there is a general trend in rubber garden management related to the age of the garden. According to Thomas (1965: 108), Barlow and Muharminto (1982: 91) and De Foresta (1992: 3) in their studies on rubber cultivation in South Sumatra, rubber gardens are merely left growing with the pioneer vegetation in the time between abandonment of the *ladang* and the first tapping of the trees. Also Barlow and Tomich (1991: 38) stated that Indonesian smallholders generally do not undertake "further labour-intensive initiatives aimed at improving economic returns such as clearing competing undergrowth so that rubber trees grow faster and reached the tapping stage earlier", because they would earn lower present net incomes. In my research area in Jambi and West Sumatra, however, this is only true for part of the land planted to rubber. In some gardens the trees are only planted into the rice field or into the young fallow, receiving little or no care in the following years. Those rubber gardens that are extensively managed like that generally have a very low number of surviving rubber trees per area.

Table 19: Useful spontaneous vegetation within rubber gardens not cleared by farmers

local name	botanical name	local name	botanical name
fruit tree species		***medicinal plants***	
duku	Lansium domesticum	bidaro	Eurycoma longifolia
durian	Durio zibethinus	kasai talang	Pometia pinnata
jambu air	Eugenia aquea	jirak padang	Eurya acuminata
jengkol	Pithecellobium jiringa	kunyit	Curcuma domestica
kabau	Archidendron sp.	kunyit bolai	Zingiber purpurteum
langsat	Lansium domesticum	sicerek	Clausena cf. cavata
macang	Mangifera sp.	sidingin	Kalanchoë pinnata
mango	Mangifera indica	sikakau	Cyrtandra sp.
mangosteen	Garcinia mangostana	sikumpai	indet.
nangka	Artocarpus hereophyllus	sitawa	indet.
petai	Parkia speciosa	***timber species***	
rambutan	Nephelium lappaceum	kawang	Dipterocarpaceae
other wild plants		kuli	Scorodocarpus borneensis
dalok	Macaranga javanica	kumpabok	indet.
damar	indet.	madang	Litsea spp. and various other species
kayu sibuk	indet.	maraneh	Elaeocarpus palembanicus
jambu monyet	Bellucia axinanthera	meranti	Lithocarpus sundaicus and various other species
kopi	Coffea robusta	petaling	Ochanostachys amentacea
rimbang	Solanum torvum	sungkai	Peronema canescens
sitarak	Macaranga cf. nicopina	surian	Toona sureni
		tamalun	indet.

Besides those gardens mentioned above, which usually are too far away to be managed intensively, most of the young gardens are cleaned regularly. Especially young rubber plantings below the age of three years are cared for intensively. More than three-fourths of the respondents clean their gardens of this age twice a year or more, some even every month (table 20). Gardens aged four to five years are only cleaned that often by about half the farmers, and those between 6 and 10 years old only by some one-fourth of the garden owners. If rubber trees have reached an age of more than ten years, most farmers do not clean their gardens more than once a year. At that age the rubber trees are considered to be strong enough to compete with the secondary vegetation. The trees already form an almost closed canopy to shade out most of the weeds and fast-growing pioneer species. If secondary growth is not cleared regularly when the rubber trees are still small, however, many trees die and the remaining grow only poorly *(*cf. Barlow and Muharminto 1982: 91*)*. Mature gardens generally are cleaned while tapping, mainly along the paths from tapped tree to tapped tree. However, most of the farmers at that age only cut down those plants hindering them in their tapping activities. The wage per day for cleaning rubber gardens was given as Rp. 2,500.- to Rp. 3,000.-[13] per day, including food (Pemunyian; 12/1993) and Rp. 3,000.- per day, including food, for planting rubber (Lubuk Malakko; 8/1994).

Table 20: The relationship of cleaning frequency for rubber gardens and garden age

% of farmers cleaning their rubber garden *	***age of rubber garden (years)*** 1 - 3	4 - 5	6 - 10	> 10
≥ 4 x / year	53.7 %	32.8 %	12.8 %	3.9 %
2 - 3 x / year	22.1 %	18.6 %	14.7 %	6.7 %
1 x / year (or less)	24.2 %	49.5 %	72.5 %	89.4 %

* In % of respondents owning rubber gardens

The cleaning of a rubber garden is very labour intensive. Especially in young gardens, where a high percentage of sunlight still reaches the ground, regrowth of secondary vegetation is vigorous. If the soil of the location is somewhat degraded, the plant community will be dominated by the vicious fern *Dicranopteris*, which forms dense thickets and even scrambles upon the rubber trees. This impedes the development of the rubber trees and negatively influences the performance of the trees when reaching maturity. According to the farmers, the time needed to clean one hectare of rubber is about one to three weeks, depending on the density of secondary regrowth. Many farmers do not have the time to clear their rubber gardens regularly. If the rubber is not tended properly, however, many trees die and it remains only lush secondary vegetation with some poorly growing rubber trees.

The intensity farmers care for their young rubber gardens depends very much on their plans about a certain garden. If the garden is on a former rice field and quite far from of the village itself, and if it is just meant as a productive reserve or to establish a claim to that land, it probably will not be tended very thoroughly (Werner 1997: 12). These gardens might only be cleaned or tapped again, if the family once again has a swidden nearby, a strategy also employed by other shifting cultivating communities in Indonesia (Dove 1993: 141). The farmer will invest his energy where he will get the

[13] About US$ 1.40.

highest revenue, which means, the nearest and most productive or promising garden will be cared for most intensively. Also if a family has abundant labour, they can manage more gardens or give more attention to the gardens they own than small families. This characteristic is in line with the statement of farmers, that the gardens which are not tapped first in times of labour scarcity are those too far away and those whose harvest is too little because the garden is either too young, too old, or contains too few productive trees.

Harvest

Since they are cleaned regularly during the early years of the growing period, the rubber trees already reach a harvestable age by about eight years. In areas with less intensive management, where the young stands are not cleared in the period between the end of annual cropping and the first tapping, trees only reach maturity at an age of 10 years (Barlow and Muharminto 1982: 99). Rubber is tapped every day or every second day, with an average frequency of 4.3 times per week, except for the periods where all family labour is absorbed by work in the *ladang*. Tapping frequencies of 3 - 5 times per week were also reported by Gouyon *et al*. (1993: 191) for Jambi and South Sumatra. Thomas (1965: 105) calculated, that on about 100 days per year rubber can not be tapped due to labour peaks in rice production in shifting cultivation communities. Also rain, especially in the morning when rubber is generally tapped due to a better latex flow, inhibits the tapping. Rain during times of tapping can over-fill the latex collection cups and leads to premature coagulation.

The quality of the rubber produced by the smallholders is very low. The liquid latex runs from the cut into coconut shells, which are used as a receptacle. The rubber is purposely mixed with other substances like the bark of trees to increase the weight of the rubber and to fill the coconut shells more quickly. Up to 60 % of the produce consists of water and dirt, states Scholz (1988: 28). The rubber is sold in the form of week-old *slabs*, which are manufactured from dirty latex, unsmoked and ungraded. On international markets, the quality of Sumatran rubber is rated as one of the lowest. According to Lim (1985: 7), smallholders are caught in a ‘producer-middleman syndrome’. They are not able or encouraged to upgrade their rubber through improved processing and therefore are compelled to sell their primitively processed rubber at very low prices. Frequent indebtedness of the smallholder to the trader or simple need for cash money and no alternatives for better marketing contribute to their dependence.

According to Barlow and Tomich (1991: 35), the average Indonesian smallholder harvests 320-370 kg/ha/a. Provincial rubber yields in Jambi have increased up to 720 kg per hectare until the year 2000, exceeding the national average yields, but remaining below optimum (Potter and Lee 1998:

36, Kompas 9. 3. 2000). The price per kg of wet rubber ranged from Rp. 400.- to Rp. 600.- within the three villages between November 1993 and August 1994[14]. Farmers generally adjust their tapping frequency and the area tapped in accordance with the rubber prices. When rubber prices are low, farmers will try to balance the loss of returns with increased tapping activities (McHale 1965: 44, Geinitz 1984: 23, Dove 1993: 143). 'Sleeping rubber forests' might become reactivated during these times, especially, if other sources of income are limited. During low rubber prices farmer also pay more attention to subsistence food crop production, which might be neglected when rubber prices are high.

Sharecropping

Part of the rubber gardens is not tapped by the owners themselves, but instead sharecropped (table 17). In general, the harvest of sharecropped gardens is divided one third for the owner and two thirds for the tapper. This pattern is typical for all of Sumatra (Scholz 1988: 75). In the system, where the harvest is divided 1 : 2, the tapper cleans the garden and provides the facilities for tapping and rubber processing. However, if the garden owner cleans the garden himself and provides for the facilities, the harvest is divided 50 : 50.

In Pemunyian, more than half of all farmers are engaged in sharecropping (52.5 %), whereas in Dusun Birun the percentage of respondents tapping other people's gardens is lowest (16.7 %). This is one more indicator for the falling interest of the farmers in rubber cultivation on the one hand, and, for the high profitability of cassiavera cultivation on the other. In areas, where alternatives for cash generation are highest, the percentage of farmers tapping the gardens of others is lowest. Lubuk Malakko has an intermediate position here (35 %), representing an area with more diverse income opportunities, but without any certain 'boom' like Dusun Birun.

Fruit Trees Inside the Traditional Rubber Gardens

Besides their major economic tree crops, traditional rubber gardens generally are mixed with other useful species, especially fruit trees. Some fruit trees may be 'planted' inadvertently while consuming fruits in the garden or while the garden still was a rice field. If intentional, the fruit trees are planted about one month after the rubber. Often people also plant fruit tree species around the field hut of their *ladang*, which, if the field has become a rubber garden, becomes part of the garden. Other fruit tree species are dispersed by birds and other animals. Some of the latter are uncultivated but spared during times of cleaning the garden, because their fruits are consumed.

[14] Prices increased about threefold until March 2000 due to the impact of the economic crisis (Kompas 9. 3. 2000).

Planted fruit tree species include durian, stinkbean (*jengkol*), rambutan, locustbean (*petei*), mango, jackfruit and mangosteen. *Petei* and *jengkol*, both members of the family Mimosoidae, do not harvest sweet, juicy fruits, but pods, whose seeds are eaten raw or cooked as vegetable. Both legumes as well as many other fruits are also highly priced in urban markets and probably would sell well, if only transportation were available. Some fruit tree species like langsat and carambola are only planted in the village area, because they are said not to grow well in shady forest conditions. Also mango species (*macang, kwini, mangga golek, mempelam*) were mainly found within the village area.

Fruit trees in the traditional rubber gardens where inventories were made were quite rare. There were mainly locust bean, stinkbean and rambutan species, which, however, also occur in the wild. While questioning during the fieldwork in Pemunyian if the individual fruit tree was planted, this was only affirmed for some stinkbean trees. Durian, for example, is rarely planted, because everybody may take durian fruits that have fallen to the ground. As a result, during durian season, there are always many people in the rubber gardens, checking the various durian stands for ripe fruits. The picking of durian, however, is only allowed to the owner. Due to the height of the trees, this is very difficult, and as marketing possibilities are few, rarely done.

Other Used Products of Traditional Rubber Gardens

Valuable timber species are seldom planted into the rubber gardens, but wild species are generally used and spared in times of clearing the undergrowth (see table 19). The timber mainly is used locally for house construction. In areas where no more natural forest is with reach of the villages, however, traditional rubber gardens have become the main source of timber for the local people (De Foresta 1992: 4). In these areas, timber from rubber gardens is already sold, indicating a prospective source of income that could be expanded by the planting of valuable timber species.

Besides, like secondary vegetation, rubber gardens are also a source for firewood, which is the only source of cooking fuel, and for several medicinal plants (table 19) and handicraft materials. These species are also spared during slashing the regrowth.

Rubber Mixed with Other Economic Tree Crops

A certain percentage of farmers incorporate other economic tree crops in some of their rubber gardens. The kind and frequency of mixing differs very much between the three villages that have been investigated (table 21). In the most remote area, only about 15 % of all rubber gardens are mixed with either cassiavera or coffee, whereas in tree crop oriented villages with good market access merely 22.7 % are *not* mixed. Whereas coffee has been planted in the area for several decades, the planting of cassiavera is a relatively new phenomenon. In Dusun Birun, where all families own young cassiavera gardens, almost no more rubber is planted in single stands anymore, but only together with cassiavera (Werner 1997: 9).

Young cassiavera (-rubber/-coffee) gardens are often also planted with vegetables and upland rice. However, this is only the case if the farmers have the time to care for these mixed gardens intensively, or even are able to stay at the garden in a temporary shelter during times of fruiting. Otherwise, vegetables and rice are vulnerable to pests, especially rats and wild pigs, the latter being very abundant in the research area.

*Table 21: Composition of rubber gardens **

Main crop	***Pemunyian***	***Dusun Birun***	***Lubuk Malakko***
rubber	84.6%	22.7 %	44.1 %
rubber and cassiavera	7.7 %	69.2 %	23.5 %
rubber and coffee	12.8 %	-	20.6 %
rubber, cassiavera and coffee	-	9.1 %	11.8 %

* In % of respondents owning rubber garden

Besides the actual composition of their rubber gardens, people also have distinct preferences about how their rubber gardens should be composed. In table 22 it is expressed that about half of the respondents would rather not mix their rubber gardens with other useful tree species. In tree crop oriented villages with good market access (the ‘cassiavera-boom’-area) the percentage of farmers who like to mix rubber with cassiavera, is highest.

Table 22: Farmers’ preference for mixing rubber with other tree crops

		% farmers preferring certain kind of mixture		
		Pemunyian	***Dusun Birun***	***Lubuk Malakko***
cash crops	cassiavera	10.0 %	38.9 %	25.0 %
	coffee	25.0 %	2.8 %	32.5 %
legumes	jengkol	37.5 %	-	-
	petai	25.0 %	-	-
other fruit trees *		12.5 %	2.8 %	-
single rubber stands only		45.0 %	54.3 %	52.5 %

* Durian, *jambu medan*, rambutan, mango species (*macang, mempelam*).

The actual percentage of farmers preferring to mix rubber with cassiavera, however, is much higher than those who admit to already having done so. In Pemunyian, 35 % of the farmers would like to mix their gardens with either coffee or cassiavera, but actually, only about 15 % have already mixed their rubber gardens. In Lubuk Malakko the correlation between preference of tree crop mixture and actual planting habit is closest of all locations.

High Yielding Rubber Varieties

Compared to the harvest of high yielding rubber varieties, the harvest of local rubber trees is very low. Improved varieties, however, are more demanding concerning management practices and inputs needed. The Indonesian government promotes high yielding rubber clones[15] planted in single stands, fertilized with urea, planted with cover crops and sprayed with pesticides. This intensive management, where no mixing with other tree crops or secondary growth is allowed has been mainly applied in transmigration projects, where the new settlers were handed over nine year old ready-to-tap-gardens. The transmigrants then have to repay the expenditures for the establishment of the gardens they received by instalments. Smallholders, who already cultivate rubber traditionally, however, usually fare better with local management schemes involving mixed cropping. The susceptibility to diseases and sensitivity to poor management makes monocultures less suitable for smallholders. The main constraint is usually the access to improved cropping technologies as well as farming inputs (Penot 1997: 11).

Until recently, high yielding rubber clones found little distribution among local communities. Barlow and Tomich estimated in 1991 (p. 39), that only 1-2 % of Indonesian smallholder rubber would be under high-yielding materials, largely within the official improvement projects. The failure of many improved tree planting activities has resulted in smallholders being unable to repay the credit advances within government programs for improved rubber gardens. In Jambi, where about 500,000 ha of smallholder rubber gardens exist, only 23,000 ha could be successfully established with improved varieties from 1985 to 1995 through government programs. Many farmers also prefer to acquire improved planting material from private nurseries instead of getting involved with government programs (Potter and Lee 1998: 36). In the research areas, only one respondent in Dusun Birun and two in Lubuk Malakko admitted having gardens with improved rubber[16]. In Pemunyian, on the other hand, 35 % of the farmers already owned high-yielding varieties. Only two respondents, however, owned gardens at harvestable age. Pemunyian is located

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[15] Budgrafts, where improved material is grafted on a young seedling stock.

[16] The two respondents owning high yielding varietal rubber received these gardens as participants in a local transmigration project in a near-by village, Sungai Kunyit. The rubber gardens were handed over to the transmigrants after they reached the harvestable age of nine years. After the rubber can be harvested, the cost of its establishment has to be paid back. In these high yielding varietal rubber gardens, Urea fertilizer is applied and the pesticide, Tiodan Borat.

near a transmigration village where farmers cultivate improved rubber. The observation of the success and high yields of these gardens might have inspired the farmers. In August 1993, the Indonesian government provided 30,000 high yielding rubber plants, as well as Potash (KCl), Nitrogen (urea) and Phosphate (TSP) fertiliser in Pemunyian. These saplings have been planted by 50 families on 50 ha, with 600 trees per hectare. The saplings were provided free and people received land titles without charge for an average of 0.25 ha, which they had to plant according to instructions[17].

The average ownership of high yielding rubber varies between one and two hectares (table 23). Whereas the gardens in Lubuk Malakko are already productive, in Pemunyian only 20.5 % are tapped already. Also the average age of the rubber gardens is still very low in Pemunyian and Dusun Birun, whereas also the age of the productive gardens is lower than those of local rubber. These features are in accordance with the fact that the cultivation of high yielding clones is a relatively new development in the area as a whole.

Table 23: Ownership and age structure of gardens planted with high-yielding varietal rubber

	Pemunyian	***Dusun Birun***	***Lubuk Malakko***
% of farmers owning improved rubber garden	35.0 %	2.8 %	5.0 %
% of farmers owning productive gardens & tapping them	5.0 %	0 %	5.0 %
average rubber garden ownership*			
total	1.4 ha	1.0 ha	2.0 ha
productive gardens	0.3 ha	-	2.0 ha
not yet productive gardens	1.1 ha	1.0 ha	-
% of gardens in productive age (≥ 8 yrs.)	20.5 %	0 %	100 %
% of all gardens tapped	20.5 %	0 %	100 %
average age of rubber gardens			
productive gardens	15.0 years	-	11.0 years
all gardens	4.2 years	5.0 years	11.0 years

* Farmers' assessment. Area per family owning improved rubber gardens.

Tree crop development in developing countries usually proceeds through three stages according to Barlow and Jayasurija (1986: 639 pp.), characterised by different endowments of land, labour and capital. During the first stage, called 'Emergence from Subsistence', agriculture begins its transition

17 These instructions included, that the trees had to be planted on small, single-tree terraces, which were cut into the hills. I could not find any explanation for this practice, which involved high labour input. Possibly, it even has negative impacts on the growth of the trees, because all fertile topsoil had to be removed for this purpose, and subsoils tend to be highly aluminium-saturated, which is toxic to plants.

to a cash economy, while during stage II 'Agricultural Transformation' agriculture is commercialising rapidly. During stage III, 'Extended Structural Change', agriculture is no longer dominant, being increasingly dwarfed by manufacturing services and other sectors. While during stage I the technology employed is simple, seedling material unimproved and land still abundant, during stage II land is becoming scarcer and at the same time mechanisation is increasing and higher yielding planting material is used. If this model is applied to the Sumatran rubber smallholder economy, it now seems to progress from the first to the second stage, which in West Malaysia, for comparison, already had started in the late 1960s (ibid.: 651). The use of high yielding varieties, which started in the late 1970s to early 1980s only now begins to spread slowly.

Barlow and Tomich (1991: 46) reported for improved rubber planted in the frame of the PRPTE[18] scheme, that 90-95% of the farmers only had slightly better harvests, equal harvests or no harvests at all, due to shortfalls in both budgeted material inputs and technical guidance of the PRPTE. Only the 5-10% of the farmers who cultivated their gardens according to standard recommendations also without guidance could expect yields at least 50% more than with optimally cared-for traditional trees. Because high yielding rubber is a new development in the research area, data do not suffice to draw further conclusions. To make rubber cultivation more profitable, however, it seems to be necessary to optimise rubber management through extension and research on improved rubber management adapted to local conditions and farmers' needs.

According to Gouyon *et al.* (1993: 198), high prices of improved planting material as well as heavy expenditures for herbicides, legume cover crops and fencing still hamper the spread of improved varieties. Government programs for the promotion of clonal rubber are limited and credit facilities besides for rice intensification programs still are lacking. Up to 1961 there was still a government credit organisation to assist the rubber-owning smallholder, *Yayasan Karet Rakyat*, but that was dissolved thereafter. The importance of these facilities for the modernisation of the smallholder rubber economy has been demonstrated in Malaysia, where rural credit programmes like replanting grants together with research and extension are provided by the government. The lack of these facilities mainly is responsible for the inability of Indonesian smallholders to undertake investments in higher yielding rubber varieties (Barlow and Jayasurija 1986: 653, Barlow and Tomich 1991: 38). In Indonesia, programs for the development of high-yielding rubber have in the 1970s. Assistance, however, was mainly granted to government estates and nucleus estate schemes for transmigrants, whereas no special programs for the average local smallholder have been provided (Barlow and Muharminto 1982: 112 pp.). Although smallholders dominate latex production, only 13 % participated in government programs to improve productivity (Penot 1995: 13).

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[18] *Peremajaan, Rehabilitasi dan Perluasan Tanaman Ekspor* / Rejuvenation, Rehabilitation and Expansion of Export Crops.

The clones selected until now do not perform well under traditional rubber garden management, with a high mortality rate and slow growth. Local varieties normally are planted with a high density, already implying a high mortality rate until reaching a harvestable age. This practice, however, would be uneconomic with selected varieties having high costs of plant propagation. Farmers near commercial plantations employing high yielding clones have overcome this constraint by collecting clonal seedlings. Even with low maintenance their yields are 20-30 % higher than those obtainable from 'best practice' with local varieties (Barlow and Tomich 1991: 40). By applying material inputs in conjunction with appropriate skills, these trees may achieve 70-85 % of the yields of high yielding clones (Geinitz 1984: 120).

Information about the performance and needs of selected seedlings, however, has not reached the majority of the smallholders yet. Also Barlow and Muharminto (1982: 91) prefer the propagation of clonal seedlings among farmers instead of budgrafts, because they are more robust and therefore less sensitive towards poor maintenance and tapping practices. Increased research for improved planting material which can be cultivated with low external input as well as credit schemes to support local tree crop development would be important to prevent a marginalisation of parts of the rural population threatened by increasing land scarcity. Lately, the ICRAF Smallholder Rubber Agroforestry Project (SRAP) was first to try the integration of high-yielding varieties into mixed agroforestry systems (see Penot 1997: 9 for details). This initiative showed that it is possible to combine high latex production, mixing with other crops and biodiversity conservation. Depending on the management regime, labour inputs vary between the intensity of traditional rubber agroforests and those of monocultures.

An increase of the extension personnel to one officer per 500 - 1,000 clients, as suggested by Barlow and Muharminto (1982: 92) would probably be ideal, but is not very realistic due to a lack of funds and of skilled personnel willing to work in remote areas. The development of improved practices that can be adapted easily and of seedlings that can be propagated by the farmers themselves could be more prospective. Together with suitable credit schemes they would allow for dissemination through farmer-to-farmer communication. Unfortunately, the endeavours for the improvement of the traditional rubber cultivation system have been regarded as marginal by provincial and district authorities, anxious to speed the pace of change towards modernity, i.e. oil palm or rubber monocultures (Potter and Lee 1998: 45).

4.2.2 Cassiavera (Batavia Cinnamon)

Whereas true cinnamon, *Cinnamomum zeylanicum* is native to Sri Lanka, cassiavera *Cinnamomum spp*. originates from lowland to hilly tropical forests with a monsoon climate from India to China.

The cassiavera species present in the research area is *C. burmanii*, also called Batavia cinnamon and Indonesian or Padang cassia[19]. It occurs wild in parts of South and Southeast Asia. Due to its physiological needs, *C. burmanii* grows best on well-drained soils at an altitude from 500 to 1,500 m with an average precipitation of 2,000 - 3,000 mm per year. At altitudes below 500 m its growth is quicker, but the bark is thinner and the content of caneel-oil in the bark is low. The aromatic bark from cinnamon and cassiavera has been long appreciated in the Orient for flavouring food, for medicinal purposes, as an ingredient in incense, and as an aphrodisiac. Cassiavera, which is mainly exported by China and Indonesia, however, is generally considered inferior to true cinnamon (Smith *et al*. 1992: 352 p.).

Cassiavera has been cultivated and gathered from the forests surrounding the Kerinci valley for a long time. Since the 1920s, the tree has been cultivated, and already in the 1970s, Kerinci accounted for 63 % of the cassiavera production of all Sumatra and 40 % of the national production (Indrizal *et al*. 1992: 26, Aumeeruddy 1994: 11), rising up to 72 - 77.9 % between 1981 - 1986 (Yonariza, 1990[20]). More than 65 % of the Indonesian cassiavera was exported to the USA in the 1970s, being mainly used for pharmaceutical, cosmetics and food industries, especially for the production of soft drink cola (Ardha 1974[21]). However, only 12 % of the gross margin of cassiavera is reaped by the farmer, who produces it. Traders, middlemen and processing industries garner 88 % of the profit.

Table 24: Cassiavera qualities and average prices in 1993

		Quality		***Price (kg)***	
No.	***Name***	***Clarification***	***thickness (mm)***	***min.***	***max.***
1.	KM	Trunk > 25 yrs., bark cuttings of 110 cm.	5.0 - 10.0	Rp. 4,000.-	Rp. 4,500.-
2.	KF	Trunk 18-25 yrs., branches > 25 yrs. Bark scales of about 40 cm size.	3.0 - 5.0	n. a.	n. a.
3.	KA1	Trunk 15-18 yrs, branches > 20 yrs. Bark scales of all sizes.	2.5 - 3.0	n. a.	n. a.
4.	KA	Trunk 8-15 yrs., branches > 15 yrs. Clean bark of all sizes.	1.5 - 2.5	Rp. 3,000.-	Rp. 3,500.-
5.	KB	Branches of all ages and dirty bark of trunk and branches > 15 yrs., all sizes.	1.0	Rp. 2,000.-	Rp. 2,500.-
6.	KC	Unscraped bark from small branches and twigs.	1.0	Rp. 750.-	Rp. 1,250.-

n. a.: data not available

Sources: Savouré 1991, Bina Kelola 1994: 36 p.

[19] Indonesian cassiavera was originally called Batavian cinnamon, after the capital of Dutch Indonesia, now called Jakarta (Smith *et al*. 1992: 353).

[20] As cited in: ICDP 1994: 36.

[21] As cited in Aumeeruddy 1994: 12.

The bark of cassiavera, which can only be obtained by felling the tree, can be harvested from the age of 5 years onwards. The price of the bark depends on the part of the tree it comes from and grows with increasing age of the tree (table 24). At an age of 20 to 30 years, the best harvest can be expected. A cassiavera tree of 20 to 30 years will harvest 80 - 100 kg of (wet) high quality bark, whereas a 6 to 8 year old tree will only harvest 15 - 25 kg of (wet) low quality bark (5 - 7 kg dried bark). Although a farmer will always try to cut down his cassiavera trees at the optimal age, economic reasons often cause him to sell several trees at a younger age. For daily cash needs, however, it often suffices to cut some of the lower branches and to sell the bark. This measure, which is already practiced by some farmers at a tree age of three years, is also considered to increase the growth of the trees (Indrizal *et al*. 1992: 44). Post harvest processing is generally left to the traders, or the farmers directly sell the standing trees and also leave the harvesting to the buyers.

Because cassiavera promises a good harvest and revenue, needs little care and is not prone to pests and diseases, its cultivation spread rapidly through the hills and mountains of the Kerinci area. Investment costs are low, the price for one eight to twelve month old sapling was only Rp. 100.- in 1994 (US $ 0.05), but most farmers cultivate their saplings themselves or collect those growing in the wild. Further advantages of cassiavera production are that the harvest can be stored well and transportation charges are low due to the low weight of the produce. During the first three years of cassiavera cultivation, when the canopy still is permeable to sunlight, various food crops are planted between the trees. These food crops are generally produced for home consumption, but part of them may also be sold on the local market. Cassiavera in fields far away from the villages, however, is not so often mixed with food crops, because the danger of damage by wild animals like wild pigs, monkeys and deer is very high. During the time of the research (1993-94), high cassiavera prices attracted many farmers in the research area to plant new gardens. However, also cassiavera prices, like prices for many agricultural products, are prone to severe price fluctuations. While rising sharply during the 1950s and 1960s, they dropped dramatically in the early 1970s (Belsky 1993: 136). Although recovering through the late 1970s, prices were too low to make cassiavera an interesting crop to be planted until the early 1980s, when prices started going up again (Scholz 1988: 126). Also for Sri Lankan cinnamon, Smith *et al*. (1992: 356 p.) reported unstable prices, and responding fluctuating planting areas.

Cassiavera Cultivation Systems in the Kerinci Enclave

Savouré (1991: 7 pp.) distinguished seven different farming systems incorporating cassiavera in the Kerinci area. The first two are cassiavera monocultures, one where planting density is high (1,000 - 2,000 trees per ha) and where after a first harvest at the age of 6 years cassiavera is subsequently harvested annually or bi-annually as coppice, and one, where planting density is low (400 - 800 trees per ha) and where the main harvest is carried out after the trees are 10 - 25 years old. Three further farming systems combine annual crops with cassiavera trees and coffee. The first combination equally emphasizes both crops, therefore cassiavera is cut at the age of about ten years before it 'kills' the coffee bushes. The second system prioritises coffee production over cassiavera, therefore cassiavera is cut at the age of five or six years, before it starts to disturb the coffee plants. The last cassiavera - coffee system is similar to the cassiavera monoculture, but coffee is planted as a by-product until cassiavera is 8 to 10 years old and shades out the coffee bushes. Cassiavera will be harvested between the 15th and the 25th year under this system. Another farming system combines the production of cassiavera with those of annual crops (vegetables, soy, peanuts, maize, etc.), which are grown on ridges and form the main, regular production. To avoid too much shade that could affect the growth of the annuals, cassiavera is planted in rows 10 to 20 metres apart. The trees are pruned regularly and cut at an age of about ten years. The last farming system including cassiavera combines various perennial crops within a mixed forest garden or agroforestry system. These gardens are often very old (over 50 years) and are of varied composition, in accordance with the needs of the owner. Species include, rubber, fruit trees, timber trees and wild forest species. Cassiavera is generally managed as coppice and planted of varied density within this system.

Concerning ecological sustainability, systems where cassiavera is cut back completely and the soil is without protection for a certain period, are most unfavourable. This kind of management causes quick erosion of the topsoil. Therefore, after two or three harvests, the soil fertility of the cassiavera fields starts to decrease, which causes it to be laid fallow (Indrizal et al. 1992: 95). The process of soil degradation favours also an invasion of the notorious *Imperata* grass and light-loving ferns. These rhizome plants are very difficult to eradicate once they have established and they compete seriously with the cassiavera plants, causing poor growth. The system being ecologically most favourable is certainly the mixed cassiavera garden, where soil disturbance is least and biodiversity highest.

Cassiavera Cultivation in the Research Area

In both Lubuk Malakko and Pemunyian, about half of the farmers own cassiavera gardens, with an average total size of 1.1 ha viz. 1.2 ha per family (table 25). In Dusun Birun, however, already all farmers have planted cassiavera gardens, although the average total garden size was given as only 0.7 ha. Because the cassiavera-boom has just begun to spread to the lowland villages, only a few farmers already have harvestable cassiavera. In general, the average age of cassiavera gardens still is very low, only 3.3 years. Some farmers already own cassiavera aged up to ten years, but most of the farmers have only started planting. In the remotest area (Pemunyian), cassiavera cultivation commenced most recently, and the plantations are the youngest in comparison (average age: 2.5 years). The percentage of farmers already having planted cassiavera is lowest of all villages (45 %), but the average area assigned to cassiavera per family is highest (1.2 ha).

Table 25: Cassiavera garden ownership and age structure

	Pemunyian	*Dusun Birun*	*Lubuk Malakko*
% of all farmers owning cassiavera garden*	45.0 %	100.0 %	52.5 %
average cassiavera garden ownership**	1.2 ha	0.7 ha	1.1 ha
% of all gardens harvested	0 %	11 %	0 %
average age of cassiavera gardens	2.5 years	4.5 years	3.0 years

* Including gardens mixed with rubber and coffee.

** Farmers' assessment. Area per family owning cassiavera gardens.

Cassiavera-saplings are either bought or grown by the farmers themselves. The price for 100 saplings was Rp. 10,000.- in 1994 (US $ 4.50). Farmers who were among the first to plant cassiavera in their village sometimes only planted 50 trees into their rubber gardens, probably to try their performance under local conditions and to see if it could be profitable. Planting distance of cassiavera is 2.5 x 2.5 m[22] on average (range: 1.5 – 3.5 m). Many farmers plant additional young cassiavera under the older trees, presumably to increase density or to replant already harvested trees.

Often, cassiavera is mixed with other tree crops (table 26). Besides fruit tree species, mainly economic tree crops like rubber and coffee are planted in between the cassiavera trees or vice versa. In case of rubber, many farmers have increased the economic value of their garden through clearing the undergrowth and planting cassiavera trees in the understory.

*Table 26: Composition of cassiavera gardens **

Main crop	*Pemunyian*	*Dusun Birun*	*Lubuk Malakko*
cassiavera	82.0 %	24.8 %	40.9 %
cassiavera and rubber	18.0 %	58.1 %	40.9 %
cassiavera and coffee	-	10.3 %	4.6 %
cassiavera, rubber and coffee	-	6.8 %	13.6 %

* In % of respondents owning cassiavera garden.

22 Equalling 1,600 trees per hectare.

Coffee is often mixed with cassiavera to provide monetary income during the early years of cassiavera growth. During the first three to four years, cassiavera is also often interplanted with vegetables and upland rice. The tree seedlings benefit from the regular weeding and fertilization provided to the annual crops (Belsky 1993: 137). After the age of four years, the young cassiavera trees form a closed canopy, terminating the period of intercropping. The major pattern of cassiavera production, however, differs between the research sites, partly due to the differing economic importance it has in the three areas.

There are several reasons why cassiavera is spreading also into less suited lowland areas and starts to be favoured over rubber cultivation. While young rubber plantations often are disturbed by wild pigs, cassiavera is not. Cassiavera needs less care, can be harvested quicker and provides cash income according to needs. While rubber is already a very flexible crop, which can be tapped according to needs, the harvest of cassiavera can be adapted even more to individual cash needs. In times of low demand, only some branches are cut and sold, while at occasions of high need, like for school fees or marriages, whole trees can be cut and sold (Werner 1997: 10).

Harvest

How much a farmer harvests from his or her cassiavera garden at which time depends mainly on the cash needs the family has. It is most profitable, as it has already been stated, to let cassiavera grow until it is twenty years old. However, most farmers cannot wait that long. The individual strategy of farmers, concerning how many trees to plant per hectare, with what crops to mix and at which age to cut is very different. Many farmers owning five to ten year old cassiavera have never harvested it, others start to cut branches at an age as early as three years. This is certainly one of the main reasons, why cassiavera has become so incredibly popular during the last years: it is an extremely flexible crop, which can be harvested at any time and in any needed quantity. It is like a bank deposit, however, one having high interest rates. Those who cut quickly have the smallest revenue per amount of labour invested.

4.2.3 Other Cash Crops

Cloves

Cloves are dried flower buds of the evergreen tree *Syzygium aromaticum* (Lauraceae), native to the Moluccas, Indonesia. Cloves are used as a spice in many curries, pickles and sauces, whereas clove oil is employed to flavour food and particular pharmaceutical products as well as to scent soaps, bath salts and certain perfumes. Indonesia is the largest producer of cloves, but also the largest market for the spice, which is used for the manufacturing of *kretek*, clove cigarettes (Smith *et al*. 1992: 338 p.).

In the 1950s and 60s the Indonesian government promoted extensively the planting of cloves as a cash crop. Over 95% of cloves are produced by smallholders with farm sizes of less than 10 ha. Main production areas today are Aceh, West Sumatra, Lampung, West and Central Java, North Sulawesi and the Moluccas (ibid.: 344). Due to a very small genetic base of the clove plantings outside its area of origin, the trees are very susceptible to diseases. From the three principal diseases threatening clove plantings in Indonesia, the most violent one is the Sumatra disease, which was first recognized in 1961 in West Sumatra. During the 1970s this bacterial disease attacking the root system of the tree caused high mortalities in clove plantations in Sumatra and West Java (Belsky 1991[23], Smith *et al*. 1992: 348).

In the research area, cloves were planted in the mid-70s to mid-80s. In Dusun Birun, farmers stated that already after one harvest, most trees died of the bacterial disease. Also in case of the availability of resistant varieties, any new planting is discouraged by the low prices of cloves today. The price of cloves dropped sharply some years ago due to the invention of a central marketing system, where only one national trader was allowed to buy and sell cloves.

Coffee

Coffee was first brought to Indonesia by the Dutch in 1696. In the beginning the species *Coffea arabica* was cultivated, which originated from the montane tropical forests of southwestern Ethiopia. In the later part of the 19th century, however, in most areas of Java and Sumatra the plantings were destroyed by coffee rust, a fungal disease caused by *Hemileia vastatrix* (Smith et al. 1992: 22, 27, 32). Since then, robusta coffee, *Coffea canephora,* is cultivated in most areas of Indonesia. Native to the lowland humid tropics of the Congo basin, this species is hardier and better adapted to warmer locations, but its beans are of lower quality than those of arabica coffee (ibid.: 22). Besides its use for local Indonesian consumption, robusta coffee is sold on the international market, where it is mainly processed to instant coffee. Indonesia is the third largest coffee producer in the world after Brazil and Colombia, producing 462,000 t in 1992 (Stat. Bundesamt 1994: 56).

Coffee has been cultivated in the Minangkabau homeland since the 1820s and entered the Kerinci area at the beginning of the 19th century. Between 1900 and 1920, a disease damaged most of the coffee gardens, which had been planted with the *arabica*-variety at that time. Later, the *robusta* variety was introduced, and is widely cultivated until now. During the world depression in the

[23] As cited in Aumeeruddy 1994: 12

1930s, coffee price dropped and many farmers preferred planting cassiavera instead, which gained popularity during that time. At times of high coffee prices like in the 1970s, farmers once more started increasingly to plant, only to stop anew in the early 1980s, when prices dropped again[24] (Scholz 1988: 159). Although smallholder production accounts for 90% of Indonesian coffee production and Sumatra for 80% of the smallholder production, the lowland border area of the KSNP is no major coffee-producing region. Coffee, yielding best at altitudes between 700 and 1,200 m a.s.l., is mainly produced in the mountain regions of the three southern Sumatran provinces Lampung, South Sumatra and Bengkulu, the so-called 'coffee belt' (Godoy and Bennett 1989: 400, 402). In some areas near the KSNP coffee is still planted in the early stages of a cassiavera garden, mixed with fruit crops. In these cases coffee mostly functions only for home use and as a source of supplementary income and is often not cared for well (ICDP 1994: 38).

Also in the research area, coffee is not a major source of income. It contributes, however, to the diversification of cash crops and therefore to the reduction of overall risk. In Pemunyian and Dusun Birun only an average of about 15 % of the respondents cultivate some coffee, with an average area of 1.4 ha in Pemunyian and half of that in Dusun Birun. The largest part of the farmers cultivating coffee was in Lubuk Malakko, where it was included in 40 % of the gardens, with each family owning about one hectare as a mean. One reason for this high percentage is the agricultural history of that particular region. Coffee is a crop planted for a long time in the region of Lubuk Malakko. The local production centre is Muara Labuh, which is located some hundred meters higher, making it a favourable location for coffee growth.

With 12.9 years, the mean age of coffee plantings is highest in Lubuk Malakko, whereas it is lowest in Dusun Birun, with gardens only aged 4.3 years on average (table 27). Usually, not all coffee-fruits are picked at once, but only the ripe ones every day. The harvesting of coffee is often done by children. Scholz (1988: 160) reported an average harvest of 500-600 kg of dried coffee beans in Sumatran smallholder plantations (while in estates yields are up to 4,000 kg/ha!). Because coffee is generally planted mixed with other crops, its production is very low in the research area. Michon *et al*. (1986: 324) also report low yields of only 120 kg/ha for mixed gardens at Lake Maninjau, West Sumatra.

24 Coffee prices are among the most unstable of the major agricultural commodities (World Bank 1986: 86).

Table 27: Coffee cultivation

	Pemunyian	Dusun Birun	Lubuk Malakko
% of farmers owning gardens including coffee	17.5 %	13.9 %	40.0 %
average mixed coffee gardens ownership*	1.4 ha	0.7 ha	1.0 ha
average age of coffee gardens	10.5 %	4.3 %	12.9 ha
% of gardens in productive age (≥ 6 yrs.)	80.0 %	15.4 %	76.9 %

n.a.: Data not available * Farmers' assessment. Area per family owning gardens including coffee.

The composition of gardens including coffee differs between villages. Whereas in Pemunyian coffee is either planted in separate stands or mixed with rubber, in Dusun Birun coffee is always mixed with cassiavera, part of the gardens also containing rubber (table 28). In Lubuk Malakko, all four mixture types do occur, with the majority being interplanted with rubber. This feature, again results from the agricultural history of the village, where coffee and rubber are relatively long established crops, while cassiavera is a newcomer.

*Table 28: Composition of coffee gardens **

Main crop	*Pemunyian*	*Dusun Birun*	*Lubuk Malakko*
coffee	28.6 %	-	25.0 %
coffee and rubber	71.4 %	-	37.4 %
coffee and cassiavera	-	60.0 %	6.3 %
coffee, cassiavera and rubber	-	40.0 %	31.3 %

* In % of respondents owning coffee garden.

The fact, that no coffee gardens without cassiavera exist in Dusun Birun also strengthen the assumption, that coffee entered the area together with cassiavera. The land use system spread from the Kerinci enclave to the lowlands, along the road linking Bangko to Sungai Penuh. If an area is a centre for the cultivation of a certain crop, including processing and marketing facilities, the production of that crop spreads more easily than in areas where this not is the case. That Dusun Birun farmers also increasingly are starting to grow coffee is one more indicator for the strong influence of the cassiavera- (and coffee) based market economy of the Kerinci-enclave.

4.2.4 Recent Developments of Tree Crop Cultivation

In those areas where the primary goal of upland field establishment is the planting of a cassiavera garden, more than half of the farmers planted economic tree crops into their upland field during the last two years (table 29). Also in remote areas where rubber is the main means of cash generation about half of the respondents had planted their old *ladangs* with tree crops. However, also the demonstration of land ownership through these plantings may be a major reason, keeping in mind that not all gardens will be managed after (cf. Dove 1993: 142 on the planting of rubber for this purpose in West Kalimantan). The low rate of farmers planting tree crops during the last two years in Lubuk Malakko is mainly determined by the added income and higher labour demand of a second annual paddy rice crop made possible by the technical irrigation system. Therefore few farmers made *ladangs* during that time.

The average area planted with upland crops generally was close to the size of the upland field opened. Therefore it appears, that farmers tend to plant all their old *ladang*s with tree crops, not just part of them. This seems rational, since the establishment of upland fields demands major efforts, compared to those of planting tree crops.

Table 29: Tree crops planted into upland field

	Pemunyian	*Dusun Birun*	*Lubuk Malakko*
% of farmers having planted tree crops into their old upland field*	50.0 %	53.0 %	27.5 %
% of farmers having planted**			
cassiavera	17.5 %	36.1 %	15.0 %
rubber	12.5 %	2.8 %	2.5 %
high-yielding rubber variety	20.0 %	-	-
coffee	2.5 %	2.8 %	-

* In % of the families owning upland rice field. ** Besides fruit trees.

Every village exhibits a distinct pattern in the distribution of the different economic tree crops planted into the upland fields. Whereas in Pemunyian there is a clear preference for rubber, and less attention is paid to cassiavera or even to coffee, in both other areas cassiavera is the tree crop most frequently planted. In accordance with the fact that farmers in Dusun Birun tend to neglect their harvestable rubber gardens, also the new planting of rubber is much lower than those of cassiavera. Nevertheless, most existing cassiavera gardens are mixed with some rubber. Because the majority of the cassiavera gardens are still very young, it might be possible that after the cassiavera is older and needs less care, farmers will again pay more attention to rubber and to their rice fields. Besides, rubber could be also a kind of ‘insurance crop’, in case cassiavera should experience what happened to cloves some years ago - diseases or a sharp drop in prices. In Lubuk Malakko, on the other hand, only a few had planted tree crops in the previous year (15 %). The majority of the crops were cassiavera, only a few respondents had planted rubber or coffee. Also in this village, cassiavera has been planted increasingly since 1987 and even more since 1991 (Werner 1997: 13).

In Pemunyian, due to its isolation, the influence of these tree crop production centres is less felt. Here, another development process is taking place: the trend towards high yielding variety rubber. Supported by a government program, but probably also influenced by a near-by transmigration area with an economy based on high-yielding variety rubber, most of the farmers planting new rubber gardens employ improved variety saplings. Given the fact that overall rubber yields are low in Pemunyian, further extension concerning improved management and processing practices would be important.

Summarizing, it can be said, that besides through its environmental potential, the agricultural development of an area seems to be influenced very much by its proximity to any successful 'centre' of crop cultivation. This is important for receiving information concerning, profitability, management and marketing of the respective crop as well as access to seed material, other agricultural inputs and marketing facilities. Therefore villages mainly influenced by the powerful cassiavera-economy of the Kerinci-enclave will try to imitate the success of the Kerinci farmers, those living close to successful coffee farmers will do the same, as will villages observing the profitability of high yielding rubber compared to their traditional varieties. The new influences merge with traditional practices and experiences. Management practices then slowly become adapted to the local environment in the process of gathering experience with the performance of the new crop under local conditions (Werner 1997: 14).

4.3 Use of Primary Forest Resources

4.3.1 Extraction of Primary Forest Products

Similar to other societies living near or within primary forest, the local people inhabiting the KSNP boundary zone of Jambi and West-Sumatra use a wide range of wild plant species for food, medicine, and making of cultural artefacts. These are mainly timber, rattan, freshwater fish, deer and food plants for personal use, but also timber, rattan, gaharu and wildlife for commercial sale (Schweithelm 1994: 6). With increasing economic development of a village, the dependence on and therefore the intensity of use of those resources decreases. In Pemunyian, where the possibilities for gaining cash income are much more limited than in both other villages, the degree of non-timber forest product extraction for sale is highest. Medicinal plants may be gathered in all locations, but the availability of "modern" drugs, as well as the capability and willingness of the population to pay for them increases with accelerating affluence. Although chemical drugs in many cases may not be better than traditional herbal medicines, the government health policy does not provide for the recognition of this kind of traditional wisdom. On the other hand, traditional knowledge on medicinal plants increasingly gains international recognition and is in danger of being exploited in the course of commercial endeavours to discover active substances for the development of new pharmaceutical drugs and processes that are patentable[25].

The extraction of timber from the primary forest traditionally has been limited for the purpose of local house construction. In cooperation with certain individuals of local authorities, however, local people often become involved in illegal timber exploitation for commercial purposes nowadays.

4.3.2 Opening of New Fields in the Primary Forest

When approaching the problem of the opening of new fields in the primary forest through interviews, and having the conflict described in section 3.4 in mind, one will rightfully ask, to what extent people would answer frankly and honestly to a question like that. Due to these circumstances, I did not really expect to receive an empirically relevant result. Therefore I was rather surprised how many respondents admitted that they already had been opening fields in the primary forest.

In Pemunyian, almost every respondent acknowledged already having opened a piece of primary forest between 1956 and 1993, most of them in the early to mid-1980s. In Lubuk Malakko, still more than two-third of the respondents agreed to having opened a new field in the forest between 1959 and 1994. About an estimated two hectares was cleared per family in both villages. In other boundary villages of West Sumatra, an average of 1.14 ha per family was opened within primary forest (Bappeda 1991: 8), whereas the average size of land opened in Sangir sub-district is 2.18 ha per family from 1975 to 1992 (Radja *et al.* 1994: 53). However, as it cannot be proved if people mentioned all the fields they ever open, and because the people also never measure the size of their fields, all these numbers should be viewed with some reservation.

In Dusun Birun, however, only every sixth farmer admitted to have already cleared a piece of forest for agricultural purposes, averaging an estimated 0.2 ha for all families. Compared to the size of land admitted to have been cleared in Lubuk Malakko and Pemunyian, which well might be less than the total area really opened, the numbers of Dusun Birun seem to be unrealistically low. Especially given that Dusun Birun just experienced quite a cassiavera boom during the previous years, all of which was planted on land far from the village along the road leading to the Kerinci-enclave, one questions if this number can be realistic. Nevertheless, the local people do claim that the land they planted with cassiavera across the Merangin River and up the road to the enclave already belonged to their ancestors, and accordingly had the Dutch colonial government already

[25] The problem of access to genetic resources, intellectual property rights and bio-patents is a sensitive and increasingly hotly-debated topic, which finds widespread attention. At the Global Biodiversity Forum in Jakarta, November 1995, it was one of the main topics. In the frame of this study, however it can be mentioned only briefly, though it is discussed extensively elsewhere (e.g. Zakri 1995, World Resources Institute 1993, Barber and Viña 1995, Kate 1995, WWF 1995abc).

prohibited them from farming these lands. Nowadays, however, they do not care about these regulations anymore, because cassiavera needs good soil, which is to be found on these lands, which rightfully belong to them. According to the botanist Valerié Trichon (pers. comm. 1994), who investigated the primary forest bordering the village lands of Dusun Birun, the lands across the Merangin river claimed as secondary forest opened long ago by their ancestors, in fact is primary forest without any trace of human disturbance. It might still be probable, that the inhabitants of Dusun Birun have a right to these forest lands according to their customary law. But it might as well be true, that only a legitimation is sought to farm these lands with cassiavera, because it promises a good harvest. Wherever the truth lies it seems, that the problem cannot be solved through mere prohibitions to open any new fields: evidence shows that it does not work in practice.

In a survey of the BPN (1993: 8 p.) in villages in the park border area in Jambi on reasons why people opened fields in the protected area, several reasons were named. In accordance with the author's experience in the research area, also according to Bappeda (1991) and BPN (1993), in most villages, especially in areas outside the enclave, the course of the border was not known by the inhabitants. Other reasons for clearing primary forest land were:

- The harvest of the land already owned is not enough to cover family needs.
- The village has existed for generations / since Dutch colonial rule.
- Wish to increase family income and savings for the future.
- The land outside the national park is limited.
- The soil in the reserve is more fertile.

On asking if it was planned to open any new field in primary forest in the future, all respondents of all three villages denied this. It might well be as it is hoped by the forest and the national park administration, that the people finally learned their lessons and will give up encroaching upon new forest land. But why should they stop so suddenly, if still many of the families acknowledged having been clearing forest even in the years this research was carried through? More probable is, indeed, that the people are afraid of legal punishments, so they would rather not admit their plans, even if they had any. The circumstances causing this situation already have been discussed within section 3.4, which focussed on how people were involved in national park establishment and the nature of their participation in recent park policies.

4.5 Summary

It seems that a process away from shifting cultivation is taking place in those areas, where people have alternatives to do so. Whether it is irrigated rice or economic tree crops taking the place of the major labour absorbing system is not the most important feature of that development. It is mainly the increasing role cash income gets in the village economy, which also means a greater dependence on the market. Dove states that typically, agricultural development characterized by intensification

> "... is likely to rarely involve the precipitous and complete abandonment of one system of cultivation for another. It is likely that long stages in the evolution of agriculture have been occupied by composite systems, consisting of both more or less intensive sub-systems." (Dove 1984: 55)

This also holds true for Central Sumatra, except that in this case these 'composite systems' do not consist of distinct land use patterns, but take place within one and the same. In the 'cassiavera-boom' example, people integrated shifting cultivation (rice and vegetables) with the establishment of tree crop gardens. It is the same principle as in remote areas, where people plant rubber into their old rice fields, only the primary aim of the agricultural system changed. It is no more food subsistence but cash generation instead. In Lubuk Malakko, people don't even plant rice anymore into their upland fields, but vegetables only. The system has moved even further from the original shifting cultivation system. People still establish upland fields by means of shifting cultivation, but they skip the rice-phase and directly establish gardens. Vegetables are still planted, but directly mixed with tree crops (Werner 1997: 18). From an ecological point of view, a shift from swidden agriculture to tree crop cultivation ensuring permanent plant cover would be an ideal alternative in the hilly terrain (Ramakrishnan 1992: 368).

Originally, the 'dual system' of subsistence oriented shifting cultivation and cash-oriented tree crop production developed through the introduction of rubber at the beginning of the twentieth century. Now, tree crop production has replaced subsistence rice production on upland fields. Irrigated rice cultivation, on the other hand, did not develop out of shifting cultivation, but out of swamp rice cultivation. Swamp rice cultivation has been traditionally carried out in seasonally inundated areas along rivers, rivulets or in depressions. Although both concern rice production, irrigated rice in many areas is the more 'novel' introduction compared to tree crop cultivation. Paddy rice represents a totally different land use system, whereas tree crop cultivation initially was no more than a kind of economic fallow that could be integrated into the shifting cycle easily.

Rubber production could be made more profitable through extension concerning better rubber processing. Nevertheless, farmers would only be willing to produce rubber of higher quality, if it would fetch higher prices on the market and increase family incomes. Until recently, however, the average international price differential between the substantially higher quality rubber grade TSR[26] 10 and the most common Indonesian grade, TSR 20, was less than 1% (Barlow and Tomich 1991: 40). In this case, the costs for separating out and producing higher qualities may easily exceed the value of the bonus.

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[26] Technically Specified Rubber.

Credit schemes for tree crop development and extension for the propagation of selected rubber varieties could increase the revenues from rubber production per land area. Also direct marketing structures would contribute to a rise in farmers' shares in export revenues, which up to now only account for 25-40% (Geinitz 1984: 25). Nevertheless, a lack of competition and high transportation costs generally lead to low farmgate prices. Cooperation for direct marketing could raise the revenue for the smallholders and also farmgate prices. Furthermore, manufacturing processes close to the rubber growing areas would reduce transportation costs and provide additional sources of income for the rural population.

During the last decades, Indonesian national agricultural policy has put very little attention on the development of tree crop cultivation by small farmers. Although actual economic returns may be high, there is some bias in perception towards tree crops. This is based on traditional perceptions, giving an unchallenged priority to rice cultivation. For Javanese farmers, rice cultivation is more than an agricultural system, it is an ideology. Farmers believe that rice is the reincarnation of Dewi Sri, the wife of god Wisnyu. Thus, it is considered sacred and its cultivation cycle is connected to several religious ceremonies. Although rituals are on the decline in the course of modernisation, its role as a status symbol is strengthened, with paddy cultivation being more prestigious than the planting of upland rice (Soemarwoto 1984: 272). This conviction still is reflected in the Indonesian policy of national rice self-sufficiency. The Indonesian agricultural policy puts more emphasis on the extension and development of paddy cultivation than on the cultivation of any other crop, independent of its relative market value. This policy enforces the intensification of paddy cultivation wherever environmental circumstances may allow it. Under economic aspects, however, benefits gained through the production of cash crops and products for the national industry or international markets, like rubber, non-timber forest products and locally grown timber, might well exceed those gained through rice production (Thomas 1965: 112, Booth 1988: 210, 234). Modern paddy cultivation demands high inputs of labour, fertilizer and pesticides, and, if using modern high yielding varieties, is very susceptible to various diseases. Thus, especially under ecological conditions suboptimal for paddy cultivation due to geomorphological factors, danger of soil erosion and low soil fertility, it is more sustainable to grow tree crops. However, government policy has put very little effort on the development of upland crops, let alone, tree crops (Soemarwoto 1984: 281 p.). If it had invested only part of the amount that has been invested in the development of high-yielding rice varieties during the last decades, economic results would be even less in favour of rice.

Until the early 1980s, government support for tree crop development was mainly focussed on the estate sector. Although smallholders dominated rubber production, for example, until this time only 8% of the Indonesian smallholders participated in government programs to improve productivity (Booth 1988: 217). This is in contradiction to the expected continuing high demand of natural rubber on the global market. In the late 1980s, rubber planting worldwide lagged behind replacement needs by almost 50 % (Smith *et al*. 1992: 231). Also government support for cassiavera cultivators who have sought to improve seed stock and management practices is still lacking (Belsky 1993: 138).

Modern agricultural development often is marked by broad-scale technological recommendations. Therefore it has largely ignored the environmental, cultural and socio-economic heterogeneity typical for traditional agricultural systems, which caused an inevitable mismatching of agricultural development with the needs and potentials of local people and localities (Conway 1985: 32). Many rural populations have been made to feel that their traditional techniques in agriculture, medicine, and veterinary care are in some way backward and unscientific. Rural people are aware that educated government officials and extensionists who sometimes visit their villages, tend to promote new technologies, encouraging a more scientific approach to all aspects of life and generally disregard traditional approaches (Barker and Cross 1992: 125). As a result, people start to lose faith in their traditional beliefs and practices or even become ashamed if they have to admit that they "still" use the traditional practices or varieties. Planners, scientists or extensionists, however, need not view traditional patterns of belief as obstacles that must be overcome or removed for development and progress to succeed. By understanding the characteristics of traditional agricultural systems like folk ecological classifications, the ability to bear risk and the efficiency of mixed crop production, information can be gained for the development of agricultural strategies more adapted to the needs of the local population and ecological conditions (Lovelace 1984: 203p, Altieri 1990: 552). If extension workers merely present solutions without linking their techniques with the farmers' own experiences, local capacities are undervalued. Feeling surpassed, farmers are also less likely to volunteer further suggestions (Barker and Cross 1992: 134). Traditional agricultural systems, nevertheless, are by no means static and resistant to change, as has often been argued by agricultural planners and extensionists. Besides exhibiting many variations due to different experience, individual skill and certain practices between individual farmers, traditional agriculturalists also steadily experiment in developing new crop mixtures and varieties. Rhoades and Bebbington (1991: 1) have identified three types of farmer experimentation: experiments based on pure curiosity, problem-solving experiments and adaptation experiments. However, farmers prefer low-risk strategies in agricultural development, testing new approaches and crops in a small plot first before investing heavily in them. Johnson (1972: 150) states, that it "would be foolish for traditional agricultural communities, to undertake major untested projects, especially where what was being risked was not mere investment capital but the very livelihood of the community members".

Traditional agroecosystems are genetically diverse, containing several varieties of adapted landraces as well as wild relatives of cultivated species, increasing the gene flow between crops and their relatives. Such genetic diversity results in partial resistance to diseases frequent in monocultures of high-yielding varieties. The partial preservation of natural ecosystems like hillside forests, riverrine vegetation, swamps and old forest gardens within or adjacent to their properties not only contributes to the conservation of biodiversity but is also a valuable source for the gathering of various non-timber forest products.

> "The knowledge, skills and survival strategies of farmers operating with low levels of external inputs have often been ignored or even eroded by outsiders promoting modern agricultural technologies. However, with increasing awareness of the limitations and hazards of conventional agriculture, a growing number of scientists have begun to recognize indigenous knowledge as a major untapped resource for developing sustainable agriculture. Local practices offer joining points for developing ways of increasing the productivity and sustainability of local resources. Indigenous technologies can reveal missing ecological keys, which may help scientists develop alternative technologies less dependant on non-renewable resources (e.g., fossil energy) and environmentally damaging inputs (e.g., chemical pesticides) than conventional technologies." (Odhiambo 1990: 3)

A new technology can readily succeed when it offers a better all-round return to the rural family than the technologies they are already using.

Within this chapter (5) it has been explained, how the agricultural landscape in the lowland area of the buffer zone surrounding the KSNP has become shaped through the influence of people. The ecological situation and its alteration due to the local agricultural system, especially concerning the vegetation structure and composition, have been revealed. Together with the previous chapter (4), the basis for a general comprehension of the local land use system and its impact on the natural environment should be established by now.

5. Botanical and Pedological Properties of the Upland Farming System

The local agricultural landscape is a complex patchwork, consisting of different successional stages of unmanaged fallow vegetation, traditional rubber gardens, cinnamon and coffee gardens as well as upland fields and paddy rice fields. Covering the largest part of the village land and being botanically richest in the three study villages, this study has focused on analysing secondary vegetation and traditional rubber gardens. Upland rice cultivation for food subsistence, however, becomes less and less important in villages with regular means of transportation and/or technically irrigated rice paddies (chapter 4.1.1).

Although since the 1920s farmers already plant tree crops (mainly rubber) into their upland fields, secondary and primary forest is increasingly cleared for the specific purpose of garden establishment only. Because of the limited profitability due to pest pressure, especially wild boar, these gardens are are often no longer intercropped with annual food crops during the first years (Werner 1997: 7). This development leads to a rapid decrease of secondary vegetation without rubber. Traditional rubber gardens, where secondary vegetation is allowed to thrive to a certain extent, become therefore increasingly important for the conservation of secondary vegetation species diversity as well as for providing plant resources for local needs (Penot 1999, Werner 1999).

In the previous chapter the local land use system and land use management practices have been discussed. Understanding these is one precondition for communicating with local people about their land use. A second precondition is the knowledge of the local environment as well as how it is affected and formed through agriculture.

Therefore the botanical and pedological study of the land use system has two purposes: First, to understand how local management practices have shaped the environment. For that purpose, unmanaged fallow and traditional rubber gardens of different ages and geomorphological position as well as related topsoils were studied. The second purpose of the botanical and pedological inventory was to comprehend the farmers' perception of their environment. A precondition to achieving this is to understand the environment itself. The results of the assessment of plant resources availability as well as soil fertility can then be used for a comparison with local classifications (chapter 6).

5.1 Development of Traditional Rubber Gardens and Secondary Vegetation

The agricultural areas of the study villages have a rich species diversity. Particularly fallow vegetation and traditional rubber gardens, where cleaning measures are limited to the first few years, harbour plenty of secondary and partly even primary forest species. Examples are in particular medical uses and edible fruits, shoots and tubers when food crop harvests are low, as well as timber and handicraft materials (e.g. Mackie 1986: 456, Harris 1971: 481, 487, Denevan and Padoch 1987: 2 pp.). Many of them are used regularly, but even more of them are potentially useful. The latter ones are mainly medicinal plants that are taken only when somebody ill needs them.

The major part of the study villages is covered by various fallow stages, be it in their unmanaged form or interspersed with rubber. Within the author's investigation of one-year-old fallow up to 65-year-old rubber gardens, four main stages could be identified. Compared to these areas, the land size that is actually cultivated only accounts for a small part of it. This is due to the need for several years of fallow after rice cultivation, and, in some areas, because rice is increasingly bought from rubber revenue, so fewer and fewer upland fields are established (Werner 1997: 12).

Vegetation recovery already starts during rice cultivation and quickly covers the whole upland field as soon as it is left open. While species diversity and botanical composition varies between fields and areas, secondary vegetation after cultivation of a *ladang* in the study area, like in other parts of the tropics, usually develops through a series of stages. The general pattern seems to be an initial shrub-dominated stage, followed by several tree stages, during which primary forest species increasingly regain dominance. Each stage is characterized by a typical structure and plant composition. Transitions from one stage to the next, however, are more or less fluid.

In his book on the tropical rain forest, Richards (1952: 388 pp.) gives a brief description of the secondary development process in tropical Africa and America. For Nigeria, he describes three stages of recovery: (i) a 2 years lasting invasion stage, during which a closed covering of vegetation is established; (ii) a 15-20 years lasting pioneer stage, during which the species *Musanga cecropioides* holds dominance; and (iii) a long stage of unknown duration, where secondary are slowly replaced by primary trees. Secondary succession in Congo, on the other hand, has three tree-dominated stages after the initial one, dominated by herbs, shrubs and woody climbers. In the third stage, primary forest trees become dominant again. In tropical America, herbs, shrubs and lianas dominate the fallow during the first two years of vegetation recovery; after that, the pioneer trees *Cecropia mexicana* and *C. longipes* become dominant and a young secondary forest is formed. After about 15 years, in the next stage, the dominance of *Cecropia* recedes as the secondary community has become more diverse, with also primary forest species starting to establish themselves.

The occurrence of vegetation recovery after swidden cultivation proceeding in stages was observed in the early 20th century (e.g. Jochems 1928). Consecutively, several theories and explanations about successional processes were developed (e.g. Egler 1954, Drury and Nisbeth 1974, Noble and

Slatyer 1980, Peet and Christensen 1980). Besides these theories, publications on secondary vegetation are more concerned with the description of vegetation development in the first years (e.g. Eussen and Wirjahardja 1979, Uhl *et al*. 1981, Swaine and Hall 1983) or with incidental descriptions of secondary vegetation (e.g. Hall and Okali 1979, Vayda 1985, Djailany 1987, Ramakrishnan 1992, Laumonier 1997) rather than with the fallow stages and their species compositions. This is due to the difficulty of finding locations, where all factors influencing vegetation composition except for age are relatively similar.

Notwithstanding the limitations mentioned above, it becomes obvious when observing a large number of plots, that certain families, genera and species prefer one fallow stage over another (see annex 2 for a list of these species). These plants can be considered as character species for the respective fallow stages (Mueller-Dombois and Ellenberg 1974: 178). Other species, however, exhibit a non-specific behaviour, which cannot be related to a certain fallow stage. They are called constant species (ibid.). A large number of species occur too rarely to draw conclusions about their preferred fallow stage. Most of these infrequent species, however, are thought to be typical for old fallow or primary forest, because they are only present in old secondary vegetation and even then in small number(s).

Although concepts developed for moderate climates demand that a classification into vegetation types is characterized by a high amount of floristic similarity, this is different for fallow stages in the humid tropics. A high species diversity in this area usually consists to a large part of rare species with low constancy. Therefore, the classification into fallow stages is based on the abundance of certain typical species as well as on structural similarities.

5.1.1 Very Young Fallow (1-2 Year Old Secondary Vegetation)

The first stage of secondary vegetation development is the most dynamic one, characterized by quick changes and major developments. In the first two years, shrubs, herbs and grasses dominate secondary vegetation. Within the total species diversity, consisting at average of 31 different plants, these lifeforms amount to 29 % of all taxa present, but their frequency amounts from 63.8 % to 76.4 % (table 30). In one-year old secondary vegetation in East Kalimantan Vayda (1985: 13) also found 67 % of all plant cover to be from herbs. These species often have light, wind dispersible seeds, which allow them quickly to capture exposed sites, such as upland fields. In a study of secondary vegetation in the Amazon Basin, Uhl *et al*. (1981: 635) found 10-month old fallow consisting to 74 % of all individuals out of herbs and fast-growing trees. The tree community, representing only about half of all species, is mainly characterized by several quickly growing pioneer species. These light-demanding trees, if compared to primary forest species, have soft, low-density timber, regenerate quickly and have a short lifetime.

Tree species frequent in this fallow stage are various *Macaranga* species, *Trema orientalis*, *Commersonia bartrama*, several *Mallotus* species, *Homalanthus populneus*, which can dominate whole stands of three-year old vegetation, and *Piper aduncun* in one of the three sites. In some sites there are furthermore *Endospermum diadenum*, *Breynia sp*. and *Chisocheton erythrocarpus.* Less frequent species include several *Saurauia* species, *Aporusa octandra*, several *Leea* species; *Mimosa sp*. and *Dysoxylum spp*. Non-pioneer species are still restricted to some single tree-individuals. Many of the dominant young fallow species also occur in other areas of comparable environmental conditions within the archipelago (e.g. Riswan and Abdulhadi 1992: 80, Laumonier 1997: 146p, Djailany 1987: 111, Richards 1952: 381).

Vegetation height of one-year-old fallow is varying from one to three meters in one-year-old secondary vegetation, reaching up to four meters in two-year-old vegetation (see table 30). Similar growth rates were also reported from other regions. Young secondary vegetation in East Kalimantan grew an average of 82 cm in height and 0.5 cm in diameter per year (Riswan and Abdulhadi 1992: 80). Vayda (1985: 13) reported 2 m high secondary vegetation in an East Kalimantan one-year-old fallow site. In Amazonian young fallow, two-year-old trees were about 2 - 2.5 m tall (Uhl 1987: 387). As will be mentioned later, several factors influence the development and composition of secondary vegetation. Growth rates are, among others, influenced by species composition, soil fertility and cultivation history.

5.1.2 Young Secondary Regrowth (3-7 Year Old Secondary Vegetation)

Whereas during the first two years herbaceous plants dominate the secondary vegetation, after three years the trees take over and start shading out the non-woody vegetation. This early successional process is typical for young fallow vegetation and has been described by several authors (e.g. Ewel 1980, Seavoy 1973, Uhl 1987, Riswan and Abdulhadi 1992). Species richness has risen about one-third to an average of 41 different plants as compared to very young secondary regrowth (table 30).

Generally, a closed tree cover has been established by now, which is starting to shade out light-demanding plants like weeds and grasses. Concerning their proportion of the total species numbers, the overall importance of trees has remained constant. The high frequency of herbs and shrubs, however, has declined, giving way to a stronger presence of lianas and fern species. Ramakrishnan (1992: 128 pp.) reported for *Eupatorium odoratum*, a colonizer from Latin America, maximum populations in 3-year old fallow and a sharp decline after a fallow age of five years. Typically, herbaceous vegetation becomes less vigorous in growth with declining reproductive potential in fallows beyond a maximum of 5-6 years.

Vegetation height has reached three to six meters in three year old secondary vegetation, four to eight meters in five year old, as well as six to nine meters in seven year old one (see table 30). Similar heights and an average diameter at breast height (DBH) of 5 - 10 cm were mentioned by Gunawan and Abdoellah (1994: 6) for secondary vegetation of the same age in East Kalimantan. Vayda (1985: 13) gave account of 4 m high secondary vegetation for an East Kalimantan four-year-old fallow site. In West Kalimantan, two to five year old vegetation reached a height of five to twelve meters (Seavoy 1973: 527). In the Brazilian Amazon basin, Uhl (1987: 398) found secondary vegetation growing about 1-2 m in height and 1-2 cm in DBH every year during the first five years of fallow.

The plant community at this stage is dominated by several pioneer trees. The species diversity is rising, because more and more species start to establish themselves (*Artocarpus spp., Ficus spp., Eugenia spp., Anisophyllea disticha, Carallia spp.*). This typical pioneer tree dominated composition was also observed by Djailany (1987: 111), who studied a seven-year old secondary stand in the same area. This pioneer tree dominance of secondary vegetation development lasts until the age of five to seven years. After that age, a distinct change is taking place. Differences in recovery rate and resulting duration of the respective fallow stage are partly due to the impact of soil fertility (Inoue & Lahije 1990).

In Lubuk Malakko, the West Sumatran research site, young secondary vegetation was strongly dominated by *Bellucia axinanthera*, a South American pioneer tree. Large, localized formations of this Melastomataceae in eastern Central Sumatra, at the feet of the Barisan mountain range, were also mentioned by Laumonier (1994: 248).

5.1.3 Medium Aged Secondary Forest (7-19 Year Old)

After secondary vegetation has reached the age of seven years, most of the pioneer trees suddenly disappear (except of some *Macaranga*) and hardwood trees begin to dominate. This process is due to the fact that many pioneer species have a limited life span, which leads to periodic decline of successional plant communities (De Rouw 1991: 54 p., Richards 1952: 388 p.). This gives a chance to previously subdominant species to establish themselves. There are still many early-stage species, which generally are present until the vegetation is 15 years old (*Saurauia spp., Macaranga spp., Dysoxylum spp., Ficus spp.*). Therefore, the stage of medium aged secondary vegetation, i.e. from seven to 15 years after shifting cultivation, is also some kind of transformation stage: while the typical pioneer trees vanish, several other young fallow species are still present, but no longer dominating the tree community. Another typical feature for this fallow stage is the biological suppression of herbs due to reduced light availability (Ramakrishnan 1992: 136).

A lot of species typical for older successional vegetation start to occur now and those starting to establish themselves at the last stage become more frequent. As opposed to the pioneer- or early seral species of the first two fallow stages, these plants can be classified as late seral species. Several other trees being mainly present in old fallow occur for the first time in this medium aged fallow. These species were classified as mature phase species by Ashton (1978: 192). They need the closed canopy of the pioneer trees to establish themselves, because their saplings cannot tolerate high insulation and low humidity. More research about the behaviour of the respective species is necessary, however, to know under which conditions they grow and sprout.

Species typical for medium aged to old fallow vegetation are *Koilodepas glanduligerum*, *Macaranga hullettii*, *Dialium sp*., *Millettia atropurpurea*, *Pongamia sp*., *Aglaia leucophylla*, *Ochanostachys amentaceae*, *Eurycoma longifolia* and *Gironniera hirta*. Genera that can be found frequently include *Durio*, *Elaeocarpus*, *Aporusa*, *Baccaurea*, *Pternandra*, *Artocarpus* and *Streblus*. Other families typical for this fallow age are Anacardiaceae, Annonaceae, Clusiaceae, Fagaceae, Lauraceae, Myristicaceae, Myrtaceae, Rhizophoraceae, Rubiaceae, Sapindaceae and Sapotaceae, all represented with several genera and species. Spontaneous *Parkia* species, as opposed to the commonly in rubber gardens cultivated *Parkia speciosa,* which has edible seeds, only seldom occur in medium aged secondary vegetation, being more frequent in old fallow lands.

The average species diversity of medium aged secondary forest amounts to 45 different plants (table 30). An East Kalimantan 17-year old secondary forest also harboured 45 species (Mackie 1986: 435). Plant height in seven-year-old secondary vegetation reaches from six meters up to nine meters in some sites. The trees of 15-year-old secondary vegetation are about ten to 15 meters high, with some emerging species already growing as tall as 20 meters. Gunawan and Abdoellah (1994: 6) characterized secondary vegetation of that age in East Kalimantan with significant canopy closure and a high proportion of larger trees over 10 cm DBH.

5.1.4 Old Secondary Forest (20 Years and Older)

When secondary vegetation has reached the age of more than 20 years, its structure starts to resemble those of primary forest, which has also been stated for secondary forests of that age in other areas in Southeast-Asia of comparable climatic conditions (Richards 1952: 381, Gunawan and Abdoellah 1994: 6). In a 35-year old secondary forest in East Kalimantan, Riswan and Abdulhadi (1992: 80 p.) found secondary forest trees still dominant concerning their frequency. The majority of the species, however, were already primary ones. According to Gouyon *et al*. (1993: 187) the structure of old traditional rubber gardens is similar to that of a secondary forest, with rubber trees holding the ecological place of pioneer trees like *Macaranga spp*. found in unmanaged fallow vegetation in the area. The secondary forest is characterized by several tree storeys by now and young fallow species have vanished except of very few remnants. Among these remnants from younger fallow stages are *Saurauia* species, *Macaranga* species and *Ficus* species.

With increasing age, structural differentiation of the forest is proceeding. Also the botanical composition is still different from those of primary forest and species diversity is rising yet. The proportion of trees among all species present, however, remained constant (see e 30). The tree community is composed of species typical for medium aged to old secondary vegetation and of those only occurring in old growth secondary forest. The few species strictly confined to old secondary vegetation are *Dillenia albiflos*, *Archidendron sp*. as well as members of the families Myrsinaceae (*Ardisia macrophylla, A. sumatrana, Discocalyx sp*.), and Rutaceae (*Euodia sp., Tectracomia sp*.). In old secondary forest typically there are no species having a high density. Many trees were only present in one or two plots with one or two individuals. Rare species are generally excluded from considerations for the classification into vegetation types (Mueller-Dombois and Ellenberg 1974: 178).

Vegetation height in 20-year-old secondary vegetation and rubber gardens reaches from 20 up to 30 meters, with emergent trees up to 35 meters. Also the upper storeys of other old rubber gardens in Jambi and South Sumatra were about that height (Gouyon *et al*.: ibid.). The oldest secondary vegetation, which has been investigated, were 60 to 65 old rubber gardens with an average height of 25 to 35 meters, but with some emergent species as tall as 55 meters. The average DBH of old secondary forest and rubber gardens ranges around 30 cm (table 30). Conditions in secondary forest of that age in other humid tropical areas of Indonesia are similar. In East Kalimantan, for example, vegetation of that age was reported to reach diameters of 35 cm and more (Gunawan and Abdoellah 1994: 6).

5.1.5 The Process of Secondary Vegetation Development

During secondary vegetation development, several parallel processes are taking place. Probably the most spectacular feature is the change in botanical composition, i.e. density and frequency of the respective species that are typical for the respective successional stage described above. Each fallow stage is dominated by certain species groups, which give way to a new one with the end of the period. When studying a large number of plots, it is possible to observe a preference of species for a special succession stage. More frequently still, whole genera or even families have a typical behaviour in accordance with the age of the secondary vegetation. Other species, however, exhibit a non-specific behaviour, which cannot be related to a certain fallow stage. A large number of species occur too rarely to draw conclusions about their preferred fallow stage. However, most of these infrequent species are only present in old secondary vegetation and in primary forest.

Accompanying the replacement of one species group with another is the transformation of the structure of the secondary vegetation. This is characterized by two processes. As part of the first process, as already described in the former sections, the tree vegetation increases in height and diameter. Growth form composition changes, too. This means, that the role of herbs and shrubs, lianas, grasses, ferns and trees within the vegetation composition is subject to alteration. This change again has two aspects. The first is the supremacy lifeforms have as concerning their density, the second as concerning their percentage of the total number of species (frequency). When secondary regrowth is still very young, the frequency of shrubs, herbs and grasses amounts from 63.8 to 76.4 %. When trees take the lead, the frequency of these lifeforms is reduced to 31.6 - 33.7 % in 7-year old fallow and 8.5 - 30.1 % in older secondary forest. Regularly cleaned gardens always have a higher frequency of herbs, shrubs, ferns and grasses, i.e. 47.9 % for 7-year-old rubber and 30.5 - 32.2 % for mature rubber gardens (table 31). Differences in floristic composition between plots of the same age, however, usually do not concur with structural variations. The typical vegetation structure of the different regrowth stages can be achieved by a variety of species combinations. The structural differences between fallow stages were also unrelated to variations in soil fertility, elevation and previous land use (Hall and Okali 1979: 334).

The second process concerns the species diversity within the respective lifeforms. Very young fallow is characterized by large numbers as well as a high frequency of herbs and shrubs. Furthermore, young fallow in general, i.e. pioneer vegetation, has a high amount of lianas and grasses (table 30).

Table 30: Species diversity and structural composition of the different fallow stages

fallow stage	***trees***		***herbs & shrubs***		***lianas***		***ferns***		***grasses***		***palms***		***total***	
	no.	***%***	**no.**	***%***	**no.**	***%***	**no.**	***%***	**no.**	***%***	**no.**	***%***	**no.**	***%***
very young fallow	16	*53*	7	*21*	6	*15*	2	*5*	3	*8*	-	-	31	*100*
young fallow	23	*52*	5	*14*	7	*18*	4	*10*	2	*7*	1	*1*	41	*100*
medium aged secondary forest	29	*64*	5	*10*	7	*14*	3	*11*	2	*5*	1	*1*	45	*100*
old secondary forest	37	*63*	5	*10*	9	*14*	4	*8*	2	*3*	1	*2*	57	*100*
average	27	*59*	5	*13*	7	*15*	3	*9*	2	*6*	1	*1*	45	*100*

Sources: Drawn from vegetation sampling and herbarium analysis

During the transition from pioneer vegetation to secondary forest not only the total number, but also the percentage of trees within the total species number increases strongly. Also, the percentage of ferns gets higher after the first fallow stage. It is, however, important to note that apart from the decrease of herbs and shrubs after the first fallow stage, changes of the relative proportions of the respective lifeforms are not accompanied by a change in total numbers of the respective life forms, except for trees.

The increase in species diversity is a linear process starting immediately after burning activities in slash-and-burn agriculture (before subsequent rice cultivation in the respective plot) and ending after a yet undefined time period. Nevertheless, species diversity can widely differ between sites, depending on several factors, which will be explained in the following section. A five-year old fallow vegetation therefore can have a higher species diversity than old-growth traditional rubber gardens, but this is not usually the case. If looking at the average species diversity of all sites, where inventories were made, there is an increase in species diversity, especially between very young fallow and young fallow as well as between medium aged secondary forest and old secondary forest. Both transitions are triggered by a growing number of tree species. While pioneer vegetation is characterized by a high percentage of non-woody plants, their total numbers remain almost stable during the successional process (table 30).

5.2 Factors Influencing Vegetation Composition

There are many other factors influencing the composition of secondary vegetation besides vegetation age. Depending on the circumstances, other factors might even become more important. One important factor is the cultivation history of a site, which strongly influences the composition of the soil seed bank (cf. Hall and Okali 1979: 342). Management practices like selective cleaning in rubber gardens favour certain species as well as prevent the establishment of others, and therefore alter the composition of the secondary regrowth (cf. Werner 1999). Soil physical and chemical properties as well as the geomorphological position furthermore represent important variables, under which the respective species thrive differently. Within upland fields, the distribution of plants during early succession is strongly influenced by the type of surface, i.e. bare soil, burnt tree debris and rootmat, and if it is covered with slash or not. While surfaces covered with slash usually encountered more and stronger regrowth, different species varied in their preferences (Uhl *et al.* 1981: 643). The microhabitats formed by geomorphology, type of soil surface as well as differences in intensity of the burn and related soil moisture loss cause varying seed survival and favourable conditions for plant growth of different species. The weather at the time of seed germination and early establishment also has an impact on how favourable growing conditions are for the respective species at the different microsites. Finally, inter-species competition plays a role, too. Which species is going to be quicker in establishing dominance and shading out competitors will be determined by the interactions of the latter factors and the soil seed bank. All these factors lead to rich variations within the lands of one village concerning the vegetation composition of plots of the same age.

5.2.1 Cultivation History

Like botanical composition, species diversity is influenced by a number of factors, leading to a wide variation between plots of the same age. One very important factor determining the number of species present in a plot of certain age is the cultivation history. Burning destroys the seeds of those species sensitive to high temperatures. Short fallow cycles prevent the regeneration of those species having reproduction cycles exceeding those of the fallow length (Egler 1954: 417, De Rouw 1991: 245). The loss of species richness in secondary forests due to repeated shifting cycles was also reported by Manner (1981: 364) for Papua New Guinea. Therefore plots that have been cultivated only a few times since they have been opened from primary forest have a higher species diversity and a larger part of primary forest species than plots which have been cultivated frequently.

This feature is demonstrated by the large difference in species diversity of two 20-year-old sites in Lubuk Malakko (see table 31). One of them had been cultivated only once since it was opened from primary forest and subsequently planted with rubber, but never cleaned, whereas the other one is a well-managed rubber garden. Within 1,000 m², the less-tended plot had a total species diversity of 93 species (of which 67 are trees). Within the same area, the rubber garden has only a species diversity of some 50% of the less-tended plot, i.e. 48 species (of which 28 are trees).

Table 31: Species diversity and structural composition of the different vegetation types of the village land of Lubuk Malakko, Kec. Sangir, Kab. Solok, West Sumatra

age (years)	*plot no.*	*geo. pos.*[1]	*utilisation*	*average DBH (cm)*	*veg. height (m)*	*trees*	*herbs & shrubs*	*lianas*	*ferns*	*grasses*	*palms*	*total species*
20	7	l	rubber	25-30	20	28	9	5	3	3	-	48
20	11	t/s	fallow (r)[2]	20-25	20-25	67	2	13	6	2	3	93
65	9	l	rubber (fruits, coffee)[3]	35-40	25-35	20	5	7	6	2	-	40
65	10	t/s	rubber (fruits)	25-35	20-30	39	5	16	7	4	2	73

1 Geomorphologic position: f = flat/level area, ls = lower slope, s= slope, t = hilltop.

2 This site has been used only once after primary forest has been cut down. Some scattered rubber trees present.
3 Because of low productivity due to the high age of the garden, rubber is not tapped anymore since about one year, whereas coffee is not cared for anymore since a long time. However, the coffee still bears some few fruits, which are collected by children.

In permanent trial plots in East Kalimantan Riswan and Abdulhadi (1992: 82) also found a drastic reduction of species diversity with each cultivation cycle. Within 2,500 m² in the first fallow following forest clearing, 221 species were recorded. After the fourth cultivation cycle within four years only 36 remained. On the other hand, frequent cultivation increases the role of forbs among the secondary regrowth. In frequently cultivated East Kalimantan swidden sites covered with four-year-old fallow vegetation, Vayda (1985: 16) reported an herb cover of 44 %, whereas it was only 24 % in sites cultivated only once after opened from primary forest. Woody cover from resprouting and seedlings was approximately the same at both sites. Within tree regrowth, however, species composition differed between recently and already more often used sites.

This feature is related to the ‘all-importance of the pre-existing seed bank’ (De Rouw 1991: 222), which is strongly linked to the cultural history of the site. Not all seeds of tropical rainforest trees withstand the influence of sunlight, drought and fire in shifting cultivation. Most of the mature tropical rainforest trees produce fruits with large, heavy seeds, which have a high water content and germinate quickly. These kinds of seeds are often well adapted to shaded or partly shaded conditions. If this seeds are kept in dry conditions, they are prevented from germination and will die. Since these seeds lack dormancy, they are not found in the soil seed bank (Primack 1990: 233). This results in entire absence of plant families producing this kind of seeds in secondary forest succession, like Dipterocarpaceae, which are characteristic of Sumatra’s and Borneo’s climax forest (cf. Richards 1952: 381).

Another reason for certain primary species not occurring in secondary vegetation is their pattern of seed dispersal. Large seeds, like those of durian, are usually dispersed by big mammals, as apes, eating their fleshy seeds. These animals, however, usually don’t occur within secondary growth (Seavoy 1973: 522). Plants which seeds are not present at the onset of cultivation and which do not coppice from stumps will have to invade from the forest. Distance to the forest, range and means of seed dispersal of the respective tree, and its ability to concur with other trees determines both its potential and the time period of its reinvasion. Seeds only dispersed by gravity, for instance, will have difficulty regaining a site again. Therefore the size of the cultivated area and its proximity to mature forest is vital for its reoccupation by those species that do not withstand ecological modification by shifting cultivation (cf. Vayda 1985: 9). Seeds of grasses and many forbs, on the other hand, are mainly wind dispersed (Uhl *et al*. 1981: 640). They therefore can quickly fill the void, especially if competition from other seed sources is small.

During an extensive research in the "Parc National de Tai" in Cote d'Ivoire, De Rouw (1991: 208 pp.) discovered, that fields made in primary forest could be distinguished from sites where the vegetation was slashed and burnt once, and these again from other fields where the vegetation was disturbed twice or more. The cultural history of a site is expressed through the floristic composition of its successional plant community. The more frequent an area is cultivated, even if a fallow period considered sufficient for fertility recovery is maintained, the more primary forest species will be substituted by secondary forest trees, pioneer species and weeds, finally leading to a more or less complete dominance of grasses like *Imperata* or of the fern *Pteridium* (Richards 1952: 391). These species proliferate after fire due to underground rhizomes that can survive scorching surface burn (Ramakrishnan 1992: 137). Secondary succession patterns and processes may be therefore linked to the frequency and intensity[1] of agricultural use (ibid.: 205).

5.2.2 Management Practices

Secondary regrowth was investigated within secondary vegetation, which was simply left fallow after shifting cultivation, and within those, where rubber has been planted into the maturing rice field and which has been cleared regularly in the years after. Management practices are very important for the course of succession and alter it significantly. This is indicated by the results of comparing secondary vegetation with fallow planted to rubber but unmanaged, regularly cleaned gardens and old traditional rubber gardens that are longer cleaned[2]. Regular cleaning of young rubber gardens has a distinct impact on vegetation composition and species diversity.

Rubber gardens intended for future use usually receive regular weeding during the immature period as well as selective cutting of vegetation to favour economically valuable trees. As undesired species are cut and weeded out, Irvine (1989: 232) calls this kind of intervention in the natural course of fallow development a ‘guided succession’. Furthermore, species diversity in regularly cleaned gardens is much lower than in unmanaged fallow or uncleaned gardens (table 32).

At Dusun Birun, a three year old, regularly cleaned rubber garden had a total species diversity of 16 species, six of which were trees (table 32). Secondary vegetation of the same age had almost twice the level of species diversity, namely 40 species, including ten tree species.

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[1] I.e. fallow length and duration of cultivation.

[2] See chapter 4.2.1 for details on rubber garden management.

Table 32: Species diversity and structural composition of the different vegetation types of the village land of Dusun Birun, Kec. Sungai Manau, Kab. Sarolangun-Bangko, Jambi

age	***plot size (m^2)***	***plot type*** [1]	***geo.. pos.*** [2]	***utilisation***	***av. tree DBH (cm)***	***veg. height (m)***	***tree species***		***herbs & shrubs*** [3]		***lianas***		***ferns***		***grasses***		***palms***		***total species***
							no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	
1	10 m	t	ls	fallow	1	1	12	*29.0*	12	*47.4*	9	*11.8*	2	*2.6*	3	*9.2*	-	-	38
2	20 m	t	s	fallow (r) [4]	2	2-3	17	*40.2*	7	*25.0*	6	*6.8*	2	*3.8*	4	*24.2*	-	-	36
3	30 m	t	f	rubber*	7	6	6	*32.3*	3	*31.5*	3	*4.8*	2	*8.9*	2	*22.6*	-	-	16
3	30 m	t	s	fallow	2.5	3-4	14	*37.4*	7	*27.1*	10	*10.3*	4	*9.3*	4	*15.0*	1	*0.9*	40
5	50 m	t	f	fallow	5-6	6-8	15	*71.2*	3	*3.9*	3	*2.9*	2	*15.4*	3	*6.5*	-	-	26
7	70 m	t	ls	rubber *	10	8	15	*41.8*	5	*10.2*	6	*10.2*	4	*35.7*	2	*2.0*	-	-	32
7	70 m	t	ls	fallow	5	6	29	*61.6*	3	*5.8*	3	*3.5*	3	*26.7*	1	*1.2*	1	*1.2*	40
7	70 m	t	s	fallow	8-10	6-7	28	*57.1*	8	*19.3*	6	*10.1*	2	*8.4*	2	*3.4*	1	*1.7*	47
10	200 m^2	p	s/t	fallow (r)	5	8	39	*76.2*	4	*7.6*	5	*3.5*	3	*9.3*	2	*3.5*	-	-	53
15	200 m^2	p	ls	rubber **	25	10-15	24	*37.1*	9	*17.0*	9	*15.1*	5	*23.9*	2	*6.3*	1	*0.6*	50
20	1000 m^2	p	s	a) rubber, fruits b) cinnamon**	a) 40-50 b) 10-15	a) 7-15 b) 6	25	*61.8*	11	*18.4*	3	*4.6*	6	*6.6*	4	*7.9*	1	*0.7*	50
20	1000 m^2	p	s	fallow (r)	25	30	47	*71.1*	5	*3.9*	10	*16.4*	1	*4.7*	1	*0.8*	2	*3.1*	66
25	1000 m^2	p	s	rubber **	30-40	25-30	25	*63.7*	5	*12.8*	4	*5.9*	3	*12.8*	3	*4.9*	-	-	40
33	1000 m^2	p	s	fallow	20	20-30	36	*80.8*	4	*1.5*	8	*10.8*	5	*6.2*	1	*0.8*	-	-	54
42	1000 m^2	p	s	fallow	30	30	36	*66.7*	3	*10.9*	7	*7.0*	5	*10.1*	1	*2.3*	2	*3.1*	54
50	1000 m^2	p	s	rubber ***	30	30	36	*65.6*	8	*9.1*	12	*11.7*	5	*12.3*	2	*1.2*	-	-	61

1 t = vegetation transect, p = vegetation plot
2 Geomorphological position of plot: f = flat/level area, ls = lower slope, s= slope, t = hilltop.
3 Incl. bamboo and pandanus species
4 Some scattered rubber trees present.
* Rubber is not yet productive. Cleared regularly from weeds and secondary regrowth.
** Cleared regularly from weeds and secondary regrowth.
*** Not productive anymore (no more tapping since one or two years).
(r) Some few rubber individuals present.
% Frequency

The same feature was observed in seven year old gardens. The cleaned garden had a species diversity of 32 species, whereas the two fallow sites contained 40 and 47 species. The differences were more apparent for tree species diversity. In the cleaned garden only 15 tree species were present, whereas in the secondary vegetation plots 29 and 28 tree species could be found. Furthermore, 15, 20 and 25 year old rubber gardens, which had been cleaned only occasionally exhibited a much lower species diversity, especially tree species, than undisturbed secondary vegetation of a similar age (table 32).

Besides favouring useful species, regular cleaning also causes a preliminary interruption in the course of succession development. In plots, where secondary regrowth was slashed every year, succession was ‘frozen’ in an early stage. The phenomenon of arrested succession due to frequent disturbances was also observed by Ramakrishnan (1992: 146). In up to 25-year-old regularly cleaned rubber gardens, pioneer species and species of early succession were still present. Especially grasses, herbs and shrubs were not shaded out, because a lack both of undergrowth and of a closed tree canopy. Some young rubber gardens had dense undergrowth of vigorously growing ferns that had been favoured by the altered succession process.

The influence of management practices also becomes very obvious in a rubber garden in Lubuk Malakko, where the part located on a small hill and the one at the hillfoot are managed differently. The lowland part of the about 65 years old garden is mixed with coffee. Examination of the 1,000 m^2-sized plot in each part of the garden reveals that the species diversity of the lowland plot was only about half of the upland area; a total of 40 species (20 trees) compared with 73 species (39 trees; see table 32). An indication is the undergrowth of the lowland plot, which is strongly dominated by spontaneous coffee saplings – about 1000 saplings within a 100 m^2. Although the coffee is no longer managed, this section had been cleaned longer than the uphill rubber garden, where no coffee had been planted, thereby influencing species diversity. After being left fallow, the high density of coffee undergrowth is supposed to have prevented tree regrowth to a certain extent.

Uncleaned rubber gardens, on the other hand, merely experience an enrichment planting by the farmers, resulting in ‘secondary vegetation with rubber’ (an ecological definition initially used for mapping by Laumonier *et al*. 1986). Besides some scattered rubber trees, no differences to unmanaged fallow could be observed. The differences between fallow vegetation and rubber gardens become blurred again, when regular cleaning ends. When succession is allowed to develop freely because weeds pose no more threat to rubber growth, what is termed ‘traditional rubber gardens’ develops. The longer a garden is left uncleaned, the more species diversity levels approach those of unmanaged fallow.

5.2.3 Soil Properties and Parent Material

Considering the influence of soil fertility on vegetation regrowth, the question arises as to whether successional sequence is altered or productivity of successional vegetation is lowered by decline of soil fertility following slash and burn cultivation. It is difficult, however, to mark off the influence of fertility changes due to alternation of seed sources or suppression of coppice, or even from effects of differences in site physical characteristics (Harcombe 1980: 8). With secondary vegetation species recovering site fertility and primary vegetation species establishing in their shelter, succession is directed towards the re-establishment of climax forest where continued disturbance is absent (Whitten *et al.* 1987: 472). Although long fallow cycles, being crucial to prevent degradation, are provided for, repeated use of a site may result in changes in the floristic composition of local successional communities (Vayda 1985: 16).

Two important soil-related properties affecting the soil seed bank and germination after slash and burn is the degree of water loss and the temperature during the burn. As these factors vary within the microhabitats of a site, germination and regrowth is supposed to differ accordingly (Uhl *et al.* 1981: 646). Also the condition of the soil surface where seedlings germinate influences their chance for successful establishment. Bare soil or charcoal covered with slash offers more favourable regrowth conditions than root mats with or without slash, exposed charcoal and exposed bare soil. Differences between seeds and dispersal methods, however, cause grasses to establish themselves best on bare soil, and successional woody species on slash habitats. The weather present during germination and early growth also contributes to some sites being more favourable than others (ibid.: 647 p.). These factors influencing the vegetation composition of a young fallow are not directly related to the mineral soil, but rather to the slashed vegetation cover and the burn.

Box 7: Bedrock materials of the research area

PEMUNYIAN

The parent material present in the village area of Pemunyian comprises several bedrock materials:

- *Acidic volcanic rocks:* mainly in the area of "black soil" and "red soil", i.e. in the area before crossing the river to the village (River Pemunyian).
- *Granitic rocks:* mainly in the area of "yellow soil".
- *Quarzit (metamorphic) or gang-rock material*: in the small area of "yellow soil" between "red soil", "black soil" and the Sungai Pemunyian, i.e. in the area before crossing the river to the village.
- *Very fine-grained silicified rock*: Maybe a kind of hornfels-facies / chert or gang-rock material. Seems to occur together with the granitic rocks in areas of yellow soil.

DUSUN BIRUN

- In the whole village land of Dusun Birun, only one bedrock material, namely very *fine-grained graphite schist* is present.

LUBUK MALAKKO
The village land of Lubuk Malakko consists of two different parent materials:
- *Very fine grained schistose rocks* in the hills and
- *Porphyric basalt* in the lowlands.

Notwithstanding the difficulty to distinguish between the influence of the factors mentioned above and soil properties itself on vegetation composition, a relationship between both factor complexes exists. Several authors described differences in species occurrence related to soil type, topography, and/or geology (e.g. Kellman 1980: 35, Werner 1993: 85). Also in Nigeria, soils derived from basement complex rocks and from sedimentary formations exhibited distinct fallow compositions (Hall and Okali 1979: 341). In the research area, different bedrocks are present in the three villages. Furthermore also within two of them, more than one kind of bedrock material occurred (see box 7). The soil types, as identified according to the USDA classification system, differ in their respective predominance within the villages. Nevertheless, many of the soil types are present in all villages (see chapter 5.3.1).

Also the species diversity varies between villages. The studied secondary vegetation and rubber gardens in Pemunyian only harbor a total of 153 species (trees, shrubs, grasses, ferns, herbs, lianas and palms). In Dusun Birun, in the same number of vegetation plots of similar ages, 240 species were present. In Lubuk Malakko, this number rises up to 415 species in 14 vegetation plots (table 33). Due to the geographic proximity and the presence of similar management practices in the three villages, differences in soil fertility and/or bedrock material seem to be a plausible explanation for this feature. One could still assume, that low species diversity could have been influenced by more recent and more prolonged use of the respective village lands. Nevertheless, if considering mere settlement size and infrastructure available, it seems that just Lubuk Malakko is the village being inhabited longest.

Table 33: Rubber garden and secondary vegetation species diversity in the research area

	Lubuk Malakko	***Dusun Birun***	***Pemunyian***
Number of species	415	240	153

When analysing the influences of parent material and locally classified soil types on botanical species richness, it becomes obvious, that neither of them seriously modifies the course of species diversity increase with fallow age (see Figure 2, 3, 4). Notwithstanding the fact that species richness differs between villages, especially among younger secondary vegetation, parent material does not seem to cause variations within villages. Calculations of the correlation between species diversity and locally classified soil types are significant only (though highly) in Pemunyian and Dusun Birun. However, when plotting these factors into graphs, no differences between the respective soil types were evident.

Two deviant features of this general picture need further explanation. Firstly, in Pemunyian species diversity of young fallow on black soil is particularly low, although nutrient content is intermediate. No obvious reason for this condition could be found. Secondly, on black soil / porphyric basalt in Lubuk Malakko, species diversity seems to decrease with fallow age. In fact, however, all plots on this soil / parent material older than 10 years are within managed rubber gardens. In these cases, intensive human intervention into the course of vegetation recovery through regular cleaning practices are the main reason for this untypical development.

Figure 6: Correlation between species diversity and parent material

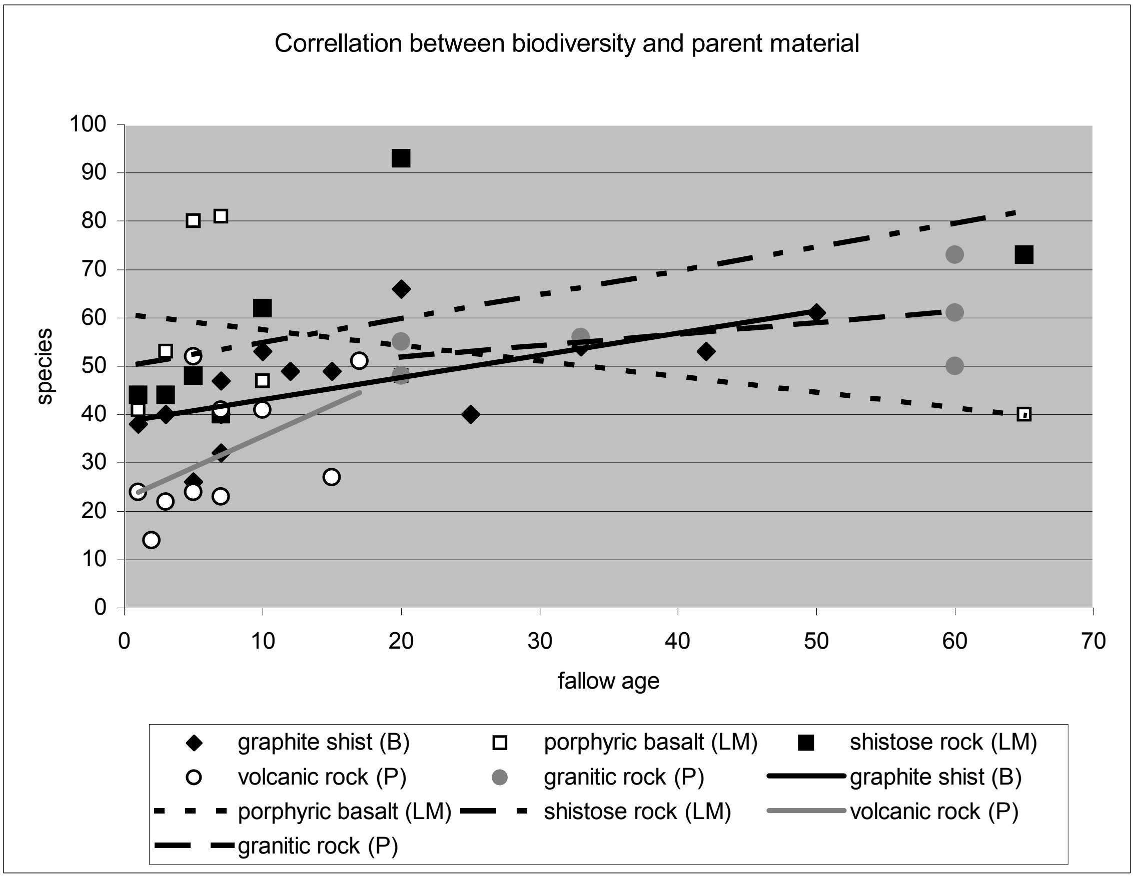


Figure 7: Correlation between species diversity and local soil type

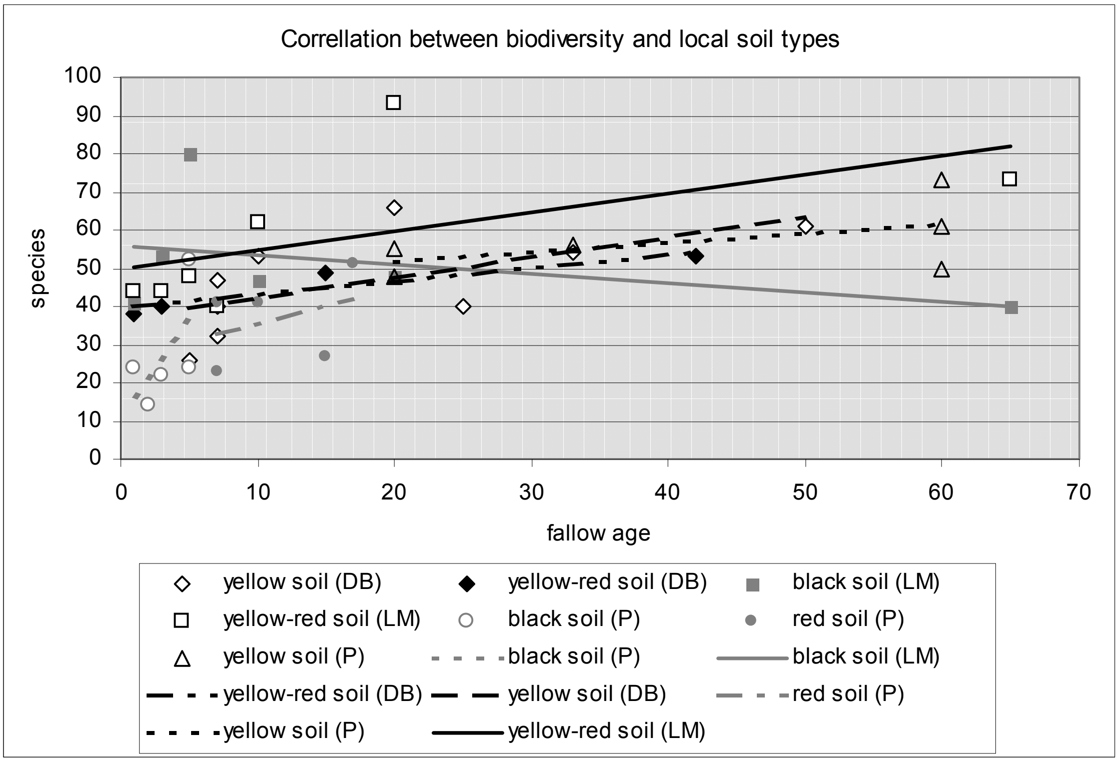
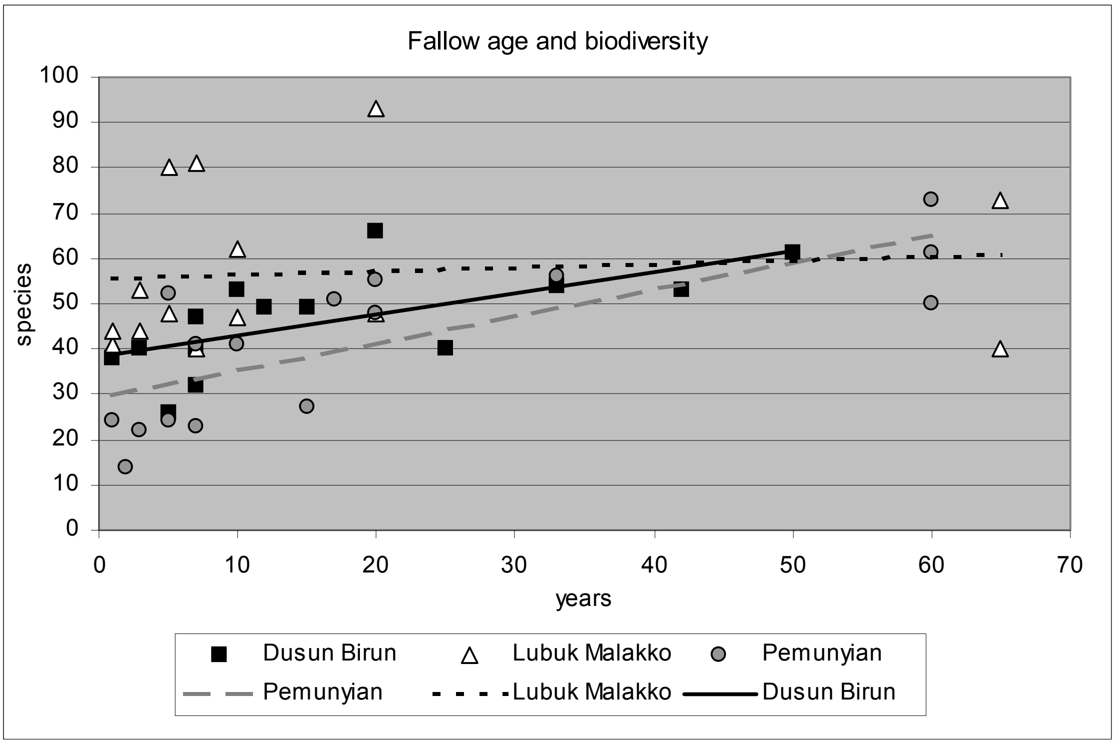


Figure 8: Fallow age and species diversity



Although in the study area, the presence and density of species is mainly influenced by the age of the vegetation and management practices, some secondary species seem to prefer particular (locally classified) soil types or geomorphological locations above others. In locations where there is more than one type of bedrock material, i.e. Pemunyian and Lubuk Malakko, some plants were more or even exclusively present on soils from one of them (see table 34). This feature, however, is not related to the USDA-soil type present. The percentage of species, which show this kind of behaviour, however, is comparably small. 5.2 % (eight) and 2.2 % (nine) of all species in Pemunyian and Lubuk Malakko respectively are limited to a certain local soil type and/or parent material. The number of species associated with a particular geology or soil, however, was about the same for all parent materials.

Table 34: Tree-species associated with a particular parent material

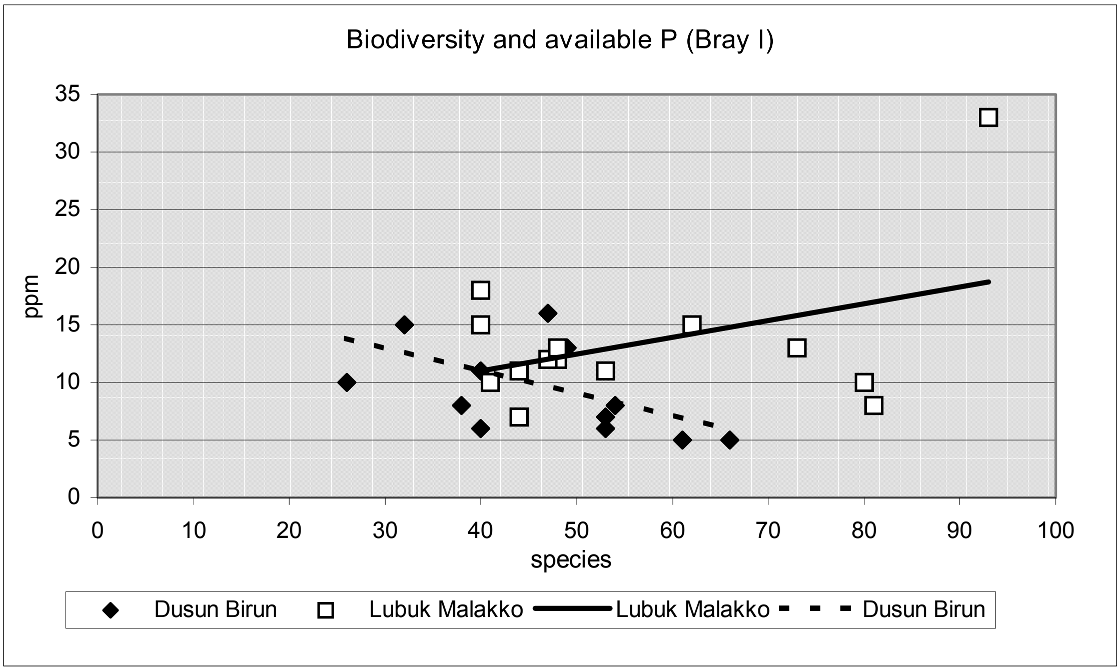
botanical name	***local name***	***main occurrence***
PEMUNYIAN		
Campnosperma auriculatum ANACARD	tantang	On granitic rocks + red soil on volcanic rocks
Rhodammnia cinera MYRT	marpoi	On granitic rocks + red soil on volcanic rocks
Anisophylla disticha RHIZO	bibu	On granitic rocks + red soil on volcanic rocks
Macaranga sp EUPH	kayu sapek	On granitic rocks + red soil on volcanic rocks
Mallotus peltatus EUPH	masiro	Granitic rocks
Payena cf. acuminata var. fulchra SAPO	narahan	Granitic rocks
Alstonia scholaris APOCY	pulai	Volcanic rocks
Macaranga gigantea EUPH	sekubung	Volcanic rocks
LUBUK MALAKKO		
Artocarpus elasticus MORA	tarok	Porphyric basalt (lowland)
Eugenia cf. pendens MYRT	bosarai, ubau jambak	Porphyric basalt (lowland)
Helicia robusta PROTEA	sirantau tuah	Porphyric basalt (lowland)
Vitex pinnata VERB	laban	Porphyric basalt (lowland)
Vitex sp. VERB	madang tima	Porphyric basalt (lowland)
Macaranga gigantea EUPH	sikubung	Schistose rocks (hills)
Macaranga hoseii EUPH	kayu lande	Schistose rocks (hills)
Macaranga cf. nicopina EUPH	sitarak	Schistose rocks (hills)
Pithecellobium bubalinum LEG	alang kabau, jariang tupai	Schistose rocks (hills)

Within the area of acidic volcanic rocks in Pemunyian, several species prefer only one of the two local soil types present in that area, i.e. red soil (see table 34). They do not occur on black soil. This feature could be either related to certain soil properties, or is due to the fact that according to the local people, black soil is cultivated only from one to two shifting cycles. These species may therefore have merely not invaded yet. As will be mentioned in chapter 6.5.2, concerning soil chemical properties, black soil has an intermediate position between red and yellow soil. To analyse differences in species occurrence due to soil chemical factors, correlational calculations would have to be carried out between the respective abundance as well as soil properties. This complex, though certainly very interesting investigation, however, would have exceeded the scope of this study. Nevertheless, the limited correlations between soil types and species presence imply that the most important factors determining species abundance in secondary vegetation tend to be fallow age and the pre-existing soil seed bank.

Nevertheless, for mature tropical rainforests, where these factors are not applicable, several studies have confirmed species composition to be controlled by soil characteristics (Ashton 1978 and 1989, Baillie *et al*. 1987). Besides soil nutrients, soil physical factors like the soil's air-water balance and free versus blocked vertical drainage were also shown to influence both species composition and basal area present. Total tree density is not influenced by these factors, but the density of the individual species is (Lescure and Boulet 1985: 161 pp.). Other authors still accounted only dispersion and reproduction strategies as being responsible for differences (Kwan and Whitmore 1970, Poore 1968). During studies in northeast Borneo, Ashton (1989: 243) found the pattern in tree species composition being influenced by soil content of concentrated HCl extractable phosphorus and magnesium below 200 ppm phosphorus and 1200 ppm magnesium. Below this threshold there is also a positive correlation between species richness and magnesium content. Higher potassium amounts, usually coming along with a higher clay content, on the other hand, were negatively correlated with species richness. Higher clay content cause a higher water holding capacity, which allows trees to carry a higher heat load in their leaves. This allows species with large, densely arranged leaves to gain dominance by shading out competitors (idem.: 244 p.).

As with other factors mentioned earlier, nutrient content correlations with species diversity are also not the same in each study site. Based on correlation analysis, however, usually the results for one or more methods for extractable phosphorus showed significance, as well as one or more aspects of organic matter (in two of the sites). Furthermore, the results for acid-extractable calcium correlate significantly with species richness in Pemunyian. The impact of phosphorus confirms Ashton's experiences mentioned above. In Lubuk Malakko, both available P (P_{av}) extracted through Bray I and through double-lactate (DL) is correlating, whereas it is Bray(I)-P and acid-extractable P in Dusun Birun. In Pemunyian, for which samples the Bray-method was not used, the results for the DL-lactate method indicated a significant relationship of P content and species diversity.

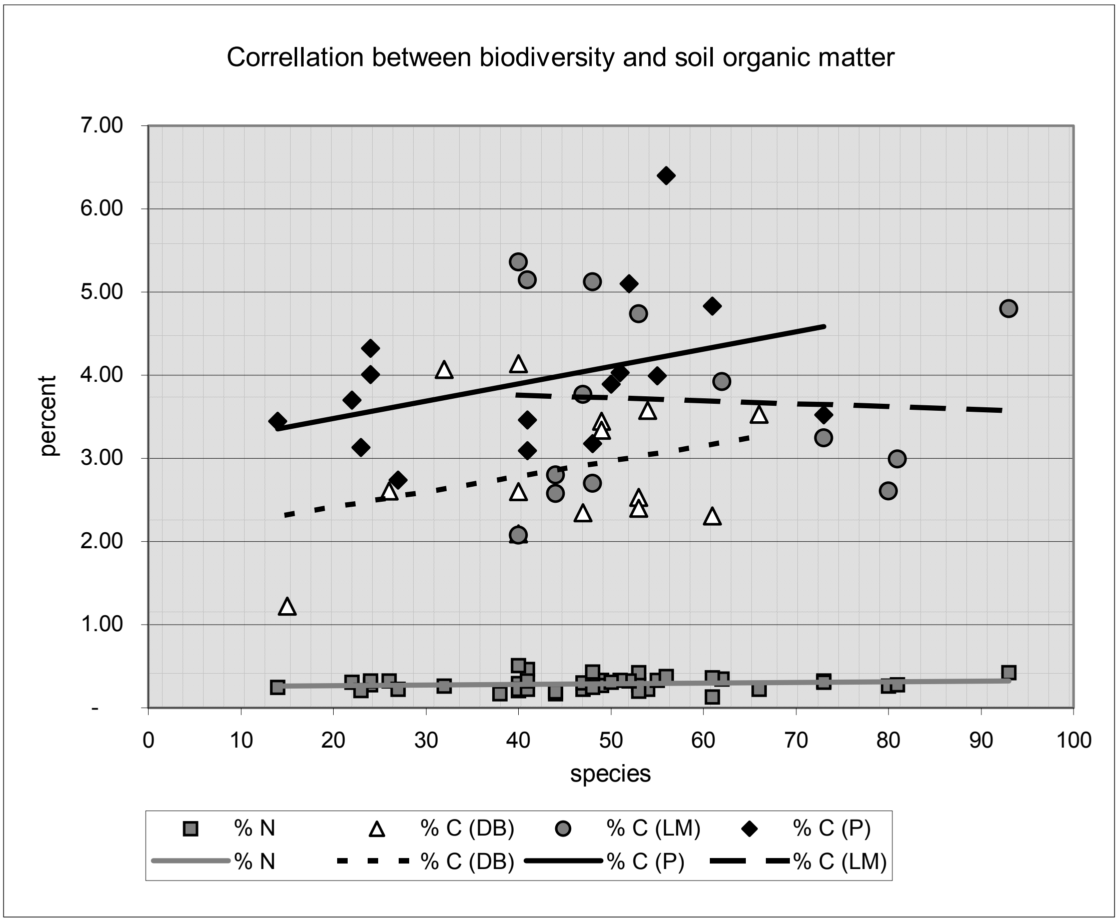
Figure 9: Correlation between species diversity and plant-available phosphorus (DL)



When plotting these relationships into graphs, the clearest picture was given by the DL-correlations, which are positive for all three villages (see Figure 5). For no clear reason the results for Bray(I)-P correlates positively with species diversity in one village, but in the other negatively. Also the graphs plotted based on the results for this method does not show any clear trend. The same is true for acid-extractable P, which positively correlates in Dusun Birun only, but slightly negatively in the two other sites. At least for Lubuk Malakko, the amounts of reserve phosphorus present at a certain species diversity differ widely. Of all soil nutrients present, the relationship between phosphorus and species diversity indeed seems to be most profound. As P is in general the most deficient nutrient in highly weathered tropical soils, this is not surprising.

Correlations between species richness and organic carbon content are significant for Dusun Birun only. Figure 6, however, also shows a rising trendline for Pemunyian, but the overall value distribution seemed to have been too scattered for a significant correlation. In Lubuk Malakko, differences of % C between sites are not related to species diversity. For nitrogen, only in Pemunyian a positive correlation could be confirmed. When plotting a graph, the trendline for Lubuk Malakko appears also to be positive, but individual values again are too scattered. In Dusun Birun, no clear relationship seems to exist. For this village, falling C/N ratios are significantly correlated to a rising species diversity. Also in Lubuk Malakko, a similar development is indicated by a falling trendline, but like also in Pemunyian, values are to scattered.

Figure 10: Correlation between species diversity and soil organic matter



Differently than for P, organic matter content is not consistently correlated to species richness. In this case, the major reason behind the indicated trends seems to be rather increasing fallow age, which is correlated with rising organic matter content. The increase of soil humus with fallow age is a general feature. Its intensity, however, is related to the initial organic matter content of the soil as well as to the maximum level that is typically achieved under local conditions (Nye and Greenland 1960: 47, 53). A further hint of towards this explanation is that, as with the relationship between fallow age and organic matter, no correlation exists also between species diversity and organic matter for Lubuk Malakko, whereas it does for the two other sites. Nevertheless, also for phosphorus, at least Bray(I)-P, these two developments seem to correlate to a certain extent.

A further example emphasizes the importance of both P_{av} and the soil seed bank. From all investigated vegetation plots, the highest species diversity (93 in total) was found in a 20 year old hillside fallow plot in Lubuk Malakko. According to local farmers, this location had only been cultivated once since being opened from primary forest. Besides an overall good, though not high, nutrient status with relatively abundant organic matter, this Hapludox also has by far the highest amounts of P_{av} as measured with both methods (Bray I: 33 ppm, average Lubuk Malakko: 13 ppm; DL: 1.30 mg / 100g soil, average: 0.90 mg). Values for acid-extractable P are about average, nevertheless. Also Ashton (1989: 244 p.) found species richness to be 24 % higher within fertile sites than at sites of intermediate and low fertility.

Poor vegetation regrowth, on the other hand, is not necessarily rooted in a poor soil nutrient status. Sites showing deflected succession due to an infestation with the fern *Dicranopteris* had no consistently lower content of particular nutrients. They were not very fertile, either. Some had a low CEC, low pH, low exchangeable potassium or available phosphorus. Nevertheless, other sites also show this feature without having a deflected succession. In these cases, the soil seed bank seems to be more decisive.

The influence of both seed bank and soil features on the course of succession has also been shown by Richards (1952: 398 pp.). In the West Indian islands, lowland sites with their humus layer still intact, subsumably just recently under cultivation, have a different vegetation composition than sites where the humus layer already has been depleted, supposedly already frequently cultivated. Minor variations in soil quality alone are unlikely to account for major differences in secondary vegetation. According to Harcombe (1980: 13 pp.), the influence of site history on the soil seed bank tends to be more important. His experiments indicated no accelerated vegetation growth of fertilized and unfertilized fallow sites. Therefore he points out that there is no proof for succession being strongly influenced by low soil fertility. Only long-continued cultivation or the incidence of severe erosion might sufficiently reduce soil fertility to limit regrowth vitality (Nye and Greenland 1960: 36). It is therefore suggested, that it is a combination of plant-available phosphorus, organic matter and the soil seed bank which influences species richness. Further studies concentrating on these three factors should be carried out to investigate the importance of the respective factors as well as their interaction.

5.3 Soils under Secondary Vegetation and Rubber Gardens

5.3.1 Soil Types of the Study Villages

The soils of the three villages in the moist tropical hill zone of the research area belong to three soil orders according to the USDA soil taxonomy (Soil Survey Staff 1997). The first are the Inceptisols, being represented by the great group of Dystropepts, which are present in all three locations. The second order, the Ultisols, are represented by the great groups of Paleudults. The latter order is characterized by an argillic horizon, whereas the former has a cambic B-horizon. The third order present is the Oxisols, having an oxic subsoil horizon characterized by low-activity clay minerals. This order is represented by the great group of Hapludox and Kandiudox. The Dystropepts as well as the Oxisols, with one or both of their subgroups, are present in all three villages, whereas Paleudults were only found in Dusun Birun and Pemunyian (table 35).

Table 35: Soil groups and subgroups in the research area

soil groups and subgroups	***Pemunyian***			***Dusun Birun***			***Lubuk Malakko***		
	domi-ant	*abun-dant*	*subdo-minant*	*domi-nant*	*abun--dant*	*subdo-minant*	*domi-nant*	*abun-dant*	*subdo-minant*
Oxic Dystropept					X				X
Typic Dystropept			X	X			X		
Paleudult		X				X			
Hapludox	X					X		X	
Kandiudox			X			X			

In Lubuk Malakko and Dusun Birun, the most frequent soil type is the Typic Dystropept, whereas it is the Hapludox in Pemunyian. The Typic Dystropepts are the soils with the highest CEC in the two villages, whereas in Pemunyian, this role is taken by the Paleudults (see annex 3 for properties of the research area's soil types). The lowest CEC per soil volume is featured by the Oxic Dystropepts in Lubuk Malakko and Dusun Birun. These less frequent soils do not only have low activity clay minerals, but also low overall clay content. The Oxisols, whose clay also has a low CEC, at least have high clay content.

Both Dystropepts and Paleudults are characterized by an overall low ECEC and base saturation. Although differences between great groups and subgroups indicate a relatively higher fertility of some soils, in the international comparison all of them belong to the strongly weathered and leached, highly acid, low nutrient reserve soils of the tropical rain forest climates. In these areas, usually only soils with additions of basic volcanic material or in higher mountain areas have a higher chemical soil fertility. Besides, the physical fertility such as drainage and profile development represents no inhibiting factor in the research area. Root growth is mainly supposed to be hampered by high aluminium saturation, which usually increases with soil depth.

As it has already been mentioned in chapter 5.2.3, besides the differences between soil types within villages, there were also different types of bedrock materials present. As will be explained later in chapter 5.4.1, sometimes the latter variations coincided with the former. However, this was not always the case. Also in villages, being homogenous concerning the bedrock material present, different soil types occurred. To what extent bedrock material was accounting for the differences between soil types could not be investigated during this study. For this purpose, the boundaries of the parent materials would have had to be known more precisely. Because the soils are deeply weathered, stones are rarely present within the observed profile depth of one meter. Nevertheless, along road cuts and rivulets nearby bedrock material can usually be observed. One could assume that, due to intense weathering, the tropical lowland soils bedrock material would no longer cause important differences between soils. Nevertheless, there are obvious indicators that it still affects soil properties.

As will be explained in the following two sections on soil chemical and soil physical properties, the averages for the respective properties also differ between villages. Among the three study sites, the soils of Lubuk Malakko are most fertile concerning their chemical properties (see table 36). Pemunyian and Dusun Birun alternately have a higher average content of the respective nutrients. Dusun Birun, nevertheless, ranks last for a large part of them, especially organic matter.

5.3.2 Soil Chemical Properties

pH

All soils in the research area can be categorized as being acid to very acid. Although differences in the acidity of the soil types exist, these are only up to a maximum of a half pH unit (see table). On average the pH (H2O) of the different soil types in the study villages varies between 4.1 and 5.0, the pH (KCl) between 3.5 and 4.0, whereas the pH (CaCl) has a range from 3.5 to 4.8. In general soil pHs below 5.5 are classified as acid, below 4.5 as very acid. Below a pH of 5.5, aluminium-toxicity is possible; Co, Cu, Fe, Mn and Zn are available in excess, whereas Ca, K, N, Mg, Mo, P, S and B are likely to be deficient (Landon 1991: 113).

Effective Cation Exchange Capacity

The effective cation exchange capacity (ECEC), giving the cation exchange capacity of the soil at its natural pH, ranges from low to very low for the soils studied, depending on the soil type. ECEC was one of the most significant factors differentiating the great groups and subgroups present. The significance obtained through t-test statistics ranged from 96 to 100 for most soils. Only for some, ECEC differences were not as decisive as other factors. Oxic Dystropepts and Kandiudox as well as Hapludox and Paleudults in Dusun Birun respectively have similarly low ECECs. For these, it is the subsoil variations leading to different classifications.

Table 36: CEC and ECEC (meq/100 g soil) of the soil types in the research area (standard deviation)

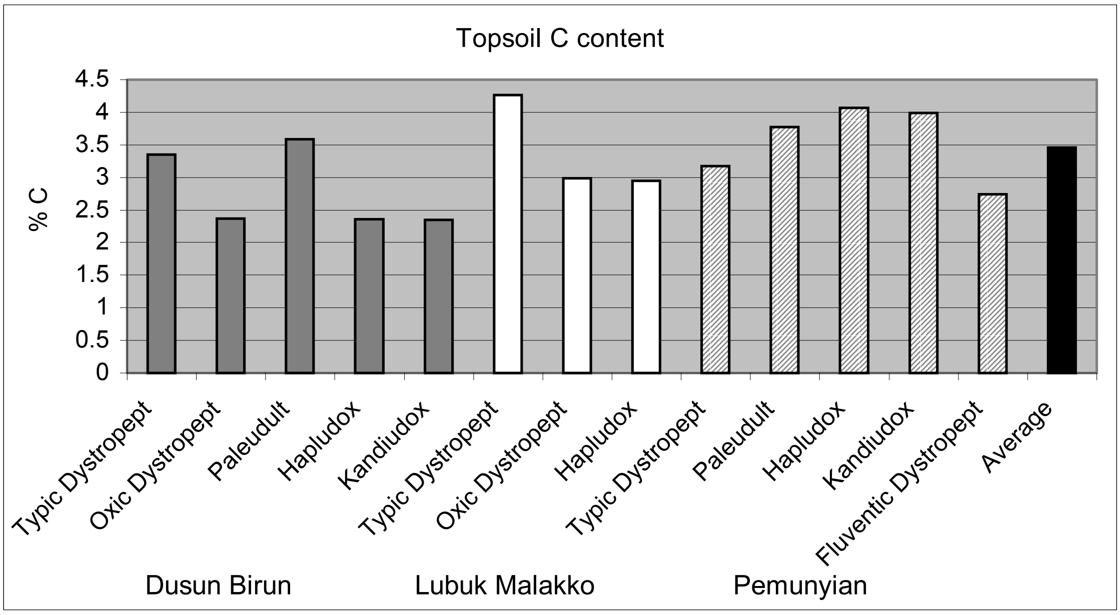
Soil Type	***Pemunyian***	***Dusun Birun***		***Lubuk Malakko***	
	CEC	CEC	ECEC	CEC	ECEC
Oxic Dystropept		4.48 (0.78)	3.40 (0.60)	4.30 (0.36)	3.34 (0.45)
Typic Dystropept	8.83 (6.31)	13.51 (5.60)	4.51 (1.23)	13.34 (6.34)	5.98 (2.05)
Paleudult	14.43 (5.34)	6.01 (0.42)	4.48 (0.97)		
Hapludox	5.95 (1.35)	7.13 (1.37)	6.44 (1.19)	7.10 (0.88)	5.67 (0.92)
Kandiudox	4.70 (0.00)	5.21 (0.55)	4.04 (0.41)		

The most widespread soil type in the study area, the Typic Dystropept, has a low ECEC, which by definition ranges from 5-16 meq / 100g soil for Indonesia (Sukma *et al*. 1990: 27). Similarly, also the CEC of the Paleudults in Pemunyian can be classified as low (table). All three locations, however, do have soils of extremely low CEC. The soils with very low ECEC, defined as below 5 meq/100g (ibid.), are the Oxic Dystropepts of Dusun Birun and Lubuk Malakko, as well as the Paleudults and Kandiudox of Dusun Birun.

Organic Matter

Organic carbon. On average, organic carbon content of the study area's topsoils can be classified as intermediate to high. This is due to the fact, that the sampled areas were traditional rubber gardens and secondary vegetation of shifting cultivation with intermediate fallow cycles. This land use type usually prevents topsoil erosion and enables nutrient restoration. The mean content found is 2.87 % for Dusun Birun, 3.71 % for Lubuk Malakko and 3.93 % for Pemunyian. Within the villages, differences exist mainly between the higher fertility Typic Dystropepts and Paleudults as well as the other soil types (Figure7). Like the ECEC, the former also have above average organic C content, being 3.35 % in Dusun Birun and 4.08 % in Lubuk Malakko. Topsoil organic carbon content of soils of the rainforest zone is classified as low, if their amount falls below 1.2 % for sandy soils and 1.7 % for heavy-textured soils (Young 1976: 300). Similarly, the Indonesian Soil Research Centre in Bogor classified organic C content of 1 – 2 % as low, 2.01 – 3 % as intermediate and 3.01 – 5 % as high (Pusat Penelitian Tanah 1983).

Figure 11: Topsoil carbon content of soil types

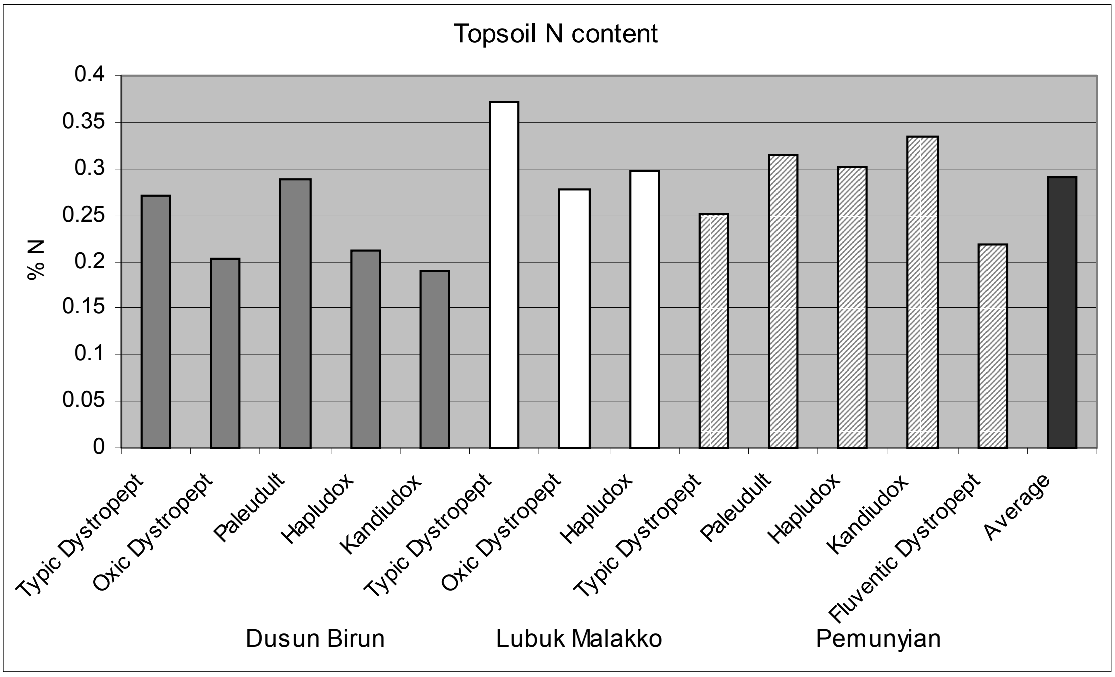


Results of other research carried out near the study area found a similar organic C content. On sites with comparable land use in the West Sumatran district of Solok, where the study village Lubuk Malakko is located, Imbang *et al.* (1996a: 39 pp., 1996b: 30 pp.) found organic C content ranging from 1.5 % to 3.3 %. Soil mapping carried out in the research area found organic C content ranging from 1.1 – 4.3 % (Suparto *et al.* 1990). Undisturbed rainforest soils near the study villages had an average organic C content of 5 %, which is similar to those of the Typic Dystropepts in Lubuk Malakko (Trichon, unpublished data). In udic areas of Puerto Rico and in Hawaiian topsoils, the mean content of several hundred topsoils was 2.06 % and 2.18 % organic carbon respectively (Sanchez 1976: 162 p.).

Nitrogen. The levels of nitrogen in the topsoils under fallow and rubber are generally high to very high. Again, highest values in the respective villages were achieved by the Typic Dystropepts and Paleudults, ranging from 0.27 % in Dusun Birun over 0.31 % in Pemunyian to 0.36 % in Lubuk Malakko. With amounts between 0.19 and 0.21 %, nitrogen content was overall lowest in the Oxisols and Oxic Dystropepts of Dusun Birun (Figure 8). The N-content of the other soils in the study areas ranged about 0.28 %. Values of 0.15-0.25 % are considered high, whereas values above 0.25 % are considered very high (Fairhurst 1998: 28). Similar N-content was observed under comparable land use in the Solok district, West Sumatra, and under rubber, forest, or other natural vegetation in the Muara Bungo district, Jambi, near the study village Pemunyian (Imbang *et al.*

1996a: 39pp, 1996b: 30pp, Arya *et al*. 1992: 45). The high total nitrogen content is related to the high organic matter content and an overall favourable C/N ratio between 11 and 14. As already mentioned before, this is caused by the type of land use, where nitrogen losses during the cultivation period are balanced by fallow periods.

Figure 12: Topsoil nitrogen content of soil types



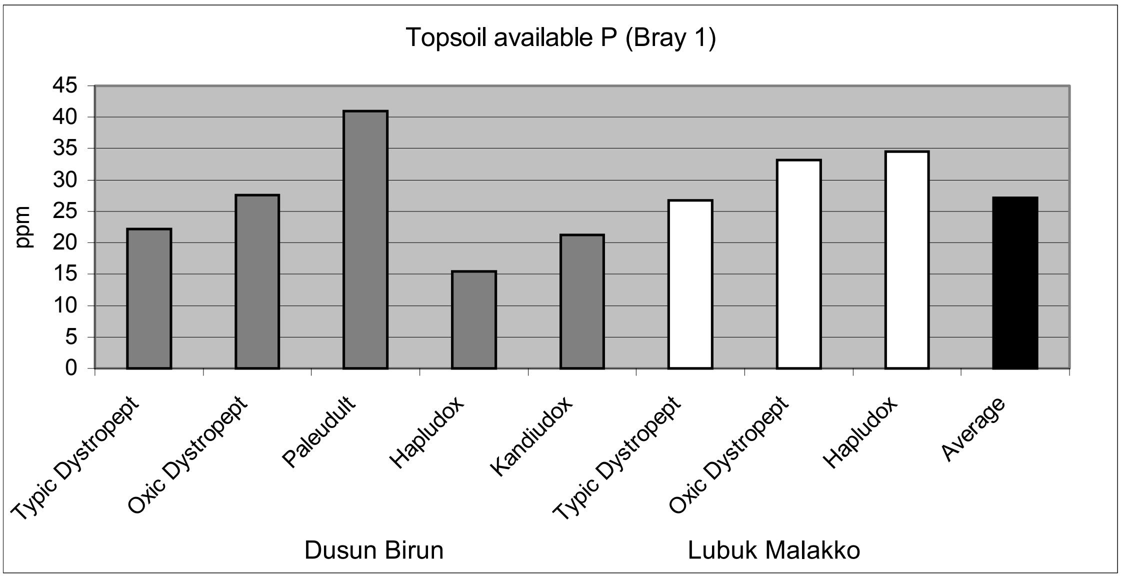
Sulphur. In general, total S content is related to the amount of organic matter present (Sanchez 1976: 281). If a soil is rich in organic matter, sulphur is also usually abundant. Therefore, due to the high C and N contents present, sulphur is not deficient in the soils of the study area either. Sulphur in the soils of Dusun Birun is lowest, amounting to 0.02 %. Higher values are achieved in Pemunyian and Lubuk Malakko, where sulphur content of the different soil types ranges from 0.02 to 0.04 %. Only at total S amounts below 0.02 %, deficiency is said to be likely (Landon 1991: 144).

Phosphorus

One particularly critical soil nutrient in the research area is phosphorus. This is typical for the humid tropics. In highly weathered soils especially, extractable phosphorus is usually low (Fox and

Kamprath 1970: 902). Under strongly acid conditions and the abundance of iron and aluminium oxides as in the soils present, P forms insoluble complexes with aluminium and iron and therefore is unavailable to plants (Young 1976: 296). High amounts of exchangeable aluminium furthermore represent a high phosphorus fixing capability for any P added in the form of fertilizer. Leaching during weathering and soil formation as well as topsoil erosion causes further losses of P (Stevenson 1986: 231, 239). Furthermore, the parent material does not contain major amounts of P, making the weathering of topsoil organic matter the main source. Therefore P_{av} content are low at all sites studied in Jambi and West Sumatra.

Figure 13: Topsoil available P (Bray I) of soil types



Although of higher fertility concerning ECEC and other nutrients, the P_{av} content obtained through Bray I for the Typic Dystropepts frequently falls below those of the other soil types (Figure 9). On average, their amounts of P_{av} present are 9 ppm in Dusun Birun and 11 ppm in Lubuk Malakko. Hapludox contain 6 viz. 15 ppm in these villages. Highest is the P_{av} content of the Paleudults of Dusun Birun, achieving 16 ppm. An available content of 10-15 ppm P is generally considered as low, whereas 6 ppm are the critical levels for rice production (Sukma *et al*. 1990: 27, IRRI 1985: 329). The very low P_{av} content of the otherwise fertile Typic Dystropepts at Dusun Birun, which have been partly subject to the influence of volcanic ashes, are due to P forming aluminium phosphates with the aluminium oxides of the allophanes. These minerals have the highest P-fixing capacity (Sanchez 1976: 261).

Available P measured with the double-lactate method is also lowest for Typic Dystropepts in Lubuk Malakko, whereas in Dusun Birun, the values have the opposite trend. Although both methods extract P_{av}, their measured amounts are usually lower for the double-lactate method than for the Bray I-method. Therefore it is assumed that both methods extract somehow different fractions of the weakly absorbed inorganic phosphate.

Notwithstanding these differences, however, both methods account for a low to very low available P-content in the study area. The analysis by double-lactate method accounted for an average of 0.67 mg P per 100g soil in Dusun Birun, 0.90 mg in Lubuk Malakko, and 1.07 mg in Pemunyian (table). Values below 3.5 mg are considered as very low (MELF 1997: 15). Acid-extractable reserve phosphorus was at similar levels in all soil types, with averages ranging from 15.96 mg to 26.00 mg P per 100g soil. Only the Typic Dystropepts of Lubuk Malakko had again higher values, namely 35.65 mg P per 100 g soil.

Exchangeable Bases and Available Nutrients

All available nutrients and exchangeable bases are present in low to very low amounts only. This is due to the overall low ECEC and high aluminium saturation in the study area, caused by excessive weathering, leaching and low pHs.

Calcium. In general, amounts below 2 meq calcium per 100 g soil are considered to be very low (Pusat Penelitian Tanah 1983[1]). The Ca-content of soils in the study area is without exception by far lower. Again, highest values are achieved by the soils of Lubuk Malakko, having an average of 0.46 meq Ca, whereas in Dusun Birun with 0.22 meq Ca the content was less than half of that. In other tropical lowland soils of Indonesia, Ca-content was similarly low (Werner 1993: 76, Imbang *et al*. 1996a,b). Nevertheless, deficiencies of Ca are likely only at values below 0.2 meq/100g (Young 1976: 298). Therefore the supply of the soils is still sufficient.

Magnesium. The deficiency threshold for exchangeable magnesium is 0.2 meq/100g (*idem*.). Soil content, however, is already considered very low at less than 0.3 meq/100g and low 0.4-1.0 meq/100g (Pusat Penelitian Tanah 1983[2]). With 0.48 meq/100 g soil, exchangeable Mg is highest in the Oxic Dystropepts of Lubuk Malakko. The Hapludox of Dusun Birun had lowest the content, with an average of 0.16 meq Mg in 100 g soil. Also the other soils of Dusun Birun had lower exchangeable Mg content than those of Lubuk Malakko (Figure 10).

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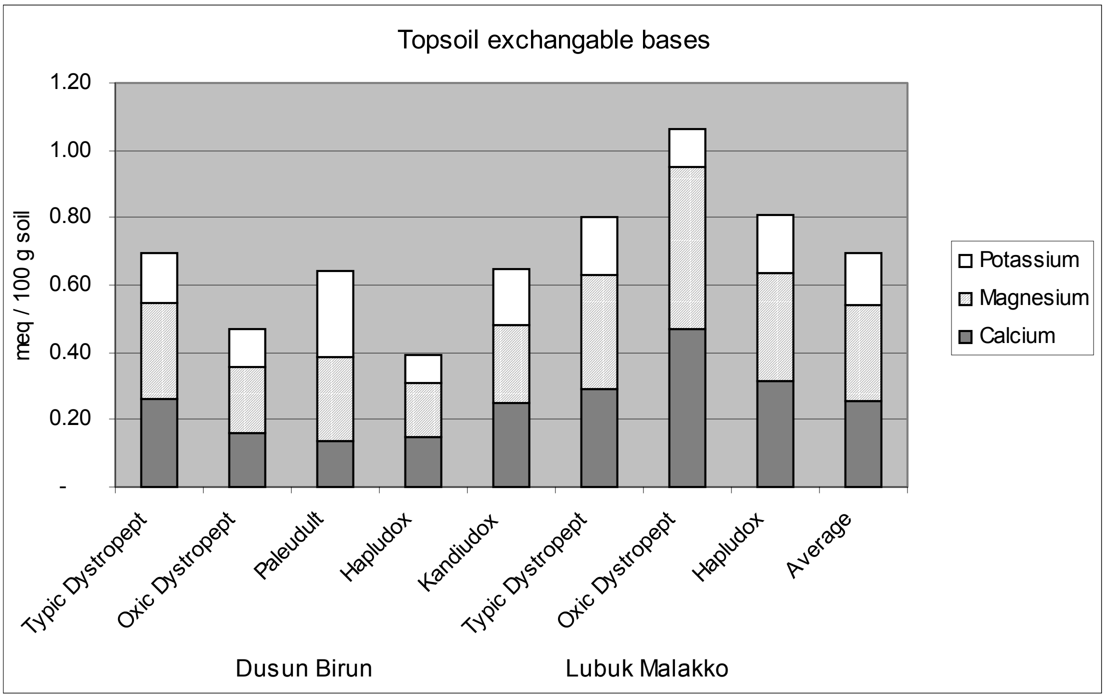
[1] As cited in Imbang *et al*. (1996a: 75).

[2] As cited in Imbang *et al*. (1996a: 75).

Available magnesium extracted with the $CaCl_2$-method shows similar trends in Lubuk Malakko and in Dusun Birun. In the latter village, average amounts are overall lowest, namely 2.87 mg/100g soil. The soils of Lubuk Malakko contain a mean of 4.12 mg Mg per 100 g soil, whereas amounts in Pemunyian are highest with 4.40 mg/100g soil (table 37). Nevertheless, the soil type with the single highest available magnesium content is the Typic Dystropept of Pemunyian, having 4.44 mg/100g soil. Mg ($CaCl_2$) lower than 4.1 mg is considered very low for loamy soils, whereas a content of 4.1-7.5 mg is considered low (MELF 1997: 15). The evaluation of both methods applied indicates, that the soils in the study area generally have a low to very low available magnesium content.

Figure 14: Topsoil content of exchangable bases



Potassium. Exchangeable potassium is low in all soils of the study area, containing less than 0.2 meq K per 100 g soil (Young 1976: 291, Fairhurst 1998: 28). Only the Paleudults of Dusun Birun are at the lower boundary for medium content with 0.26 meq per 100 g soil. Other West Sumatran and also West Kalimantan upland soils under similar land use have a comparable content of exchangeable potassium (Imbang *et al*. 1996a, 1996b; Werner 1993: 76 p.).

Also, available potassium extracted with the $CaCl_2$-method is on average low for the three study villages (see table 37). A content of less than 5 mg/100 g soil potassium is considered very low, whereas a content between 5 and 8 mg K is considered low (MELF 1997: 15). The soils of Pemunyian, the Paleudults and Oxisols of Dusun Birun as well as the Dystropepts of Lubuk Malakko have the lowest amounts of available K (< 5 mg/100 g). Although low for exchangeable K, easily plant-available K ($CaCl_2$) is comparably highest in the other soils of Dusun Birun. The different results obtained through the two methods are supposed to be due to different fractions of K extracted. Therefore it can be concluded that, although low, the exchangeable bases in the study villages are not supposed to be deficient, except for K.

The amount of reserve potassium is not always in accordance with the different levels of available K in the different soil types. Within the results attained by the *aqua regia* method, the Hapludox and the Oxic Dystropepts of Lubuk Malakko contain the highest amounts, with 141.32 mg/100g soil and 102.76 mg respectively. Lowest in reserve K are the Hapludox and Paleudults of Pemunyian, having only 34.40 mg and 49.63 mg each.

Exchangeable Acidity

Tropical soils with low amounts of bases and a low pH usually have a high aluminium saturation. This is also the case for the soils of the study area. The average amount of exchangeable aluminium is 3.59 meq/100g soil for Lubuk Malakko and 3.21 meq for Dusun Birun (table 37). Of all soil types, exchangeable aluminium is highest for the Hapludox in both villages, with 3.86 meq and 5.23 meq respectively. Exchangeable H+ amounts to 0.65 meq/100 g soil in Lubuk Malakko and 0.71 meq in Dusun Birun. A difference in exchangeable acidity between soil types is highly significant for most soil types.

Aluminium saturation differs strongly between soil types and villages (Figure 11). Resulting from their low content of exchangeable bases, it is highest within the Hapludox of Dusun Birun, amounting to 81.21 %. The aluminium saturation of Typic Dystropepts is distinctively lower, only 48.29 %. The aluminium saturation of most other soils of Dusun Birun and Lubuk Malakko was around an intermediate 68 %. Probably due to their very low ECEC, the Oxic Dystropepts of Lubuk Malakko has an aluminium saturation of merely 45.51 %.

Saturation levels of 41-60 % are considered as medium, 61-80 % as high and more than 80 % as very high (Budianto *et al*. 1990: 27). Levels of more than 30 % exchangeable aluminium can affect sensitive crops, whereas 60 % is generally toxic for most crops. Nevertheless, levels up to 85 % may be tolerated by certain crops, such as tea, rubber, cassava, pineapple, and some tropical grasses and legumes (Landon 1991: 132).

Figure 15: Topsoil exchangable cations

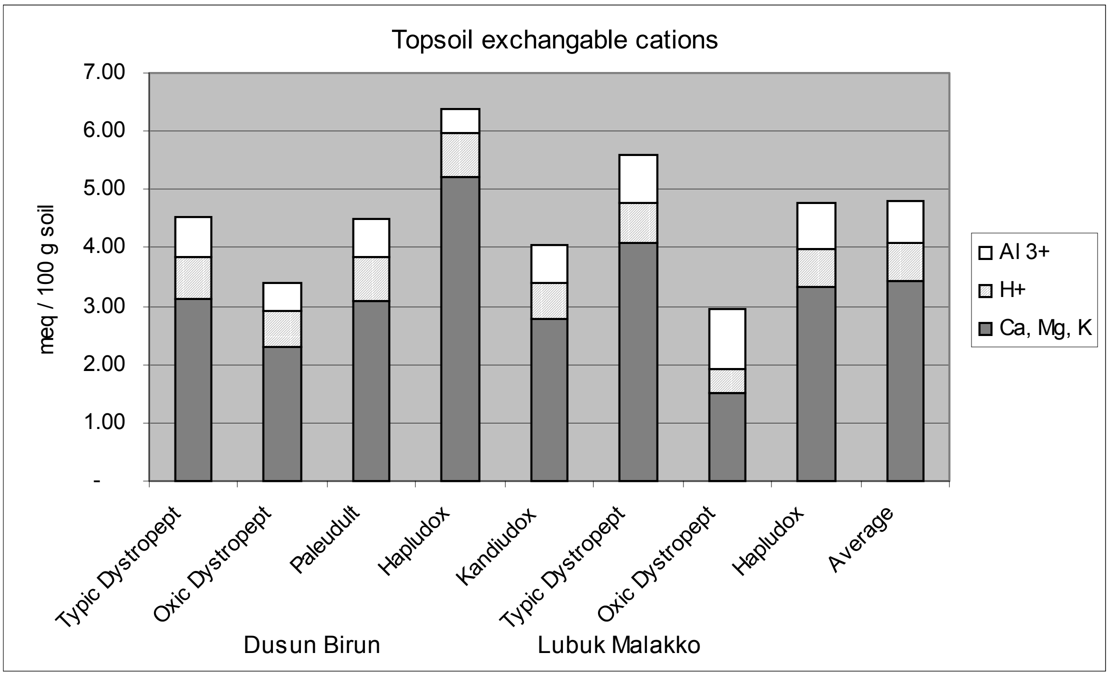


Table 37: Soil properties of the research sites

soil property	*Average (Standard-Deviation)*		
	Lubuk Malakko	*Dusun Birun*	*Pemunyian*
Species diversity (total no. of species)	415	240	153
Texture			
Sand %	15.38 (9.38)	7.81 (16.56)	15.74 (24.79)
Silt %	30.71 (12.28)	37.45 (12.80)	21.32 (7.81)
Clay %	53.43 (16.15)	45.99 (13.41)	53.89 (14.71)
CEC (NH_4Cl; meq/100g)	10.91 (5.82)	8.74 (5.05)	8.54 (4.62)
ECEC	5.65 (1.84)	4.50 (1.35)	
pH			
H_2O	4.7 (0.3)	4.4 (0.3)	
KCl	3.8 (0.2)	3.6 (0.1)	
CaCl	3.7 (0.2)	3.8 (0.5)	4.0 (0.3)
Organic matter			
% C	3.71 (1.10)	2.87 (0.80)	3.93 (0.88)
% S	0.04 (0.02)	0.02 (0.01)	0.02 (0.01)
% N	0.33 (0.10)	0.24 (0.05)	0.30 (0.05)
C/N	11 (2)	12 (1)	13 (2)
P (ppm; Bray I)	13 (6)	10 (4)	
Exchangeable bases (meq/100g)			
Ca	0.46 (0.25)	0.22 90.10)	
Mg	0.37 (0.12)	0.24 (0.08)	
K	0.17 (0.04)	0.14 (0.05)	
Exchangeable acidity (meq/100g)			
Al3+	3.63 (2.05)	3.22 (1.31)	
H+	0.65 (0.16)	0.71 (0.09)	
Al-saturation (%)	66.28 (19.12)	71.56 (8.00)	
Aqua regia (mg/100g)			
K	97.06 (51.36)	83.41 (21.83)	42.58 (28.22)
Mg	24.73 (28.65)	13.76 (13.34)	15.01 (4.07)
Ca	3.09 (1.48)	2.16 (3.09)	3.12 (1.12)
Na	23.27 (8.07)	14.03 (2.82)	
P	31.30 (15.78)	21.65 (4.11)	18.89 (5.17)
Al	647.69 (360.27)	429.71 (182.21)	710.90 (183.04)
Watersoluble nutrients (mg/100g)			
K	2.00 (1.06)	2.11 (1.05)	1.26 (0.45)
Mg	0.37 (0.74)	0.06 (0.04)	0.15 (0.11)
Ca	0.35 (0.36)	0.04 (0.11)	0.02 (0.01)
Na	1.40 (0.38)	0.93 (0.20)	0.36 (0.09)
P **(DL)** (mg/100g)	0.90 (0.16)	0.67 (0.15)	1.07 (0.29)
$CaCl_2$ (mg/100g)			
K	5.16 (1.00)	6.61 (4.22)	6.08 (0.90)
Mg	4.12 (2.75)	2.87 (4.72)	4.40 (1.97)

5.3.3 Soil Physical Properties

Texture

The texture of the soils in the study area ranges from sandy loam to loamy clay. Although the differences in textural composition between soil types are significant, they are usually not high enough to result in distinct textural types. The clay content of the majority of soils ranges from 50 to 70 %. Some soil types, however, have only a clay content of 25 to 50 % (table 38). High clay content indicates high water retentivity (Arya *et al*. 1992: 11).

Table 38: Texture of soil types in the research area (%; standard deviation)

Soil Type	***Pemunyian***			***Dusun Birun***			***Lubuk Malakko***		
	sand	*silt*	*clay*	*sand*	*silt*	*clay*	*sand*	*silt*	*clay*
Oxic Dystropept				16.25 (6.54)	48.75 (12.06)	35.00 (6.19)	20.33 (2.89)	48.00 (2.65)	31.67 (5.03)
Typic Dystropept	60.00 (12.73)	9.50 (0.71)	30.50 (13.44)	19.35 (10.68)	29.71 (12.08)	50.94 (17.27)	14.81 (11.07)	28.44 (12.96)	56.74 (18.90)
Paleudult	28.44 (10.14)	22.78 (9.60)	48.78 (11.08)	53.00 (1.00)	40.00 (6.66)	36.67 (8.33)			
Hapludox	13.35 (6.20)	19.90 (7.20)	66.75 (10.20)	12.33 (1.03)	32.50 (5.86)	55.17 (5.15)	15.42 (10.01)	31.50 (11.75)	51.42 (7.63)
Kandiudox	35.00	23.00	42.00	11.33 (1.86)	40.33 (8.38)	48.33 (6.65)			

Not only between soil types, but also between villages, differences could be observed (see table 38). Especially in Dusun Birun, average the sand content is lower, with mainly textures of clayey loam to loamy clay present. In Pemunyian, differences between soils are less prominent; texture ranged mainly from sandy to clayey loam. Lubuk Malakko has the broadest range of textural classes, extending from some sandy, but predominantly clayey loams up to sandy clays.

Structure

Regardless of soil type differences, the usual soil structure present in the study is crumbs in the topsoil and subpolyeders in the subsoil. Polyedric structures are rarely discovered in the lower subsoil. The presence of a crumb structure in the topsoil reflects an active soil biota and an abundant organic matter content. Due to this, the density is also lowest in the topsoil, whereas the subsoil normally has medium densities. This is due to a not too heavy soil texture, a lack of compaction by agricultural practices, and deeply rooting trees and shrubs. Besides, Ultisols, Alfisols and Inceptisols are said to possess an excellent structure, in terms of aggregate stability, porosity and infiltration rates (Sanchez 1976: 98).

The stability of the aggregates as tested in the field usually ranges between low and medium. Usually, the topsoils are somewhat less stable than the subsoils. Again, no direct link between this feature and soil type could be observed. Studies on structural stability indicate, that aggregate stability is not correlated with clay or silt content, but with organic matter content, which increases the cohesion of aggregates (Lal & Greenland 1979: 13). Probably due to this factor, the soils of Dusun Birun have particularly fragile A-horizons, which are very susceptible to erosion. This feature can be observed well, even when under the closed canopy of old, mixed rubber gardens erosion could be observed. In these cases, regular tapping of rubber by farmers seriously disturbed the soils on the tapping trails, especially on slopes. Most of the soil physical properties, however, are inherent qualities of the soils. It is mainly the structure of the surface horizon being influenced by cropping and fallowing under shifting cultivation (Nye and Greenland 1960: 85).

Rooting

Irrespective of factors like fallow age, rooting is generally dense in the topsoils of all sites. Below the A-horizon, rooting decreases rapidly. Sometimes, the layer below the topsoil is still moderately rooted. More often, however, only weak rooting is present. Physical barriers to root development, i.e. lithic or paralithic contact, are less common in the tropics than in temperate regions, because of the generally deeper subsoil in highly weathered areas. More frequently, aluminium toxicity limits root growth in these areas (Sanchez 1976: 96 p.). Although weak to very weak, rooting nevertheless could be observed up to the bottom of the analysed profile depth of one meter. This means, that notwithstanding high aluminium saturations, rooting is not restricted. Therefore the vegetation in the study area is capable to exploit soil water and nutrients well into the subsoil, up to the depth of one meter and probably beyond. Nevertheless, crops sensitive to aluminium toxicity as corn, soybean, mungbean, peanut, and rice to varying degrees, show inhibited root growth in a research site near the study area. This restricts their ability to extract soil water (Arya *et al*. 1992: 7).

Water

Calculated based on texture and density, the total pore volume of the soils in the study area is medium to high; ranging from 40 to 56 vol. %. The sandy clays and clayey loams of Lubuk Malakko have a relatively lower pore volume than soils of the other two locations. Depending on the same factors as total pore volume, air capacity ranges from low to very high. It reached highest values in Pemunyian because of the overall higher sand content present there.

A study carried out close to the study area in Sitiung found, that the soils present retain large volumes of water, but they also transmit water rapidly. The latter feature is necessary for the rapid and safe disposal of the region's torrential and voluminous rainfall (Arya *et al*. 1992: 7 p.). The total field capacity of the study sites usually ranges from medium to high for the effective rooting space. Because of the finer texture, values are particularly high for Dusun Birun, where the field capacity is high for all soils. The overall high values are mainly due to the lack of rooting limitations, so a profile depth of one meter (or even more) can be utilized by the vegetation. Because of this, also the available-water capacity (AWC) is generally high for the effective rooting space of all soils. Especially in the sandy clays of Lubuk Malakko, however, sometimes only medium values are achieved. On the other hand, some clayey loams have even very high AWCs. The AWC of soil profiles in the field may be estimated by measuring the thickness of each horizon, assessing its texture, and summing the products of the thickness of each horizon and the mean values of AWC for the relevant textural classes (Salter and Williams 1967: 174). To control for the influence of structure, the factor density is also included in the calculation (Institut für Ökologie 1990: 27). The presence of high or low organic matter content, however, may still lead to an under- or over-estimation of the AWC (Salter and Williams 1967: 180). Therefore the assessments have to be considered to be only general approximations (Salter and Williams 1969: 130).

5.4 Factors Influencing Soil Properties

The main factors determining the features of the soils in the research area are bedrock material, geomorphology and utilization. As mentioned before, the first factor, parent material, is different at all three research sites. Furthermore within the first and the second research site itself, different types of bedrock material are present. The soils at these sites show different physical properties concerning e.g. soil colour, aggregation, stability of aggregation and texture.

5.4.1 Soil Variations According to Geomorphology

Within areas of the same parent material, soils vary depending on their geomorphological location. Soils along slopes, for example, generally have thinner topsoils and a lower content of organic matter within the topsoil, than soils at footslopes or in level areas. Although the land is covered with rubber gardens or secondary vegetation, on steep slopes erosion is severe.

Table 39: Correlations of soil chemical properties with geomorphological position:

village	***significant***	***highly significant***
Dusun Birun	▪ USDA soil type ▪ pH ($CaCl_2$)	
Lubuk Malakko	▪ Reserve nutrients (Mg, Ca, Na)	▪ CEC ▪ pH (H2O, KCl, CaCl) ▪ Organic matter (% C, N, S) ▪ Exchangeable Bases (Ca, Mg) ▪ Exchangeable Acidity (Al, H) ▪ Reserve nutrients (K, P, Al) ▪ Plant-available Mg
Pemunyian	▪ C/N	▪ % C

The intensity of the correlation between soil chemical properties and geomorphology differs between villages (table 39). Particularly in Lubuk Malakko, correlations are strong, because the landscape around this village is not dominated by rolling hills as in the other two locations, but consists of a plain with some low, emerging hills. Unlike in Dusun Birun and Pemunyian, the plain and the hills also consist of a different bedrock material, respectively porphyric basalt and very fine-grained schistose rocks. Therefore correlations become even more profound, when grouping the different geomorphological positions into two groups, (1) plain and (2) lower slope, middle slope, upper slope and hilltop. Existing correlations also increase through groupings in the other two villages, but in these cases, plain and lower slope (plus eventually middle slope) can be considered one group. Grouping of geomorphological positions, nevertheless, do not lead to new correlations.

5.4.2 Soil Variations According to Vegetation Vitality and Age

Shifting cultivation inevitably causes a disruption of the nutrient cycle of the ecosystem. The nutrients stored in the biomass are set free by the burn. Especially available P and both exchangeable and extractable Ca, Mg and K in the topsoil largely increase directly afterwards. This is accompanied by a corresponding increase in pH (Andriesse 1983: 80). These influences decrease with increasing soil depth. Due to the lack of soil cover on the one hand, and vegetation to absorb the nutrients set free through burning and rotting on the other hand, much of the minerals will be lost in surface runoff and drainage water. Soluble nutrients are susceptible to leaching, whereas the solid particles of the ash will decrease due to mechanical wash down. The recovery of a certain site, which had been disturbed by shifting cultivation, during the course of succession is not limited to the vegetation. Microclimate, soil and fauna undergo a parallel development until an equilibrium is attained again (Richards 1952: 401). As the soil nutrient recovery process starts only after 10 years, the soil fertility at a given site is generally lower under a short shifting cultivation cycle than under long ones. Under a 5-year cycle, the agroecosystem starts with a net deficient of 300 kg/ha of nitrogen after every shifting cycle (Ramakrishnan 1992: 370 p.). Nevertheless, the major part of the nutrients is stored in the secondary vegetation within the first five years of regrowth. Because leaves and twigs, which are richer in nutrients than other components of the vegetation, rapidly increase to their maximum amounts in the fallow, the subsequent increase in storage is relatively slow (Nye and Greenland 1960: 36).

This section will now analyse, to what extent these developments can also be found in the secondary vegetation and rubber gardens of the study area. When observing the development of soils during the fallow cycle not over time within one location, but through comparing several sites of different ages, however, other factors might blur the trends present. Different sites might have also had different soil nutrient content when shifting cultivation started, resulting in developments at different levels during the fallow cycle. Notwithstanding variations of the nutrient content between the respective sites, the developments usually occurring during the fallow cycle can also be observed within the study area. While the development trends of the respective nutrient become obvious when plotting their changing content over time, differences between sites are not always significant when analysed with t-test statistics.

Compared to the former secondary forest, vegetation cover is still scarce during the cultivation cycle, resulting in nutrient leaching and subsequent acidification. Already after the crop harvest nutrient conditions have changed in the soil: depending on soil permeability, effective cation exchange capacity (ECEC) has declined. The more permeable the soil, the higher the rainfall rates and the slower the regeneration of the natural vegetation, the bigger is the loss of easily leachable elements (Andriesse 1983: 83, 129-130). It still takes time during the fallow period, before the regrowth is large enough to immobilize these nutrients (de Rouw 1991: 25).

Figure 16: Topsoil CEC values and fallow age

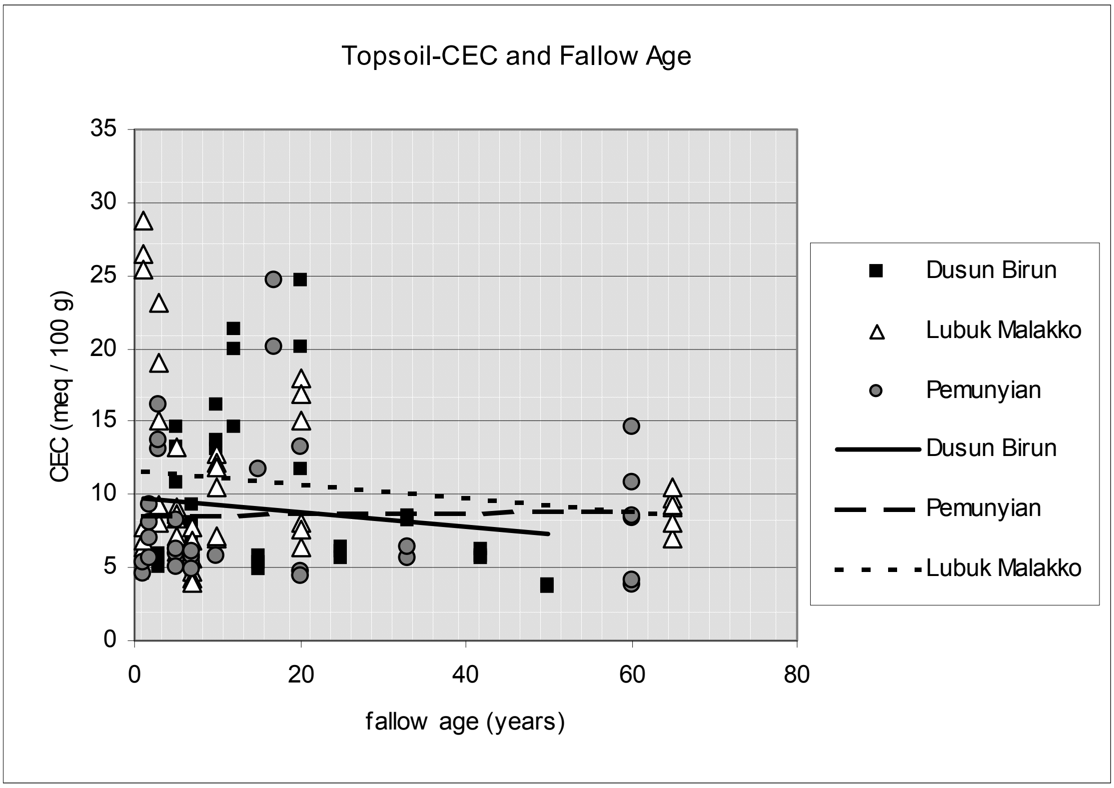
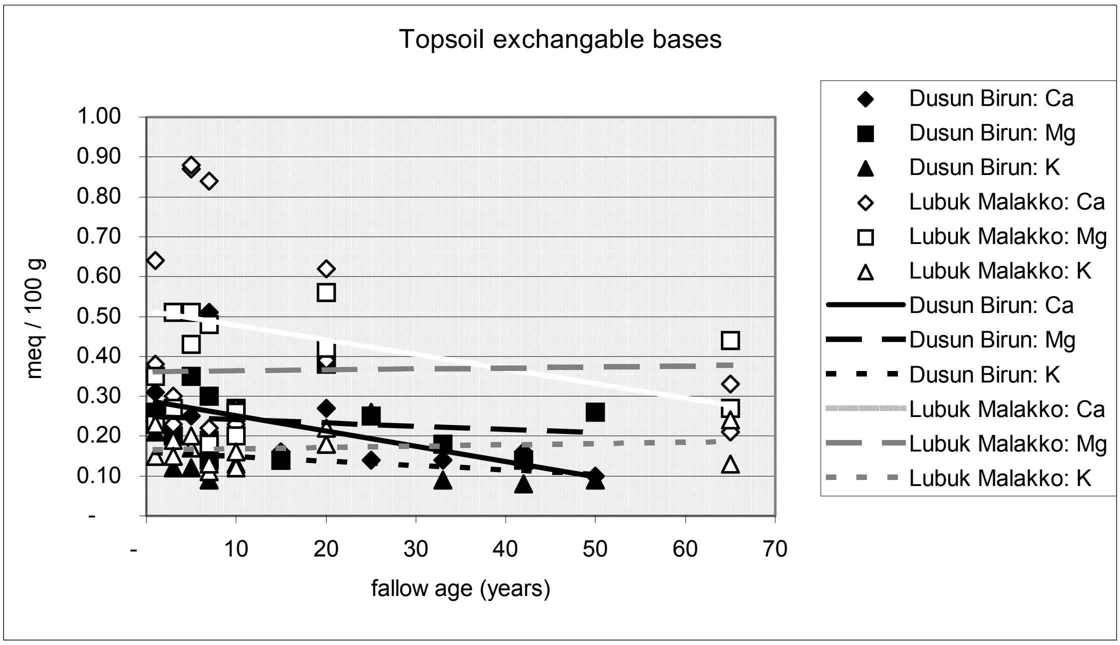


Figure 17: Topsoil exchangeable bases and fallow age



As it is expected, the CEC and content of exchangeable bases in the topsoil is generally higher within young fallow sites than in older sites (see Figure 12, 13). This is due to the fact, that burning releases the nutrients stored in the biomass, which causes an increase in CEC and pH. On the other hand, part of the CEC gets lost due to a decrease in organic matter (Nye and Greenland 1960: 64). Due to leaching processes, the nutrients are then washed down within the profile and later pumped up again by the developing secondary regrowth. Potassium, although mobile, is not lost, because it gets absorbed on the surface of clay minerals. Andriesse (1983: 85) found in his study in Sri Lanka and Sarawak, that due to leaching the CEC after the first harvest again was as high as before. Also exchangeable Ca and K four years after the beginning of the shifting cycle were still above the baseline. As it can be seen in Figure 13, also in the study area exchangeable Ca still decreases steadily with increasing fallow age. Because the contents of Mg and K are much lower than Ca, their decrease is less drastic and can also not be observed in all sites in the same manner. When fallow vegetation is allowed to regenerate, these nutrients are not lost, but stored in the biomass (Ramakrishnan 1992: 186). Also for the CEC a steady decrease from young to old secondary forest is obvious in two of three villages (Figure 12). In Pemunyian, however, the trend is somewhat blurred due to the high CEC of some old rubber gardens. This seems to be mainly related to high organic matter content, though.

Figure 18: Topsoil carbon content and fallow age

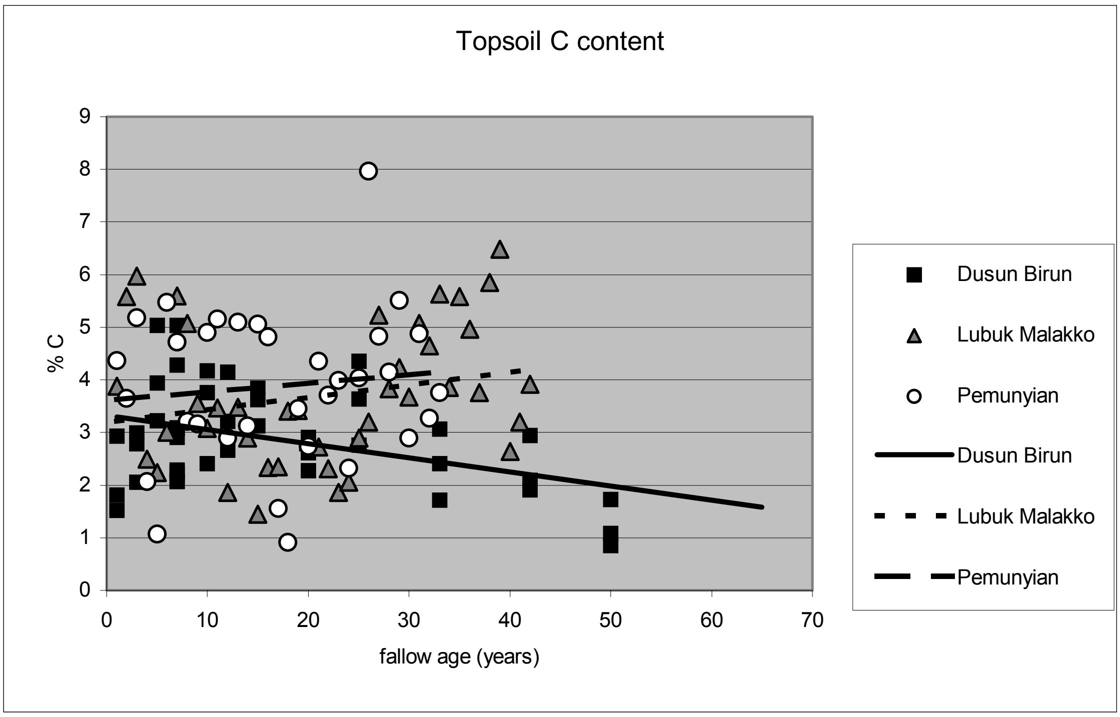
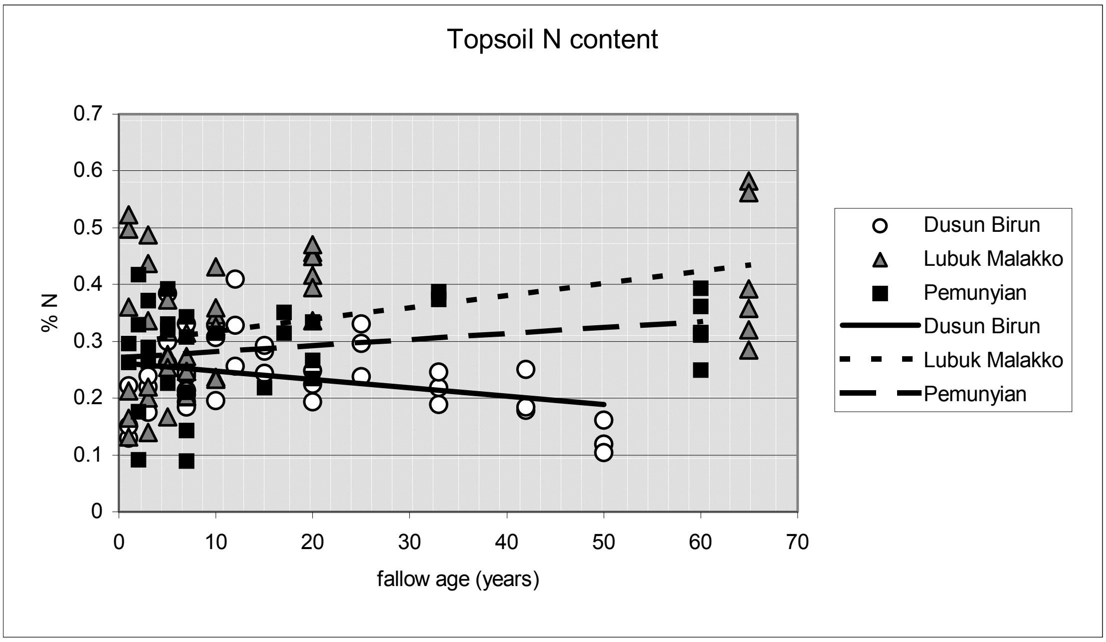
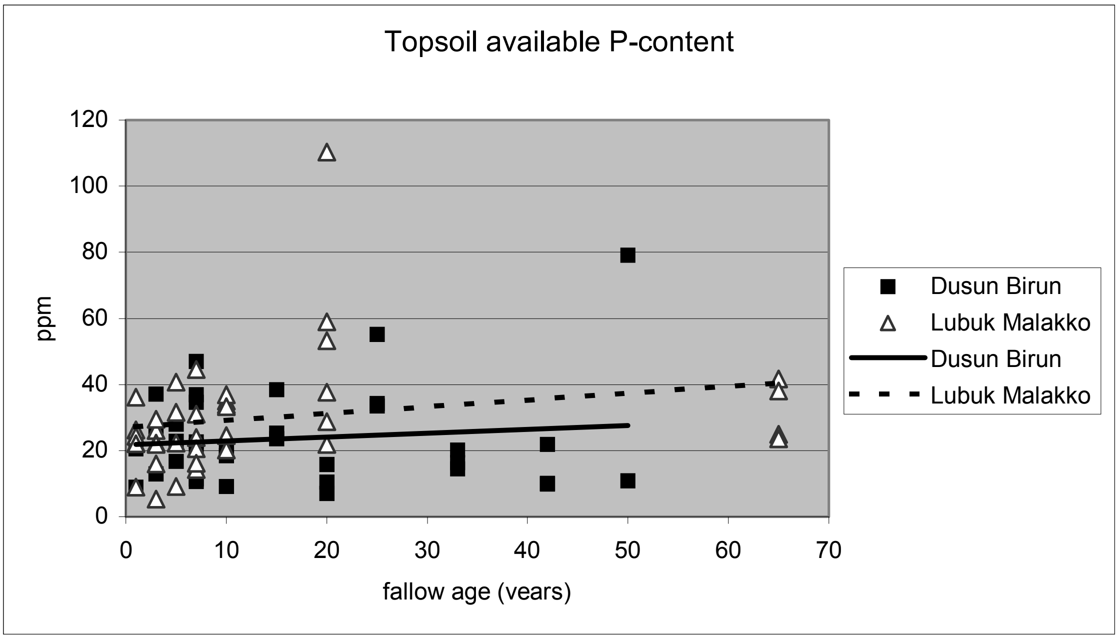


Figure 19: Topsoil nitrogen content and fallow age



Organic carbon is supposed to increase after the burning of the secondary vegetation. The nitrogen content, on the other hand, will decrease, if the fire was hot enough, because nitrogen is a volatile element. An incomplete burn of the biomass might lead to an increase in N, however. During the fallow cycle therefore topsoil content of organic C usually decreases, whereas N-content will increase. Due to the inherent differences mentioned above, however, these developments could not be observed in all villages studied. Only in Lubuk Malakko both elements follow the expected trends (Figure 14, 15). In Pemunyian, N increases, whereas C remains more or less stable; and in Dusun Birun N remained more or less stable and C decreases.

Figure 20: Topsoil available phosphorus (Bray 1) and fallow age



Being likewise released from the ash, available phosphorus generally increases after the burn, too. It might be also volatile, however, if the burn is too hot. In the following years, available P decreases again, but rather due to transition from active forms to relative inactive, occluded forms (fixation at Al and Fe) than due to leaching like the exchangeable cations. Andriesse (1983: 84) observed that, even four years after the beginning of the shifting cycle, P_{av} was two times as high as before (but still being at very low levels). In the study area, however, this expected trend is only present in Lubuk Malakko, whereas in Dusun Birun older secondary vegetation even has a lower P_{av} content than the young ones (Figure 16). These data show again the difficulty of correlating soil nutrient content with fallow age when observing different locations.

Notwithstanding the short-term decline of soil fertility following forest removal, successional vegetation is renowned to be very good at regenerating it again, so that there is little evidence of irreversible nutrient depletion of tropical soils. Single cropping periods typical for shifting cultivation therefore are not likely to have much effect on the availability of nutrients in the topsoil. The regeneration of sites is achieved through the rapidly growing fallow vegetation pumping up nutrients that have leached into lower soil horizons. Most nutrients then accumulated during the fallow period will be stored in the standing vegetation rather than in the soil (Nye and Greenland 1960: 62, 116; Whitten 1987: 472, Harcombe 1980: 10, Uhl 1987: 377). Shortened fallows therefore will not only lead to a decreased soil fertility, but moreover to a decreased nutrient content of the whole ecosystem.

5.5 Summary

The local upland farming system consists of upland fields as well as various regrowth stages of fallow vegetation, both unmanaged and mixed with rubber. Four major regrowth stages can be identified, each of it having a typical botanical composition and structure. The results of this study show that many species, genera, or even plant families have a clear preference for certain succession stages. The secondary vegetation development process is mainly characterized by species groups typical for older fallow replacing the pioneer species, trees taking over from grasses, herbs and shrubs, as well as a rising species diversity.

Several external factors further influence or alter the course of this natural process. Very important is the management history of each site, which determines the composition of the soil seed bank at the onset of cultivation. Nevertheless, it may be difficult to assess the particular impact of utilization frequency and fallow length at the respective site, especially when the site history is not known. One inventoried site having a very high species diversity, however, had been cultivated only once after primary forest had been cut down.

Soil properties and parent material also influence to a certain extent vegetation composition and species diversity. This becomes obvious from the different species diversity of the three study sites as well as its correlation with available phosphorus and soil organic matter. Management practices may seriously influence the botanical composition of a site, depending mainly on cleaning frequency, duration and intensity.

As indicated by the large amount of species finding their place within the agricultural landscape of fallow and rubber gardens, this land use system seems to work well in being productive and protective at the same time. Old growth rubber gardens are important for the preservation of non-pioneering, primary forest species, because they usually last for 40 years or more, whereas secondary vegetation seldom exceeds 20-25 years (Gouyon *et al.* 1993). Rambo (1984c: 248 p.) states in his research on traditional Malaysian shifting cultivators that, while any swidden plot is impoverished in species diversity, the complex mosaic environment as a whole supports a far greater species diversity than would a comparable area of undisturbed primary forest.

The soils in the study area generally exhibit a low chemical fertility and good physical properties. Depending on the parent material, susceptibility to erosion may pose a problem on steeper slopes. The main soil types present are Hapludox, Kandiudox, Typic and Oxic Dystropepts as well as Paleudults. The study sites usually contain soils of higher and of lower fertility, the latter being generally in the majority. The major factors influencing soil properties are parent material, geomorphology and the fallowing process. Nevertheless, the relationship between soil properties, especially soil fertility, and the regeneration of vegetation needs to be investigated within fallowed plots over several years, for being able to exclude regrowth variances due to factors such as the soil seed bank and external influences.

The analysis of the upland farming system in this chapter makes it possible to understand its botanical composition, soil fertility, development over time and influencing factors, both human and natural. For any planning endeavour involving local people as well as their land use system and practices, this knowledge is very helpful, as it enables outsiders to communicate with the farmers. Together with an understanding of local environmental knowledge, the results of the botanical and soil scientific analysis of the land use system may be used to put planning targets into perspective and facilitate a cooperative implementation.

6. Local Environmental Knowledge

To enable a deeper understanding of the small farmers' background of managing and viewing their natural resources, this chapter will attempt to explain their notion of ecological features, their traditional uses of plants, as well as the local classification of sites concerning their suitability for agricultural endeavours. Next, I try to expose how farmers view the influence of their agricultural activities or their natural environment and how they judge this influence. Finally, a comparison will be drawn between the local and scientific classification of the environment, especially plants and soil.

Traditional ecological knowledge can be defined "as a body of knowledge built up by a group of people through generations of living in close contact with nature. It includes a system of classification, a set of empirical observations about the local environment, and a set of self-management that govern resource-use" (Johnson 1992: 4). Although termed 'traditional knowledge', 'traditional' does not imply 'static'. The basic features of traditional knowledge are its firm roots in the past, with a specific origin in indigenous culture and the local environment. "Tradition is often unwritten, based not only on what each generation learns from the elders, but also what that generation is able to add to the elders' knowledge." (Baines 1992: 100). Each generation has to verify aspects of the previous generation's knowledge through its own experiences. If traditional knowledge systems did not have the ability to adapt, borrow and innovate, they could not serve a society's survival in ever-changing living conditions. Farmers "will adapt to use whatever method serves them best, be it traditional or modern, old or new; there is no nostalgic attachment to archaic practices" (Barker and Cross 1992: 128). The spontaneous diffusion and adoption of rubber cultivation by Indonesian farmers in the early 1920s is one example for their innovativeness concerning agricultural technologies (Dove 1994: 382).

Some of these local ecological knowledge systems have been described by Western scientists, starting with the famous work of Conklin (1954a) on Hanunóo agriculture, which was followed by an increasing number of case studies, monographs and articles, the latter mainly being published in journals like Human Ecology, Economic Botany, Agriculture and Human Values, the Journal for Ethnobotany, the American Anthropologist, the American Ethnologist, the ILEIA Newsletter (LEISA) and the Indigenous Knowledge and Development Monitor. Compared to other traditional ecological classification systems, ethnobotanies still are the most commonly documented folk taxonomies.

Although local ecological knowledge is not limited to utilitarian purposes, small farmers generally put it in use systematically. Traditional Ecological Knowledge and Management Systems (TEKMS; see box 8) are based on the ecosystem view of local communities.

Box 8: Aspects of Traditional Ecological Knowledge and Management Systems (TEKMS)

- indigenous taxonomies (soil, plants, animals, rocks, etc.)
- indigenous knowledge for potential use of local plants
- indigenous knowledge of animal behaviour and acquired hunting skills
- local knowledge of important tree species for agroforestry, firewood, fodder management, integrated pest management as well as for the control of soil erosion and soil fertility
- indigenous agronomic practices such as terracing, contour bunding, fallowing, organic fertilizer application, crop-rotation and multi-cropping
- indigenous soil and water conservation practices

Modified after: Atteh 1989, in: Lalonde 1993: 56

Of course, ecological or plant knowledge is not evenly spread within the population. The feature that ethnobotanical knowledge varies with gender, age, personal experience, intelligence as well as with social status and role of a person has been recognized by many scientists in all parts of the world since it was initially noted by Sapir (1938: 9). Minangkabau men, for instance, are more likely to know trees and other plants growing in primary forest and secondary vegetation than are women, mainly related to their frequency of activities in forested land, especially for collection of non-timber forest products. However, not all men have forest-related activities, and those who don’t generally also don’t know much about forest plants. Those people specialising in herbal medicine, local medicine men and women (*dukun*), are those who will recognize these plants best. This means, that there is a general folk botanical knowledge system, but not all people share all of it at all times. People learn with age, and elders, who have been gathering and hunting in the forests all their life, will have accumulated more knowledge during the years than someone who has done the same for only half of that time. Farmers who are knowledgeable concerning their environment, however, were found to be more successful in their agricultural endeavours than others who aren’t (Iskandar 1994: 31). To describe the local ecological knowledge of the inhabitants of the eastern lowland buffer zone area surrounding the KSNP and its application in their daily life is the purpose of this chapter.

The local people employ several different types of environmental classification systems. There are two systems for the classification of plants and one system of land use classification. The first system, which is explained in section 6.1, classifies plants in accordance with their uses, be it for curative purposes, construction and food, handicraft or income generation. Subsequently, the Minangkabau folk system of botanical classification is described in section 6.2. Concerning agriculture, environmental knowledge is used to classify the suitability of a piece of land for a certain crop or, more comprehensively, for a certain land use system. Therefore several criteria are used by the local people, including the application of indicator species for assessing the soil fertility status, which will be described in detail within section 6.3. Next, the perception of the local people about the impact of their agricultural activities on soil and vegetation is illustrated in section 6.4.

To link up with the previous chapter (5), in section 6.5 the local and the scientific classification and view of the environment will be compared. Thereafter the results of this chapter will be summarized in section 6.6.

6.1 Local Botanical Classification System

Biological diversity, as scientists understand it today, is based on the Linnaean classification system of flora and fauna, created in Europe at the end of the eighteenth century. Originating from the Western world, it is now accepted as valid by university educated biologists all over the world[1].

Not surprisingly, rural societies not touched by this scientific concept, created their own pattern to classify animals and plants living and growing around them. The potential for utilisation of animals and plants for various needs like subsistence, trade, social and religious purposes are one, but not the only reason for local people to categorize the living world. It is indeed an intrinsic feature of the human spirit to organize and systematize one's natural environment, triggered by the natural curiosity and the pleasure to experiment inherent in every individual. Or as Lévi-Strauss puts it, human beings classify their environment out of an "intellectual need" and because of their elemental "demand for order" (Lévi-Strauss 1966: 10). Also Frake (1962: 81) claims, that the taxonomic organization of concepts "is a fundamental principle of human thinking". Berlin (1992: 8 p.) however, emphasizes, that this order is not created by humans, but an inherent quality of nature, only being discerned by human beings: "Groups of plants and animals present themselves to the human observer as a series of discontinuities whose structure and contents are seen by all human beings in essentially the same way", nevertheless, "biological diversity can be organized in several different ways".

Whereas scientific botanical classification generally strives for a full inventory of all plants in a certain area, traditional classifications do not aim at completeness. Local taxonomies generally

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1 The Linnean taxonomy, however, was also nothing else but a codification of the folk taxonomy of a particular area of Europe. The history and development of the Linnean taxonomic system has been described in Raven et al. (1971).

include the most salient species in their local habitat only, i.e. those species being biologically most distinct (Berlin 1992: 21). Also rare species and those difficult to observe because of their size are those, most likely not to be distinguished by the local ethnobiological categorization.

6.1.1 The Structure of the Local Taxonomy

In a way comparable to that of scientific taxonomy, recognized plant taxa are grouped into ever more inclusive groups to form a hierarchic (taxonomic) structure comprised of six mutually exclusive taxonomic ranks. The six ranks, in descending order of taxonomic inclusiveness, are the kingdom, life form, intermediate, generic, specific[2] and varietal. Taxa of each rank exhibit systematic similarities in their relative numbers and biological content across all folk systems of ethnobiological classification (Berlin 1973: 260).

The local folk botanical classification of the research area exhibits a clear structure similar to those of the scientific botanical system. At first, plants (***tumbuh-tumbuhan***, lit.: things which are growing) are divided from non-plants like animals (***binatang***). This highest, most inclusive rank of folk biological classification is termed 'kingdom' by Berlin (1992: 22).

Members of the plant kingdom then become subdivided in accordance with their life form. Based on the recognition of the strong correlation of gross morphological structure and ecological adaptation, the life-form rank consists of a small number of highly distinctive morphotypes. Life-form taxa include most of the taxa of lesser rank and are at large polytypic, i.e. consist of several members (ibid.: 24). The local population within the research area recognizes the following life form taxa:

◊ Plants having woody stems, i.e. trees and shrubs (***pohon***).

◊ Plants with twining behaviour, i.e. vines and lianas (***akar***).

◊ Herbaceous plants, i.e. herbs and grasses (***rumput***).

◊ Ferns (***pakis***).

This division of the plant kingdom into folk botanical taxa of life form rank is quite similar in other traditional societies (cf. e.g. Conklin 1954 about the Hanunóo and Headland 1981 on the Agta in the Philippines, Morris 1976 on the Hill Pandaram in South India). Some ethnic groups, however, don't recognize ferns as a life form category, others further distinguish herbaceous plants into distinct life forms. Trees, vines and herbaceous (non-woody, non-twining) plants, nevertheless, are distinguished in all known systems.

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[2] The folk equivalent to botanical genera are therefore folk generic taxa, the folk equivalent to botanical species are folk specific taxa.

Life form taxa harbour the majority of all taxa and are subdivided into folk botanical generic taxa. Taxa of generic rank are the most numerous within folk biological taxonomies, reaching a maximum of about five to six hundred taxa in systems of typical horticulturalists. Approximately 80% of the folk generic taxa are monotypic, which means that they do not include taxa of lesser rank. Although most folk generics are taxonomically embodied in taxa of life-form rank, some few generic taxa remain unaffiliated due to their morphological uniqueness, or, in some cases, economic significance. As children acquire the local system of biological system, it is the generic taxa that are acquired first (Berlin 1992: 23).

During my inventory of secondary vegetation and traditional rubber gardens the amount of folk generic taxa that were collected in the respective villages varied between 155 and 376 generics. Local people figured the percentage of the biodiversity, sampled in the particular village lands between three-fourths to ninety percent. However, strikingly the biodiversity in the three research locations was very different, although the three villages are located only between thirty-five to seventy-five kilometres as the crow flies apart and situated under comparable ecological conditions. The different biodiversity of the secondary vegetation and rubber gardens is also reflected in the number of folk generic taxa, as can be seen from table 40. Berlin (1992: 99) states, that there is a direct correlation between the biodiversity of a region, and the number of folk generic taxa being recorded. The average reported numbers of plant generic taxa from ten traditional cultivating societies in the tropics is 520 generics, ranging from 238 taxa among the Quechua in Peru to 956 taxa for the Hanunóo in the Philippines (ibid: 98). If adding another ten to twenty-five percent to the numbers of generic taxa collected respectively, the amount of folk generics in the research area also would be in the scope of these other tropical farming societies. These numbers, however, do not yet include most of the cultivated species, especially annual crops, and also many of the primary forest species, which do not or only rarely occur within secondary vegetation.

6.1.2 The Naming of Plants

While the name of the taxon of the first rank, the plant kingdom, usually is not mentioned in connection with a certain taxon, the designation of the taxon of the second rank often is part of a particular plant's name. The name of the life form taxon is often put in front of the folk botanical name. Ferns are always, with the exception of the one most frequent and notorious weed, designated as '***pakis*** xyz' (lit.: 'fern so-and-so'). The same is true for lianas, but this life form taxon knows more exceptions. Many herbs' names also include the term for the herbaceous life form taxon ***rumput*** as the first word of the plant name. Also tree names may consist of the local word for tree plus the generic name, but more frequently, trees are either referred to with their generic (plus eventually their specific) name only. Many trees are also referred to in accordance with their used part, i.e. '***kayu*** xyz' (lit.: timber so-and-so), ***buah*** xyz (lit.: fruit so-and-so), or even '***kulit***' xyz, if the bark is an important used part. Shrubs and trees also may include the word '***batang***' (lit.: stem, stalk) as the first word of their name, while shrubs having conspicuous flowers often are named '***bunga*** xyz' (lit.: flower so-and-so).

In distinction to folk generic taxa, which mostly have single names, folk specific taxa have composed ones. Not all taxa having a two- or three-word name, however, are folk specific taxa. An example is ***pohon medang***. The reference ***pohon*** indicates that this plant is a tree and ***medang*** is the name of the folk generic taxon for a group of highly valued timber trees used for the construction of houses and the like. The generic ***medang*** includes a set of folk specific taxa, which are referred to as ***medang kuning*** (lit.: the yellow ***medang***), ***medang talo***, ***medang laso***, ***medang pilabak***, etc. Inexperienced respondents always will refer to this folk generic as '***medang***', whereas only experienced people will be able to tell, which kind of ***medang*** this tree belongs to. The tree ***asam galugu***, whose fruits are used for cooking, however, may not be referred to as '***asam***' only. The term '***asam***' in this case is not a name of a folk botanical generic class, but the name of a totally different plant, namely a notorious fern infesting eroded and degraded soils. Therefore one has to pay attention if a compound generic name does indicate a folk specific, member of a generic class, or if a monotypic folk generic merely has a compound name.

Specific plants names frequently refer to perceived (contrasting) properties of these members of a folk generic. Often these taxa are distinguished using the names indicating the perceived attributes like 'sex' ('male' or 'female'), habitat (riverrine, 'hill' and 'lowland' species), age ('youth form' and 'adult'), colour, size, shape and the like. Among farmers in the Kerinci valley, Aumeeruddy (1994: 19) found criteria like fruit size, leaf pilosity and length of the internodes to be decisive for classifying plants into 'male' and 'female', whereas according to Watson (1928: 21) these attributes used in Malay ethnobotany suggest smaller and larger forms respectively. He further found attributes like ***pasir*** (sand), ***tulang*** (bone), ***besi*** (iron) and ***tandok*** (horn) as referring to wood consistency and animal names like ***gadjah*** (elephant) and ***tikus*** (mouse) as reflecting plant size (ibid.). The use of animal names could also reflect the interaction between certain plants and animals, such as '***jaring tupai***' (the *squirrel* stinkbean) and '***jambu monyet***' (the *monkey* custard apple), where these animals eat the fruits of the plants.

6.1.3 The Inner Organization of Local Generic Taxa

The majority of all Minangkabau folk generic taxa are monotypic and are not subdivided further. A certain part of the folk generic taxa, however, form classes of two or more members, called folk specifics, which sometimes can be partitioned further into folk varietals. As it can be seen from table 40, only for about one quarter of all generic taxa collected in the research area was more than one member recorded. Although no total inventory of all folk generic taxa in that area was made, the percentage of polytypy found during the ethnobotanical inventory is in accordance with the results of Berlin (1992: 118), who also reported an average of about twenty percent of polytypic generics in most folk systems. According to him the majority of polytypic generics are species of culturally important species, wherefrom he concludes that the recognition of subgeneric taxa partly seems to be motivated by cultural reasons, because the majority of them are domesticated plants and animals (Berlin 1992: 24, 119). This theory partly could be approved from the data collected in secondary vegetation and rubber gardens in the border area of the KSNP, however, still a big portion of subgeneric taxa are neither cultivated nor exhibit any frequent utilisation. Therefore there are also other reasons for specific differentiation, like distinctiveness and frequency of a certain folk generic (cf. Hunn 1982: 834).

Subgeneric taxa in general exhibit a high degree of similarity concerning their overall morphology and habit (size, stem habit, leaf features), but are distinguished due to a few typical properties. In general, most of the polytypic folk generics merely have two members (between 2/3 two-third to four-fifth), another ten to twenty-five percent have three constituents, whereas only about six to twenty percent have four members or more (table 41).

Table 40: Monotypy and polytypy of folk botanical generic taxa

Village	monotypic		polytypic		Total no. of generics
	no. of generics	%	no. of generics	%	
Pemunyian	129	83.2	26	16.8	155
Dusun Birun	162	80.2	40	19.8	202
Lubuk Malakko	245	65.2	131	34.8	376
mean	175	76.2	66	23.8	244

Table 41: Distribution of folk biological generic classes with two or more members

Village	number of botanical folk generic classes with						Total no. of polytypic generic classes
	two members	%	three members	%	≥ four members	%	
Pemunyian	9	81.8	1	9.1	1	9.1	11
Dusun Birun	11	68.8	4	25.0	1	6.2	16
Lubuk Malakko	27	64.3	6	14.3	9	21.4	42
mean	16	71.6	4	16.1	4	12.2	23

The psychological salience of folk generic taxa, which are members of one class, however, is not always the same. For taxa of generic and subgeneric rank some members of a taxon often are considered to be the best example of a certain taxon, representing a kind of prototype.

Prototypicality is generally caused by the biological distinctive ness of a taxon, its frequency of occurrence and its cultural importance (Berlin 1992: 22). This is generally indicated by the name of the folk specific taxa: While the prototype of one class often is referred to with the name of the folk generic taxon only, the non-prototypical members of the class are always named with their full folk specific name. For example, if somebody would refer to the common secondary vegetation shrub ***keduduk***, everybody would at once imagine of a pink-flowering bush growing in young fallow and buffalo grazing grounds surrounding the villages. For this common plant there is no need to refer to it as ***keduduk biasa***, the 'common ***keduduk***', except for distinguishing it from ***keduduk hutan***, the 'forest ***keduduk***', which is rare and grows in older secondary vegetation.

6.1.4 Unaffiliated Folk Generic Taxa

Not all folk botanical generic taxa, however, are a member of a life form taxon. Some taxa seem to be recognized as being of generic rank without being classified as one of the major life forms. These kinds of 'unaffiliated generics' are also found in other folk botanical systems and are generally characterized by their morphological aberrance from the most general defining criteria of the major life forms and/or their cultural significance (Berlin 1992: 172). Two examples of the Minangkabau ethnobotanical classification are the generics ***puah*** or ***puar*** and ***kunyit*** or ***kunik***. The first one grows in the wild, but is used, the second one is cultivated; botanically both generics are members of the family Zingiberaceae. The same is true for the folk generic taxon ***rotan*** (rattan), a twining palm whose stem is used for pleating, binding and furniture making. On asking if these plants would be trees or what they would be, the respondents would generally answer, that they would just be a '***batang***', literally meaning a stalk or a stem. Having a stalk or stem, however, is a property, which is also assigned to trees or lianas, not a life form rank. Also the folk generic ***pandan*** is not assigned to any life form rank. ***Pandan*** is partly cultivated and mainly growing wild within secondary growth, and is used for pleating mats. Its scientific botanical equivalent is the genus *Pandanus*. ***Pandan*** is no tree for failing to have the required woody stem, and through its conspicuous growth form it also does not qualify as a herb. If the respondents were asked what it then would be, they said it would be a kind of ***tandan***, which literally means something, which grows in clusters. The reference ***tandan***, however, also is a property, a description of a growing behaviour, not a life form rank, too.

6.2 Traditional Uses of Plants

The local population uses many plants growing wild within secondary vegetation, rubber gardens and primary forest. Although the respective frequency of use was not recorded, the results show that primary forest is an important source for the gathering of certain products, including timber for house construction. Also many wild plants within secondary vegetation and rubber gardens are used in daily life (table 42). While primary forest is a major source for a variety of fruits, latex and resin as well as for timber species, secondary growth harbours more wild plants used as vegetables, for handicraft and medicinal plants[3]. Colfer *et al*. (1994: 20) note a similar distribution of the occurrence of useful plants in accordance to the age of the secondary vegetation among the Uma' Jalan Dayak of East Kalimantan. These data indicate, that fields fallowed for the ecological function of restoring soil fertility, are not lying 'idle', as is often perceived by outsiders. Wild fruits and vegetables represent a significant part of the local nutrition, which is often low in cultivated vegetables due to soil fertility constraints.

Table 42: Useful species in the study area

USES		Pemunyian	Dusun Birun	Lubuk Malakko	Total
TIMBER	**construction & furniture**	28	29	46	**74**
	firewood	21	1	-	**22**
FOOD	**fruits**	28	32	26	**60**
	vegetables	10	19	10	**26**
MEDICINAL	**medicinal**	50	55	44	**122**
HANDICRAFT	**handicraft**	6	7	4	**14**
OTHERS		2	8	2	**12**
CASH-	**latex & resin**	5	6	5	**9**
GENERATION	**others**	-	3	5	**5**
TOTAL[4]		128	145	129	**291**

Several useful wild species growing in secondary forests and rubber gardens also are protected and favoured by farmers through measures like cutting other plants surrounding the used plant. In young rubber gardens often all secondary growth is cleared, except for wild used species. Besides representing a kind of 'managed succession', such protective manipulation also often is a first step towards domestication (Rambo 1984c: 250). Many highly priced fruit trees like durian, petai, jengkol, mango, rambutan and the like originate from secondary and primary forest. The process of domestication still proceeds through replanting of saplings and seeds from wild species into rubber

[3] See annex for a list of the species used for the respective purpose.

[4] Total numbers not equalling sum of single uses for many species having more than one use.
For comparison: Colfer *et al*. (1994: 24, 27) found 88 used plants within young secondary forest and 87 within old secondary forest among the Uma' Jalan Dayak in East Kalimantan.

gardens and homeyards. The practice of replanting useful species from primary forests is also practised by people of other areas like the Quichua in the Ecuadorian Amazon (Macdonald 1993: 13). Also plants used for handicrafts, medicine or as spices have been collected from secondary or primary forests and subsequently cultivated in fields and gardens to increase their availability (e.g. several members of the ginger family and pandanus species).

6.3 Local Land Suitability Classification for Upland Farming

If all factors are recorded, which local people take into account to judge the fertility and suitability of a certain piece of land for various types of agricultural endeavours, it can well be said that they form a kind of local land suitability classification. Local land classification systems in other areas have been known to take into account some or all of the following factors: topography, microclimate, vegetation soils and crop suitability (Talawar 1996: 5 p.). Resulting from this system, for the selection of an upland field several criteria have to be met, some of which are caused by practical considerations concerning the cultivation process, others are related to soil fertility. In the following the prerequirements of a potential upland field should meet will be revealed. Land use classification and decisions furthermore are also influenced by socio-economic and cultural factors such as tenure or inheritance patterns. Within this study, however, the main focus was on the ecological aspects of local land use.

6.3.1 Soils

The fertility of different sites or soils is clearly distinguished. This feature has also been recognized for other traditional societies in Indonesia (e.g. Chin 1985, Mackie 1986, Werner 1993, Gunawan and Abdoellah 1994: 8) and other areas like Nepal (Müller-Böker 1988), Zambia (Sikana 1993), Nigeria (Adewole Osunade 1988), Burkina Faso (Siderius and Mafalacusser 1998), Mexico (Bellon and Taylor 1993) and Peru (Sandor and Furbee 1996).

Soil Types

The most important criteria for the selection of an upland field is the soil and its fertility. The farmers of Pemunyian, Dusun Birun and Lubuk Malakko physically distinguish their soils on the basis of particular characteristics and classify them accordingly into soil types.

The soil classification of the local people of every village is quite similar. The main factors are: the colour of the topsoil, soil texture, structure and soil moisture. Similar criteria were also used to distinguish soils in other areas of Indonesia like Kalimantan (Mackie 1986: 439, Werner 1993: 85) and West Java (Iskandar 1994: 30), as well as other parts of the world (e.g. Sikana 1993: 15, Siderius and Mafalacusser 1998, Adewole Osunade 1988: 196p, Bellon and Taylor 1993: 767, Sandor and Furbee 1996: 1507). This physical distinctness between soils are known to the farmer to indicate differences in soil fertility, which can be measured for instance in the amount of upland rice harvest which can be expected on the respective soil type. Also the oil content of the coconut is said to depend on soil fertility. Besides, local people consider each soil only to be suitable for the cultivation of certain annual or perennial crops, whereas other crops do not yield well on them (table 44). This perception was also was found by Conklin (1954b: 140) among the Philippine Hanunóo, by Dialla (1993: 17) among the Burkina Faso' Mossi, Adewole Osunade (1988: 200) for the Nigerian' Yoruba and by Habarurema and Steiner (1997: 81) among Rwandan farmers. Limited availability of certain soils, however, may oblige farmers to make a second best choice. Following the concept of crop suitability, the farmers of Jambi and West Sumatra generally grouped soils into three categories. In Pemunyian, however, several farmers grouped category two and three as being only one soil type.

Category number one is *tanah hitam*, or black soil. It is the most fertile and the most desired soil. Its topsoil is said to be darker and softer than those of the other soil types, and the rice harvest is best on this soil type. Because *tanah hitam* is the most fertile soil, it can be planted with all kinds of crops, like vegetables, spices, fruit trees and other commercial tree crops. Also the East Kalimantan Kenyah Dayak, the Guatemalan Kekchi and farmers of both Chiapas, southern Mexico, as well as Nepal, termed the soil they considered as most fertile "black soil" (Mackie 1986: 439, Marten and Vatyakon 1986: 204, Bellon and Taylor 1993: 771, Müller-Böker 1988: 111).

The second soil category is named *tanah kuning*, or *tanah kijang*, or *tanah kasang*. This can be respectively translated as yellow soil, deer soil and dry soil. According to the farmers, it is significantly less fertile than *tanah hitam* and is only cultivated if no black soil is available. According to Colfer *et al.* (1989: 211), *tanah kasang* is typically found in rolling hill geomorphology. The topsoil *of tanah kuning* is thinner and harder than those of *tanah hitam*, and the rice harvest on this soil type is much lower compared to those on black soil. None of the respondents would plant any vegetables or spices on *tanah kuning*, but merely some fruit trees like durian, rambutan, petai and jengkol, as well as sugarcane and rubber. Rubber is sometimes even said to bring better harvests on yellow than on black soil, because the latex production would be lower if the soil is too fertile. The ranking of soils in accordance with their suitability for certain crops was also found among the African Sumuka and the Peruvian Shipibo (Weinstock 1984b: 148, Behrens 1989: 90 pp.).

The third soil category is called *tanah merah* (*-kuning*), or *tanah liat*, or *liat merah* (*-kuning*), which literally means red soil, or clay soil, or red (-yellow) clay. *Tanah merah* is generally avoided for agriculture, if possible, because it is considered to be infertile. This soil type is recognised by the farmers by its sticky texture and its red or yellowish-red colour, thin topsoil and low soil moisture. The upland rice harvest of *tanah merah* is very low, so that most farmers admit, they would rather not cultivate any rice on this soil. Also other crops are rarely planted on this soil type, but it seems still to be suitable for mixed rubber gardens. Black, yellow and red soils were also identified as the main soil types in a study of West Sumatran villages elsewhere, where also red soil was considered worst for agriculture (Colfer *et al*. 1989: 211 p.).

If comparing the local classification of soils and their fertility with the soil types where farmers make their upland fields, it becomes apparent, that the vast majority indeed choose locations with black soil (table 43). Only one sixth of the farmers farming on black soil do so on yellow soil, and only a total of five percent on red soil. Also in other areas, farmer tended not to cultivate the soils perceived as inferior, as indicated by poor plant growth (Behrens 1989: 90). The statistic also shows, that only 3.3 % of the respondents chose hilltops as locations for upland fields. Although farmers in theory preferred flat areas to slopes (cf. chapter 6.3.2), the percentage of those farming on slopes exceeded that of those farming on level land. The mere availability of level land for farming in a major rolling hill relief, however, might limit the choice of flat areas available.

Table 43: Location of upland rice field

	Level land[5]	**slope**	**hilltop**	**TOTAL**
black soil	35.8 %	43.5 %	2.1 %	81.4 %
yellow soil	4.6 %	8.6 %	0.4 %	13.6 %
red soil	0.5 %	3.7 %	0.8 %	5.0 %
TOTAL	40.9 %	55.8 %	3.3 %	100 %

The choice of black soil is well founded on farmers' experience. Besides much higher rice harvests (cf. chapter 6.3.2), also vegetables, which are traditionally mixed with rice, are not considered suitable for other soil types by the majority of the farmers (table 44). Most of the tree crops, especially fruit tree species, on the other hand, are also considered suitable for yellow soil, by some farmers even for red soil. The majority of the farmers, however, do not plant commercial tree crops like cinnamon and coffee, on yellow soil.

The choice of a farmer to plant a certain crop on a certain soil, depends mainly on his experience and choice of land. As will be described below, not only soil fertility is relevant for the decision

5 Because of the local geomorphology (mainly rolling hills), fields made on level land generally are located in small valleys, and, due to the limited size of these valleys, also extend on the adjacent slope. The same is true for fields located on hilltops, which usually also extend to the adjacent slopes.

where to farm. Therefore, some farmers will still plant vegetables on yellow soil, although results might be less than on black soil, bearing in mind, that farmers generally do not use fertilizer. What is proved by these results is, that local communities have knowledge of soil fertility demands and agricultural practices for a wide variety of crops.

Table 44: Suitable soil type for certain crops according to farmers' experience

crops considered suitable by the majority of the farmers			
for black and yellow soil and by some farmers also for red soil	*for yellow soil almost as suitable as for black soil*	*for black soil and by some farmers also for yellow soil*	*for black soil only*
banana	avocado	cinnamon	amaranth / *bayam*
coconut	carambola / *belimbing*	coffee	chilli
langsat / *duku*	cassava	corn	ginger
jackfruit	cloves	cucumber	groundnuts
lemon	durian	eggplant	lemongrass
rambutan	guava / *jambu*	swamp cabbage / *kangkung*	mungbeans
rubber	stinkbean / *jengkol*	*katuk*	onions
sugarcane	mango / *kuini*	*katulo / pitulo*	pineapple
sungkai	mango / *macang*	stringbean	potatoes
	mango	papaya	St. Thomas bean / *gando / gadun*
	mangosteen	soybeans	tobacco
	locust bean / *petai*	sweet potato	tomato
	pumpkin / *labu*		turmeric
	taro / *keladi*		watermelon
	tarok		white gourd / *kundur*
------------------→	---------------------------→	--------------------------------→	-------------------------------------→
increasing demand for soil fertility			

Distribution of Soil Types

The abundance of these different soil types is generally related to certain areas said to be most fertile, less fertile or infertile and unsuitable for cultivation.

In Pemunyian, the farmers identified three major fertile areas having black soil, which are the hill-area near the river *Batang Ule* (65 % of all respondents), the area of the hill *Bukit Kasai* (32.5 %) and the hill *Bukit Batu* / *Bukit Melantai* (55 %). Additionally, also the hill *Bukit Kubang*, the land near the rivers *Mudik Sungai Batang* and *Batang Munyin*, the hill *Bukit Batu Buruak* and areas close to rivers in general were mentioned.

The areas of average fertility with yellow soil in the village land of Pemunyian were the hill *Bukit Kubang* (42.5 % of all respondents), the land near the village and the road to the village (20 %), the hill *Bukit Kasai* (20 %). Other areas mentioned were *Bukit Kaca, Mudik Sungai Batang, Taroh Macan Hutan* and *Batu Buruak*.

Infertile sites with red soil were indicated as the area of the village and its surrounding (42.5 % of all respondents) as well as the hill *Bukit Kubang* (10 %). Further places with clay soils named were *Padang Labur*, parts of *Bukit Batu* and upriver areas of the river *Sungai Pemunyian*.

In Dusun Birun, the most fertile area having *tanah hitam* was clearly the plain and the lower slopes along the river *Batang Merangin* (100 % of all respondents). Less fertile and infertile soils were both reported in the plains, slopes and hilltops of the village land (100 %).

Fertile areas in Lubuk Malakko were said to be located along the river *Batang Ikua* (80 % of all respondents), at the areas called *Durian Amping* (22.5 %) and *Puntian Sibasa* (20 %). To a lesser extent, several other places were mentioned as having black soil: *Surumbuak, Tanjung, Pidang, Bukit Putus, Bukit Tampui, Lubuak Panjang, Padang Alau, Lubuak Batuang, Bukit Galugu*, the area around Lubuk Malako and the area *around Padang Bukit Batu Balah*.

Territories in the village land featuring *tanah kuning* / *kijang* are, according to the farmers, *Sirumbuak* (45 % of all respondents), *Lubuk Batuang* (40 %), *Pidang* (27.5 %), *Bukit Pinang* (15 %) and *Asahan* (10 %). Other places with yellow soil were given as *Taratak, Padang Darek, Idang, Labuai, Sungai Limau, Sinyaru, Sawah Padang* and *Sungai Jambu*.

The areas with the least fertile soil, clay soil, are situated at the hill *Bukit Asahan* (82.5 % of all respondents). Occasionally, also the following locations have been mentioned as being characterised by infertile clay soil*: Bancah Baguang, Lubuak Batuang, Batang Sinyaru, Bancah Tanah Kapuang* and the area around the village.

6.3.2 Geomorphology

Concerning the fertility of a field, not only the soil type according to the local classification system that has been explained above is relevant. The geomorphological location is considered equally important influencing the agricultural potential of a field. Also Sandor and Furbee (1996: 1509) noted differing local soil productivity ratings in accordance with geomorphology in Peru, as did Habarurema and Steiner (1997: 79) for Rwanda as well as Siderius and Mafalacusser (1998: 6) for Burkina Faso and Müller-Böker (1988: 111) for Nepal. The local people generally avoid hilltops, because they are too dry and promise no good harvest. For upland rice cultivation, normally plains or valley bottoms are preferred, also because they are not prone to erosion, so the farmers say.

However, plains might not always be available in a sufficient amount for all farmers who want to make a new ricefield, as for instance in Pemunyian.

Based on experience values, the local people clearly relate soil type, geomorphological position and anticipated rice harvest (table 45). Although farmers are neither used to measuring the size of their land, nor the exact amount of rice harvested, their assessment of the average yield showed clear differences as well between the soil types as well as between geomorphological positions. As the variation between the answers of the respective respondents was very high, these numbers and the distance between them may not so much reflect absolute yields which can expected, but more the perceived difference in fertility between the soil types and the respective geomorphological position.

Table 45: Good rice harvest on different soil types: farmers' assessment (%)

village name	*tanah hitam*			*tanah kuning*		
	plain	slope	hilltop	plain	slope	hilltop
Pemunyian	100	96	69	56	39	35
Dusun Birun	100	67	49	46	39	30
Lubuk Malakko	100	81	55	51	44	35

The best rice harvest is always to be expected on *tanah hitam* on level land followed by *tanah hitam* on slopes. Third comes, with considerably lower results, hilltop/*tanah hitam* and plain/*tanah kuning*. Yellow soil on slopes brings rather poor harvests and the hilltops of hills having yellow soils are rarely planted with rice, because the harvest is so low. Some farmers say that the grains remain empty, if rice is planted on too poor soil like yellow soil on slopes or even hilltops. Many respondents never have planted rice on these locations.

In Lubuk Malakko, where relief conditions favour the cultivation of irrigated rice, however, half of the respondents have never planted any upland rice. Consequently they could not assess the amount of harvest to be expected on different geomorphological units. Nevertheless, the farmers still knew that the harvest would be different on different relief positions.

If asked for the most favourable geomorphological position to make a field, in Pemunyian almost all farmers answered it would be the plain / valley bottom. In Dusun Birun, however, where people cultivate a lot of cinnamon, almost a third of the respondents favoured the slopes, because they say plants like cinnamon, coffee and other tree crops grow better on the slope, whereas vegetables and the like preferably are planted on the plain or valley bottom.

6.3.3 Vegetation

One factor for the selection of a future rice field by local people is the structure and composition of the vegetation. The importance of different forms of vegetation as a factor for qualification as a possible swidden location has also been observed in other traditional communities, like the Hanonóo of the Philippines (Conklin 1954a: 135) and the Wehean-Dayak of East Kalimantan (Gunawan and Abdoellah 1994: 8). Another example are the Philippine farmers from the Eastern Visayas, who assess an area to be suitable for renewed cultivation, when the vegetation exhibited a certain composition and height. This was usually the case at an age of 10 – 15 years (Pielago *et al*. 1987: 14).

Indicator Plants

Not only the soil type and geomorphology indicate the extent of soil fertility to the farmer, but also the vegetation growing on it. In every village, the abundance (or lack) of certain plants is correlated with fertile soil and the occurrence of other plants is connected with infertile soil. The knowledge of soil-vegetation relationships is not restricted to central Sumatra, but has also been noticed by authors like Hunn (1982: 842) for the Sahaptin of North America, Rambo (1984b: 192) for the Senoi of West-Malaysia, Werner (1993: 33 p.) for the Land-Dayak of West-Kalimantan, Mackie (1986: 442) for the Kenyah of the East Kalimantan Apo Kayan region, Iskandar (1994: 30) for the Baduy of West Java, and Behrens (1989: 92 p.) for the Shipibo of the Peruvian Amazon. Farmers in Northeast Thailand also use the fruit-bearing pattern of perennial crops like tamarind, custard apple, kapok and mango as indicators for the prediction of the rainy season, as has been observed by Suphanchaimat and Grisnaputi (1985). The selection of potential locations for an upland field according to certain indicator plants has also been noted by ICDP (1994: 28) in the area of the village Letter W, Sangir sub-district, West Sumatra. In Pemunyian the respondents named the most plants (86), for fertile (55) as well as for infertile soil (34). Second comes Dusun Birun with a total of 56 indicator species, 28 for fertile and 35 for infertile soil. Last rates Lubuk Malakko, where 21 plants were mentioned indicating fertile soil and 9 plants typical for infertile soil, or a total of 28 species[6].

The difference in the amount of indicator species mentioned in the three villages correlates to the farmers' dependence on shifting cultivation for (subsistence) production of upland rice. In Lubuk Malakko half of the respondents reported never having planted any upland rice. Also in Dusun

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[6] The difference between the sum of indicator species for fertile and for infertile soil and the total amount of indicator species results from the fact that some farmers (usually a small number) named a species as indicating infertile soil which was also mentioned as a plant typical for fertile soil by other farmers.

Birun many farmers predominantly grew rainfed rice on valley bottoms or no rice at all, because they preferred to grow cinnamon and other marketable crops and to buy rice for home consumption instead. Therefore it seems that the need for farmers to interpret the botanical composition of secondary vegetation as a potential field is not as high in Lubuk Malakko and Dusun Birun, as it is in Pemunyian.

Nevertheless, many of the species mentioned in the three villages, for fertile as well as for infertile soil, are the same. The frequency with which the respective plant is mentioned in each village, however, may differ (see annex 4). It is not surprising that many indicator species are different in the three villages, because the flora is distinct, too, as are a lot of the local plant names. Worth mentioning is also, that although in Pemunyian the most plants were mentioned as indicator species, Pemunyian also has the lowest biodiversity of secondary forest species, whereas Lubuk Malakko has by far the highest. These facts supports my conclusion above about the reason for the difference in the amount of indicator species mentioned in each village.

Whereas the plants typical of fertile soil mentioned most frequently differ a lot, the most typical plants for infertile soil don't. Unsurprising for any botanist or land use planner of tropical Indonesia, it is one of the world's worst weeds, the grass *(i)lalang* (*Imperata cylindrica*) and the notorious fern *resam/asam/padang asam* (*Dicranopteris currannii*). They were mentioned by about two-thirds of the respondents. Also the East Kalimantan Kenyah Dayaks of the Apo Kayan considered sites covered with aggressive fern weeds unsuitable (Mackie 1986: 442). Another widespread plant of early secondary growth is *Melastoma malabathricum*. The pink-flowering shrub was deemed typical for infertile soil by about one-third of the respondents.

Species indicating fertile soil can be grouped into three main categories. The first is species typical for primary forest. This group embraces many Dipterocarpaceae and large-leaved Araceae, Maranthaceae and Musaceae; understory-plants which prefer high soil moisture. The second group consists of large-leaved pioneer trees like members of the *Ficus* and *Macaranga* families, *Artocarpus elasticus, Mallotus paniculatus, Cnesmone sp., Commersonia bartrama* and *Trema orientalis*. A small number of respondents also considered some of these species as infertility indicators. This is probably a matter of preference and individual experience. Third are transcontinental weeds and grasses. The South-American weedy shrub *Clibadium surinamense* dominates young secondary vegetation in Dusun Birun, but is also considered to restore soil fertility. It is much easier to weed out than *Dicranopteris linearis* or *Imperata cylindrica*, which otherwise may capture dominance in early regrowth. Therefore 91.7 % of the respondents named it as a fertility indicator. Another small weed from South America is *Erechtites valerianifolia*. Also found in very young fallow, it is much less dominant than the former. 61.1% of the respondents in Dusun Birun considered it as a fertility-indicator. The grass *Axonopus compressus*, likewise of

South-American origin, was the most frequently mentioned fertility indicator in Lubuk Malakko (50 % of the respondents). It is mainly found in grazed secondary regrowth and covers buffalo-pastures, wherefore it is also preferred over aggressive and non-palatable ferns and grasses. Interestingly, in isolated Pemunyian none of these foreign weeds were considered fertility indicators, but only primary forest trees and pioneer species.

Secondary Vegetation

Local farmers recognize certain regrowth stages, which are mainly related to the use, size and general appearance of the fallow vegetation. They differentiate upland fields, a brush stage, secondary forest and old-growth forest (Colfer et al. 1988: 195 pp.). This differentiation is more detailled among the Dayak, who generally divide regrowth stages by tree diameter (Werner 1993: 84, Chin 1985: 138 p., Inoue and Lahije 1990: 278 p.). The age or the height of secondary vegetation did not seem to be of major importance for the selection of an upland field, as had been reported, for example, for Kalimantan (Colfer 1994: 14, Werner: ibid.).Whereas in Pemunyian, where upland rice production is most pronounced, only about one fourth of the respondents stated, that the fallow age is important for the choice of a future field, in both other research locations it was less than ten percent.

Also old secondary vegetation with many big trees is not appreciated by many respondents, probably because the work involved for clearing. Related to this, farmers generally do not wait until plants have reached a certain diameter, before a field is used again.

Three quarters of the respondents of Pemunyian and Lubuk Malakko acknowledged that if a field is fallowed before it is cultivated again, the time it is left unplanted is dependent on the soil fertility. Half of the respondents in these villages also agreed that also the geomorphological location of a field determines the fallow period necessary for its recovery. The farmers of the Central New Guinea' Highlands also recognized the necessity of upper mountain slopes for longer fallows (Marten and Vityakon 1986: 203).

In Dusun Birun, however, only about one quarter of the respondents left their fields unplanted for recovery in accordance with soil fertility, and only ten percent acknowledged that the geomorphological location influences the fallow period. Most of the people didn't fallow their fields at all. They preferred to plant them with tree crops, although they admitted, they might not have the time to care for all of these fields afterwards.

This feature indicates a relatively lower awareness for the role and importance of fallowing, as compared with, for example Dayak shifting cultivators. In Kalimantan, the size of secondary regrowth and the vitality of its undergrowth are considered more important for site selection (e.g. Mackie 1986: 439, Werner 1993: 84). Dayaks usually prefer fallow with trees whose diameter exceeds a man's thigh and with plants having large, dark green leaves. The latter indicate abundant soil moisture, while the former guarantee a fallow length sufficient to shade out weeds and to provide enough ash to support a rice crop. Adewole Osunade (1988: 200) mentioned also for the Yoruba of Nigeria, that the degree of vegetation regeneration is an important factor in the local land suitability classification.

Table 46: Influence of soil fertility and geomorphology on fallow duration (in years) of upland fields

location	fallow duration and soil fertility		fallow duration and geomorphology			
	fertile soil	Infertile soil	plain	slope	hilltop	average
Pemunyian	2.7	6.5	2.2	5.4	7.2	4.8
Dusun Birun	3.0	6.2	2.3	4.9	6.8	4.6
Lubuk Malakko	2.5	4.6	2.5	4.0	4.7	3.7
average	2.7	5.8	2.3	4.8	6.2	4.4

Table 46 illustrates, that fallow periods in all three villages is rather similar, ranging from two to three years in the plains or on fertile land to about five to seven years on hilltops or infertile soil. The similarity of the average time a field is left unplanted on infertile soil and on hilltops as well as on fertile soil and on plains indicates again, that hilltops are in general associated with infertility while plains are regarded as being equivalent to favourable growing conditions. If comparing, again, farmers' statements about average fallow length with the average age of secondary vegetation, where the upland fields were made, it becomes obvious, that farmers tend to understate their actual fallow length. The mean fallow length, as calculated from the age of the secondary vegetation where the respondents made their upland fields during the last two years, is a period of nine years (table 47). A certain percentage of farmers make upland fields in young secondary vegetation aged only one to five years, but the majority rather prefer older regrowth stages.

Table 47: Former vegetation in upland rice field area

	Pemunyian	Dusun Birun	Lubuk Malakko
Young fallow (1-5 yrs. old)	30.7 %	4.0 %	14.3 %
6 - 10 year old fallow	15.4 %	19.3 %	7.1 %
11 - 15 year old fallow	23.3 %	32.8 %	-
Old fallow (> 15 year old)	7.4 %	39..9 %	21.4 %
Primary forest	23.3 %	4.0 %	57.1 %

Also observations in the field did not indicate any degradation of secondary growth or vast areas of with scrubland. To the contrary, secondary growth generally was well mixed and rather was in accordance with farmers' information on field site choice than with their information on average fallow length. The maximum age of secondary vegetation generally did not exceed twenty years, with rare exceptions.

Compared to other regions, like Mindanao and Kalimantan, where the period fields are left uncultivated ranges from 6 - 8 (Bennagen 1993: 77), 8 - 15 (Conklin 1954b: 141), 12 years (Dove 1985: 98) and 10 - 20 years (Gunawan and Abdoellah 1994: 6) respectively, the villages in the lowland buffer zone area surrounding the KSNP represent an area with short to intermediate cultivation cycles. The assessment of minimum fallow lengths necessary to restore soil fertility and maintain ecological stability differ between seven to fifteen (Weinstock 1984a: 16), ten to fifteen (Mackie 1986: 444, Scholz 1988: 21, Ramakrishnan 1992: 370) or even 15 to 20 years (Padoch 1988: 21 p.). The fallow period needed for site recovery certainly is not equal everywhere, depending on regrowth vitality, which is determined by soil fertility, seed bank and coppicing potential. The latter depends on the number of species present that are capable of coppicing.

In Pemunyian, farmers considered long fallow periods as being linked to secondary forest soils, while the time a field is left unplanted on former primary forest land, is generally assumed to be shorter. Several people of Dusun Birun also said that if the soil is fertile, there is no difference between soils on hilltops, slopes or plain, and if the soil is fertile, there is no fallow period necessary. It was answered, too, that a fallow period only needs to be long, as the time it takes for the trunks left after the last burn to rot and to become fertiliser.

6.3.4 Other Factors

Up to now it has become clear, that besides soil fertility, the geomorphological location is decisive for qualifying a site as a prospective upland field. On the other side, the age of the secondary vegetation seems to be not so important, as long as a field is not dominated by to many plants perceived as indicator for infertile soils. Besides these physical factors, there are some more practical criteria that a location of a potential field has to meet.

At first, the farmers always try to farm in big groups to prevent damage by wild pigs and other pests. Farming in groups makes it easier to guard the fields and not all people have to be present at all times. This feature is common among shifting cultivators. Also Vayda (1985: 10) reported for the East Kalimantan Apo Kayan region, that farmers were willing to make compromises concerning the quality of a household's site, than to farm alone. Another reason why farming in a group is important is because its members collectively carry through field preparation, sowing and harvesting. Secondly, the field should be close to a river to enable the cultivators to take water for drinking and cooking, as well as to refresh and to relieve themselves. This is necessary, because the farmers always build a small house or hut in the new field as a temporary shelter and to guard the fields in the ripening season. Also this criterion was mentioned by shifting cultivators of other areas (e.g., Mackie 1986: 439).

Thirdly, the proximity of a prospective field to the village is deemed to be important, especially in Lubuk Malakko, where almost all respondents agreed upon it. In Pemunyian, however, only a quarter of all people interviewed considered this criterion to be important for field choice, and in Dusun Birun almost nobody would make the choice of a piece of land dependent on its distance from the village. What accounts for these differences? It is assumed, that the willingness to choose far-away fields in Dusun Birun clearly results from the fact that the most fertile soil is quite far from the village. As the people now turn to cinnamon-cultivation, which only grows on these better soils, they prefer to take the disadvantage of distance to cultivating cinnamon on soils where it will not grow well. In Pemunyian, there is also an area considered to be very fertile, which is also some distance from the village. Also here, several people value the advantages of fertile soil higher than the burden of distance. On the other side, in Lubuk Malakko, irrigated rice is cultivated near the village, and if somebody opens a field, it will be for tree crops. Because soil fertility in Lubuk Malakko is not restricted to distant areas, of course fields will be chosen as close to the village as possible. It might be feasible to have a rice field some distance from home, because the family will stay in the temporary shelter at that field in times of labour peaks anyway. A rubber garden, which has to be tapped everyday, however, is of no use, if it is too far away.

Furthermore, land ownership has been mentioned as one factor determining the choice of a field. A person may only cultivate fields where (s)he is the rightful owner according to customary law, which means that (s)he either opened that particular field from primary forest himself, or inherited it from her/his ancestors, who opened that land, or, more exceptionally, bought that piece of land.

These factors mentioned above might be as important for the choice of a field, as is land suitability itself. People might well choose an inferior piece of land for cultivation, if there is no fertile land which they own or may have the right to use near a major farmers' group which they can join in.

6.4 Perception of Effects of Management Practices on Soil and Vegetation

The awareness among cultures of the impact that people can have upon their natural environment differs from culture to culture. Some societies clearly possess a traditional conservation ethic, whereas others apparently perceive little or no relationship between their activities and the state of their resources (Johannes 1993: 35). Ecological linkages generally are well understood as part of the local environmental knowledge. People believe that they are part of the environment and any damage to the environment will also adversely affect their lives. Consequently, although they view the biophysical factors of the environment as resources for future needs, they exploit them carefully. Upon being asked why the forest is important to them, people tended to answer, that the forest is their source of life and that consequently a damaged forest will make their life difficult because they cannot open any new fields anymore. If they cut down forest other than in accordance with existing traditional consensus and rule, they believe they will become sick as a consequence. This perception, however, does not consider the forest as a limited resource. It implies that there always has been enough forest and that therefore always will be, if the people act in accordance with existing regulations.

However, it was somewhat surprising that on soils considered to be fertile, long forest fallows leading to the restoration of secondary forests were not deemed to be a necessary precondition for successful agriculture, as in other regions like the Philippines (Conklin 1954b: 141), or Kalimantan (Werner 1993: 84). Because actual fallowing behaviour is different to the fallow duration mentioned by the farmers, this might be another expression of local people having been made ashamed of their “inefficient” land use practices by government extension workers. Nevertheless, the local people agreed upon that on less fertile soils, the land might need to be left uncultivated for a certain time to restore its fertility. They also recognised, that even if the land has been fallowed for some time, if the soil is inherently also infertile, like *tanah merah* or *tanah kuning* on hilltops, these sites should be avoided for upland rice production and rather planted with tree crops.

Fertile soil is linked to black soil colour, which could be interpreted on the one side as a distinct soil type associated with different chemical properties than other soil types. But as it seems, the term ‘*tanah hitam’* rather indicates an abundant, dark-coloured topsoil or A-horizon being rich in organic matter. A proof for this assumption represents the claim by the people of mainly Dusun Birun and Pemunyian, that the soil around their villages is the most infertile (Lubuk Malakko is mainly surrounded by irrigated rice fields). Also farmers of Chiapas, southern Mexico, found soils close to the village to be of poor quality, whereas high-quality lands were supposed to be at a greater distance (Bellon and Taylor 1993: 779). As it can be ruled out that the farmers would have founded a village at a location where the soil is unfavourable for agricultural endeavours compared to other areas, it can be assumed, that soil fertility in fact decreased through consecutive cultivation cycles. Stark (1978: 4) suggests that some tropical soils in the New World may have a ‘biological life span’ of under two hundred years if exposed to slash and burn cutting on a thirty year cycle. If this were also the case in the central Sumatran lowlands, it could explain why the local people do not perceive the decreasing fertility of their soils through successive farming cycles. The time spans in which such processes occur are simply too long to be realised by the individual observer.

The interdependence of utilisation frequency and soil condition, so it seems, is not fully realised by the farmers. The local soil typology, though related to geology as we will see later (6.5.2), mainly describes contemporary fertility status, which is considered an inherent soil property. It defines the actual state of a soil, and its suitability for agriculture at the current time. Therefore local people do not realize, that recurrent shifting cycles can change one soil type into another, for instance black soil into red soil. Also the local repertoire for soil improvement is limited. If a soil is not fertile (anymore), there is nothing that can be done about it, except for leaving it fallow and turning one's agricultural activities to more promising lands. Under conditions of sufficient land resources to allow adequate fallow cycles, there also was no need for other practices. This means, local soil knowledge mainly focuses on site selection, and areas that have proven infertile are not cultivated again. Other traditional societies, like the Philippine Hanunóo and Rwandan farmers, sometimes have a more distinct knowledge of the effects of erosion, exposure and overswiddening on soil quality (Conklin 1954b: 140, Habarurema and Steiner 1997: 81).

All respondents in each village admitted having experienced some kind of natural disaster like landslides or floods. If asked for the reasons of these occurrences, the answer was in general that God sent it or heavy rains caused it. Notwithstanding landslides and floods also happening without human interventions, the relationship between human activities and subsequent natural disasters was apparently not obvious to the farmers. Although some respondents already had learned that deforestation causes landslides and floods and that it consequently is important to preserve the forest in the watershed areas through the forestry service or through the media, the possible connection between the natural disasters happening in their villages, and human activities in upriver areas seemed not to occur to them.

6.5 Comparison of Scientific and Local Classification of the Environment

When I was working with the local people in the outer border area of the KSNP, I wanted to make a botanical inventory of secondary vegetation and jungle rubber, but at the same time learn about the traditional botanical classification system in that area from my local assistants. The local taxonomic system again seemed to resemble very much those systems I had observed before in southern Sumatra and Kalimantan, and in fact, also our scientific one. Having grown up in a rural environment myself, I also felt very familiar with the local distinction of plants in accordance with their life form, like herbs, trees, ferns and the like. The same is true for the traditional classification of soil types. Whenever I asked for the name of the soil type at a distinct place, there was one, and whenever I observed any soil differences, there certainly was a different local name, too.

These similarities in the classification of nature between traditional societies and modern Western societies are explained by Berlin (1992: 8) by the argument, that “human beings everywhere are constrained in essentially the same ways - by nature’s basic plan - in their conceptual recognition of the biological diversity of their natural environment”. Although people can recognise many different pattern in nature’s structure, one pattern stands out from the rest in any local fauna and flora (ibid.: 9).

6.5.1 Correspondence of the Botanical Classification Systems

The scientific and the Minangkabau botanical classification exhibit several similarities. These correspondences concern features of the general structure of the botanical classification as well as the position of certain taxa within this structure. As already mentioned above, this feature is not a mere coincidence but rather a structural feature of all folk biological classifications. According to Berlin (1992: 25 p.), the majority of the folk biological taxa exhibit a high degree of correspondence to those of the scientific taxonomy, concerning their folk biological rank, especially folk generics and subgenerics. It would make no sense to obtain the scientific identifications for plants if folk taxonomy bore no relation to biological classification, if the traditional systems was entirely based on biologically arbitrary, but culturally relevant discriminations, states Bulmer (1969: 4).

The main correspondences between folk and scientific botanical taxonomy are on the generic and subgeneric rank. Taxa of life form rank, however, are mainly oriented to the stem habit of plants (woody, twining). They do not find their equal in biology, but rather cut straight through higher-order botanical classes. The degree of agreement between folk generic classes on the one hand and botanical classes like genera or families, however, is variable. As is shown by some examples in table 48, Minangkabau folk specific taxa belonging to one generic may or may not be members of one botanical genus or even family. The constituents of a folk generic class may botanically belong to one genus, one family, or more than one family. Some specific taxa may be botanically members of one genus or family, other members of the same generic may belong to another family.

Table 48: Folk specific taxa and their botanical equivalents (examples)

members of folk generics belonging to one botanical genus / family		members of folk generics belonging to more than one botanical family	
folk specific	**botanical equivalent**	**folk specific**	**botanical equivalent**
aro langi betina [7]	Ficus hispida MORA	asam kumbang betina	Casearia cf. capitellata FLAC
aro langi jantan [8]	Ficus variegata MORA	asam kumbang jantan	Glochidion cf. sericeum EUPH
cubadak	Artocarpus heterophyllus MORA	pudiang geni	Codiaceum variegatum EUPH
cubadak hutan	Artocarpus integer MORA	pudiang hitam	Chosalia curviflora RUBI
cubadak air	Artocarpus sp. MORA	pudiang tima	Planchonella nitida SAPO
binaran	Knema latifolia MYRIST	tampo-tampo badak	Tabernamontana sp. APOCY
binaran sasok	Horsfieldia cf. punctatifolia MYRIST	tampo-tampo basi	Callicarpa albida VERB
puar angit	Curcuma xanthoriza ZING	sipadir baluh	Lasianthus sp. RUBI
puar batu	Globba maranthina ZING	sipadir cubadak	Goniothalamus umbrosus ANNO
puar kincang	Globba paniculata ZING	sipadir tanah	Ficus ribes MORA

Another structural feature of the correspondence between the local botanical system and the scientific one is the degree of equivalence between single taxa, especially generic taxa. As it can be seen from table 49, in most of the cases one botanical species is equivalent to one folk generic taxon. A smaller percentage of folk generics, however, exhibit either biological over- or underdifferentiation. In these cases, several generic taxa are equivalent to one botanical species (folk generic taxa having the biological range of a single species) or one generic taxon includes more than one botanical species (botanically diverse folk generic taxa).

Table 49: Correspondence of scientific genera with folk botanical generic taxa

	Pemunyian	Dusun Birun	Lubuk Malakko	mean
Biological overdifferentiation: One scientific genus is equivalent to more than one folk generic taxon	6 (4 %)	22 (11 %)	44 (12 %)	9 %
Biologically diverse folk generics: One folk generic taxon is equivalent to more than one scientific genus:	3 (2 %)	10 (5 %)	22 (6 %)	4 %
Correspondence: One scientific genus corresponds to one folk generic taxon	146 (94 %)	170 (84 %)	310 (82 %)	87 %

[7] 'Jantan' is the Indonesian word for 'male', i.e. according to the local classification this species is the male form of *aro langi*.

[8] 'Betina' is the Indonesian word for 'female', i.e. according to the local classification this species is the female form of *aro langi*.

As it can be seen, an average of 87 % of all folk generics correspond in a one-to-one fashion with botanical species, whereas about 9 % of the taxa are biologically overdifferentiated and only 4 % of the generics are biologically diverse[9].

Inter-Village Variations

Folk botanical classification varies between villages although they are inhabited by the same ethnic group and are only located fifty kilometres apart on average. Only one village (Lubuk Malakko), however, is entirely located within wholly Minangkabau-inhabited land. The second village (Pemunyian) is inhabited by ethnically Minangkabau people, but in territory mainly settled by migrants of Minangkabau descent. The third village, being located most apart from the Minangkabau heartland, is inhabited by settlers of Minangkabau descent mixed with Malay people from Bengkulu province. Although one would expect, that the correspondences between villages located closely to one another would be more marked than between villages more distant from each other, this is not the case. Taking the scientific taxonomy as the reference for inter-village comparison, several points can be made.

The floristic similarities are not bigger between more proximate villages than between those located far from each other. Therefore the majority of the species differs between villages. Comparing the names of those species occurring in two or all of the sites investigated, only a few of them were referred to by using the same folk name (table 50). Only few botanical species that were present in all three sites were also named the same.

Table 50: Inter-village similarities of folk generics and their biological content

	taxa identical in two ore more villages			
	Pemunyian-Lubuk Malakko	Pemunyian-Dusun Birun	Dusun Birun-Lubuk Malakko	all three locations
botanical taxa	21	13	34	40
folk generics having the same biolog. content				
- *same botanical species*	11	7	8	23
- *same botanical genus only*	4	4	3	2
- *same botanical family only*	3	2	4	0
folk generics having different biolog. content	2	8	3	1

[9] To facilitate this comparison, every folk specific was counted seperately as a member of one folk generic class. Berlin (1973: 269) who counted polytypic folk generic classes as one single generic taxon, received a very high percentage of ‘underdifferentiated’ folk generics while not accounting for their folk taxonomical differentiation into specific taxa.

Besides, concerning the similarities between the two villages most distant to each other, Lubuk Malakko and Dusun Birun, there were several folk taxa with the same name, but which were different in the third village, located between them. Again, the villages close to one another had common names for certain botanical species with different names (or not occurring) in the third village. And there were also quite a number of identical folk specific names in two or three villages, but having a different biological content.

Those species that were named the same mainly were used species or very common species of young fallow vegetation. Only a few of these species, however, were also cultivated, remembering, that the inventory was made in secondary vegetation and rubber gardens. In an inventory of species cultivated in upland fields and home gardens, lexical similarities should be higher, referring to the results of Balée (1986) and Berlin *et al*. (1973), who found lexical similarities between several tribal groups in South America sharply rising with the intensity a species is managed.

6.5.2 Local Soil Classification Compared to the Results of Scientific Soil Analysis

Soils which were different according to the local people generally also showed distinct features when analysed concerning their chemical and physical properties. Laboratory tests furthermore in most cases agreed with farmers' quality ranking of their soils, a feature also found elsewhere (Bellon and Taylor 1993: 172). The relevance of local soil knowledge for plant growth was indicated by sites with a high fertility according to the local people also showing a very high biodiversity. This did not, however, correlate with specific soil types (see also chapter 5.2.3). Also in other areas like Africa, researchers found, that by using the knowledge of local people during a soil survey, it was possible to create perfectly usable soil maps in a fraction of the time that would have been required by scientific methods alone (Howes 1980: 344). The Cambodia-IRRI-Australian Aid Project even developed a manual for the identification and management of the soils used for rice production in Cambodia, using the Cambodian Agronomic Soil Classification system, which is based on local soil categories (White *et al*. 1997).

However, farmers and scientists use different criteria to categorise soils. Scientists classify major soil types in accordance with physical and chemical characteristics of the subsoil, because they seek consistency and reliability. The topsoil, varying constantly on account of numerous factors, merely determines the pedologic subgroup. Farmers, on the other hand, are more interested in features of the topsoil, as these influence important management decisions. In areas, where there are soil types with limited rooting space, however, the subsoil becomes important for tree crops (Adewole Osunade 1988: 196). In general, farmers focus most of their attention on the actual state of a certain soil, which determines its suitability for agriculture. Farmers' soil classes therefore can be seen as corresponding to soil suitability classes (Habarurema and Steiner 1997: 75). In accordance with the changing crop performance on a certain piece of land, the farmers' perception of the fertility status of a particular soil, i.e. the soil type, changes, too. Besides applying different criteria, farmers and scientists also arrive at soil categories in different ways. "The scientific system starts with a detailed description of the various chemical and physical properties, and sums these up into a single unit called soil type. Farmers start the other way round. They arrive at a soil type first by observing a single most notable feature (be it colour, structure or consistency) and then give a more detailed description of the characteristics of that particular soil", observed Sikana (1993: 15) in Zambia. This assessment is also applicable for the research area, where farmers depart from soil colour, and then specify the properties of the respective soil type having the particular colour. When compared to the scientific soil taxonomy that has several levels, the depth of hierarchy of the local classification in Jambi and West Sumatra is shallow. Other authors have observed a similar feature elsewhere, although in some areas classifications with up to three levels have been found (Talawar 1996: 6 p.). Ethnopedological studies among Nepalese farmers indicated ethnospecific distinctions in TEK, becoming obvious by the varying degree of systematic differentiation between soil types (Müller-Böker 1988: 112).

If compared to scientific classification systems like the US soil taxonomy, within both systems correlations of soil types with the same factors occur. The cation exchange capacity (CEC) is a major distinguishing factor within local as well as USDA classification. Nevertheless, only in Dusun Birun a correlation between the different soil types of both systems exists. In the other two villages, local soil types mainly correlate with differences of the bedrock material (table 51).

Table 51: Relationship between local soil types and geology

Local soil type	***Parent material***
PEMUNYIAN	
Black soil	Acidic volcanic rocks
Red soil	Acidic volcanic rocks
Yellow soil	Granitic rocks
LUBUK MALAKKO	
Black soil	Porphyric basalt
Yellow-red soil	Very fine grained schistose rocks

A stronger correlation between local and USDA soil taxonomies seems to occur in areas where the different soil types show stronger distinctions than in our case. Sandor and Furbee (1996: 1510), for example observed local classifications to distinguish between soils with and without subsurface horizons limiting crop growth, which were equally recognized by the USDA soil taxonomy. In general, however, local taxonomies are supposed to be more closely related to use-oriented classifications that are likewise rather agronomic than taxonomic in purpose, like the Fertility Capability Soil Classification System (FCC) (Sanchez *et al.* 1982).

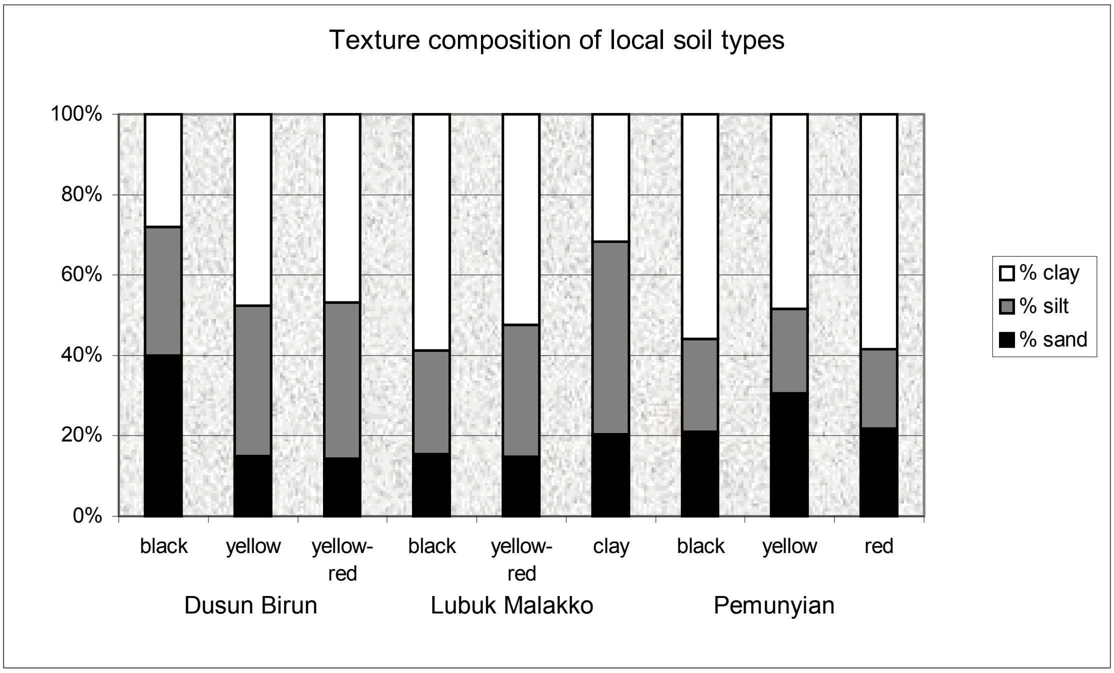
In Lubuk Malakko, the correlating local soil types and geology furthermore coincide with geomorphology. Black soils on porphyric basalt are mainly found in the lowland, whereas yellow-red soils on schistose rocks dominate on the emergent hills.

This feature indicates several interesting aspects. First, my hypothesis that local soil typology is a mere representative of the contemporary fertility status could not be verified in all cases. It is true where several soil types can be found on a single bedrock material, as is the case with black and red soil on acidic volcanic rocks in Pemunyian and with yellow and yellow-red soil on schist in Dusun Birun. The locally observed soil differences, however, also correlate to scientifically observed environmental differences, i.e. geology, although less so to the USDA classification.

Second, not all factors mentioned as being used to differentiate between local soil types did prove true when using soil physical analysis. In several cases, where textural differences were mentioned, they did not exist. Maybe, rather the local people took other aspects of soil structure into account. The differentiation according to the colour of the soil was an indicator of organic matter content in both Dusun Birun and Lubuk Malakko. The name “black soil” in Pemunyian, being considered very fertile, however, was not related to high organic matter contents. Its other chemical properties indicate a higher fertility than red soil, but still a much lower than yellow soil. Therefore the location, which is supposed to have been used only one or two times since it was opened from primary forest, probably provided high rice yields due to the fertilisation from the large amounts of burned biomass. Black soils in the other two villages usually also have a thicker topsoil than the other types. In Dusun Birun, however, this is only true for red soil. Also in Cambodia, local soil experts mainly distinguished soils on the basis of organic matter content, and furthermore, texture (Oberthür *et al*. 2000: 20). These properties are directly observable by the naked eye. Soil fertility, on the other hand, is rather perceived through crop suitability or productivity (Talawar 1996: 5). The results of analysis of the physical and chemical properties of local soil types show, that farmers’ soil taxonomy discriminates between objective properties of soil in a certain geographical area.

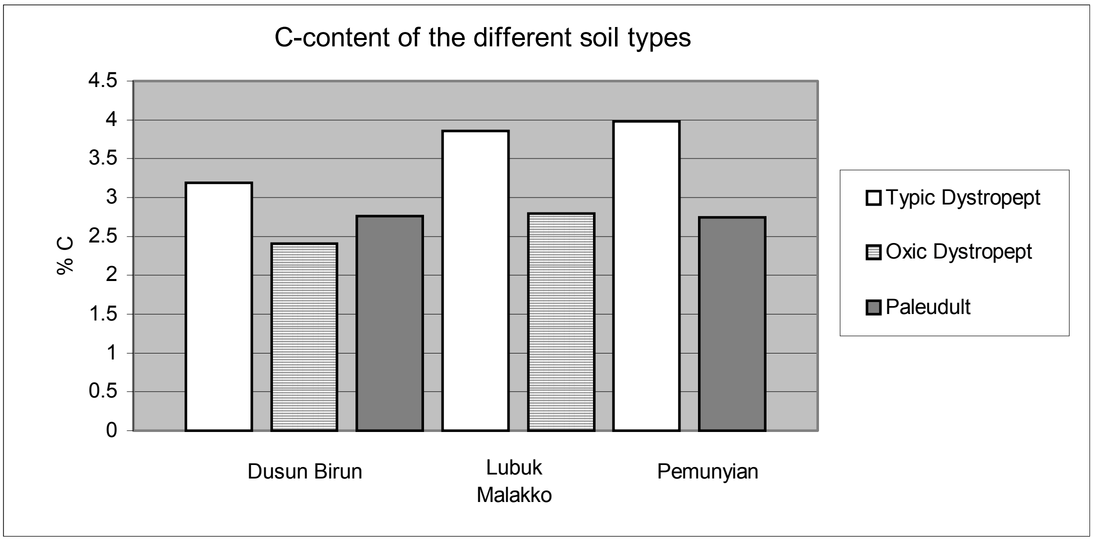
Textural differences could be observed within as well as between villages (Figure 17). The soils of Pemunyian, for example are relatively rich in clay and poor in silt. The soils of Dusun Birun, on the other hand, are poorer in clay and richer in silt. Within Pemunyian, black and red soils, because originating from the same bedrock material, have a similar textural composition. The yellow soils of that village, however, have significantly higher sand content and lower clay content. In Lubuk Malakko, black soils on average have somewhat higher clay contents and lower silt content, than yellow-red soils. The differences, however only had some significance for silt. So-called clay soils, on the other hand, had highly significantly lower clay contents and very high silt content. Therefore, their name probably rather refers to their sticky consistency. Finally, in Dusun Birun, the texture of yellow and yellow-red soils was very similar, but the black soils had a significantly higher sand content.

Figure 21: Texture of local soil types



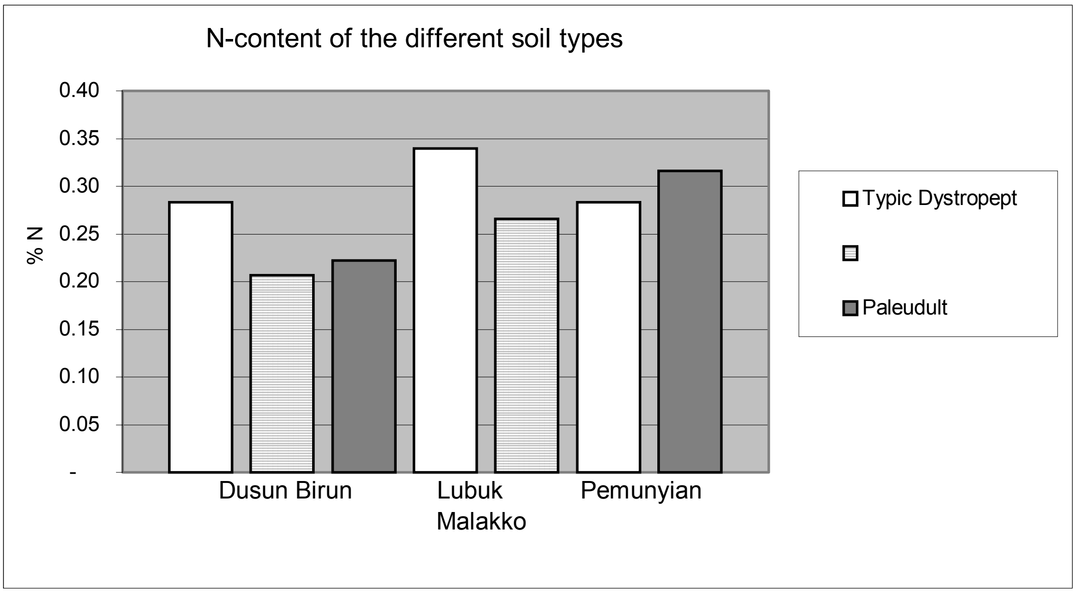
Topsoil organic carbon content differs between villages as well as between local soil types (Figure 18). On average, such contents are lowest in Dusun Birun and highest in Pemunyian. Among all local soil types, the black soils of Lubuk Malakko and the red soils of Pemunyian have the highest C-contents. Due to the higher variation within the Pemunyian soil types, however, only the differences in Lubuk Malakko are significant. As mentioned before, the name black soil is not related to organic matter content as would have been expected from the experience in the other two villages and elsewhere (e.g. Bellon and Taylor 1993: 172).

Figure 22: Topsoil organic carbon and local soil types



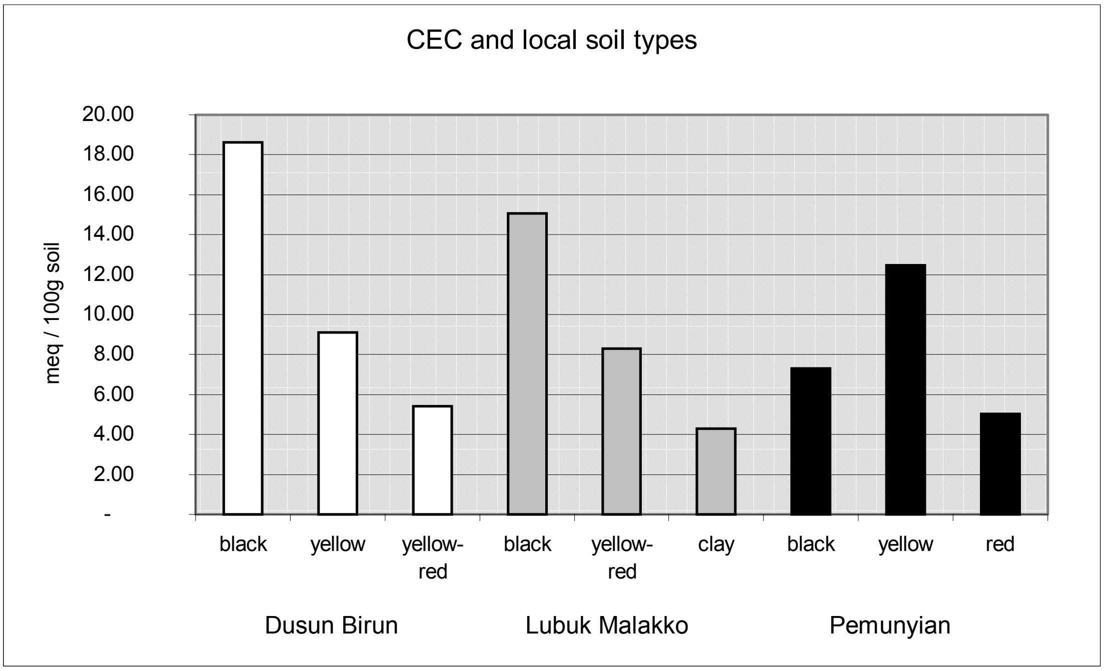
As for organic carbon, total nitrogen content was highest for the black soils of Lubuk Malakko and Dusun Birun (see Figure 19). The differences to the other local soil types were statistically significant. In Pemunyian, however, there were no distinctions between the N-content of red and yellow soils as there had been for carbon.

Figure 23: Topsoil nitrogen content and local soil types



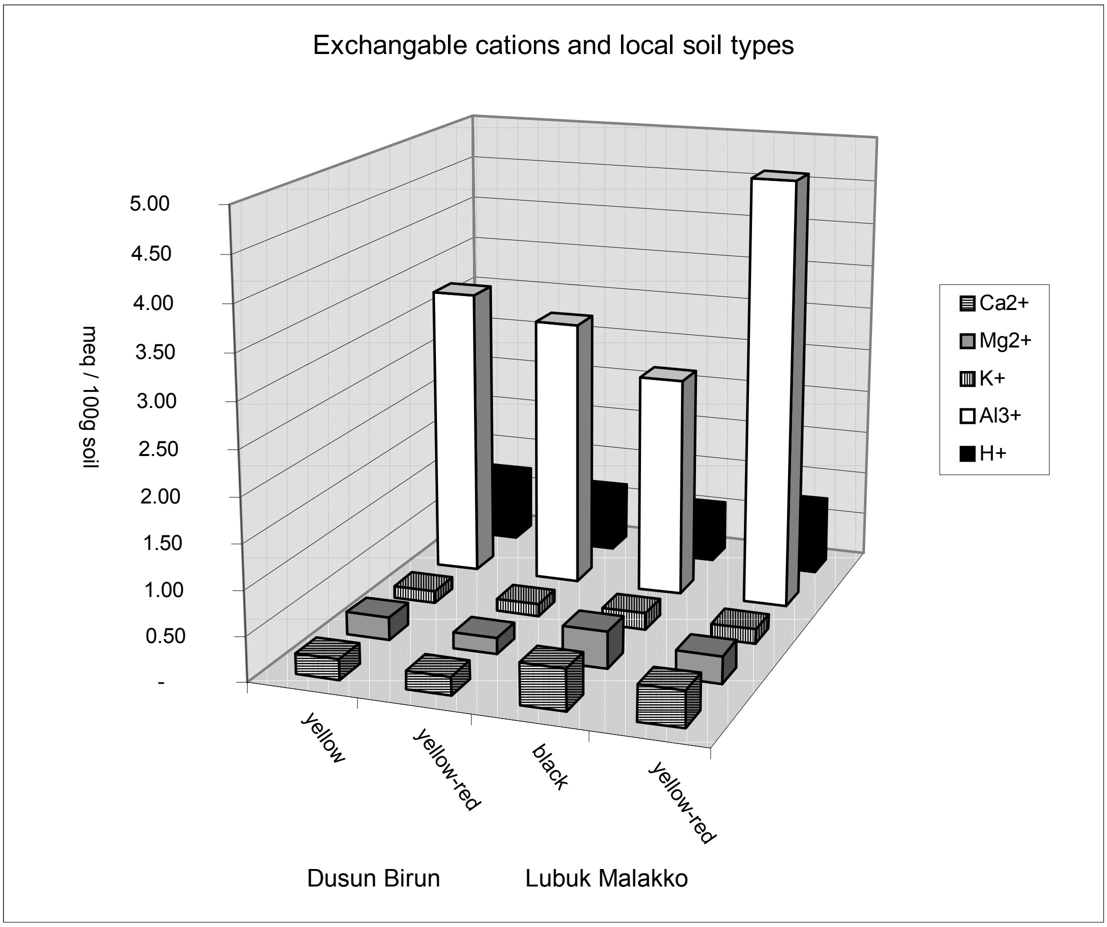
The most obvious differences between local soil types, highly significant for all villages and categories, exist for the cation exchange capacity (see Figure 20). The CEC of black soils in Dusun Birun and Lubuk Malakko is more than twice as high as for the other soil types. In Pemunyian, black soils have a higher CEC than red soils, but that of yellow soils still is much higher. The reasons for this exception have already been mentioned.

Figure 24: CEC and local soil types



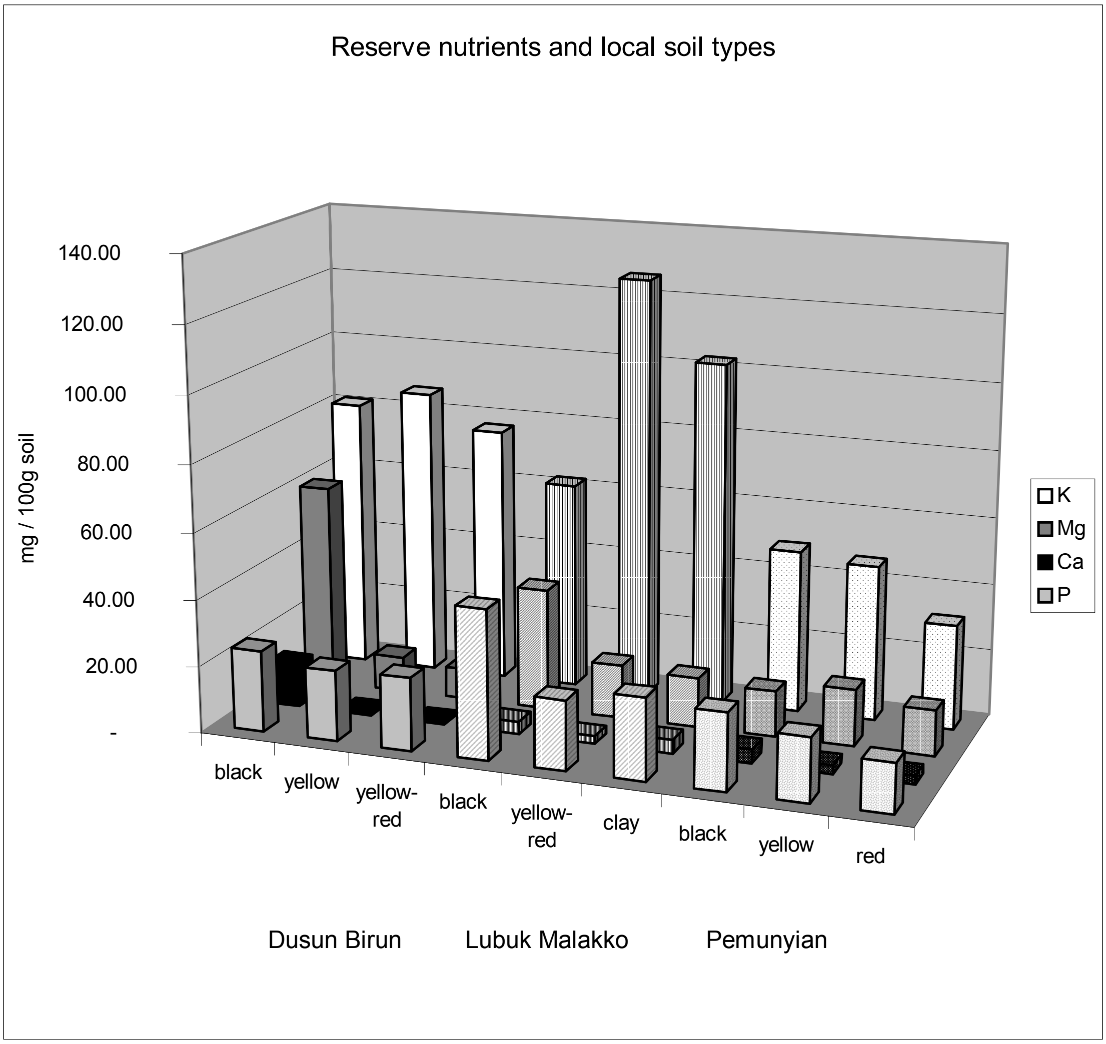
As for organic matter and CEC, so for exchangeable cations, local soil types perceived to be more fertile had higher average nutrient contents (see Figure 21). Especially for magnesium, these differences were significant. For example, black soils in Lubuk Malakko had an average of 41 meq exchangeable Mg, which was only 28 meq for yellow-red soils. Differences of the average contents of Ca and K were also present, however, not statistically significant (see annex 3).

Figure 25: Exchangeable cations and local soil types



Reserve nutrients of the local soil types were on average highest in Lubuk Malakko und lowest in Pemunyian (see Figure 22). Within the respective villages, however, contents were not higher in all instances for those soils considered most fertile by the local people. Black soils in Lubuk Malakko, for example, had much lower reserve potassium than the other two soil types. Other reserve nutrients, nevertheless, were again higher within this kind of soil (see also annex 3). Also in Dusun Birun, average reserve K contents were slightly lower for black soil; other nutrients, however, were again highest there. The black soils of Pemunyian, although relatively low in organic matter and CEC, have significantly higher reserve nutrient contents than the red and yellow soils of that village.

Figure 26: Reserve nutrients and local soil types



As we have seen, the factors differentiating local soil types were, above all, CEC, texture, organic carbon and nitrogen, as well as exchangeable magnesium and reserve potassium. Also in other areas, similar factors discriminated the local soil types present. In Cambodia, it was mainly clay content, CEC, organic carbon, plant available magnesium and calcium (Oberthür et al. 2000: 25).

The higher CEC and higher nutrient contents of black soils indicates, why farmers classify these soils as being most fertile: they do store and supply nutrients best. This is a judgement based on experience. Therefore, farmers rightly know that their most nutrient-demanding crops will grow best on these soils. The recognition of fertile locations for agriculture is an expertise fundamental for their survival. If their crops perform poorly due to bad growing conditions, their families will go hungry.

As will be seen in chapter 5.2.3, some plant species prefer certain local soil types above others, the latter being mainly related to the parent material present. There was no obvious relationship to the USDA soil types. Nevertheless, only in some cases, was there a relationship between perceived soil fertility and the abundance of species considered as indicator plants by the farmers on certain local soil types. Most indicator species neither occured primarily on particular local soil types or USDA soil types.

Finding out to which soil or environmental factors the respective indicator species are correlated, would require another in-depth study. This would certainly further clarify local peoples´ view and knowledge of the environment. If correlations existed, researchers and planners could also use local indicator species for ecological assessments.

Besides their relationship to soil chemical and physical properties, it is already obvious that some of those species being classified as typical for infertile soils are plants thriving on frequently used and burned sites (see annex 3). Indicator plants for fertile land, on the other hand, frequently are plants preferring shady or moist sites, like primary forest plants and large-leafed pioneer trees. Interestingly, some very abundant transcontinental invader weeds have been considered indicators of fertile land both in Dusun Birun and Lubuk Malakko.

6.5.3 Natural Resource Management and Perception of Nature

Western science and Minangkabau traditional knowledge are most distinct concerning their explanation of ecological processes and concepts of environmental management. For the local people, their belief system is a basic element of their land use system, as important as practical empirical knowledge and appropriate technology. Traditional beliefs consist of a spiritually based ethic that governs the interaction between the human, natural, and spiritual world (table 52). It encompasses a number of general principles and specific rules that regulate human behaviour towards nature (taboos, rituals, etc.) (Johnson and Ruttan 1992: 59).

Local people translate and categorize the information gathered in their interaction with the environment by referring to, and in terms of, the societies' beliefs about the nature of the Universe (Lovelace 1984: 197). TEK therefore is not only a system of knowledge and practice, but also a system of beliefs (Berkes 1993: 5). However, it should not be assumed, that all superstitions and myths conceal functional ecological concerns. Some certainly do, but the assertion that all do implies that the *only* preoccupation of local people would be with their natural environment. In general, wise and unwise environmental practices and valid and invalid environmental beliefs coexist in many cultures (Johannes 1993: 37).

Table 52: Comparison of indigenous knowledge and Western scientific knowledge

Comparison	***Indigenous knowledge***	***Western scientific knowledge***
Relationship to nature	subordinate	dominant
Dominant mode of thinking	intuitive (holistic)	analytical (reductionist)
Communication	oral (storytelling, subjective experimental)	literate / didactic (academic, objective, positivist)
Data creation	slow / inclusive	fast / selective
Prediction	short-term cycles (recognize the onset of long-term cycles)	short-term linear (poor long-term analysis)
Explanation	spiritual (the inexplicable)	scientific inquiry (hypothesis, laws)
Biological classification	ecological (inconclusive, internally differentiating)	genetic and hierarchical (differentiating)

Source: Wolfe et al. *1991, in: Lalonde 1993: 57*

According to Berkes (1993: 4), TEK does not aim to control nature, in contrast to scientific ecology. However, many traditional environmental management practices are aimed to prevent certain things from happening or influencing events and processes in a desired way. If the local people plant particular species in the corners of a rice field, they, in accordance to their beliefs, ward off wild pigs or evil spirits which would cause their harvest to fail. What is the difference to spraying a pesticide, which would be an appropriate measure according to scientific knowledge? Also if local farmers cut down certain plants within rubber gardens and let others grow, this means they decide about the desired composition of the garden by *controlling* the course of secondary succession.

6.6 Conclusions

The local people in the research area have a profound knowledge of the plants and soils of their environment. They probably are equally well-informed about other ecological factors, which have not been covered by this study. This kind of wisdom is typical for traditional shifting cultivating societies, because their survival still depends very much on their knowledge of the environment (cf. Conklin 1957, Howes 1980, Werner 1993).

Every plant occurring in secondary vegetation has got a local name and its uses are known. Local plant knowledge represents their own taxonomic system similar to the Western one. The fertility of different locations with their respective soils is clearly distinguished and taken into account when deciding which crops to cultivate (as described in more detail in chapter 4). Local people also often relate the abundance of special plants to soil features and fertility. The recognition of similar characteristics in other areas suggests that indigenous knowledge systems are widespread (Sandor and Furbee 1996: 1507).

However, knowledge about plants differs between the three villages. It seems to be related to the frequency and intensity people interact with their forest environment, which is distinct at the different research sites, too, determined by the dependence of the respective village economy on secondary or primary forest. For the same reason, ecological or plant knowledge is not evenly spread within the population. Some people know more than others, mainly related to their frequency of activities in forested land, especially for collection of non-timber forest products.

The farmers apply their TEK for the selection of upland rice fields. A prospective field has to fulfil several criteria, depending also upon its intended purpose. Not all factors taken into account are purely ecological. The need to cultivate their land as a group causes families to select adjoining sites, as described above. Eventually some families may have to accept an inferior field in exchange for the neardby assistance of their neighbours. Therefore an understanding of the management system is only feasible, if economic, symbolic and institutional aspects are taken into consideration (Aumeeruddy 1994: 35).

7. Understanding TEKMS for an Improved Communication in Nature Conservation Projects

As a signatory to the Convention of Biodiversity, Indonesia has demonstrated its acknowledgement of the importance of nature conservation. The national goal to protect 10 % of its land surface until the year 2000 also proved that the Indonesian government realized that more and more primary landscapes become converted to agricultural lands, large scale tree crop estates (especially oil palm), and timber plantations in the course of development, and that there is a need for the protection of the rich and typical ecosystems of the country as a national heritage. Also the recognition of the Indonesian government for increasing local participation in natural resource management is growing, although it frequently has not yet been realized in practice. The information and understanding about the existing and potential forest management skills of local people, however, remains scarce (Momberg *et al*. 1996: 3). Therefore, recognition of the role of local communities in nature conservation is low and there has been little use of indigenous knowledge and technologies in related projects, including ICDPs (UNEP 1995: 7, Wells and Brandon 1992: 33).

Consequences of not employing TEKMS. The environment, social life and rural economy are all inseparable aspects of the daily life of rural people. Traditional natural resources management systems are not just economic options, they are intrinsically part of a community's cultural identity. When scientists and development experts detect a problem within one aspect and suggest a solution, feasibility studies and impact analysis are usually restricted to this particular problem. When the realization of the suggestions fails, one major cause is usually that the project was not adapted to local needs. This results in a waste of resources and disappointment for both project workers and villagers. The reason for the failure can often be found in a difference of perception by the local people, which had not been taken into account. This is not always a matter of preferences, but frequently also a matter of local expertise on environmental features, which had not been realized by the short-term scientific survey on which the suggestion had been based. An analysis of 23 ICDPs in 14 countries concluded that most projects were designed without sufficient understanding of the local socio-economic context, and consequently, little knowledge about the threats to the conservation areas they were seeking to protect (Wells and Brandon 1992: 9, 13).

When farmers' knowledge systems, resources and practices are suppressed due to being considered of little practical value by extension workers, resistance towards development programs occurs (Ashley 2000: 20). Farmers in North Thailand, the Philippines and sub-Saharan Africa were found to reject extension due to a different problem view and different criteria by farmers and researchers (Pahlman 1991: 24p, Tung and Alcobar 1991: 27, Critchley 1991: 52). Soil conservation techniques that just addressed researchers' priority - environmental sustainability - and not farmers' needs such as food, income, productivity, labour or availability of planting material needs were, therefore, not accepted. Thai peasants furthermore preferred extension for farming practices that were based on existing practices rather than replacing them. For developing and extending farming practices, which are appropriate in the perception of the local people, the whole community should be involved[1] (Pahlman 1991: 26). This experience can also be transferred to local development projects in general. The importance of basing technology on farmers' traditional systems has been mentioned by several authors before (e.g. Weinstock 1984b, Reij 1987, Szymanski *et al*. 1998: 4, Leeuwen 1998: 19).

Most current project planning and management approaches integrate local participation to a certain degree. Participatory planning tools, such as PRA and community mapping, however, have been designed by social scientists and development experts, which is probably the reason why their focus is limited on the socio-economic and management aspects of rural life. A lack of ecological understanding by project workers, combined with a lack of awareness of TEKMS, however, has dangerous consequences in projects concerned with agriculture and nature conservation: when they address problems such as environmental degradation, encroachment or poaching, project workers never know, whether they are talking about the same thing as the farmers. So how can they make sure relevant factors get addressed and appropriate solutions are found? The answer is: most probably, they can't. Nevertheless, besides the scope it provides, the application of TEKMS still faces many obstacles. The following sections will analyse both the possible contributions of TEKMS, as well as its limitations, both concerning practicality as well as the enabling environment.

7.1 A New Scope for Mutual Understanding and Communication

Considering the experiences mentioned above, this study postulates the necessity of the integration of TEKMS into development and conservation, both research and practice. In the context of Kerinci Seblat National Park, this study has assessed exemplarily the agroecosystem and associated land use practices as well as folk taxonomies of soil and vegetation and related perceptions of nature. The results enable an improved planning mechanism for villages in the park bufferzone, because project

[1] In the sense that local farmers are not only middle aged and old men, which are usually approached by project workers.

workers can better relate to the outcome of participatory planning and local data assessment as well as communicate their own perceptions to the local community.

According to Aumeeruddy (1994: 20), "indigenous classification systems should be taken into account by conservation managers for any activity in the peripheral zones of the park which entails partnership with the inhabitants". Also Johnson (1992: 12) emphasizes the relevance of traditional knowledge for contemporary natural resource management as well as for conservation education in and around protected areas. Scientists and government agencies should be more open towards traditional ecological knowledge, which they often regard as fatalistic and superstitious. Instead of bringing ready-made solutions, they have to stimulate development of existing knowledge and critical analyses of community members themselves (Leeuwen 1998: 19). However, because local people's functional ecological concerns and conservation strategies are often concealed by spiritual explanations, traditional knowledge cannot be properly understood if it is analysed independently of the social and political structure, in which it is embedded.

TEKMS in current project practice. Although at least agricultural research has encountered increasing integration of TEKMS, general development practice still remains relatively untouched by this. Projects carried out by international development agencies do at least employ methods to ensure local participation, which does not necessarily include local knowledge, however. Government projects still do none of these. Also within international projects in general the division remains between research on the physical aspects of the environment and land use on the one side and on anthropological and socio-economic aspects on the other.

Environmental protection endeavours like the ICDP Kerinci-Seblat also still follow this general division, having separate components on nature conservation and rural development. While this might also be a matter of sheer feasibility, it still represents the general division between responsibilities and disciplines, resulting in a mental scientific boundary, which in real life does not exist. Consequently, in the diagnostic study of KSNP boundary villages, TEKMS has not been studied. The section of the report on local peoples' perception, attitude and responsibility towards nature conservation does not mention any aspects of it (see Perbatakusuma and Rufendi 1993: 41). Such divisions arise when projects are designed according to an 'exclusive' management approach, commonly adopted in the US, intending of de-coupling the interests of local people from the protected area – as opposed to the 'inclusive' approach frequently adopted in Western Europe, where the well-being of those living and working in national parks must always be a first consideration (Borrini-Feyerabend 1996: 4). An approach based on the sustainable livelihoods framework which puts people (and with them their whole land use system, culture, values, needs and strategies) at the centre of any study, planning or management process would be more able to take into account how traditional land use systems often have a thoroughly integrated, holistic approach. These systems combine short-term production with long-term conservation aims, i.e. the possibility for production of future generations. Many development projects start thinking in a compartimentalised way (according to classic disciplines or specializations) and then afterwards half heartedly try to reconstruct an artificially integrated approach. Why divide first to then unite again?

Benefits of employing TEKMS. TEK and scientific knowledge, both endowed with strengths and limitations, offer a stronger basis for decision making when taken together (Inuit Circumpolar Conference 1996: 8). Because of their different information base, the two knowledge systems allow for an increased effectiveness of protected area management when taken together. While the capacity of scientific knowledge for nature conservation is widely known and documented, the potential of TEK has just begun to find recognition. Local people are benefiting from generations of knowledge and experience in living in direct contact with mammal, fish and bird species of their tropical rain forest environment. As such, they have the empirical knowledge to address key principles in the wildlife-management process, at a time when scientific information on many species and most populations remains limited and fragmented. Locations of rare and endangered species are more likely to be identified by local resource users involved in such mapping exercises than by outside researchers doing site inventories. Therefore TEK can be very valuable for environmental impact assessment and wildlife management (Johannes 1993: 34). The employment of existing knowledge can also prevent projects from "spending time and money to reinvent the wheel": frequently TEKMS are more appropriate for a certain area than formal technologies could ever be (Leeuwen 1998: 13).

In many cases, traditional communities have "a great store of environmental knowledge and a long tradition of conserving biodiversity" (Barber 1996: 19). Nevertheless, local resource use might not always be compatible with nature conservation. Therefore it is important to understand the ways that indigenous knowledge provides the basis for local-level decision-making for both individuals and groups (Warren 1991: 2). Additionally, for changing local resource use patterns into more park-friendly activities, an adequate knowledge of the social, economic, biological and cultural factors shaping this pattern is necessary (Wells and Brandon 1992: 28). To enable a successful integration of local people into park protection, their traditional knowledge should become part of the conservation concept. TEKMS can be more than an additional value to conservation strategies, which are still largely based on formal knowledge. Despite the inherent differences between traditional and scientific knowledge systems, innovative mechanisms are being sought by scientists such as anthropologists and development planners to integrate both systems effectively in order to facilitate sustainable natural resource management planning. The learning process envisioned needs to be two-way: some important aspects of nature conservation are absent from the people's list, simply because they have no experience of their value. One example was the lack of awareness of a need for grazing control in a study of Lusigi (1983[2]). The improved communication between local people and project workers, therefore, also provides an opportunity to integrate scientific knowledge in solutions for problems that TEKMS are incapable to cope with.

Care must be taken, however, that TEK such as the knowledge of medicinal plants is not exploited for the mere use of academics and pharmaceutical manufacturers. Benefits resulting from the use of TEK have to be distributed equally and the intellectual property of local people has to be protected by law. In case of an insufficient legal framework, appropriate *ad-hoc* contractual agreements or regulatory agreements must be ensured. The local communities should decide which of their ecological knowledge could be relevant for protected area management and how it should be applied and protected. The traditional knowledge collected, which is often specialists' knowledge, should also be further disseminated in the local community to be actively used by the people (Johnson and Ruttan 1992: 61). Local communities could also carry out further environmental research to extend their knowledge and capabilities to actively participate in nature conservation.

Better communication is possible. When Dusun Birun farmers, for example, prefer cassiavera cultivation on land far from the village, the result is encroachment upon KSNP. Besides other factors causing encroachment, this behaviour also has soil related reasons. At a certain distance of the village the soils are influenced by volcanic ash, making them more fertile. In a study of Bellon and Taylor (1993: 780) in Chiapas, Mexico, farmers' perceptions of soil qualities on their land significantly shaped the adoption of high yielding corn varieties. Because the local soil taxonomy reflects scientific soil properties, corn varieties also performed differently on the separate soil types. Agricultural extension had not taken soil differences into account, blaming the inconsistent adoption on the farmers. These examples strongly support the need for a study of local environmental classification (see box 9).

If project workers have no basic understanding of the soils of an area and the related local perceptions, problems cannot be addressed properly. To understand the "logic" of a local

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[2] As cited in West and Brechlin 1991: 397.

classification, such as the soil classification, scientists or project workers first have to study the concerned aspect of the environment using the scientific taxonomy (Müller-Böker 1988: 103).

Box 9: Why study how local farmers classify their environment?

The study of classificatory behaviour of local farmers with regard to soils helps us to understand how they perceive different soils and on what basis they divide soils into different categories. Unlike in the past, efforts in this direction should be focused not only to identify the number of soil classes in a local soil classification, but also to examine the criteria of classification[3], understand the basis of categorization and determine how all the criteria considered in local soil classification may affect soil management. Thus, identifying the numbers and types of classificatory units is only a means to find out agro-ecological and socio-cultural dimensions of local soil classification (Talawar 1996: 4).

Experiences in rural Zambia confirmed the problems of conventional research and extension. Therefore Sikana (1993: 15) stated that it would be easier for researchers and extension workers to communicate with farmers if local soil categories could be related to the scientific classification. Additionally, an understanding of TEKMS by extension workers increases the effectiveness of communication through allowing for a proper use of vernacular terms in relation to explanations rooted in the formal knowledge sector (Warren 1991: 26).

A step in the right direction has been taken by the Cambodia-IRRI-Australian Aid Project with their soil manual based on local soil types (White *et al*. 1997). Also Sikana (1993: 16) advocates the systematisation of local soil property descriptions in terms of advantages and limiting factors into general principles, on which research and extension could be based. Most soil scientific research recommendations, however, still do not communicate information about soils to farmers, but only to scientists, because they are based on a technical classification system that has no relation to farmers' soil characterisation. Farmers' soil classification serves the requirements of extension services better than genetically oriented soil maps, because the choice of crops and soil management practices correspond better to soil suitability classes than to soil series or orders. Consecutively, extension messages can be more finely tuned (Habarurema and Steiner 1997: 85). By this, the use of TEKMS can facilitate the dialogue between farmers and project workers, allowing both knowledge systems to complement each other.

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[3] Criteria can include color, texture, geomorphological location, consistency, vegetative indicators, water retention and permeability, possible inundation, presence of rock, crop suitability and fertility (Talawar 1996: 6).

How to assess TEKMS for project practice. Incorporating TEKMS into planning allows culture and belief systems to direct the ways in which information is collected and used (Szymanski *et al*. 1998: 4). Several instruments can be used to learn about the social, economic and human-ecological characteristics of communities living at the fringe or within conservation areas as well as their pattern of interaction with the forest. Two of them are Participatory Rural Appraisal (PRA) and participatory mapping techniques (Momberg *et al*. 1995: 2).

PRA consists of semi-structured interviews, participant observations, time lines, trends and changes, ranking, transect walks and sketch maps (Dias and Indiani 1996: 23). To quickly assess the local environmental categories present, within PRA, it is particularly land use transects providing scope for learning about TEKMS. This instrument is usually applied for the distinction of major zones of land use and topography, but it can be used for the collection of still more data (see box 10). Different aspects of TEKMS, however, are important in different villages. The scope of an assessment is therefore dependent on local problems and circumstances.

Box 10: Why do local people manage their land as they do?

Factors to be assessed:

- Land availability and ownership distribution[4]
- Local regulations for environmental protection
- Land use system (structure, seasonality, management practices)
- Development trends of local land use
- Agroecosystem (agroecological zones, soils, vegetation, geomorphology, etc.)
- TEK (agroecological zones, soils, vegetation, geomorphology, etc.)
- Adaptation of management practices to environmental features
- Used secondary and primary forest species and the intensity of their use (i.e. forest dependence)

Project members with a formal ecological training can roughly assess local soil and vegetation types of the different land use systems during transect walks as well as elicit related traditional ecological categories. With the assistance of farmers, Bellon and Taylor (1993: 781) found local soil

[4] Socioeconomic and cultural factors such as tenure or inheritance patterns also play a role in land use classification and decisions. Therefore, the land use pattern is as much socio-economic and cultural in nature as it is ecological (Talawar 1996: 15).

taxonomies "relatively easy to learn, and data on soil quality easy to collect". By this, a comparison of the local environmental classification with scientific assessment is possible, allowing for a 'translation' and consequently communication about the matter between farmers and project workers. Also resource management problems and opportunities of the respective areas can be assessed as well as discussed with local experts during the transect walks. This includes problems such as areas with low fertility or those degraded by fire. The method encourages viewing community problems and opportunities from a spatial perspective (Momberg *et al*. 1995: 6 p.).

Because it is best to discuss environment-related matters on-site, other ecological questions can also be addressed during transect walks. These include matters related to environmental perception and awareness. If, for example, the black soil is considered more fertile than the red one, do farmers see any connection between the two types, or not? In Pemunyian, there was no awareness of the – scientifically observed – fact, that red soil is nothing but degraded black soil. If wanting to talk about environmental problems and develop solutions together, these differences and limits in perception are important. The knowledge and vision of the farmers may enrich those of the project workers, and vice versa, which is the first step towards participatory planning and management of conservation areas involving TEKMS.

Another, more time-consuming approach for studying TEKMS is Continuous Rural Appraisal (CRA). In this approach, project workers participate in village life during the whole project period, enabling them to learn about TEKMS. While the continuous support and appreciation of their knowledge system motivates the local people, it also creates awareness and understanding by the project workers (Leeuwen 1998: 19). This improves the appreciation of local people for the latter and the confidence of the community in the project. CRA can best be employed as an approach for TEKMS assessment in conservation projects where NGOs are involved at village level. In ICDP-KSNP, the Village Conservation Facilitators from WARSI permanently stationed at village level should make use of CRA. The Local Community Organizer assisting VCFs can also advise them on TEKMS. To enable communication about ecological features, however, VCFs would additionally need a scientific ecological education.

To get a more complete picture of the distribution of local environmental categories within the agricultural landscape, the method of participatory mapping can be used. The methodology is also based on PRA techniques. As part of it, local people map village boundaries and current land use/ownership, evaluate the capability of their lands, and through a participatory decision making process, zone lands for various forms of agriculture, common use areas, traditional use zones in the park, and conservation areas. To include TEKMS, the ecological categories received from transect walks described above within participatory mapping are applied to the mapping units. By this, maps of local soil and vegetation types, geomorphological units as well as of, for instance, locally classified environmental problem areas can be obtained. The combined methodology can help to derive both the scientific as well as the local perspective of ecological constraints of present resource management systems. These two views can then be discussed between villagers and project members, providing scope for a mutual understanding of the respective perspective. As a result, a widely accepted solution for problems can be facilitated.

Scientific vegetation mapping combined with the assessment of local vegetation classifications has been carried out before in West Kalimantan (Werner 1993). Within the WWF Kayan Mentarang Project, East Kalimantan, participatory village mapping was integrated with vegetation mapping, following cognitive vegetation classes obtained through the mapping process (Momberg *et al*. 1995: 16). Another example for the application of this kind of mapping is represented by the work of Hrenchuk (1993: 73). In his research among Native communities in Manitoba, Canada, he created composite thematic maps of community use to determine the use and occupation of the area by the community within living memory. The location of hunting, fishing and trapping resources, local place names, the sites of residency, the travels of community members, and areas of preferred use were mapped through individual map biographies. This kind of research could also be useful to map the extent of community use within primary forest in general and within the KSNP in particular, first, to define the dependence of local people upon the resource, and second, to assess the impact upon the ecosystem. Nevertheless, it must be mentioned again that the study of TEKMS must always be integrated into the larger set of factors influencing the local land use rationality. These include, among others, legal factors such as land ownership as well as socio-economic factors and values.

Another tool is participatory inventory of natural resources by which communities identify the species of plants, animals, mushrooms etc. within their customary land, estimate the available quantity and quality of those resources and describe their different uses[5]. With proper facilitation the process serves not just as an assessment of a community's natural resources pool but also to initiate discussions among its members about long-term trends, sudden changes and seasonal or other fluctuations in the availability of those resources. The NGO Pancur Kasih in West Kalimantan is experimenting facilitation of this, usually as a post-mapping activity and a first step to facilitate a community towards a shared long-term management plan of their resources.

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[5] See Stockdale and Corbett (1999) for a field manual for this approach.

How to integrate TEKMS into planning and management of natural resources. Besides work on agriculture, where this demand is already more common, also some studies concerned with nature conservation are already talking about "building on local knowledge" (e.g., MacKinnon 1997: 60). However, little attention is given yet to the methodology that should be applied for the incorporation of TEKMS into conservation practice. Pimbert and Pretty (1995: 30) suggest that professionals have a better access to information at the macro-level through geographic information systems as well as worldwide electronic communications networks and data banks. At the micro-level, conservation scientists have accurate identification techniques and taxonomic skills. However, local peoples' knowledge of their watersheds, forests, rangelands, coastal strips and wetlands gives them distinct advantages at the meso-level at which the protected area management is ultimately aimed.

"Local residence implies a degree of sophistication about what goes on in the neighbouring social and biological spheres that defies the professional trappings of outside managers", says Marks (1991: 356). Local communities need this knowledge to secure their livelihoods and sustain the diversity of natural resources on which they depend. This involves also a tradition of vernacular conservation. "Adjustment process, and fine tuning, ecological wisdom and oral culture ... must be given recognition, if projects are to become meaningful locally" (ibid). The study of both TEKMS and agroecosystems described earlier provides the instrument necessary to communicate with local people about these features. Consequently, local knowledge can become part of the park management scheme.

New scopes for nature conservation. The sharing of authority and responsibility for the management of a specific area or set of resources between the government and local communities is called co-management. The partnership may furthermore include non-governmental organisations and other resource users and stakeholders (Berkes 1995: 140, IUCN and WWF 1998: 1). Under this management scheme, the government provides administrative assistance, scientific expertise and enables legal arrangements for communal access to biological resources. Local resource users, on the other hand, contribute knowledge of traditional management systems and practices developed from their extensive experience in the local environment. One characteristic of a typical co-management strategy is the combination of scientific knowledge and traditional environmental knowledge (IISD 1998: 1).

Co-management is not a new concept. Partnerships for resource management are already present in various forms in many countries[6], and exhibit both potentials and limitations. Although a certain degree of co-management is essential in most cases, the approach is not applicable in situations that require rapid decisions and actions, such as in cases where the fast ecological deterioration of an area has to be blocked. The most important feature of co-management of protected areas is that it does not employ blueprint prescriptions, but that through learning-by-doing the project approach is tailored to the specific local conditions and its historical and socio-political contexts (Borrini-Feyerabend 1996: 15). Therefore there is no ‘right place’ to be in the participation spectrum, which ranges from active consulting to transferring authority and responsibility. Different management arrangements always contain potential advantages and pitfalls for conservation. When local institutions exercise full control, powerful individuals may be co-opted them for their personal interests, whereas when control is completely in the hands of public agencies, TEKMS are unlikely to become recognised, for example. Management partnerships therefore build on the complementarity of the different roles and capacities of the separate stakeholders. Because communities are often not used to co-management with neighbouring communities, local land tenure disputes can interfere with regional management strategies (Leeuwen 1998: 22). It is advisable to pursue a management partnership when one or more of the conditions listed in box 11 apply.

Co-management tries to harmonize different stakeholder interests, assuming that it is possible to manage protected areas in an effective way while treating the relevant people with respect and equity (ibid: 16). Therefore these locally-negotiated conservation programmes may be more sustainable in the long-term than current projects. The applied system of participatory learning and interaction, which are part of the process-oriented project approach also implies new roles for conservation professionals (Pimbert and Pretty 1995: 30pp). Their attitude should change from teachers to facilitators (Leeuwen 1998: 30). Because these conservation projects rather involve an open-ended learning process than a pre-specified project design, protected area management is regularly reviewed by all relevant stakeholders and improved in accordance with the experience gained since. Regular monitoring of project results are a precondition for this “learning-by-doing”.

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[6] See Borrini-Feyerabend (1996: 11 pp.) for examples.

Box 11: Conditions, under which co-management in nature conservation is advisable

o	when the active commitment and collaboration of stakeholders is essential for the management of the protected area (e.g., when the reserve's territory is inhabited or privately owned);
o	when the access to the natural resources included in the protected areas are essential for local livelihood security and cultural survival;
o	when the local stakeholders have historically enjoyed customary/legal rights over the territory at stake;
o	when local interests are strongly affected by the way in which the protected area is managed;
o	when the decisions to be taken are complex and highly controversial (e.g., different values need to be harmonized or there is disagreement on the ownership status of the land or natural resources);
o	when the agency's previous management has clearly failed to produce the expected results;
o	when the various stakeholders are ready to collaborate and request to do so;
o	when there is ample time to negotiate.

Source: Borrini-Feyerabend 1996: 9.

As a result of local vested interest, village control over resources may be more effective to halt their degradation. A central principle of co-management is, therefore, linking management rights and responsibilities (Borrini-Feyerabend 1996: 16). Nevertheless, although many traditional societies have an intuitive understanding of conservation and ecology, the idea of a strictly protected area is a novel one to most of them (Sanjayan *et al*. 1997: 16). In Kalimantan, however, many Dayak communities reserve a part of their ancestral forests as untouchable, where any kind of extraction or exploitation is forbidden. This is related to mystic or religious beliefs, which are linked to their local equivalent of the Christian genesis. Often these areas "happen to be" of crucial ecological value to the whole watershed the community's natural resources depend upon[7].

A difference in conservation ethic between local people and conservation professionals involves that the former protect land for use rather than from use (Pimbert and Pretty 1995: 39, Barber 1996: 12). Employing full participation in project planning and design could, therefore, well mean having to compromise on biodiversity conservation. This might be necessary in many parks anyway, where areas of traditional use tend towards a patchwork rather than a "doughnut" pattern, the idealized model of limited economic activity around a "core" of strict protection (Barber *et al*. 1995: 50).

[7] Eva Garçia-Castañer, DFID, personal communication October 2000.

A major part of the world's protected areas do not conform to this idealized model: about half of existing protected areas have people living in them (Borrini-Feyerabend 1996: 3). An alternative approach for the remaining settlements inside park boundaries in general and KSNP in particular could involve "to abandon the long term goal of managing for pristinity and instead manage to stabilize a biodiversity rich landscape mosaic which includes permanent plots of smallholder plantations" (World Bank 1998: 9). This also means a need for conserving biodiversity and biological resources within agroecosystems, in the sense of bioregional management. The aim is balancing local people's basic needs with the potential of natural resources in their bioregions for achieving harmonious and mutually dependent sustainability of society and the environment, as defined by ecological, economic and social criteria[8] (Miller 1996: 8, 12p). Also West and Brechlin (1991: 399) suggest to not always prioritise protection objectives over resident people's needs. Protection efforts should focus on critical regions with peak populations and may compromise with human use in other areas. Where maximal biodiversity conservation is envisioned, however, full protection might be necessary, allowing for no exploitation. Conservation and utilization are not compatible in all cases (MacKinnon 1997: 58).

If people have a stake in the long-term survival of forest resources, biodiversity may not be maximally maintained, but the ecosystem should be sustainable with local cooperation (Uphoff and Buck 1997: 20). Local people should be treated as partners in conservation and development. A successful example for this is the CAMPFIRE program of Zimbabwe, which has attempted to promote the sustainable, legal use of certain wildlife species by small, homogeneous communities in order to provide both employment and cash[9]. Harvests are determined by ecologists of a nongovernmental trust. Realizing the long-term benefits of healthy wildlife populations via their ability to generate revenues, local people developed a sense of "ownership" over wildlife (Barrett and Arcese 1995: 1074).

Another successful example is that of Arfak Mountains Nature Reserve in the Bird's Head of Irian Jaya. Following maps and without village consultation, the Indonesian authorities were planting concrete markers along the eastern boundary of the reserve. As a result, some village lands and gardens of the local Hatam people were included within the reserve. In the western part, the Hatam developed a management strategy with the WWF that would enable them to continue their

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[8] Already in Australia, California and Western Canada, the bioregion is the unit of planning and management (ANZECC 1994, in: Miller 1996: 4p).

[9] Kiss (1990), in: Barett and Acese 1995: 1074.

traditional collecting of resources within the reserve and retaining enough land outside of it for future subsistence needs. In exchange, the Hatam marked the western boundary, to which all had agreed, without pay and act as guardians against infringements. While the government's markers were removed or ignored, the villagers respected the western boundary (Mandosir and Stark 1993[10]).

Need for further research. Because a comprehensive study of TEKMS and agroecosystems can be very time consuming, it will not be reasonable to base all projects on detailed research of local knowledge and the environment. For practical use within nature conservation, therefore, rather a method for exploring the potential of both the environment and TEKMS should be developed, in which project workers and extension personnel are trained.

As already mentioned, the author suggests integrating the assessment of TEKMS and the local environment into the process of participatory mapping and PRA. Before any integration can be successfully instrumentalized, however, there needs to be more research and practical experience. This includes particularly further research on how to adapt the study of a field as complex as TEKMS and agroecosystem research for project needs, without losing its meaning. One possibility would be to develop a catalogue of environmental aspects as well as related questions towards both TEK and scientific knowledge. Resulting, the aspects and questions relevant for the respective project can be selected. Additionally, the participatory inventory of natural resources can be developed as an excellent communication tool when coupled in-field with scientific ecosystem analysis.

Constraints. It seem to be impossible, however, to assess all aspects of TEKMS with a "quick-and-dirty"-tool such as PRA. Two particular features are local wisdom of plants on the knowledge side and area-related information on the management side of TEKMS. The latter includes all area-related properties of fields, gardens or forest like trees per area, yield per area or inputs per area. The simple reason is that land is not titled and therefore has never been measured. Farmers only know about their harvest but, even when employing local measuring standards, an exact knowledge of land size does not exist. To receive information on yields or trees per area, for instance, one

[10] As cited in MacKinnon 1997: 53.

possibility is to measure the land, which is very time consuming. Participatory mapping techniques that include the use of GPS allow for a quicker measurement and calculation of field size[11].

Also for the study of local plant knowledge, a different and more complex research approach is needed. Exploring local botanical taxonomies involves the collection of samples within the land use system or forest, the establishment of a field herbarium, and the consecutive botanical determination of the species involved. To elicit the local botanical taxonomy, both work with key informants as well as with a wider village audience for the confirmation of the terminology, is necessary. While the study of botanical names and taxonomies is mainly translation work, the investigation of the local perception of plants is more difficult. It demands for the evaluation of the experiences made during joint plant collection with the local people, comparisons, observance and questions about external and self-assessment (Müller-Böker 1988: 121). These difficulties highlight again the importance of being aware of the priorities of Western science and local communities. While the former focuses mainly on biodiversity and taxonomy, the latter rather are interested in utility. However, not all aspects of TEKMS will have to be taken into account for each conservation project. The study on local botanical knowledge, for example, might only focus on certain parts of it, such as the site requirements of trees, technical propagation methods, planting techniques or local plant uses.

7.2 Constraints for Increasing Local Participation in Nature Conservation Projects

The suggested integration of TEKMS into park planning and management in Indonesia is hampered by a complex set of factors, which will be described in the following section. The first set is related to the relative limitation of participation *per se* within ICDPs. The second set of constraints is more basic, as it concerns the political setting and priorities in Indonesia. Finally, legal divergences between national and customary law cause long-standing, unresolved conflicts between local people and the national administration.

The limits of participation by project design. Notwithstanding the declared participatory approach of ICDPs in general and ICDP-KSNP in particular, the primary target of the projects is still nature conservation. Therefore, although the approach used by the ICDP-KSNP to involve local communities is already a large step forward, the scope for participation is limited. People are

[11] Expert mapping of the land of one village takes about two weeks. In the frame of participatory mapping, where a socialisation of the idea, as well as basic training in GPS and mapping for the communities are included, the process takes between one and three months for a village (Eva Garçia-Castañer, personal communication, October 2000).

empowered in aspects of development, including local resource management that do not lead to overexploitation of the protected area (Wells and Brandon 1992: 47). Local communities join in finding a commonly agreed upon park boundary, but have no choice to refuse it. They may decide upon land use in the bufferzone, but with the rules set beforehand by the ICDP.

Socialization is applied to inform the local people of the target and function of ICDP. Community organizers are trained to enable people's participation in project activities through information about ICDP-KSNP, and PRA is applied as a method to assess local problems and aspirations (WWF 1998b: 4). Consecutively, village development activities in the infrastructure and agricultural sectors are proposed through the usual village planning process, but involving technical assistance from the ICDP (Schweithelm 1994: 21). The target is mainly to protect the park by helping the inhabitants of the boundary villages in finding alternative land uses and income opportunities, which do not entail opening new fields or unsustainable exploitation of non-timber forest products.

Park managers hope that the development of economic alternatives will enable villages to be independent of park resources, and that education convinces the people of the benefits of maintaining the protected area. Where village facilitation can no longer help, enforcement picks up. It is unclear, however, whether local people may also enforce that the park management keeps its part of the contract. The role of local people in park planning and management is determined from the beginning, with little scope for decisive changes. Unsurprisingly therefore, project documents speak of a "consultation with local stakeholders" (Kerinci Seblat National Park 1999a: 3), which gives a clear picture of the real scope of community involvement. The participation of local people by "forming groups to meet predetermined objectives related to the project" has been termed "functional participation" by Pretty (1994[12]). In this kind of involvement, major decisions have been made before local people join in. Frequently, as within ICDP-KSNP, the ICDP is established long after the park's existence. This means, prior, mostly exclusive, top-down conservation practices already had an impact on the boundary communities, eventually building a negative attitude towards the park. Conservation projects adopting a participatory approach have to make considerable efforts later for winning back the trust and confidence of the sceptical local populations[13].

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12 As cited in Pimbert and Pretty 1995: 26.

13 In the Gorkha Development Project in Nepal, the top-down approach previously employed by other projects had created suspicion and mistrust against development measures, encouraging the participating communities to focus on their possibilities for personal profit (Leeuwen 1998: 15).

“Interactive participation”, on the other hand, means that local people “participate in joint analysis, which leads to action plans and the formation of new local groups or the strengthening of existing ones...These groups take control over local decisions, and so people have a stake in maintaining structures or practices” (ibid.). Also Wells and Brandon (1992: 42p) view local participation as a process that goes well beyond simply sharing in social and economic benefits, as common in most ICDPs. Simply giving people benefits reinforces a psychology of dependence or “cheap compensation” among them that is antithetical to genuine development. Bringing local people into the effort as partners from the outset, on the other hand, promises to result in more sustainable solutions for achieving both conservation and development (Uphoff and Buck 1997: 9p).

Participation should also include a consistent involvement of local people in strategic project issues rather than their occasional or limited involvement in day-to-day activities. This means, cooperative natural resource management instead of “incorporating local people into program design” (Macdonald *et al*. 1993: 25). The disadvantages of a wider involvement of local people are that it is less controllable, less precise and so likely to slow down planning process. Stage-managed forms of participation implemented due to the fear of these disadvantages, however, result in distrust and greater alienation (Pimbert and Pretty 1995: 25). This makes it more likely that communities will side up with or at least serve and not oppose outsiders who deplete the forest (i.e. they may want to act as cheap labour for financial backers of illegal logging, instead of banning them). Also Dove (1986: 22) states, that a consultation in form but not in substance would not yield any benefits, but would only make the local people angry instead. The formal involvement of constituencies to deflect conflict without granting power has been called “formal cooptation” by Selznick (1949[14]). As a final consequence of the disrupted state of relations between the local people and the project management could be growing suspicion of the very purpose of the projects and the motivation of the management, which could be interpreted as self-interested (Dove 1986: 17). This is particularly true for Indonesia, where law enforcement is sluggish and rampant forest destruction often highest in so-called protected areas. On the other hand, when people’s ideas and knowledge are valued, and power is given to them to make decisions independently of external agencies, all the evidence points to long-term economic and environmental success (Pimbert and Pretty 1995: 26). Because currently the forest service is dysfunctional, lacking both the technical capacity and the legal autonomy to enforce protective measures against loggers, the reality means either engaging communities in nature conservation or not engaging anybody at all.

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[14] As cited in West and Brechlin 1991: 396.

To achieve a land use planning and generation of alternative income opportunities which optimises the utilization of local capabilities and potentials, it should be based on TEKMS. Within the ICDP-KSNP empowerment of local people takes place through their participation in land use and development planning. Nevertheless, people do not contribute their knowledge about the environment to park management.

> ”People in and around protected areas should no longer be seen simply as informants, but as teachers, activists, extension workers and evaluators. These local specialists include village game wardens, beekeepers, village veterenarians, herbalists, wild food collectors, fisherfolk, farmers, pastoralists, and so on. An emphasis on village specialists and different resource user groups allows their skills and knowledge to shape protected area management priorities” (Pimbert and Pretty 1995: 30).

The limits of participation by political environment. In Indonesia in general and KSNP in particular, both the administrative and legal environment in Indonesia as mentioned within chapter 3.1.5, and the divergent stakeholder interests causes obstacles to nature conservation. This is in accordance with the findings of Wells and Brandon (1992: 6), that many of the factors leading to the loss of biodiversity and the degradation of protected natural ecosystems originate far from park boundaries. As described in chapter 3.2, there are unsettled conflicting interests within departments (Ministry of Forestry and Estate Crops versus one of its directorates, PHPA), between departments and between administrative units (central government, province, regency) as well as between provinces and regencies. Due to a lack of executive conservation regulations, weak position and restricted facilities of PHPA as well as overlapping spheres of authority, protecting conservation areas remains difficult. The presence of other economic stakeholders (forest concessions, mining companies, farmers, agents of illegal forest exploitation) adds to the pressure factors. No matter how well designed and executed, an ICDP will not succeed, unless it is supported by integrated conservation policies and institutional initiatives (Barber *et al.* 1995: 4). To ensure KSNP conservation, “a fully integrated conservation and management strategy for the park and its environs, developed in the context of regional development plans and involving all intersectoral agencies” would be needed (MacKinnon 1997: 51).

Besides the factors restricting nature conservation in general, the lack of active community participation in nature conservation is mainly due to the current development paradigm in Indonesia. This includes the perception that traditional cultures and lifestyles are signs of underdevelopment and obstacles to necessary socio-economic advancement (Dove 1988: 5), and a top-down planning and implementation mechanism. Local communities are primarily perceived as a potential threat to the protected area. Resulting, indigenous knowledge, the role of local people in maintaining biodiversity, as well as traditions and insights about the environment are widely ignored in development projects of Indonesia, which as a result are alienating local communities (Fisher and Mulyana 2000: 124, Moniaga 1993: 7). This situation is common in many developing countries, where existing authority structures inhibit widespread participation in decision-making.

National governments may also limit the extent of local empowerment, when they perceive a threat to their own authority (Wells and Brandon 1992: 46). In Indonesia, development programs are mainly designed by national agencies and extended to the local level. Usually they serve ambitious "national development goals" and the interests of large scale companies, as well as the vested interests of a range of powerful stakeholders, including the armed forces who are legally allowed to pursue economic activities to compensate their insufficient financing through the state budget. While the national development planning system in theory includes a bottom-up process, in practice only about 20 % of the projects that are finally agreed upon at the highest planning level stem from the villages[15].

Participatorily oriented projects are therefore usually developed and implemented by foreign donor agencies and NGOs. While an increasing employment of participatory approaches among government agencies might only be a matter of time, it is still limited currently. It is therefore unrealistic to expect Indonesian government agencies to use TEKMS as part of a general planning and management instrument. As the formal legal landscape for community based biodiversity management is not very supportive yet (Barber 1996: 4), also more participatorily oriented conservation concepts such as co-management are not likely to become widely accepted under current political conditions. Maybe the Philippine' approach can set an example in this regard, as reflected by the statement of the former Director of the Protected Areas and Wildlife Bureau[16]:

> "People's participation, and the flowing back of the benefits of conservation into the local communities, are recognized as important elements ... Participation of local NGOs and people's organizations in the actual management of protected areas is to be encouraged through consensus-building, subcontracting management projects and, if appropriate and necessary, deputation of regulatory functions. It is important to note that the ancestral rights and lands of the indigenous cultural communities inside protected areas will be respected and recognized".

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15 Pieter Evers, personal communication 1998.

16 Catobog-Sinha 1994, in: Barber 1996: 8p.

To realize this community participation, in each nature reserve a Protected Area Management Board is created, including as members representatives of local villages and NGOs[17]. The board is involved in boundary delineation and demarcation as well as planning, protection and general management of the nature reserve. Borrini-Feyerabend (1996: 30) warned, however, that a direct representation of local people in a management body does not assure that their interests are taken on board by a majority vote. She therefore rather recommends an active consultation, leading to local peoples' interests being incorporated into the management plan. As one step towards more participative park management approaches in Indonesia, Dias and Indiani (1996: 27) suggest that the Village Conservation Facilitators of ICDP-KSNP assist in persuading the government "to devolve some responsibility in the management of resources to local communities who are demonstrating wise and careful use of those resources".

Legal constraints. As described in chapter 3.2.5, there is a difference in perception of ownership of forest lands. Originating from Dutch law, national legislation defines all unoccupied lands and all forest lands as belonging to the state. This accounts for ca 70 % of the total land mass of Indonesia. Local people, on the other hand, often claim these lands under customary law, because it has been inhabited and used by their community for generations. So-called "empty land" (*lahan kosong*) can be easily recognised in Indonesia as land where communities have clearly identifiable land marks that testify their use, such as fruit trees and other valuable trees, sanctuaries, graveyards. Up to now, the political overtones of the local land and resource rights issue together with the power of elite business interests rendered most initiatives for an official recognition of local land rights relatively insignificant (Barber 1996: 15).

The consequence of this conflict of perceptions is non-compliance of local people concerning state-imposed regulations and natural resource allocations at the local level, where the major costs of such developments are felt, states Hrenchuk (1993: 77). Decisions which are perceived as unfair, are partly due to the lack of consultation with the community concerning management or allocation of natural resources, are likely to result in resource degradation and pervasive sense of injustice among users. According to Pimbert and Pretty (1995: 38), rural communities will consider protected areas as lost village resources that are not worth caring for in the long-term, if they have no secure

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[17] In this respect, it is important to differentiate between "formal', government-initiated NGOs and independent NGOs. While not officially government agencies, the former usually support the government's development agenda, particularly in Indonesia.

rights of access to its resources[18]. There is a need to connect these divergent viewpoints. "Resource managers interested in compliance with regulations regarding resource use must become cognizant of traditional ecological knowledge, and of long-standing pattern of use and local control of resources" (Hrenchuk 1993: 78).

General considerations. Finally, it must also be noted that the project approach and participation pattern has to be adapted to the local socio-cultural setting. As TEKMS vary, so does the environmental impact of local natural resource use. Some groups live without eroding biodiversity, others do not (Sanjayan *et al*. 1997: 19). Also the ability or willingness to participate in nature conservation varies significantly both with and between locations (Wells and Brandon 1992: 43). It might also finally cause the cancellation of planned conservation projects, as happened in Mindoro island, the Philippines, where the local people chose not to participate because they did not agree with project design and planning process (Barber 1996: 8).

The great diversity of biological and social conditions under which conservation projects take place, prevent the development of unambiguous "blueprints" for these projects. Furthermore, experience with community-based biodiversity conservation is still limited, as this approach has not yet been widely employed. A documentation of existing local systems for biodiversity conservation and sustainable use would therefore make sense for governments and donors. Solutions and strategies for conservation might then be developed on their basis (ibid.: 14, 26).

7.3 Conclusions and Recommendations

The scope of this study was to investigate the possible contributions TEKMS can provide for development and conservation projects. The location of the case study was Central Sumatra's KSNP. The author found that a better integration of local people into project practice could be facilitated by an improved communication on environmental features, to which the integration of TEKMS could contribute. An understanding of TEKMS could also provide insights about the underlying factors for unsustainable exploitation through hunting, agricultural encroachment, burning, logging, or the collection of forest products (cf. Wells and Brandon 1992: 11), as well an appreciation of and learning from effective traditional systems of resource management (Borrini-Feyerabend 1996: 6). During research, however, it became obvious that besides traditional

[18] Another reason for communities refraining from protecting nature reserves is that they are witnessing their depletion by outsiders, particularly if government officials and/or the military are involved.

agriculture, a complex set of pressure factors upon KSNP exists, many of them more threatening and large-scale. The root of many of these pressure factures lies with political, administrative and legal problems, as mentioned before.

The elimination of inhibiting political factors allowing for a change of the current system of protected area administration might take longer than the time available for a conservation of the remaining forests. According to Garçia-Castañer [19] Indonesia’s forests will be gone in only five years, except for isolated patches in diverse states of degradation, if no new and successful conservation approaches are employed. In this context, regional autonomy represents both a threat and an opportunity. Local "champions" in the administration now have the freedom to exercise "discretion law" and use loopholes in the legislation in an innovative and creative fashion to generate alternatives to the current conservation paradigm. Foreign development assistance can contribute through supporting, enhancing and synergising these initiatives aimed at saving Indonesia’s forests, on which millions of people are depending for their livelihoods. Successful cases of improved community participation under integration of TEKMS can be used as a precedence to change development paradigms and natural resources management policy, including conservation, at the national level.

The major contribution of a combined application of TEKMS assessment and environmental analysis in planning and project process is to provide an understanding of both local and scientific ecological knowledge and local perceptions of nature to protected area managers. It also allows for mutual understanding between local people and project workers in general. This enables them to communicate more effectively about nature and land use practices, which results in improved project design and practice. An integration of TEKMS into planning tools such as PRA and participatory mapping is possible. The necessity of also including TEKMS into project management is obvious, but will require further research and experience.

The instruments currently applied for community participation in nature conservation already point in the right direction, but have serious limitations when it comes to integrating reliable environmental aspects, as explained above. Additionally, a number of potential pitfalls have been identified, which should be avoided by protected area managers for a successful application of existing instruments. Notwithstanding the progressive approach of applying Village Conservation Agreements to ensure local participation in KSNP conservation, it has already been identified as a problem that several community members did not respect the park boundary already agreed upon by

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[19] British-Indonesian Joint Forestry Project, personal communication, October 2000.

local leaders and institutions involved (Wardoyo *et al*. 1997: 34). The VCAs, however, will be of little use, if they cannot be enforced. Sanjayan *et al*. (1997: 18) identified the enforcement of agreements and transgressions as the most difficult issue in participatory approaches to conservation. This problem is related to a possible lack of ownership of these agreements. As already mentioned, the village governments contracting to the agreements function mainly as extended arms of the government since the enactment of the 1979 Law on Village Governance, which was an instrument to disempower customary leadership. This process is not limited to Indonesia. In many communities traditional institutions have been devalued and weakened by modern state policies (Borrini-Feyerabend 1996: 6). Resulting, the role of the village head now is to implement government policies rather than to represent the aspirations of the village community[20]. A strong commitment of the community at large to conservation agreements will, therefore, depend on a broad involvement in their development.

A precondition to recognition of the contents of community maps is their legal support by the government. The work of the NGOs Pancur Kasih in West Kalimantan and JKPP[21] nationwide in Indonesia is a very promising initiative in this respect. With their facilitation and assistance, customary communities mapped their land in over 130 villages (350.000 ha) in West Kalimantan and a total area of over 1.6 million ha in Indonesia, across 14 provinces, since 1994. Most of these maps have been recognized by Sub-District Heads, some of them by Regents. One District in West Kalimantan has already asked Pancur Kasih for their assistance in writing a Regional Regulation (*peraturan daerah*), which in the frame of regional autonomy will legally recognize customary maps[22].

It must, therefore, be emphasized again that there will be no successful nature conservation without sufficient political, legal and administrative support. In countries, where political and legal conditions are conducive, the integration of TEKMS into park planning and management is worthwhile trying. In Indonesia, regional governments and NGOs have an important role to play in developing experience with the potentials of TEKMS for nature conservation through integrating it into participative planning instruments on a case-to-case basis. The experience generated will

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[20] Except for areas, where the customary leadership was merged with the formal one, rather than standing in competition with it.

[21] *Jaringan Kerja Pemetaan Partisipatif* (Participatory Mapping Network).

[22] Eva Garçia-Castañer, personal communication October 2000.

contribute to the development of a more general approach for including TEKMS into participative conservation planning and management of protected areas.

Annex 1: Soil Scientific Methodology

The soil investigations, which had been carried out had four major aims: first, to achieve an overview over the soils of the research area and their distribution, second, to allow for an understanding of the local soil taxonomy by providing the scientific properties of the locally classified soil types. The third aim was to investigate possible differences between soils under vegetation of different age whereas the fourth was to find out, whether the vegetation on different soils was distinct concerning their composition, vitality and biodiversity.

Soil Sampling Technique

Surface soil samples were collected for texture and chemical analyses. Topsoil samples were collected from a depth of about 0-15 cm surface soil, in accordance with the depth of the A-horizon. The profile samples were collected from all soil horizons, which were different in their physical and morphological properties. The surface and profile samples were air-dried, ground and sieved for subsequent analyses.

Field Methods

Soil investigations in the field have been done by using an auger for the extraction of soil samples up to 1 m soil depth. By using a field manual for soil description, site environmental factors could be assessed, the horizonation of the soil determined and the characteristics of the horizons recorded (as texture, structure, colour, moisture, rooting, bulk density, etc.). This allowed for an ecological assessment of soil physical factors such as potential rooting space, pore volume, air capacity, usable field capacity and permeability. The USDA Soil Taxonomy (1997) served as key for the nomenclature.

Laboratory Investigations

To assess the nutrient status of the soil and its further potential for utilisation, soil texture and soil chemistry were evaluated by laboratory investigations. The following chemical properties were analysed: pH, organic matter, plant-available phosphate, exchangeable cations, cation exchange capacity, reserve nutrients, soil acidity, watersoluble nutrients.

Soil Chemical Analyses

pH

Field determination of the soil pH was determined by colourimetrical methods. Laboratory pH determination involved the Electrometric Method, specifically 1:1 pH in 0.1N KCl, 0.1N CaCl and H_2O.

Organic Matter

Total carbon, total sulphur and total nitrogen were analysed through gasanalyses by means of the elementalanalyser CNS 2000, Co. Leco.

Cation Exchange Capacity

The cation exchange capacity (CEC) of the soil was both analyses as potential CEC at pH 7 by means of NH_4Cl and effective CEC (ECEC) at soil pH. The ECEC is more suitable to assess the capacity of the soil to store nutrients than the potential CEC, which overestimates the ECEC of acid soils, especially those dominated by variable charge clays (Anderson & Ingram, 1989: 38).

Exchangeable Bases

Watersoluble Nutrients (K, Mg, Ca, Na)

The amount of water-soluble basic cations (K^+, Mg^{3+}, Ca^{2+}, Na^+) were received by calibrating the nutrients dissolved in the solution of 10g soil mixed with 50ml distilled water (1:5 dilution), which has been shaken one hour and centrifugated, by means of an atom-adsorption-spectrometer (AAS).

Plantavailable Nutrients (P, K, Mg)

Plantavailable phosphor and potassium were analysed by using the doublelactate-method for receiving the P and K supply of soils. The amount of K received by this method is somewhat lower (ca. 20 %) than that received by using HCl. However, only a relatively small portion of the total K in soils is exchangeable, approximately 1 % (Page *et al.*, 1982: 228). Scheffer / Schachtschabel (1984: 251) mentions that the doublelactate-method for analysing plant-available P is predominantly used to mark off soils with P deficiency (< 4 mg P / 100g soil).

Plant-available magnesium is received by using $CaCl_2$ (calciumchloride). The amount of Mg received by this method is about 65 % of the total exchangeable Mg (Scheffer/Schachtschabel, 1984: 212)

Reserve Nutrients (P, K, Mg, Ca) and soil Al

Total soil phosphorus, potassium, magnesium and calcium and soil aluminium were analysed by means of *aqua regia*. This method extracts all not-exchangeable fractions, except for those being components of the silicates.

Annex 2: The Botanical Composition of the Different Fallow Stages

I YOUNG FALLOW (1-5/7 YEAR OLD SECONDARY VEGETATION)

Pioneer Species

- Species, Occurring in Most of the Sites:

Macaranga spp.	EUPHORBIACEAE (several species)
Piper aduncon	PIPERACEAE (almost only in Pemunyian)
Trema orientalis	ULMACEAE
Commersonia bartrama	STERCULIACEAE
Mallotus spp.	EUPHORBIACEAE
Homalanthus populneus	EUPHORBIACEAE

- Species, Frequent only in Some Sites:

Endospermum diadenum	EUPHORBIACEAE
Breynia sp.	EUPHORBIACEAE
Chisocheton erythrocarpus	MELIACEAE

- Less Frequent Species

Saurauia spp.	ACTINIDACEAE
Aporusa octandra	EUPHORBIACEAE
Leea spp.	LEEACEAE
Mimosa sp.	LEGUMINOSAE
Dysoxylum spp.	MELIACEAE
Ficus spp.	MORACEAE (several species)

Species Starting to Occurr in Young Fallow, Becoming More Abundant in Older Secondary Vegetation

Artocarpus spp.	MORACEAE
Eugenia spp.	MYRTACEAE
Anisophyllea disticha	RHIZOPHORACEAE
Carallia spp.	RHIZOPHORACEAE

Families Infrequent in Young Fallow Vegetation, mainly Occurring in Older Succession Stages

	ANACARDIACEAE
	ANNONACEAE
Durio spp.	BOMBACACEAE
	CLUSIACEAE
Dialium sp.	LEGUMINOSAE
Pternandra spp.	MELASTOMATACEAE
	RUBIACEAE

II MEDIUM AGED SECONDARY VEGETATION (7-15 YEAR OLD)

Species of Young Secondary Vegetation, Still Present in Medium Aged Secondary Growth

Saurauia spp.	ACTINIDACEAE
Macaranga spp.	EUPHORBIACEAE
Dysoxylum spp.	MELIACEAE
Ficus spp.	MORACEAE

Species, Genera and Families Frequent in Medium Aged to Old Secondary Vegetation

	ANACARDIACEAE
	ANNONACEAE
Durio spp.	BOMBACACEAE
	CLUSIACEAE
Elaeocarpus spp.	ELAEOCARPACEAE
Aporusa spp.	EUPHORBIACEAE
Baccaurea spp.	EUPHORBIACEAE
Koilodepas glanduligerum	EUPHORBIACEAE
Macaranga hullettii	EUPHORBIACEAE
	FAGACEAE
	LAURACEAE
Dialium sp.	LEGUMINOSEAE
Millettia atropurpurea	LEGUMINOSAE
Pongamia sp.	LEGUMINOSAE
Pternandra spp.	MELASTOMATACEAE
Aglaia leucophylla	MELIACEAE
Artocarpus spp.	MORACEAE
Streblus spp.	MORACEAE
	MYRISTICACEAE
	MYRTACEAE
Ochanostachys amentacea	OLACACEAE
	RHIZOPHORACEAE
	RUBIACEAE

Species, Genera and Families Abundant in Medium Aged to Old Secondary Vegetation - contd.

	SAPINDACEAE
	SAPOTACEAE
Eurycoma longifolia	SIMAROUBACEAE
Gironniera hirta	ULMACEAE

Genera Only Infrequent in Medium Aged Secondary Vegetation, Being More Frequent in Old Secondary Growth

Parkia spp.	LEGUMINOSAE

Genera and Species Rarely Occurring in Medium Aged and Old Secondary Vegetation

Galearia spp.	EUPHORBIACEAE
Scaphium macropodum	STERCULIACEAE
Grewia spp.	TILIACEAE

III OLD SECONDARY VEGETATION (>15 YEAR OLD)

Genera, Infrequent in Old Secondary Vegetation, but Frequent in Younger Secondary Growth

Saurauia spp.	ACTINIDACEAE
Macaranga spp.	EUPHORBIACEAE
Ficus spp.	MORACEAE

Species, Genera and Families Present only in Old Secondary Vegetation

Dillenia sp.	DILLENIACEAE (rare)
Archidendron sp.	LEGUMINOSAE
Parkia spp.	LEGUMINOSEAE
	MYRSINACEAE
	RUTACEAE

IV SPECIES, GENERA AND FAMILIES PRESENT IN ALL FALLOW STAGES

	APOCYNACEAE
Bridelia spp.	EUPHORBIACEAE
Glochidion spp.	EUPHORBIACEAE
	FLACOURTIACEAE
Pithecellobium spp.	LEGUMINOSAE
Bellucia axinanthera	MELASTOMATACEAE (only abundant in Lubuk Malakko)
Helicia spp.	PROTEACEAE
Styrax benzoin	STYRACACEAE
Symplocos spp.	SYMPLOCACEAE
	THEAECEAE
Aquilaria spp.	THYMELACEAE
	VERBENACEAE

V INFREQUENT SPECIES, GENERA AND FAMILIES

Alangium kurzii	ALANGIACEAE
	ARALIACEAE
Thottea tomentosa	ARISTOLOCHIACEAE
Veronia arborea	ASTERACEAE
Viburnum lutescens	CAPRIFOLIACEAE
Bhesa paniculata	CELASTRACEAE
Tetrameles nudiflora	DATISCAE
Vatica spp.	DIPTEROCARPACEAE
Botryophora sp.	EUPHORBIACEAE
Cephallomappa sp.	EUPHORBIACEAE
Cheilosa malayana	EUPHORBIACEAE
Neoscortechinia kingii	EUPHORBIACEAE
Pimeleodendron griffithianum	EUPHORBIACEAE
Sapium discolor	EUPHORBIACEAE
Trigonopleura malayana	EUPHORBIACEAE
Barringtonia spp.	LECYTHIDACEAE
Peltophorum clypearia	LEGUMINOSAE
Pleomele elliptica	LILIACEAE
Magnolia macklottii	MAGNOLIACEAE
Xanthophyllum spp.	POLYGALACEAE
Prunus arborea	ROSACEAE
Heritiera sp.	STERCULIACEAE
Leptonychia glabra	STERCULIACEAE
Pterospermum sp.	STERCULIACEAE
Sterculia sp.	STERCULIACEAE
Trigoniastrum hypoleucum	TRIGONIACEAE

Annex 3: Correlation between Soil Properties and Other Factors

PROBABILITIES OF THE CORRELATION BETWEEN SOIL PROPERTIES AND LOCAL CLASSIFICATION*

1. Lubuk Malakko

soil property	*Average (StDev)*			*Probability*		
	I. black soil	*II. clay soil*	*III. yellow-red s.*	*I/II*	*II/III*	*I/III*
Texture						
Sand %	15.44 (12.30)	20.33 (2.89)	14.62 (9.25)		95	
Silt %	25.72 (14.74)	48.00 (2.65)	32.52 (9.54)	100	100	90
Clay %	58.83 (21.82)	31.67 (5.03)	51.90 (8.95)	100	100	
CEC (meq/100g)	15.07 (7.13)	4.30 (0.36)	8.29 (1.81)	100	100	100
PH						
H2O	4.9 (0.3)	5.0 (0.3)	4.5 (0.4)		94	100
KCl	4.0 (0.3)	4.0 (0.2)	3.7 (0.2)		99	100
CaCl	3.9 (0.3)	3.9 (0.1)	3.6 (0.1)		100	100
Organic matter						
% C	4.46 (1.37)	2.99 (0.38)	3.16 (1.01)	100		100
% S	0.05 (0.02)	0.02 (0.01)	0.03 (0.01)	100		100
% N	0.40 (0.12)	0.28 (0.04)	0.28 (0.10)			100
C/N	11 (1)	11 (0)	12 (3)			
P (ppm;Bray I)	11 (5)	15 (5)	15 (10)			
Exc. bases (meq/100g)						
Ca	0.44 (0.34)	0.84 (0.33)	0.35 (0.29)	90	99	
Mg	0.41 (0.16)	0.48 (0.10)	0.28 (0.12)		99	98
K	0.18 (0.08)	0.11 (0.01)	0.16 (0.05)			
Exc. Acidity (meq/100g)						
Al3+	2.42 (1.26)	1.52 (0.41)	4.99 (1.82)	94	100	100
H+	0.56 (0.21)	0.39 (0.19)	0.76 (0.12)		100	100
Aq.reg (mg/100g)						
K	62.29 (29.06)	102.76 (19.59)	126.04 (57.85)	96		100
Mg	31.15 (36.49)	14.89 (2.71)	16.08 (4.09)	91		
Ca	3.78 (2.53)	4.10 (1.27)	2.35 (0.98)			96
Na	19.26 (8.01)	24.34 (3.37)	26.56 (8.44)	90		99
P	44.66 (15.07)	24.47 (1.92)	20.83 (9.05)	100		100
Al	939.94 (384.72)	236.81 (35.82)	455.88 (128.79)	100	100	100
Water soluble n. (mg/100g)						
K	1.60 (1.35)	1.96 (0.43)	2.36 (1.16)			93
Mg	0.65 (1.74)	0.10 (0.13)	0.17 (0.28)			
Ca	0.31 (0.67)	0.10 (0.28)	0.05 (0.14)			
Na	1.40 (0.56)	1.64 (0.30)	1.36 (0.43)			
P (DL) (mg/100g)	0.85 (0.19)	0.98 (0.12)	0.93 (0.23)			
CaCl2 (mg/100g)						
K	5.27 (1.68)	4.20 (0.34)	4.95 (1.83)	97		
Mg	3.97 (1.44)	3.75 (1.66)	2.63 (1.21)			

*Threshold: 90 %

2. Dusun Birun

soil property	*Average (StDev)*			*P*		
	black soil	*Yellow soil*	*yellow-red s.*	*I/II*	*II/III*	*I/III*
Texture						
Sand %	40.00 (7.00)	15.20 (5.07)	14.25 (5.26)	98		99
Silt %	32.00 (1.00)	35.56 (15.09)	38.92 (6.49)			100
Clay %	28.00 (7.55)	49.24 (15.54)	46.83 (7.16)	99		97
CEC (meq/100g)	18.61 (3.48)	9.47 (5.38)	5.41 (0.53)	98	100	98
PH						
H2O		4.4 (0.4)	4.5 (0.4)		99	
KCl		3.6 (0.2)	3.6 (0.2)			
CaCl	5.5 (0.6)	3.6 (0.1)	3.7 (0.1)	97	90	97
Organic matter						
% C	3.34 (0.75)	2.93 (1.09)	2.63 (0.74)			
% S	0.02 (0.02)	0.02 (0.01)	0.02 (0.01)			
% N	0.33 (0.08)	0.24 (0.07)	0.21 (0.05)	97		99
C/N	10 (0)	12 (2)	12 (1)	100		100
P (ppm;Bray I)		10 (0)	9 (4)			
Exc. bases (meq/100g)				n.d.		n.d
Ca		0.21 (0.10)	0.20 (0.09)			
Mg		0.25 (0.10)	0.19 (0.06)		100	
K		0.14 (0.06)	0.14 (0.06)			
Exc. Acidity (meq/100g)						
Al3+		3.32 (1.44)	3.04 (1.03)			
H+		0.74 (0.10)	0.66 (0.13)		95	
Aq.reg (mg/100g)						
K	81.26 (18.32)	86.58 (27.81)	76.83 (15.23)			
Mg	60.88 (46.46)	10.51 (3.62)	9.29 (0.99)			
Ca	13.24 (6.13)	1.36 (0.63)	1.18 (0.30)	92		92
Na	15.11 (2.48)	14.49 (3.62)	12.72 (2.55)		91	
P	24.47 (4.26)	21.25 (9.18)	21.86 (5.61)			
Al	247.90 (53.10)	450.31 (281.62)	428.80 (162.50)	100		99
Water soluble n. (mg/100g)						
K	2.62 (0.78)	1.86 (1.00)	2.54 (1.91)			
Mg	0.04 (0.01)	0.07 (0.07)	0.06 (0.06)			
Ca		0.01 (0.00)	0.09 (0.18)		91	
Na	0.92 (0.12)	0.96 (0.26)	0.92 (0.30)			
P (DL) (mg/100g)	0.89 (0.30)	0.74 (0.23)	0.49 (0.11)		100	
CaCl2 (mg/100g)						
K	6.23 (2.11)	5.41 (2.38)	9.52 (8.34)		98	
Mg	1.85 (0.64)	1.57 (0.51)	6.02 (9.11)			

*Threshold: 90 %

3. Pemunyian

soil property	*Average (StDev)*			*P*		
	black soil	*red soil*	*Yellow soil*	*I/II*	*II/III*	*I/III*
Texture						
Sand %	13.90 (16.35)	19.27 (6.17)	32.08 (17.04)		98	97
Silt %	19.30 (8.90)	20.00 (5.55)	20.50 (9.67)			
Clay %	66.80 (18.59)	60.73 (7.60)	47.42 (14.20)		98	99
CEC (meq/100g)	7.06 (2.10)	5.15 (0.79)	12.98 (5.59)	98	100	100
PH						
H2O						
KCl						
CaCl	3.8 (0.2)	4.1 (0.3)	4.2 (0.4)		96	
Organic matter						
% C	3.61 (1.50)	4.26 (1.88)	3.78 (0.86)			
% S	0.03 (0.01)	0.02 (0.01)	0.02 (0.01)	98	100	94
% N	0.27 (0.10)	0.30 (0.10)	0.30 (0.04)			
C/N	13 (2)	14 (3)	12 (2)			
P (ppm;Bray I)	n.d.					
Exc. bases	n.d.					
(meq/100g)						
Ca						
Mg						
K						
Exc. Acidity	n.d.					
(meq/100g)						
Al3+						
H+						
Aq.reg (mg/100g)						
K	38.61 (32.47)	32.37 (13.61)	46.60 (28.80)			
Mg	17.08 (4.13)	13.51 (2.27)	18.43 (5.60)		99	98
Ca	4.30 (0.94)	2.89 (0.01)	2.71 (1.27)	99	100	
Na						
P	23.64 (7.08)	14.18 (6.32)	19.48 (3.95)	100		97
Al	734.00 (229.90)	842.82 (172.37)	739.83 (242.51)			
Water soluble n.						
(mg/100g)						
K	1.47 (1.09)	0.99 (0.57)	1.22 (0.67)			
Mg	0.20 (0.18)	0.10 (0.11)	0.12 (0.07)			
Ca	0.06 (0.11)	0.03 (0.03)	0.02 (0.01)			
Na	0.42 (0.15)	0.29 (0.12)	0.31 (0.11)	95	94	
P (DL) (mg/100g)	0.92 (0.50)	1.01 (0.49)	1.08 (0.26)			
CaCl2 (mg/100g)						
K	5.88 (2.39)	6.04 (1.35)	5.99 (1.97)			
Mg	4.75 (2.90)	4.08 (1.96)	3.87 (3.02)			

*Threshold: 90 %

PROBABILITIES OF THE CORRELATION BETWEEN SOIL PROPERTIES AND GEOMORPHOLOGICAL POSITION*

Lubuk Malakko

soil property	*Average (StDev)* *I. plain*	*II. hill.*	*Probability I/II*
Texture			
Sand %	16.14 (11.51)	14.62 (9.26)	
Silt %	28.90 (15.79)	32.52 (9.54)	
Clay %	54.95 (22.41)	51.91 (8.96)	
CEC (meq/100g)	13.53 (7.63)	8.29 (1.81)	99
PH			
H2O	4.9 (0.3)	4.1 (0.4)	100
KCl	4.0 (0.2)	3.7 (0.2)	100
CaCl	3.9 (0.2)	3.6 (0.1)	100
Organic matter			
% C	4.25 (1.37)	3.16 (1.01)	99
% S	0.05 (0.02)	0.03 (0.01)	100
% N	0.38 (0.12)	0.28 (0.10)	99
C/N	11 (1)	12 (3)	
P (ppm;Bray I)	19 (5)	15 (10)	
Exc. bases (meq/100g)			
Ca	0.33 (0.37)	0.35 (0.29)	
Mg	0.44 (0.15)	0.28 (0.12)	99
K	0.24 (0.08)	0.16 (0.05)	
Exc. Acidity (meq/100g)			
Al3+	3.14 (1.21)	4.99 (1.83)	100
H+	0.64 (0.21)	0.76 (0.12)	100
Aq.reg (mg/100g)			
K	68.08 (31.09)	126.04 (57.85)	100
Mg	47.03 (49.83)	16.08 (4.09)	
Ca	4.54 (1.69)	2.35 (0.98)	98
Na	19.98 (7.68)	26.56 (8.43)	99
P	41.77 (15.68)	20.83 (9.05)	100
Al	839.49 (435.32)	455.88 (128.79)	100
Water soluble n. (mg/100g)			
K	1.65 (1.26)	2.36 (1.16)	94
Mg	0.57 (1.62)	0.12 (0.17)	
Ca	0.28 (0.63)	0.05 (0.14)	
Na	1.44 (0.54)	1.36 (0.43)	
P (DL) (mg/100g)	0.87 (0.18)	0.94 (0.23)	
CaCl2 (mg/100g)			
K	5.37 (1.94)	4.95 (1.83)	
Mg	5.60 (5.26)	2.63 (1.21)	98

*Threshold: 90 %

PROBABILITIES OF THE CORRELATION BETWEEN SOIL PROPERTIES AND USDA CLASSIFICATION*

1. Lubuk Malakko

soil property	*Average (StDev)*			*P*		
	I. Oxic Dystropept	*II. Typic Dystropept*	*III. Hapludox*	*I/II*	*I/III*	*II/III*
Texture						
Sand %	20.33 (2.89)	14.81 (11.07)	15.42 (10.01)	94		
Silt %	48.00 (2.65)	28.44 (12.96)	31.50 (11.75)	100	100	
Clay %	31.67 (5.03)	56.74 (18.90)	51.42 (7.63)	100	100	
CEC (meq/100g)	4.30 (0.36)	13.34 (6.34)	7.10 (0.88)	100	100	100
ECEC (meq/100g)	3.34 (0.45)	5.98 (2.05)	5.67 (0.92)	100	100	
PH						
H_2O	5.0 (0.3)	4.7 (0.3)	4.7 (0.3)			
KCl	4.0 (0.2)	3.9 (0.4)	3.7 (0.3)			
CaCl	3.9 (0.1)	3.8 (0.3)	3.6 (0.1)			96
Organic matter						
% C	2.99 (0.38)	4.08 (1.30)	3.04 (1.20)	99	99	98
% S	0.02 (0.01)	0.04 (0.02)	0.03 (0.01)	100	93	98
% N	0.28 (0.04)	0.36 (0.12)	0.28 (0.11)			96
C/N	11 (0)	12 (2)	11 (3)	95	95	
P (ppm;Bray I)	13 (4)	11 (4)	15 (12)			
Exc. bases (meq/100g)						
Ca	0.84 (0.33)	0.35 (0.27)	0.36 (0.23)	99	99	
Mg	0.48 (0.10)	0.34 (0.14)	0.30 (0.16)			
K	0.11 (0.01)	0.17 (0.06)	0.17 (0.07)			
Exc. Acidity (meq/100g)						
Al^{3+}	1.52 (0.41)	3.79 (2.30)	3.86 (1.26)	100	100	
H^+	0.39 (0.19)	0.65 (0.22)	0.69 (0.09)	94	94	
Aq.reg (mg/100g)						
K	102.76 (19.59)	76.75 (35.32)	141.32 (69.81)			99
Mg	14.89 (2.71)	26.45 (29.95)	14.96 (4.92)	93	93	93
Ca	4.10 (1.27)	3.15 (2.22)	2.64 (1.18)			
Na	24.34 (1.92)	20.74 (7.26)	28.71 (10.14)			97
P	24.47 (1.92)	35.65 (18.14)	23.23 (10.29)	100	100	99
Al	236.81 (35.82)	795.21 (383.43)	418.50 (103.30)	100	100	100
Water soluble n. (mg/100g)						
K	1.96 (0.43)	1.74 (1.19)	2.61 (1.37)			93
Mg	0.10 (0.12)	0.11 (0.15)	0.14 (0.21)			
Ca	0.10 (0.18)	0.06 (0.12)	0.05 (0.12)			
Na	1.64 (0.30)	1.40 (0.51)	1.34 (0.46)			
P (DL) (mg/100g)	0.98 (0.12)	0.89 (0.18)	0.91 (0.28)			
$CaCl_2$ (mg/100g)						
K	4.20 (0.34)	4.92 (1.49)	5.47 (2.25)		94	
Mg	3.75 (1.66)	2.81 (1.21)	2.87 (1.55)			

*Threshold: 90 %

2. Dusun Birun

soil property	*Average (StDev)*					*P*									
	Oxic Dystropept	*Kandiudox*	*Typic Dystropept*	*Hapludox*	*Paleudult*	*I/II*	*I/III*	*II/III*	*I/IV*	*II/IV*	*III/IV*	*I/V*	*II/V*	*III/V*	*IV/V*
Texture															
Sand %	16.25 (6.54)	11.33 (1.86)	19.35 (10.68)	12.33 (1.03)	53.00 (1.00)	92	99				98		92		90
Silt %	48.75 (12.06)	40.33 (8.38)	29.71 (12.08)	32.50 (5.86)	40.00 (6.66)		96	100	99	91		92		100	97
Clay %	35.00 (6.19)	48.33 (6.65)	50.94 (17.27)	55.17 (5.15)	36.67 (8.33)	100		100	100	92				93	96
CEC (meq/100g)	4.48 (0.78)	5.21 (0.55)	13.51 (5.60)	7.13 (1.37)	6.01 (0.42)	94	100	100							
ECEC (meq/100g)	3.40 (0.60)	4.04 (0.41)	4.51 (1.23)	6.44 (1.19)	4.48 (0.97)	96	99		100	100	99				95
PH															
H2O	4.4 (0.4)	4.5 (0.3)	4.5 (0.4)	4.1 (0.2)	4.4 (0.2)			95	98	100					
KCl	3.7 (0.2)	3.6 (0.1)	3.7 (0.1)	3.5 (0.1)	3.6 (0.1)				99	99	100			93	98
CaCl	3.6 (0.1)	3.7 (0.1)	4.8 (0.8)	3.5 (0.1)	3.5 (0.1)			90	99	100	100	94	97	97	
Organic matter															
% C	2.37 (1.07)	2.35 (0.63)	3.35 (0.91)	2.36 (0.55)	3.58 (0.80)		99	97			99	90	91		90
% S	0.02 (0.01)	0.02 (0.00)	0.02 (0.01)	0.02 (0.00)	0.02 (0.01)		91	97			96				94
% N	0.20 (0.07)	0.19 (0.04)	0.27 (0.06)	0.21 (0.03)	0.29 (0.05)		99	98			96	93	98		98
C/N	11 (2)	12 (1)	12 (2)	11 (1)	12 (1)					94	93				90
P (ppm;Bray I)	8 (4)	8 (4)	9 (5)	6 (2)	16 (5)						91	92	91	90	94
Exc. bases (meq/100g)															
Ca	0.17 (0.06)	0.25 (0.10)	0.26 (0.09)	0.15 (0.05)	0.14 (0.06)	91		98		95	99			95	
Mg	0.19 (0.05)	0.23 (0.05)	0.28 (0.12)	0.16 (0.03)	0.25 (0.03)			93		98	99	90			99
K	0.11 (0.05)	0.17 (0.06)	0.15 (0.04)	0.08 (0.01)	0.26 (0.04)	92		94		100	100	100	96	100	100
Exc. Acidity (meq/100g)															
Al3+	2.30 (0.58)	2.77 (0.66)	3.11 (1.10)	5.23 (1.16)	3.08 (0.82)			96	100	100	100				98
H+	0.63 (0.05)	0.63 (0.14)	0.75 (0.09)	0.81 (0.03)	0.75 (0.14)		96	100	100	99	90				
Aq.reg (mg/100g)															
K	95.05 (11.13)	73.60 (14.57)	78.50 (29.63)	94.28 (28.31)	75.86 (4.11)	99		95				100			
Mg	8.92 (1.17)	9.15 (1.17)	20.50 (24.74)	8.88 (0.43)	6.79 (0.68)		93	94			94	99	99	97	98
Ca	1.29 (0.27)	1.06 (0.27)	3.46 (5.02)	1.09 (0.22)	1.32 (0.22)		94				94			91	
Na	14.77 (4.53)	11.53 (3.14)	14.29 (3.30)	14.22 (1.24)	14.83 (0.99)		90			90			95		
P	22.58 (7.50)	17.38 (3.84)	22.12 (9.99)	26.00 (2.01)	15.96 (3.83)	90				100		91		91	97
Al	519.40 (255.14)	389.58 (174.90)	414.73 (266.60)	275.74 (97.52)	638.67 (299.91)				98		92				

soil property	*Average (StDev)*					*P*									
	Oxic Dystropept	*Kandiudox*	*Typic Dystropept*	*Hapludox*	*Paleudult*	*I/II*	*I/III*	*II/III*	*I/IV*	*II/IV*	*III/IV*	*I/V*	*II/V*	*III/V*	*IV/V*
Water soluble n. (mg/100g)															
K	2.55 (2.22)	1.75 (0.74)	2.39 (1.02)	1.43 (0.67)	1.14 (0.13)						98	91	90	100	
Mg	0.10 (0.08)	0.04 (0.02)	0.05 (0.04)	0.03 (0.02)	0.02 (0.00)			94							
Ca	0.18 (0.23)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.20 (0.00)			96							
Na	1.02 (0.31)	0.79 (0.13)	1.02 (0.25)	0.35 (0.11)	0.86 (0.08)	93	99				95			90	
P (DL) (mg/100g)	0.57 (0.19)	0.53 (0.11)	0.82 (0.25)	0.62 (0.19)	0.59 (0.04)		100	98			94			100	
CaCl2 (mg/100g)															
K	9.77 (9.73)	4.49 (2.51)	6.36 (2.42)	4.73 (2.62)	3.80 (0.69)							90		98	
Mg	7.59 (10.14)	1.36 (0.73)	1.74 (0.52)	1.14 (0.28)	1.58 (0.89)				91		100				

*Threshold: 90 %

3. Pemunyian

soil property	*Average (StDev)* *I. Hapludox*	*II. Paleudult*	*Probability* *I/II*
Texture			
Sand %	13.35 (6.20)	28.44 (10.14)	100
Silt %	19.90 (7.20)	22.78 (9.60)	
Clay %	66.75 (10.20)	48.78 (11.08)	100
CEC (meq/100g)	5.95 (1.35)	14.43 (5.34)	100
ECEC (meq/100g)			
PH			
H2O			
KCl			
CaCl	3.9 (0.3)	4.2 (0.4)	
Organic matter			
% C	4.06 (1.74)	3.77 (0.72)	
% S	0.03 (0.01)	0.02 (0.01)	96
% N	0.29 (0.10)	0.31 (0.04)	
C/N	14 (2)	12 (1)	99
P (ppm;Bray I)			
Exc. bases (meq/100g)			
Ca			
Mg			
K			
Exc. Acidity (meq/100g)			
Al3+			
H+			
Aq.reg (mg/100g)			
K	34.40 (24.52)	49.63 (32.91)	
Mg	12.90 (3.23)	19.70 (5.35)	100
Ca	3.69 (1.23)	2.59 (1.32)	95
Na			
P	18.81 (8.24)	19.87 (4.45)	
Al	808.60 (199.59)	775.78 (261.83)	
Water soluble n. (mg/100g)			
K	1.19 (0.86)	1.33 (0.75)	
Mg	0.15 (0.16)	0.13 (0.07)	
Ca	0.04 (0.08)	0.01 (0.00)	
Na	0.35 (0.15)	0.31 (0.12)	
P (DL) (mg/100g)	0.95 (0.48)	1.15 (0.25)	
CaCl2 (mg/100g)			
K	6.02 (1.22)	6.14 (1.74)	
Mg	4.36 (2.47)	3.62 (2.88)	

*Threshold: 90 %

PROBABILITIES OF THE CORRELATION BETWEEN SOIL PROPERTIES AND FALLOW STAGES *

1. Lubuk Malakko

soil property	*Average (StDev)*				*Probability*					
	I. very young fallow	*II. young fallow*	*III. young secondary forest*	*IV. old secondary forest*	*I/II*	*II / III*	*I / III*	*III / IV*	*I / IV*	*II / IV*
Texture										
Sand %	17.17 (13.91)	18.17 (9.56)	17.25 (12.27)	9.83 (4.61)				93		98
Silt %	18.50 (5.09)	35.00 (12.67)	34.67 (13.21)	28.58 (12.68)	99		100		97	
Clay %	64.33 (18.68)	46.83 (19.84)	48.08 (13.57)	59.92 (11.90)	91		90	97		93
CEC (meq/100g)	16.93 (10.95)	11.38 (5.23)	7.87 (3.17)	10.48 (3.96)		94	90	91		
PH										
H2O	4.6 (0.2)	4.8 (0.4)	4.7 (0.3)	4.5 (0.5)	99					
KCl	3.8 (0.2)	3.9 (0.4)	3.8 (0.2)	3.8 (0.3)						
CaCl	3.8 (0.3)	3.8 (0.3)	3.7 (0.2)	3.7 (0.2)						
Organic m.										
% C	3.87 (1.59)	3.21 (0.34)	3.19 (0.96)	4.63 (1.17)				100		99
% S	0.04 (0.02)	0.04 (0.02)	0.03 (0.01)	0.05 (0.02)				100		93
% N	0.32 (0.17)	0.29 (0.11)	0.29 (0.07)	0.42 (0.09)				100	90	100
C/N	13 (3)	11 (3)	11 (1)	11 (1)			91		92	
P (ppm;Bray I)	10 (4)	10 (5)	12 (4)	19 (12)				94	96	95
Exc. bases (meq/100g)										
Ca	1.99 (2.39)	1.27 (1.59)	0.39 (0.31)	0.40 (0.37)						
Mg	0.85 (0.92)	0.65 (0.55)	0.28 (0.14)	0.42 (0.15)		94		96		
K	0.19 (0.10)	0.20 (0.17)	0.13 (0.04)	0.19 (0.05)		94	91	99		
Exc. Acid. (meq/100g)										
Al3+	3.68 (1.99)	3.34 (2.70)	3.67 (1.54)	3.85 (2.19)						
H+	0.67 (0.14)	0.56 (0.29)	0.65 (0.18)	0.71 (0.15)						
Aq.reg (mg/100g)										
K	64.44 (31.76)	109.10 (87.61)	98.34 (22.60)	100.04 (40.86)			95		94	
Mg	14.07 (5.23)	48.66 (56.34)	15.07 (3.35)	19.14 (5.03)	94	94		97	92	90
Ca	4.49 (3.32)	5.29 (8.50)	2.28 (1.26)	3.36 (1.95)			93			
Na	27.07 (17.55)	25.15 (7.24)	23.20 (5.70)	19.57 (5.14)						
P	25.36 (19.34)	34.51 (21.57)	22.96 (6.19)	39.40 (12.76)						
Al	857.61 (537.60)	652.00 (380.61)	492.95 (270.10)	693.15 (336.97)						
Water sol. (mg/100g)										
K	1.47 (0.81)	1.61 (1.02)	1.71 (0.47)	2.96 (1.68)				97	98	97
Mg	0.30 (0.49)	0.12 (0.16)	0.10 (0.09)	1.18 (2.08)				94		93
Ca	1.26 (1.07)	0.16 (0.31)	0.03 (0.09)	0.17 (0.16)						
Na	1.91 (0.59)	1.32 (0.53)	1.48 (0.22)	1.13 (0.38)	93			99	98	
P (DL) (mg/100g)	0.85 (0.14)	0.77 (0.18)	0.97 (0.14)	0.99 (0.26)		99			94	98
CaCl2 (mg/100g)										
K	5.83 (3.23)	5.04 (1.78)	4.32 (0.77)	5.78 (1.78)					98	
Mg	7.42 (7.66)	4.64 (4.55)	2.34 (1.23)	3.70 (1.60)					97	

*Threshold: 90 %

2. Dusun Birun

soil property	*Average (StDev)*				*Probability*					
	I. very young fallow	*II. young fallow*	*III. young secondary forest*	*IV. old secondary forest*	*I/II*	*II / III*	*I / III*	*I / IV*	*II / IV*	*III / IV*
Texture										
Sand %	13.00 (0.00)	21.78 (14.49)	16.21 (4.28)	14.93 (6.44)	94					
Silt %	33.67 (2.31)	34.22 (10.71)	38.07 (12.74)	36.43 (15.05)						
Clay %	53.33 (2.31)	44.00 (15.12)	45.71 (14.70)	48.64 (14.59)						
CEC (meq/100g)	4.86 (0.39)	12.36 (6.01)	9.13 (3.95)	8.91 (6.13)	100	94	96	98		
PH										
H2O	4.6 (0.1)	4.5 (0.4)	4.6 (0.4)	4.2 (0.3)					91	99
KCl	3.7 (0.1)	3.7 (0.2)	3.7 (0.1)	3.5 (0.1)			93		97	100
CaCl	3.7 (0.1)	4.4 (1.0)	3.7 (0.1)	3.5 (0.1)		92	94	90	95	100
Organic m.										
% C	2.09 (0.75)	3.34 (0.90)	3.20 (0.90)	2.42 (0.92)	97		95		97	97
% S	0.02 (0.00)	0.03 (0.01)	0.02 (0.01)	0.02 (0.01)	96		99		97	94
% N	0.17 (0.05)	0.29 90.08)	0.25 (0.05)	0.21 (0.06)	99		100	96	98	92
C/N	12 (1)	12 (1)	13 (2)	11 (1)						99
P (ppm;Bray I)	8 (3)	11 (4)	11 (5)	9 (6)						
Exc. bases (meq/100g)										
Ca	0.31 (0.09)	0.22 (0.06)	0.23 (0.10)	0.16 (0.07)					93	97
Mg	0.26 (0.04)	0.28 (0.09)	0.20 (0.07)	0.23 (0.11)		96				
K	0.21 (0.03)	0.12 (0.03)	0.13 (0.05)	0.14 (0.08)						
Exc. Acid. (meq/100g)										
Al3+	2.23 (0.25)	2.89 (0.75)	3.02 (1.09)	3.77 (1.62)			91	98		
H+	0.75 (0.08)	0.61 (0.12)	0.70 (0.10)	0.76 (0.09)		90		93	100	
Aq.reg (mg/100g)										
K	78.84 (6.82)	67.73 (19.49)	95.63 (22.41)	81.51 (25.91)		100	95			
Mg	9.57 (0.81)	27.00 (34.49)	10.80 (3.24)	9.60 (3.65)					94	
Ca	1.03 (0.30)	5.12 (6.82)	1.43 (0.42)	1.33 (0.75)	91		91			
Na	10.91 (4.84)	13.06 (2.01)	13.88 (3.79)	15.39 (2.78)					97	
P	16.31 (5.43)	20.68 (3.77)	21.96 (11.66)	22.99 (5.37)						
Al	478.01 (208.44)	287.00 (74.31)	596.29 (267.41)	339.09 (208.20)		100		95		99
Water sol. (mg/100g)										
K	1.98 (0.97)	1.99 (0.82)	2.75 (1.79)	1.57 (0.80)						97
Mg	0.03 (0.00)	0.04 (0.01)	0.09 (0.09)	0.05 (0.05)						
Ca	0.01 (0.00)	0.01 (0.00)	0.12 (0.20)	0.01 (0.00)						
Na	0.73 (0.11)	0.86 (0.12)	1.10 (0.29)	0.87 (0.22)	96					97
P (DL) (mg/100g)	0.42 (0.12)	0.72) 90.23)	0.72 (0.31)	0.64 (0.15)	98		98	100		
CaCl2 (mg/100g)								91		
K	7.24 (2.88)	5.75 (1.83)	6.00 (1.93)	4.65 (2.81)						99
Mg	2.06 90.77)	1.64 (0.69)	1.72 (0.37)	1.27 (0.39)						

*Threshold: 90 %

3. Pemunyian

soil property	*Average (StDev)*				*Probability*					
	I. very young fallow	*II. young fallow*	*III. young secondary forest*	*IV. old secondary forest*	*I/II*	*II / III*	*I / III*	*III / IV*	*II / IV*	*I / IV*
Texture										
Sand %	11.17 (7.31)	16.43 (13.64)	21.67 (14.61)	32.64 (16.37)			91		96	100
Silt %	15.67 (2.50)	16.29 (2.63)	25.56 (9.44)	20.09 (8.86)		98	99			
Clay %	73.17 (8.33)	67.29 (13.28)	52.78 (12.30)	47.27 (14.13)		96	100		99	100
CEC (meq/100g)	6.65 (1.79)	9.78 (4.44)	10.00 (7.40)	7.69 (3.78)						
PH										
H2O										
KCl										
CaCl	3.8 (0.2)	4.2 (0.4)	4.0 (0.3)	4.1 (0.4)	92					
Organic m.										
% C	3.64 (1.75)	4.16 (1.02)	3.30 (1.40)	4.33 (1.52)		92				
% S	0.03 (0.01)	0.02 (0.02)	0.02 (0.01)	0.02 (0.01)						
% N	0.26 (0.12)	0.31 (0.06)	0.25 (0.09)	0.32 (0.06)		93				
C/N	14 (2)	13 (2)	13 (2)	13 (3)						
P (ppm;Bray I)										
Exc. bases (meq/100g)										
Ca										
Mg										
K										
Exc. Acid. (meq/100g)										
Al3+										
H+										
Aq.reg (mg/100g)										
K	27.84 (7.27)	25.90 (5.40)	52.36 (33.36)	43.79 (29.15)		95	94		93	
Mg	13.07 (1.61)	15.55 (8.61)	20.98 (4.42)	15.04 (3.28)						
Ca	3.78 (1.39)	3.73 (1.13)	3.47 (1.47)	2.48 (1.14)					96	92
Na										
P	19.38 (8.77)	22.90 (7.81)	17.13 (6.85)	17.76 (4.63)					97	
Al	766.50 (82.95)	947.43 (242.34)	742.22 (284.20)	688.91 (130.12)	90					
Water sol. (mg/100g)										
K	1.20 (1.39)	1.40 (0.75)	0.97 (0.56)	1.31 (0.61)						
Mg	0.13 (0.19)	0.16 (0.08)	0.14 (0.16)	0.12 (0.10)						
Ca	0.02 (0.04)	0.02 90.02)	0.07 (0.11)	0.02 (0.02)						
Na	0.31 (0.12)	0.33 (0.18)	0.37 (0.16)	0.33 (0.09)						
P (DL) (mg/100g)	0.80 (0.42)	0.91 (0.37)	0.97 (0.53)	1.21 (0.29)					93	93
CaCl2 (mg/100g)										
K	4.58 (2.76)	6.68 (0.97)	5.97 (1.26)	6.25 (1.68)						
Mg	3.01 (2.32)	6.16 (2.57)	4.33 (2.85)	3.72 (2.24)	95				92	

*Threshold: 90 %

CORRELATION BETWEEN SOIL PROPERTIES AND SELECTED FACTORS*

1. Lubuk Malakko

soil property	*Correllation*						
	Biodi-versity	*Clay content*	*Vegeta-tion age*	*CEC*	*Local soil type*	*USDA soil type*	*Geomor-phology*
USDA soil type						-	1.00
Fallow age				-	-		
Geom. Unit			-				
Local soil type				1.00	-		
biodiversity	-						
Texture							
Sand %		(0.67)					
Silt %		(0.82)		(0.62)			
Clay %		-		0.75			
CEC (meq/100g)		0.75		-	0.64		
PH							
H2O							0.70
KCl					0.49		0.82
CaCl					0.48		0.83
Organic matter							
% C		0.73		0.61	0.56		0.50
% S		0.72		0.73	0.77		0.63
% N		0.67		0.56	0.52		0.49
C/N							
P (ppm;Bray I)	0.62						
Exc. bases (meq/100g)							
Ca							
Mg							0.48
K		0.51		0.48	0.50		
Exc. Acidity (meq/100g)							
Al3+							0.72
H+							0.63
Aq.reg (mg/100g)							
K				0.57	0.49		0.56
Mg		0.53					
Ca							0.50
Na		0.72		0.61			
P		0.54		0.60	0.65		0.66
Al		0.84		0.92	0.70		0.53
Water soluble n. (mg/100g)							
K				0.50			
Mg			0.61				
Ca		0.47	0.73	0.77			
Na							
P (DL) (mg/100g)	0.65						
CaCl2 (mg/100g)							
K		0.52		0.46			
Mg				0.78	0.47		0.54

Numbers in brackets indicate a negative correllation

* > 0.45: significant
> 0.64: highly significant

2. Dusun Birun

soil property	*correllation*					
	Biodi-versity	*Clay content*	*Vegetation age*	*CEC*	*Local soil type*	*USDA soil type*
USDA soil type						
Fallow age	1.00					
Local soil type				1.00		1.00
biodiversity						
Texture						
Sand %				0.50	0.54	
Silt %		(0.82)		(0.72)		
Clay %						
CEC (meq/100g)					0.59	
PH						
H2O	(0.62)		(0.67)			
KCl			(0.75)			0.51
CaCl				0.55	0.55	
Organic matter						
% C	(0.56)					0.56
% S		0.52	(0.52)			
% N				0.58	0.46	0.57
C/N	(0.61)		(0.60)			
P (ppm;Bray I)	(0.52)					0.50
Exc. bases						
(meq/100g)						
Ca			(0.57)			
Mg				0.62		0.51
K						0.58
Exc. Acidity						
(meq/100g)						
Al3+						0.47
H+						
Aq.reg (mg/100g)						
K				(0.48)		
Mg				0.63	0.62	
Ca				0.57	0.62	
Na		(0.58)	1.00			
P	0.46		0.58			
Al				(0.54)		
Water soluble n.						
(mg/100g)						
K						
Mg						
Ca						
Na						
P (DL) (mg/100g)				(0.69)	0.81	0.52
CaCl2 (mg/100g)						
K						
Mg						

Numbers in brackets indicate a negative correllation

* > 0.45: significant
> 0.64: highly significant

3. Pemunyian

soil property	*correllation*					
	Biodi-versity	*Clay content*	*Vegetation age*	*CEC*	*Local soil type*	*USDA soil type*
USDA soil type		1.00				
Fallow age	1.00					
Local soil type	1.00					
biodiversity						
Texture						
Sand %		(0.87)				0.65
Silt %						
Clay %						0.64
CEC (meq/100g)						
PH						
H2O						
KCl						
CaCl						
Organic matter						
% C		0.51			0.47	
% S						
% N	0.56		0.43			
C/N		0.48				0.55
P (ppm;Bray I)						
Exc. bases (meq/100g)						
Ca						
Mg						
K						
Exc. Acidity (meq/100g)						
Al3+						
H+						
Aq.reg (mg/100g)						
K						
Mg				0.64		
Ca	(0.63)		0.49		0.56	0.57
Na						
P					0.64	
Al		0.64				
Water soluble n. (mg/100g)						
K						
Mg						
Ca						
Na					0.62	
P (DL) (mg/100g)	0.45		0.48			
CaCl2 (mg/100g)						
K						
Mg						

Numbers in brackets indicate a negative correllation

* > 0.42: significant
> 0.60: highly significant

Annex 4 : Indicator Plants for Soil Fertility

Pemunyian Indicator plants for fertile soil	% of resp.	Indicator plants for infertile soil	% of resp.	Dusun Birun Indicator plants for fertile soil	% of resp.	Indicator plants for infertile soil	% of resp.	Lubuk Malakko Indicator plants for fertile soil	% of resp.	Indicator plants for infertile soil	% of resp.
kawang	35.0	pelangeh	82.5	kerinyu	91.7	asam / resam	69.4	rumput (umpuik) paik	50.0	lalang	72.5
meranti	35.0	resam / pa-dang asam	62.5	pisang kayak	63.9	lalang / ilalang	63.9	nilau	32.5	asam	70.0
jelatang	32.5	jirak padang	52.5	rumput jambing	61.1	kaduduk	36.1	kayu tanam	27.5	kaduduak	27.5
semantung	32.5	dalok	40.0	semantung	47.2	rumput belando	19.4	talunan	25.0	timalun	20.0
lalai	27.5	lalang	27.5	tarok	19.4	pelangeh	16.7	(si)tarok	5.0	kasai	17.5
nilau ruso	27.5	keduduk	22.5	nilau	16.7	kayu lalok	8.3	alang kabau	5.0	karamuntiang	7.5
lasi	25.0	bantun	17.5	jelatang	13.9	mempening / pening-pening	8.3	ambuang-ambuang	2.5	kasai talang	5.0
nilau nasi	22.5	jirak kuantan	15.0	kecubung	11.1	pakis	8.3	balik angin	2.5	umpuik paik	5.0
balek angin	17.5	kandung	12.5	pua kincung	8.3	semantung	8.3	binawuang	2.5	talunan	2.5
lirik	15.0	terentang	12.5	rumput belando	8.3	tarok	8.3	kabau	2.5		
pisang batang / hutan	15.0	kuanji	10.0	batang tutup	5.6	batang pua	5.6	kumbuak	2.5		
tamalun	15.0	mang	10.0	kayu timah	5.6	lalok aka	5.6	lirik	2.5		
cikelo	12.5	mupui	10.0	sungkai	5.6	leban	5.6	merantih	2.5		
batang puar	10.0	sikubung	10.0	batang basung	2.8	sungkai	5.6	pakis air	2.5		
pakih	10.0	aro	5.0	batang sikutu	2.8	babi kurus	2.8	petai	2.5		
sikubung	10.0	lasi	5.0	batang telbung	2.8	baki	2.8	putan jio	2.5		
sitapung	10.0	lipai	5.0	cabe burung	2.8	balik angin	2.8	rinju	2.5		

Pemunyian Indicator plants for fertile soil	% of resp.	Indicator plants for infertile soil	% of resp.	Dusun Birun Indicator plants for fertile soil	% of resp.	Indicator plants for infertile soil	% of resp.	Lubuk Malakko Indicator plants for fertile soil	% of resp.	Indicator plants for infertile soil	% of resp.
akar ketapu	7.5	rambutan aceh	5.0	duku	2.8	bayeh	2.8	rumput kasek	2.5		
aro	7.5	sianih	5.0	jirak	2.8	buluh	2.8	rumput parika	2.5		
bemban	7.5	sungkai	5.0	kayu aro	2.8	indulang	2.8	sasawi anggang	2.5		
buluh	7.5	capo	2.5	kayu rebung	2.8	jengkol	2.8	talanan	2.5		
dalok	7.5	dingari	2.5	lirik	2.8	karanji	2.8				
ganun	7.5	kampeh	2.5	menarung	2.8	kayu kelek	2.8				
jelutung	7.5	kapo	2.5	pakis air	2.8	kayu lalik	2.8				
kayu sirih	7.5	kayu pisang	2.5	rumput angik	2.8	kayu timah	2.8				
ketaping	7.5	kayu sirih	2.5	rumput kacu	2.8	kerinyu	2.8				
kulukuk	7.5	kulin	2.5	sitapung	2.8	kulin	2.8				
madang	7.5	lirik	2.5	terentang	2.8	medang	2.8				
sitarak	7.5	madang talo	2.5			petaling	2.8				
capo gunung	5.0	rengkam bumi	2.5			pimping	2.8				
durian	5.0	rumput pahit	2.5			rumput jambing	2.8				
kalampaian	5.0	sidancing	2.5			rumput jelatang	2.8				
nawuang	5.0	tembusu	2.5			sianik	2.8				
pulai	5.0					sitarak	2.8				
sabut piring	5.0					terentang	2.8				
sapek	5.0										
tarok	5.0										
aro kain	2.5										
bidi	2.5										
buau	2.5										
cimpu	2.5										
galabuak	2.5										

Pemunyian				Dusun Birun				Lubuk Malakko			
Indicator plants for fertile soil	***% of resp.***	***Indicator plants for infertile soil***	***% of resp.***	***Indicator plants for fertile soil***	***% of resp.***	***Indicator plants for infertile soil***	***% of resp.***	***Indicator plants for fertile soil***	***% of resp.***	***Indicator plants for infertile soil***	***% of resp.***
indarung	2.5										
kalumbuak	2.5										
katapian	2.5										
keladi gadjah	2.5										
kunyin	2.5										
meranti bawang	2.5										
meranti bunga	2.5										
meranti durian	2.5										
meranti semut	2.5										
palam-palam	2.5										
sungkai	2.5										
suyan	2.5										
terentang	2.5										

If a species was mentioned as indicating fertile and infertile soils by different farmers, it is printed in italics.

Annex 5: Sinopsis Disertasi

Sistem Pengetahuan Tradisional terhadap Alam dan Lingkungan serta Pengelolaan Sumberdaya Alam: Taman Nasional Kerinci Seblat (TNKS), Sumatera

Oleh Silvia Werner

Sinopsis

Titik tolak penulisan disertasi ini beranjak dari fakta adanya kesenjangan komunikasi di antara stakeholders (dalam hal ini seluruh pihak yang secara resmi terkait di dalam misi konservasi atau pelestarian alam) dengan masyarakat yang bermukim di wilayah konservasi. Kesenjangan tersebut telah mengakibatkan kesulitan serius dalam bentuk perbedaan persepsi pelestarian lingkungan di wilayah perbatasan Taman Nasional Kerinci Seblat. Inti persoalan utama dalam konservasi (pelestarian) adalah kesulitan atau buruknya komunikasi di antara berbagai pihak, kelompok maupun kalangan yang masing-masing memiliki kepentingan untuk terlibat di dalam konservasi. Secara khusus, kesulitan komunikasi yang dimaksud penulis adalah berkenaan dengan "pandangan" yang dimiliki mereka terhadap alam.

Lewat studi ini ditemukan hasil pemikiran bahwa dalam rangka menemukan solusi yang tepat terhadap masalah konservasi alam, upaya pengembangan dan perbaikan komunikasi yang lebih baik adalah sebuah cara atau pendekatan yang berharga yang perlu mendapat perhatian serta sekaligus dukungan. Lebih jauh ,untuk pengembangan komunikasi yang disebut di atas, maka kiranya diperlukan pengkajian-pengkajian terhadap ekosistem pertanian penduduk lokal *(agroecosistem),* pengenalan yang bersifat komprehensif terhadap sistem pengetahuan masyarakat lokal atas sumberdaya alam di kawasan sekitar pemukiman mereka serta pemahaman mendalam terhadap cara-cara tradisional pemanfaatan dan pengelolaan sumberdaya alam, yang secara turun-temurun dipraktekkan oleh komunitas masyarakat lokal di dalam.

Pendekatan di atas dapat ditelusuri di dalam pelaksanaan proyek-proyek pelestarian (konservasi) alam serta berabagai proyek pembanguan pertanian lainnya. Pengalaman dari proyek-proyek demikian menunjukkan pelajaran pada kita bahwa kegiatan "penyuluhan" yang dilakukan proyek terhadap masyarakat sebagai 'target group' proyek tidak akan dapat berguna kalau kebutuhan masyarakat setempat tidak ditempatkan sebagai prioritas. Artinya, sebuah taman nasional akan selalu terancam rusak karena pelanggaran terhadap batas-batas fisiknya. Dan pelanggaran ini muncul sebagai akibat dari tidak dilibatkannya penduduk setempat di dalam memutuskan atau menentukan rentang batas-batas fisik dari taman yang bersangkutan. Berhasil tidaknya proses upaya penglibatan peran masyarakat setempat yang bermukin di dalam atau di sekitar kawasan taman nasonal tersebut sangat ditentukan oleh adanya komunikasi yang baik lewat mana kesepakatan dan kesamaan pemahaman mengenai lingkungan berikut pemanfaatannya.

Untuk kepentingan studi ini, sejumlah desa di perbatasan bagian timur dari Taman Nasional Kerinci Seblat (TNKS) di Sumatera telah dipilih sebagai objek studi kasus. Penelitian yang dilakukan penulis di sana pertama-tama difokuskan pada upaya pengidentifikasian komponen-komponen utama menyangkut kondisi *landscape* atau hamparan lahan yang dijadikan sebagai area pertanian. Disini diteliti secara seksama cara-cara yang biasa digunakan penduduk desa dalam pemanfaatan lahan. Sehubungan dengan kenyataan yang ditemukan di lapangan, dimana sistem ladang berpindah-pindah dan kebun campuran menempati porsi paling utama di dalam sistem pengunaan lahan, maka disertasi ini perlu memfokuskan pembahasan terhadap struktur dan komposisi dari sistem pertanian lahan kering tersebut berikut pengenalan ciri-ciri botanis dan pedologinya.

Dalam rangka melengkapi pendekatan ilmiah tersebut, penulis melakukan pendokumentasian terhadap pengetahuan tradisional masyarakat desa khususnya menyangkut tanah, tanaman-tanaman dan kriteria-kriteria yang dipakai di dalam menentukan atau menyeleksi lahan yang hendak dimanfaatkan untuk menjadi areal pertanian. Dengan sendirinya, aspek yang diteliti akan juga mencakup kegiatan pemanfaatan hutan serta persepsi atau pandangan spesifik dari penduduk lokal terhadap hutan rimba yang berbatasan dengan lahan pertanian kering mereka. Tujuannya adalah untuk memahami manfaat dan pentingnya hutan rimba tersebut bagi kehidupan masyarakat desa sehingga hukum adat yang mengatur perilaku masyarakat desa khususnya yang berhubungan dengan pemanfaatan dan pemeliharaan hutan rimba dapat dikenali secara seksama.

Bagain terakhir pendekatan penelitian yang digunakan dalam studi ini adalah menyangkut pengkajian soal keikutsertaan/keterlibatan penduduk setempat dalam perencanaan, pengembangan dan pengelolaan TNKS. Untuk itu, data dan informasi tentang pendapat orang desa tentang aspek partisipasi (keterlibatan) mereka dan mengenai taman nasional itu sendiri juga dihimpun untuk dianalisa selanjutnya. Hasil penelitian ini memungkinkan sebuah analisis tentang masalah yang diakibatkan oleh pengabaian terhadap pendapat-pendapat dan kebutuhan penduduk setempat. Masalah ini sebenarnya dimungkinkan untuk tidak terjadi atau dapat dihindari bilamana terdapat saling pengertian atas segenap persepsi yang ada di masing-masing kelompok yang terlibat. Tujuan disertasi ini adalah untuk memberikan kontribusi kepada upaya pengembangan sebuah instrumen, yang bisa bermanfaat untuk memfasilitasi komunikasi yang baik dan memadai antara penduduk setempat dan petugas yang berwenang di dalam konservasi. Instrumen ini dapat bermanfaat untuk menghasilkan kesepakatan-kesepakatan dari desa menyangkut konservasi alam yang diterima dan disetujui oleh seluruh pihak yang terlibat.

1. Latar belakang Konseptual Disertasi

Studi ini membahas sebuah masalah yang menyangkut cara atau mekanisme yang diperlukan untuk menyesuaikan antara tuntutan yang perlu dalam rangka upaya konservasi dengan kebutuhan/kepentingan penduduk lokal yang bermukim di pinggiran wilayah konservasi tersebut. Guna keperluan pengembangan sebuah "metodologi", yang memungkinkan petugas dari konservasi dan penduduk lokal tersebut dapat berkomunikasi dengan lebih baik, sehingga ke dua belah pihak bisa saling memahami secara lebih sempurna isu tentang lingkungan berikut pengelolaan sumber daya alam, maka beberapa desa di perbatasan TNKS di Propinsi Jambi, Sumatera telah dipilih menjadi studi kasus penelitian.

Pertanyaan yang selalu muncul baik menyangkut kawasan konservasi yang telah ada ataupun kawasan baru, yang merupakan perluasan wilayah konservasi, seringkali menyinggung soal hubungan atau pola interaksi antara areal konservasi tersebut dengan penduduk yang tinggal di sekitarnya. Pola hubungan atau interaksi yang harmonis antara kedua aspek ini, senantiasa menjadi pusat perhatian yang penting bagi manajer ataupun pimpinan dari setiap taman nasional. Untuk menciptakan hubungan yang ideal demikian, adalah menjadi sangat penting untuk dipertimbangkan aspek-aspek menyangkut partisipasi dan keterlibatan dari penduduk lokal pada setiap tahapan atau langkah yang ditempuh di dalam proses pengembangan taman nasional, seperti menyangkut pengaturan tapal perbatasan, kebijakan kompensasi atau ganti rugi yang diberikan kepada penduduk karena mereka akan kehilangan akses terhadap sumber daya alam yang tersedia di taman nasional yang dibangun. Maksudnya, hanya dengan cara menjelaskan tujuan-tujuan yang baik dari adanya daerah konservasi adalah sama sekali tidak memadai karena penduduk lokal yang ada pada dasarnya memiliki konsep tersendiri tentang penggunaan sumber daya alam yang sesuai dengan pengetauhuannya.

Untuk mengukur PTSLP di desa-desa penelitian yang berbatasan dengan TNKS, sistem pertanian lahan kering akan diuraikan dari sudut ekologis serta mengenai sistem pemanfaatan lahan kering tersebut. Langkah pertama agar dapat memahami *alur pikiran* atau logika di balik sistem klasifikasi lokal (klasifikasi tradisional yang dilakukan secara turun-temurun oleh masyarakat lokal) adalah pertama-tama dengan memahami terlebih dahulu aspek-aspek dari lingkungan alam tersebut dengan memakai metode klasifikasi ilmiah (Müller-Böker 1988: 103). Untuk itu, maka tingkat pertumbuhan belukar yang ada di lapangan mesti diteliti secara seksama. Penelitian atas ciri-ciri fisik dan kandungan kimiawi dari tanah perlu dilakukan, mencakup lokasi mulai dari lahan belukar yang bersemak-semak kemudian diteruskan hingga ke areal hutan sekunder dari berbagai jenis usia.

Untuk perbandingan dengan hasil penyelidikan ilmiah, penulis kemudian menguraikan pengetahuan tradisional tentang lingkungan dari penduduk setempat serta cara pemanfaatan sumber daya alam yang berlandaskan pada pengetahuan itu. Obyek lain dari penelitian ini adalah hubungan antara penduduk di wilayah perbatasan dengan taman nasional. Titik berat pertannyaan menyinggung tentang persepsi penduduk mengenai taman nasional, pemanfaatan sumber daya alam yang tersedia di taman nasional dan partisipasi mereka di dalam perencanaan, pengembangan dan perlindungan TNKS tersebut.

Kerangka pemikiran yang sesuai untuk meneliti lingkungan dan PTSLP adalah *human ecology* (ekologi kemanusiaan). Rambo (1984a: 45) secara ringkas mendefinisikannya sebagai pandangan untuk menginvestigasi hubungan manusia dengan lingkungannya. Sebagai kerangka konsepsional untuk penelitian terapan, khususnya yang mengacu pada persoalan pembangunan pertanian dan pedesaan, ekologi kemanusiaan berguna bagi ilmu alam dan sosial untuk menempatkan manusia (masyarakat) dengan alam lingkungannya sebagai sebuah sistem yang menyatu. Karena masyarakat berikut sistem sosialnya yang hadir melekat dengan ekosistem (sistem lingkungan), maka penelitian PTSLP adalah merupakan instrumen yang cocok guna menganalisa bagaimana kedua sistem tersebut saling mempengaruhi.

2. Pengenalan Daerah Penelitian

Taman Nasional Kerinci Seblat (TNKS) adalah daerah hutan primer paling luas yang masih utuh di Pulau Sumatera, dengan ukuran luas keseluruhannya mencapai 1.368.000 ha. Taman nasional tersebut terbentang di sepanjang perbukitan Bukit Barisan, dari 100°31’8’’LT s/d 102°44’1’’ LT dan dari 1°7’13’’ BSB s/d 3°26’14’’ BSB, dengan panjang 350 km secara keseluruhan dari utara ke selatan. Di bagian yang paling lebar, ukuran lebar taman nasional mencapai hingga 70 km. Di sana, ia mengelilingi sebuah *enklave* berbentuk lembah (Kerinci) yang memiliki kepadatan penduduk yang tinggi. Lembah itu terletak di antara 900 dan 1.300 m d.p.l., serta memiliki sebuah danau (Danau Kerinci) dengan luas 41 m^2 dan dalam 110 m. Bukit yang paling tinggi di wilayah TNKS adalah Gn. Kerinci (3.804 m), sebuah gunung berapi yang masih aktif. Selain itu, taman ini masih memiliki enam bukit lainnya yang menonjol, dengan ketinggian rata-rata 2.600 m. Bila pegunungan di bagian timur dari gugusan Bukit Barisan menurun secara bertahap atau tidak terjal hingga pada dataran rendah Sumatera, maka lereng pegunungan di sebelah barat Bukit Barisan turun dengan curam/terjal hingga ke Samudera Hindia.

TNKS terletak di empat propinsi, yaitu Jambi (40 %), Sumatera Barat (25 %), Bengkulu (21%), dan Sumatera Selatan (14 %). Wilayah utama penelitian dari studi ini terletak di perbatasan timur dari TNKS tersebut yang berada di ketinggian sekitar 350 m d.p.l. dan secara administratif termasuk ke dalam Propinsi Jambi dan Sumatera Barat. Wilayah lain dari TNKS yang juga diteliti adalah dataran tinggi perbatasan timur taman nasional yaitu di wilayah kecamatan Jangkat yang secara adminsitratif termasuk ke dalam Propinsi Jambi.

Proses-proses pembentukan permukaan tanah (proses morfologis) yang khas untuk kawasan daerah tropis yang lembab membentuk relief atau kontur taman nasional itu. Terdapat tanah-tanah yang dalam karena dihancurkan oleh iklim. Akibat curah hujan yang tinggi erosi dan longsor seringkali terjadinya. Hasil dari segenap proses alamiah ini adalah relief berciri lereng-lereng curam dan lembah-lembah yang datar, yang membentuk *"rolling hills"* yang khas di daerah dataran rendah dan perbukitan. Pulau Sumatera mempunyai cuaca Köppen 'Af' dengan kepanasan tahunan rata-rata 26-27° C di dataran rendah dan curah hujan di wilayah penelitian utama mencapai 3.000 m. Tanah-tanah di daerah itu mempunyai *Kapasitas Tukaran Kation* rendah, tingkat kemasaman tinggi dan horison atas yang datar. Sehubungan dengan letak ketingian di atas permukaan laut, vegetasi di TNKS adalah hutan hujan dataran rendah sampai tinggi, hutan kabut, dan perumputan alpin. TNKS ditumbuhi oleh sekitar 4.000 tanaman-tanaman, 180 jenis burung (39 endemis), 144 mamalia (tujuh endemis), sepuluh jenis reptil dan enam binatang menyusui tingkat utama.

Daerah penelitian dihuni oleh suku Minangkabau yang bercorak matrilineal dan keturunannya berasal dari Sumatera Barat. Di perantauan di Jambi mereka berassimilasi dengan orang Melayu setempat hingga terbentuk menjadi masyarakat yang bersifat bilateral. Orang Minangkabau dan keturunannya mempunyai lembaga-lembaga adat tradisional serta hukum adat yang masih berfungsi secara aktif mengatur berbagai aspek kehidupan sehari-hari.

Berkat adanya ekspansi ekonomi uang/pasar, tersedianya pohon-pohon yang bernilai ekonomis serta adanya perkembangan di dalam arus tukar menukar barang akibat pembukaan sarana lalu lintas jalan raya, pemerintahan kolonial Belanda telah membawa arus perubahan yang cukup dalam pada kehidupan masyarakat lokal. Yang paling berarti adalah penngenalan pohon karet di awal abad 20 yang penanamannya dengan cepat meluas di daerah dataran rendah Pulau Sumatera. Di sana, pohon karet termasuk kategori tanaman produksi yang bernilai ekonomis (*cash crops*) yang sangat penting bagi para petani kecil hingga saat ini. Pohon-pohon karet tersebut mudah untuk diintegrasikan ke dalam sistem pertanian masyarakat setempat, yaitu sistem ladang berpindah-pindah. Artinya, ia bisa ditanam begitu saja di ladang bersamaan dan berdampingan dengan tanaman padi dan sayur-sayuran. Setelah tanaman padi dipanen, pohon-pohon yang bernilai ekonomis itu (*economic tree crops*) kemudian tumbuh berkembang bersama semak belukar, yang secara periodis dibersihkan, tergantung sejauh mana belukar itu telah menghambat pertumbuhan pohon-pohon ekonomis tersebut.

Sektor pertanian merupakan sumber pendapatan utama dari sekitar 90 % rumah tangga yang ada di desa yang berbatasan dengan TNKS. Untuk kebutuhan rumah tangga sendiri petani menanam padi *(subsitence production).* Tergantung dengan keadaan geomorfologisnya padi yang ditanam adalah padi ladang ataupun padi sawah. Sebagai sumber penghasilan, di dataran rendah, petani kebanyakan menanam pohon karet, sementara di dataran tinggi tanaman komoditi utama didominasi oleh kulit manis. Di seluruh tempat di daerah itu petani juga terbiasa dengan tanaman kopi, namun minat petani untuk menanam tanaman ini sangat tergantung pada fluktuasi harga kopi di pasaran setempat. Karena harganya cukup bagus/tinggi, dalam dekade terakhir ini, tanaman kulit manis telah meluas hingga ke daerah perbukitan. Di seluruh lokasi penelitian ditemukan fakta bahwa pembudi-dayaan kulit manis adalah faktor utama penyebab pembukaan lahan baru oleh petani kecil di dalam wilayah TNKS.

3. Partisipasi Penduduk Desa Perbatasan dalam Perencanaan, Pengembangan dan Pengelolaan TNKS

Konservasi alam sebagai upaya dari/oleh pemerintah telah eksis sejak jaman kolonial Belanda. Daerah konservasi untuk pertama kali dibangun pada tahun 1889. Saat kemerdekaan Indonesia dari kolonialisme Belanda di tahun 19945, negara telah memiliki sebanyak 100 daerah konservasi. Dalam kurun 50 tahun jumlah daerah konservasi meningkat hingga sebanyak 375 di tahun 1998; di antaranya terdapat 36 taman nasional. Perlindungan terhadap daerah dan kawasan konservasi tersebut, yang seluruhnya mencapai luas 21,1 juta hektar atau secara persentase mencapai 11,2% dari luas daratan Indonesia, dalam kenyataannya tidaklah selalu mudah. Hal ini bukan hanya karena dipengaruhi oleh banyaknya kelompok kepentingan yang terlibat dan yang menentang upaya pembangunan konservasi di hampir setiap tempat, tetapi juga karena adanya kelemahan/hambatan di dalam pelaksanaan hukum *(law enforcement)* atas kawasan konservasi itu sendiri. Hal ini disebabkan oleh kurangnya kapasitas dan biaya pada PHPA di satu pihak serta di pihak lain tidak adanya dan juga tidak sempurnanya peraturan-peraturan pelaksanaan dari UU (Undang undang) yang mengatur konservasi tersebut.

Meski namanya belum disebut seperti sekarang, penetapan TNKS sebagai kawasan konservasi telah lama dibuat. Beberapa bagian dari wilayah TNKS yang sekarang telah ditetapkan pada tahun 1920an sebagai kawasan konservasi oleh Pemerintah Kolonial Belanda. Konsep rencana pengelolaan yang disusun oleh UNDP/FAO pada tahun 1981 telah mengusulkan penggabungan beberapa daerah konservasi untuk menjadi TNKS. Alasannya mencakup faktor berkurangnya daerah-daerah hutan tropis yang masih utuh khusus di Pulau Sumatera, tingginya tingkat variasi habitat, banyaknya jenis-jenis tanaman dan binatang yang ada di dalam kawasan TNKS serta untuk upaya percegahan banjir pada daerah hulu sungai di dataran rendah. Satu tahun kemudian (1982), Menteri Pertanian Republik Indonesia mengusulkan status TNKS sebagai taman nasional. Walaupun demikian, proses penetapan dan pengesahan batas taman nasional baru selesai baru-baru ini yaitu pada tahun 1999. Dalam kurun waktu selama itu, dalam proses perencanaannya beberapa daerah dikeluarkan dari cakupan taman nasional di satu pihak sementara di pihak lain daerah-daerah lain disambung ke dalam wilayah TNKS itu.

Sayangnya, penduduk di sekitar TNKS hampir sama sekali tidak dilibatkan dalam proses penataan batas-batas taman. Dari 486 desa yang batasnya menyentuhkan TNKS, 134 mempunyai lahan pertanian "di dalam" areal taman nasional. Batas TNKS, yang ditentukan secara top-down "dari atas" diimplementasikan secara seragam di lapangan, tanpa lewat konsultasi terlebih dahulu dengan penduduk setempat. Artinya, petani dan penduduk desa mengetahui tentang adannya TNKS karena tiang tanda pembatas yang tiba-tiba ada di lahan milik mereka. Kenyataan seperti ini sama sekali tidak menciptakan kondisi dan iklim yang kondusif bagi proses penerimaan TNKS di desa-desa tersebut.

Proyek Konservasi dan Pembangunan Wilayah Terpadu (*Integrated Conservation and Development Project*, ICDP), yang dimulai tahun 1996 oleh WWF dan Bank Dunia, berusaha untuk lebih banyak melibatkan petani dan penduduk desa lewat pendekatan partisipatif baik di dalam perencanaan maupun perlindungan TNKS. Untuk itu, di setiap desa dikembangkan *Kesepakatan Konservasi Desa* bersama penduduk desa, dimana petani diberikan bantuan pembangunan bila mereka bersedia menghargai dan menjaga batas TNKS serta menyesuaikan pola pengunaan lahan di dalam dan di sekitar daerah konservasi tersebut. Kecuali TNKS, pada tahun 1997 ada 20 ICDP lainnya di Indonesia. Proyek-proyek tersebut menkombinasikan pembangunan, khususnya yang berlangsung di luar taman nasional dengan kegiatan konservasi di dalam taman sendiri.

Akan tetapi, daya tarik nilai ekonomis dari kegiatan eksploitasi kayu yang berlangsung ilegal dan pembudi-dayaan kulit manis serta keterbatasan kemampuan pengelola TNKS untuk mengawasi dan menghukum orang yang melakukan pelanggaran akibat kurangnya penjaga batas taman (100 untuk 3.000 km batas), telah mengakhibatkan kenyataan bahwa di banyak tempat pelanggaran atas batas TNKS tetap tinggi meskipun Kesepakatan Konservasi Desa telah dibuat. Kenyataan yang ditemukan studi ini di lapangan cukup menyedihkan, yaitu, bahwa dengan adanya konsesi penguasaan hutan (HPH), hadirnya perusahaan perkebunan dan pertambangan yang merambah daerah hutan di sekirtar/dekat TNKS dalam skala yang besar besar serta fakta pencurian kayu secara ilegal sering kali diback-up oleh tentara atau pejabat birokrat, telah membentuk persepsi di benak penduduk setempat yang mengatakan bahwa taman nasional tersebut hanyalah wahana yang berbeda atau sarana yang lain untuk mengambil-alih atau merampas lahan cadangan lahan pertanian mereka.

4. Pola Pengunaan Lahan secara Tradisional di bagian Dataran Rendah Perbatasan Timur TNKS

Sistem pengunaan lahan di bagian dataran rendah perbatasan timur TNKS terdiri dari kebun yang ditanami pohon yang menghasilkan nilai ekonomis *(economic tree crops)* serta lahan padi untuk kebutuhan subsistensi. Menyangkut jenis pohon yang kebanyakan ditanami, terdapat perbedaan antar daerah. Hal yang sama juga mengenai pola penanaman padi. Relief "rolling hills", misalnya, tidak memungkinkan penanaman padi sawah, sehingga di daerah itu jenis padai yang umumnya ditanam adalah padi ladang. Kalau ada daerah-daerah datar di antara bukit-bukit itu, di sanalah biasanya ditanam padi tadah hujan. Hanya dataran yang lebih luas memungkinkan penanaman padi sawah dengan sistem irigasi teknis. Kalau subsistensi beras bisa dicapai lewat penanaman padi sawah, budi-daya pohon-pohon bernilai ekonomis tidak menjadi prioritas. Sebagai perbandingan dengan daerah-daerah lain dimana petani menanamkan padi ladang, hasil penjualan produk pohon yang meproduksi hasil-hasil yang memiliki nilai ekonomi sebagian dipergunakan untuk membeli beras.

Jenis-jenis pohon yang dibudi-dayakan berbeda di setiap daerah. Adanya dominasi jenis-jenis tertentu yang diproduksi sangat dipengaruhi oleh adanya sebuah pusat budidaya di dekat situ. Penduduk desa di dataran rendah dekat jalan raya menuju ke Kerinci --daerah yang terkenal dengan kulit manisnya -- banyak mendengar cerita sukses petani Kerinci tersebut dan selanjutnya ikut-ikutan menanam kulit manis. Di desa dekat pusat produksi kopi di dataran tinggi juga banyak ditanamkan kopi. Dan di desa satu lagi, dekat daerah transmigrasi yang membudidayakan karet unggul, banyak petani ingin mencoba menkultivasikan komoditas itu juga. Akan tetapi, di semua desa tersebut porsi utama dari lahan pertanian yang tetap dipakai diperuntukkan untuk kebun karet. Hanya trend perkembangannya berbeda karena adanya pusat budidaya tersebut.

Karet, seperti jenis pohon-pohon lain, ataupun sayuran dan padi, ditanamkan dalam ladang yang dibuka dengan sistem ladang berpindah-pindah. Setelah panen padi ladang diistirahatkan, dan jenis pohon-pohon yang ditanamkan menumbuh besar bersama dengan belukar. Selama pohon karet masih kecil, kebunnya dibersihkan dari tumbuhan vegetasi sekunder secara periodis, dimana frekwensi penebasan itu tergantung dari jarak kebun tersebut dari desanya. Pohon belukar yang bermanfaat biasanya tidak dipotong. Kalau umurnya kebun karet sudah sepuluh tahun, getah pohonnya mulai dipanan. Kebanyakan petani tetap menyadapkan kebun karet tua, yang sudah melewati masa produksi yang rata-rata 15-25 tahun (Barlow dan Murhaminto 1982: 90). Rejuvenasi yang alami dan pemiliharaannya serta penanaman bibit karet di daerah-daerah kosong memungkinkan produktivitas berkelanjutan daripada kebun-kebun tersebut.

5. Ciri-ciri Botanis dan Pedologis dari Sistem Perladangan

Pengertian dari sistem pengunaan lahan dan praktek-praktek yang terkait dengannya, yang dijelaskan dalam bab sebelumnya, menfasilitasi sebuah komunikasi dengan para petani tentang corak penggunaan lahan berikut aspek yang berhubungan dengannya. Prasyarat penting lain adalah pengetahuan tentang alam setempat, serta pembentukannya lewat sistem pertanian. Hal ini dibahas di dalam bab ini. Di luar daerah persawahan, daerah pertanian di bagian dataran rendah perbatasan timur TNKS terdiri dari areal yang rata- rata sempit berupa ladang, belukar berbagai umur, serta kebun karet, kopi dan kulit manis. Karena bagian pokok dari lahan kering tersebut dibentuk oleh belukar dan kebun karet, yang juga memiliki biodiversitas yang tertinggi, disertasi ini memfokuskan diri untuk menganalisanya.

Pada penelitian atas belukar dan kebun karet berumur satu s/d 65 tahun, empat tahapan vegetasi sekunder dapat teridentifikasi. Seperti juga di daerah tropis basah lain, tahapan pertama didominasi oleh semak-semak yang kemudian disusul oleh beberapa tahapan perttumbuhan hutan sekunder. Bentuk transisi antara satu tahapan dengan tahapan berikutnya selalu landai atau tidak curam. Periode pertumbuhan tingkat belukar yang pertama adalah dua tahun, dimana 2/3 atau lebih dari vegetasinya terdiri dari semak-semak dan tanaman rumput-rumputan. Tahapan kedua berlangsung s/d tahun ke-tujuh, dimana pohon perintis mulai menutupi dan mengantikan vegetasi rumput-rumputan dari tingkat pertama. Perkembangan dari tingkat ke tingkat selalu diikuti oleh peningkatan keragaman hayati *(biodiversitas),* berikut pohon-pohon yang semakin tinggi dan memiliki diameter batang "tebal". Pada tahapan ke-tiga, yang berlanjut sekitar s/d tahun ke-19, terjadi penukaran dari pohon-pohon perintis digantikan oleh pohon-pohon berkayu keras. Setelah phase transisi tersebut maka perkembangan berikutnya adalah terbentuknya sebuah hutan sekunder, yang memiliki struktur yang mirip dengan yang dimiliki oleh hutan primer. Tingkat pertumbuhan mulai terbentuk dan makin banyak muncul jenis tanaman yang tumbuh di hutan primer.

Di samping faktor umur hutan sekunder, terdapat beberapa faktor lain yang mempengaruhi kondisi komposisi vegetasi. Salah satu faktor yang penting untuk disebutkan adalah sejarah pengolahan (kultivasi) lahan, yang secara langsung telah menentukan jumlah dan ragam bibit yang tersimpan di dalam tanah. Faktor yang lain adalah kegiatan penebasan yang bersifat selektif di dalam areal kebun karet. Penebasan ini mengakibatkan hilangnya sejumlah jenis tumbuhan tertentu yang keberadaannya tidak diinginkan dan selanjutnya membantu perkembangan sejumlah jenis tumbuhan lainnya. Ciri-ciri fisik dan kimiawi tanah serta posisi lereng mempengaruhi perkembangan berbagai jenis tanaman dengan mekanisme yang berbeda. Patut diperhatikan adalah bahwa perbedaan bebatuan di bawah lapisan tanah serta kondisi unsur kimia tanah muncul bersamaan dengan perbedaan yang menonjol dari keragaman hayati (biodiversitas) di antara lahan belukar dari masing-masing desa yang sama umurnya dan daerah pertanian desa secara keseluruhan. Dengan merujuk pada *USDA Soil Taxonomy* (Soil Survey Staff 1997), tipe-tipe tanah di daerah penelitian dapat dimasukkan ke dalam tiga kategori *soil orders*. Yang pertama adalah Inceptisols, yang direpresentasikan lewat *great group* Dystropepts. Kedua mencakup Ultisols, dengan *great group*-nya Paleudults, dan yang terakhir Oxisols, dengan anggotanya Hapludox dan Kandiudox. Meski semua tanah memiliki ciri-ciri fisik yang baik, namun tingkat kesuburan kimianya bersifat terbatas. Kalau antara tanah yang sejenis dibandingkan terdapat satu jenis yang relatif lebih subur daripada yang lain, dimana faktor penyebab utamanya terletak pada Kapasitas Tukar Kation dan kadar unsur hara. Adanya jenis-jenis tanah yang spesifik di masing-masing desa turut menentukan kualitas lahan pertanian di sana. Faktor utama yang menentukan ciri-ciri tanah adalah batu dasar, geomorfologi dan proses perkembangan belukar.

6. Pengetahuan Tradisional Tentang Lingkungan

Seperti yang akan dibahas dalam bab ini, pembahasan mengenai kriteria yang dipergunakan oleh masyarakat lokal di dalam menentukan cocok tidaknya suatu area menjadi tempat lahan usaha tani mereka merupakan kunci yang membantu kita untuk pemahaman terhadap persepsi penduduk lokal atas sumberdaya alam. Pemahaman ini berguna sebagai faktor yang melatar-belakangi pengolahan sumberdaya alam oleh petani. Tujuan penggunaan secara tradisional atau turun temurun tanaman-tanaman teretentu oleh penduduk lokal serta sistem taksonomi botanis setempat juga akan didiskusikan di dalam bab ini. Topik lain yang juga dibahas adalah pandangan dari petani tentang akibat-akibat yang terjadi dari pengelolaan lingkungan yang dilakukan oleh mereka. Sebagai bagian terakhir menyangkut perbandingan antara jenis klasifikasi alam secara ilmiah dengan yang tradisional yang dilakukan oleh penduduk lokal.

Faktor-faktor yang berpengaruh di dalam pemilihan sebuah lahan untuk menjadi lokasi perladangan adalah tanah, geomorfologi, kondisi dan susunan vegetasi serta ditambah sejumlah faktor praktis lainnya. Oleh petani, faktor tanah dibagi ke dalam beberapa tipe dimana tanah yang kurang subur, berdasarkan pengalaman mereka, hanya bisa digunakan untuk beberapa tanaman komiditi, khususnya tanaman jenis pohon. Sementara itu, di tanah yang lebih subur, menurut perspektif petani semua komoditi dapat tumbuh dengan baik. Menyangkut aspek geomorfologi, petani lokal memprioritaskan daerah datar dan kawasan lembah sebagai lokasi pertanian mereka dibanding dengan daerah lereng. Daerah di atas perbukitan oleh petani dipandang paling rendah kesuburannya. Posisi lereng menurut petani mempunyai pengaruh yang penting pada hasil panen padi dan komoditi-komoditi lain. Menyangkut aspek vegetasi di daerah belukar yang hendak diubah menjadi ladang, kriteria penting dari sudut pandang petani adalah menyangkut umur belukar yang hendak dijadikan ladang serta ada tidaknya jenis tanam-tanaman yang menunjukkan suburnya tanah yang bersangkutan.

Hasil penelitian tentang persepsi petani mengenai dampak pengunaan lahan pada alam mununjukkan bahwa pemahaman mengenai hubungan-hubungan ekologis merupakan bagian tak terpisahkan dari pengetahuan tradisional tentang lingkungan. Penduduk desa di sekitar TNKS menganggap keberadaa diri mereaka sebagai bagian tak terpisdahkan dari alam, dan mempercayai bahwa pengrusakan lingkungan fisik alam akan berdampak negatif pada kehidupan mereka. Hutan dianggap mereka sebagai "sumber kehidupan", namun bukan dalam pengertian etika konservasi alam yang ilmiah. Tetapi sebagai "cadangan lahan" yang perlu digunakan dengan hati-hati dan bijaksana. Menurut logika mereka, hutan yang rusak akan membahayakan basis kehidupan mereka, keluarga dan keturunan mereka karena pembukaan lahan baru akan tidak dimungkinkan bila diperlukan.

Taksonomi cara ilmiah dan tradisional menunjukkan banyak persamaan menyangkut struktur dan posisi masing-masing jenis tanaman atau spesies satwa. Menurut Berlin (1992: 25 f.) hal ini merupakan sebuah ciri umum pada semua sistem klasifikasi biologis. Mengenai taksonomi lokal hal yang menonjol adalah bahwa nama-nama tanaman dari jenis botanis yang sama di setiap desa yang diteliti umumnya berbeda meskipun jarak antara satu desa dengan desa lain tidak begitu jauh, rata-rata 50 km. Bila diperbandingkan, terdapat kesamaan hasil antara analisa kimia dan fisika tanah dengan klasifikasi tanah secara lokal, namun kesamaan tersebut bukan menyangkut klasifikasi tanah sesuai dengan USDA Soil Taxonomy. Terdapat perbedaan kimia dan fisik tanah di antara tipe-tipe tanah menurut cara tradisional, khususnya mengenai Kapasitas Tukar Kation, tekstur, karbon dan nitrogen organik serta magnesium yang tersedia dan kalium cadangan.

7. Pengetahuan Tradisional tentang Lingkungan serta Pengelolaannya guna Keperluan Komunikasi yang lebih baik di dalam Proyek Konservasi

Dari statemen verbal para aparat dan birokrat Indonesia, pemerintah Indonesia tampaknya sadar tentang pentingnya partisipasi lokal dalam konservasi alam. Walaupun demikian, di pendekatan ini belum diterapkan secara sungguh-sungguh di dalam program-program pemerintah. Sementara itu di pihak lain, partisipasi lokal sudah menjadi hal yang umum ditemukan di dalam konsep dari proyek yang dirancang oleh organisasi-organisasi internasional. Namun meskipun demikian, pemanfaatan "pengetahuan tradisional", termasuk PTSLP, tetap belum dipergunakan pada proyek-proyek konservasi alam yang didukung oleh lembaga-lembaga internasional tersebut. Bila para penyuluh pertanian dari suatu proyek mengabaikan pengetahuan, sumber daya dan praktek-praktek pengelolaan lahan secara lokal, khususnya karena dianggap tidak memiliki arti, maka akan sering terjadi penolakan terhadap proyek pembangunan yang dikelola oleh para penyuluh tersebut (Ashley 2000: 20).

Pendekatan pertisipatif, yang umumnya dipakai dalam perencanaan dan pengelolaan proyek pembangunan, biasanya terfokus hanya pada aspek pengembangan dan pengeloaan komponen sosio-ekonomi dari kehidupan desa. Keterbatasan pengetahuan tentang alam oleh pihak staf proyek serta dibarengi dengan pengabaian terhadap PTSLP mempunyai akibat yang berbahaya bagi kelangsungan proyek pertanian dan proyek konservasi: saat pembahasan masalah-masalah menyangkut seperti degradasi fisik lingkungan, pembukaan lahan baru dalam taman nasional atau perburuan gelap terhadap satwa langka, para staf proyek tidak dapat mengetahui apakah mereka membicarakan hal yang sama seperti yang dimaksud oleh petani atau tidak. Artinya, bila kesenjangan yang tidak disadari ini muncul dan terjadi, apakah dan bagaimana mungkin para penyuluh dan staf proyek dapat yakin bahwa mereka sudah menangani semua masalah yang penting dan merasa sudah menemui solusi yang tepat ?

Disertasi ini mengusulkan integrasi PTSLP dalam proyek-proyek pembangunan pertanian, pedesaan dan konservasi alam, baik di bidang penelitian maupun dalam praktek. Untuk konteks TNKS sebagai contoh kasus, penting diteliti secara seksama baik aspek ekosistem pertanian, pola penggunaan lahan yang terkait pada ekosistem tersebut maupun sistem klasifikasi tanah secara tradisional, vegetasi serta persepsi terhadap lingkungan yang berhubungan dengan klasifikasi tersebut. Hasil dari penelitian ini akan memungkinkan bentuk perencanaan proyek yang kualitasnya lebih baik untuk desa-desa yang berbatasan dengan TNKS. Soalnya dengan demikian, staf proyek akan mampu memahami lebih baik hasil perencanaan partisipatif yang dilakukan, memahami data yang dikumpulkan di lokasi proyek serta akan mampu menyampaikan hasil pikiran tersebut kepada petani dengan lebih baik.

Meskipun pendekatan atau metode PTSLP memiliki banyak kelebihan di dalam perencanaan dan pengelolaan proyek, namun dalam prakteknya sering masih ditemukan berbagai masalah dan hambatan. Sebagai contoh adalah konsep proyek ICDP. Walaupun pendekatan ICDP secara umum dan ICDP-TNKS secara khusus telah menitik-beratkan komponen partisipasi lokal, namun keputusan-keputusan pokok telah diambil sebelum dimulainya proyek konservasi serta cakupan untuk partisipasi lokal sudah ditentukan sebelum proyek berlangsung. Misalnya, petani diperbolehkan untuk ikut di dalam kegiatan penataan atau penentuan batas-batas taman, namun tidak boleh menolak batas-batas tersebut. Atau, misalnya, mereka diperbolehkan mengembangkan konsep penggunaan lahan khususnya bagi daerah perbatasan di sekitar TNKS, namun aturan-aturan tentang penggunaan lahan tersebut sebelumnya sudah ditentukan secara sepihak oleh ICDP.

Faktor penghambat lainnya adalah menyangkut kerangka kerja bersifat politik. Sistem kerja birokrasi pemerintah Indonesia, sistem hukum yang ada serta adanya *vested interest* yang berbeda-beda di antara pihak-pihak yang terlibat (*stakeholder*) pada hakekatnya telah menghambat proses konservasi alam di Indonesia secara umum dan bagi proyek TNKS secara khusus. Tujuan pengikut-sertaan penduduk lokal di dalam konservasi alam juga secara tidfak langsung dihalangi oleh pola pendekatan atau paradigma pembangunan di Indonesia. Dalam hal ini, adanya penilaian umum di kalangan birokrat pemerintah Pusat dan daerah bahwa tatanan budaya dan adat-istiadat tradisional desa adalah merupakan bentuk dan bagian dari keterbelakangan dari masyarakat lokal sendiri sehingga aspek-aspek ini secara apriori telah dipandang sebagai penghambat bagi pembangunan aspek sosial dan ekonomi yang dirancang oleh pemerintah (Dove 1988: 5). Sistem perencanaan dari atas ke bawah *(top-down approach)* yang begitu menyolok di dalam proses pembangunan di Indonesia sebagai dampak mashab pendekatan modernisasi di dalam ideologi pembangunan Indonesia juga bermakna sebagai faktor penghalang utama bagi terwujudnya partisipasi lokal. Dalam konteks ini pula, adagium yang tertera dalam konstitusi RI (UUD 1945), yang menyatakan bahwa semua sumberdaya alam yang tersedia merupakan milik negara, telah turut melahirkan sikap penolakan di kalangan pemerintah untuk tidak mengakui kepemilikan tanah oleh masyarakat lokal sesuai dengan hukum adat yang berlaku. Hal ini sangat menghambat bagi penerapan pendekatan perencanaan partisipatif.

Sebagai bagian terakhir, penulis ingin menggaris-bawahi akan pentingnya dialkukan penyesuaian-penyesuaian pendekatan proyek serta pola partisipasi masyarakat dengan kondisi dan corak sistenm sosial dan budaya dari masyarakat setempat. Hubungan PTSLP dan pengaruh pola pengunaan lahan terhadap lingkungan tidaklah sama di masing-masing desa. Juga, kemampuan dan keinginan penduduk untuk ikut serta dalam konservasi alam sangat beragam di setiap desa. Karena itu, dianjurkan agar tidak dipergunakan satu konsep standar (*blue print*) bagi semua lokasi proyek. Perlu fleksibilitas yang ditentukan oleh kondisi desa yang hendak digarap.

Upaya proses penyingkiran faktor-faktor yang menghambat secara politis guna pencapaian sebuah percobaan pada sistem konservasi alam di Indonesia, mungkin, akan memakan lebih banyak waktu dibandingkan dengan rentang waktu yang tersedia di dalam melindungi hutan yang masih tersisa. Dalam konteks ini, otonomi daerah, yang berlaku sejak awal tahun 2001, dapat bermakna sebagai ancaman di satu pihak, namun juga sebagai kesempatan di pihak lain di dalam waktu yang bersamaan. Dalam rangka otonomi daerah, pemerintah daerah memiliki kesempatan untuk memanfaatkan *celah* yang tersedia di dalam sistem undang-undang untuk secara kreatif mengembangkan alternatif paradigma konservasi alam, dimana bantuan luar negeri khusus untuk proyek seperti itu bisa dimafaatkan. Kasus-kasus yang menunjukkan pengalaman dimana partisipasi masyarakat lokal telah berhasil diterapkan lewat penggunaan

PTSLP dapat dijadikan contoh untuk mendorong sebuah perubahan dalam paradigma pembangunan dan pengelolaan sumber daya alam berskala nasional.

Annex 6: Deutsche Zusammenfassung

Umweltwissen und Ressourcen-Management: Sumatra's Kerinci-Seblat Nationalpark

Von Silvia Werner

Zusammenfassung

Die Untersuchung gilt vorrangig dem Kommunikationsproblem zwischen Akteuren im Naturschutz und der ansässigen Bevölkerung. Das Hauptproblem im Naturschutz stellen die Verständnisprobleme der beteiligten Gruppierungen, besonders hinsichtlich ihrer Naturwahrnehmung dar. Die vorliegende Arbeit setzt sich ein sowohl für die "moderne" Erforschung der natürlichen Umweltfaktoren, als auch für die Berücksichtigung des traditionellen Umweltwissens und –managements, um eine erfolgreichere Kommunikation und Problemlösung zu ermöglichen.

Den Hintergrund dieses Ansatzes bildet die Erfahrung sowohl des amtlichen Umweltschutzes als auch von Entwicklungsprojekten, dass Beratungsversuche fruchtlos bleiben, wenn sie die örtlichen Bedürfnisse und Prioritäten nicht in Betracht ziehen. Das bedeutet für Nationalparks, dass sie von Übergriffen auf ihr Territorium gefährdet sind, solange ihre Grenzen nicht unter Einbeziehung der Anwohner festgelegt werden. Dies kann jedoch nur erreicht werden, wenn eine gute Kommunikation über die Umwelt und deren Nutzung möglich ist.

Für eine Fallstudie wurden mehrere Dörfer am Ostrand des Kerinci-Seblat Nationalparkes (KSNP) ausgewählt. Die vor-Ort - Untersuchungen befassten sich zuerst mit der Identifizierung der Hauptkomponenten der Agrarlandschaft sowie ihrer Nutzung. Da sich das lokale Landnutzungssystem vor allem aus den Komponenten Wanderfeldbau und Waldgärten zusammensetzt, konzentrierte sich die Arbeit auf die Struktur und Zusammensetzung des Trockenfeldbaus und dessen botanische und bodenkundliche Eigenschaften.

Zur Ergänzung dieses naturwissenschaftlichen Ansatzes wurde das örtliche bodenkundliche und botanische Umweltwissen dokumentiert, sowie die Kriterien der Bauern zur Auswahl landwirtschaftlicher Flächen. Dazu wurde die Nutzung und Wahrnehmung des an die Trockenfelder angrenzenden Primärwaldes untersucht. Dabei ging es darum, sowohl die Rolle und Wichtigkeit des Primärwaldes für die Dorfbevölkerung zu erforschen, als auch Kenntnis über das Gewohnheitsrecht hinsichtlich des Waldes zu erlangen.

Den Abschluss bildet die Analyse der gegenwärtigen Beteiligung der ansässigen Bevölkerung an der KSNP-Planung, Einrichtung des Parks und dessen Management. Dabei wurde auch die Meinung der Dorfbevölkerung über ihre Involvierung sowie über den Park selbst dokumentiert.

Die Ergebnisse ermöglichen eine Problemanalyse darüber, inwiefern die Nichtbeachtung lokaler Meinungen und Bedürfnisse Probleme hervorruft, welche durch ein gegenseitiges Verständnis der Akteure hinsichtlich ihrer Ansichten hätte vermieden werden können. Die Arbeit versteht sich als Beitrag zur Entwicklung eines Instruments, welches eine erfolgreichere Kommunikation zwischen der lokalen Bevölkerung und Umweltschützern ermöglicht, die allgemein akzeptierte Naturschutz-Übereinkünfte hervorbringen kann.

1. Konzeptueller Hintergrund der Arbeit

Die vorliegende Arbeit setzt sich mit dem Problem auseinander, wie die Erfordernisse des Naturschutzes und die Bedürfnisse der Anwohner von Naturschutzgebieten miteinander in Einklang gebracht werden können. Um eine Methodologie zu entwickeln wie Naturschützer und Park-Anwohner besser über die Umwelt und das Management von natürlichen Ressourcen kommunizieren können, wurden mehrere Dörfern an der Grenze zum Kerinci-Seblat Nationalpark (KSNP) in Zentral-Sumatra, Indonesien, für eine Fallstudie ausgewählt.

Sowohl bei existierenden Naturschutzgebieten als auch bei der Schaffung neuer stellt sich immer die Frage nach der Art der Interaktion zwischen diesen und der in deren Nähe lebenden Bevölkerung. Ein harmonisches Miteinander ist immer ein vordringliches Anliegen eines jeden Parkvorstehers. Um dieses zu erreichen, ist eine Partizipation der Anwohner in den Schritten zur Schaffung des Parks, der Grenzziehung und eine Kompensation für einen verloren gegangenen Zugang zu natürlichen Ressourcen sehr wichtig. Es reicht nicht aus, ihnen lediglich die Zielsetzung des Naturschutzgebietes zu erläutern, da die lokalen Bauern ein grundlegend anderes Konzept von dem haben, was man als eine angemessene Nutzung natürlicher Ressourcen versteht.

Um sich dieses zu erschließen, bedarf es eines Verständnisses darüber, wie die örtliche Bevölkerung ihre Umwelt sieht und verändert, d.h. hinsichtlich ihres traditionellen Umweltwissens und -Management Systems (TUWMS). Um mit den Bauern über die Umwelt kommunizieren zu können, d.h. deren Aussagen verstehen und in den richtigen Zusammenhang setzen zu können, müssen Vertreter des Parkmanagements dazu auch selbst eine gewisse Umweltkenntnis besitzen. Diese Überlegungen führten zu der Entwicklung der in dieser Arbeit verwandten Forschungsmethodologie.

Um das TUWMS in den Grenzdörfern des KSNP zu erfassen, wurde der Trockenfeldbau sowohl ökologisch als auch hinsichtlich des verwendeten Nutzungssystems analysiert. Um die Logik einer lokalen Klassifikation zu verstehen, ist der erste Schritt, sich selbst als Orts- und Kulturfremdem diesen Bereich der natürlichen Umwelt zu erschließen, ausgehend von einer wissenschaftlichen Klassifikation (Müller-Böker 1988: 103). So wurden die unterschiedlichen Brachestadien, angefangen von Buschbrache bis hin zum Sekundärwald verschiedener Altersklassen, identifiziert und die darunter liegenden Böden auf ihre bodenchemischen und -physikalischen Eigenschaften hin untersucht.

Für eine Gegenüberstellung zu den wissenschaftlichen Untersuchungen erschloss sich die Autorin dann das traditionelle Umweltwissen der lokalen Bevölkerung sowie die auf dem Wissen basierenden Nutzungsmuster der natürlichen Ressourcen.

Ferner ging es um die Beziehung zwischen Anwohnern und Nationalpark. Schwerpunkte dabei waren die Wahrnehmung des Parks durch die lokale Bevölkerung, Nutzung von Parkressourcen, und die Beteiligung der Anwohner an der Planung, Einrichtung und dem Schutz des KSNP.

Einen geeigneten Rahmen für die Untersuchung von sowohl Umwelt als auch TUWMS bietet die Humanökologie. Rambo (1984a: 45) definierte diese als eine Sichtweise zur Erforschung der menschlichen Beziehungen zu deren Umwelt. Als konzeptioneller Rahmen für die angewandte Forschung landwirtschaftlicher und ländlicher Entwicklungsfragen hilft die Humanökologie sowohl Natur- als auch Geisteswissenschaftlern die menschliche Gesellschaft und die Natur als System zu betrachten. Da der Mensch mit seinem Sozialsystem im Ökosystem eingebettet existiert, ist die Erforschung des TUWMS das geeignete Instrument zur Untersuchung der gegenseitigen Beeinflussung dieser beiden Teil-Systeme.

2. Das Untersuchungsgebiet

Der Kerinci-Seblat Nationalpark hat als größtes, zusammenhängendes Regenwaldgebiet Sumatras eine Fläche von insgesamt 1.368.000 ha. Der Park erstreckt sich entlang der Barisan-Gebirgskette von 100°31'ÖL bis 102°44' ÖL und von 1°7' SWB bis 3°26' SWB, mit einer Länge von 350 km von N nach S. An der breitesten Stelle misst der Park 70 km. Dort umschließt er eine Enklave in Form des dicht besiedelten Kerinci-Hochtals, das zwischen 900 und 1.300 m üNN gelegen ist, mit dem 41 km^2 großen und 110 m tiefen Kerinci-See. Die höchste Erhebung des Parks ist der aktive Kerinci-Vulkan mit (3.804 m). Sechs weitere Berge mit einer Höhe um 2.600 m befinden sich im Park. Östlich der Barisan-Kette laufen die Berge sanft zum sumatranischen Tiefland aus, während die Westhänge steil zum Indischen Ozean hin abfallen.

Der KSNP erstreckt sich über die Provinzen Jambi (zu 40 %), West-Sumatra (25 %), Bengkulu (21 %) und Süd-Sumatra (14 %). Die Hauptforschungsregion befand sich an der östlichen Tieflandsgrenze des Parks in Höhen um 350 m in den Provinzen Jambi und West-Sumatra. Weitere Untersuchungen wurden im östlichen Hochland von Jangkat, Jambi, durchgeführt.

Morphologische Prozesse, typisch für die immerfeuchten Tropen, formten das Relief des Nationalparks. Tiefgründig verwitterte Böden und hohe Niederschläge führen zu starker Erosion und häufigen Erdrutschen. Das Ergebnis ist ein Relief mit steilen Hänge und ebenen Talböden, das die typischen 'rolling hills' des Tieflands und der Hügelzone bildet. Sumatra hat ein Köppen 'Af' Klima mit einem Jahresmittel von 26-27° C im Tiefland und 3.000 mm Niederschlag in der Forschungsregion. Die Böden sind von niedriger Kationen-Austauschkapazität, starker Versauerung und geringmächtigen Oberböden gekennzeichnet. Als Vegetation findet sich im KSNP je nach Höhenstufe Tiefland- oder Bergregenwald, sowie Nebelwald und Hochgebirgsmatten. Der Park beherbergt schätzungsweise 4.000 Pflanzenarten, 180 verschiedene Vögel (39 davon Endemiten), 144 Säugetiere (sieben endemisch im KSNP), zehn Reptilien- und sechs Primatenarten.

Die Forschungsregion ist bewohnt von matrilinearen Minangkabau und ihren Abkömmlingen, die sich nach Migration aus ihrem west-sumatranischen Kerngebiet zum Teil mit den Malayen Jambis und Bengkulus zu einer eher bilateralen[1] Gesellschaft vermischten. Sie zeichnet sich durch traditionelle Institutionen aus, die verschiedenste Bereiche des sozialen Miteinanders mittels des Gewohnheitsrechts regeln.

Durch die Einführung der Geldwirtschaft, Nutzbaumarten sowie eines verbesserten Waren- und Informationsaustausches durch den Bau von Straßen brachte die holländische Kolonialherrschaft tiefgreifende Veränderungen für die lokalen Gesellschaften mit sich. Besonders bedeutsam war die Einführung der Hevea Anfang des 20. Jhs, welche sich in kürzester Zeit im Tiefland Sumatras ausbreitete und dort bis heute eine der wichtigsten *cash crops* der Kleinbauern ist. Dauerkulturen konnten leicht in das bestehende Landnutzungssystem, den Wanderfeldbau, integriert werden, da sie einfach nebst Reis und Gemüse in das Trockenfeld gepflanzt werden. Nach der Reisernte wachsen die Baum- und Strauchkulturen zusammen mit der Sekundärvegetation, wovon sie, soweit diese das Wachstum ersterer behindert, periodisch befreit werden.

Landwirtschaft ist die Haupteinnahmequelle von 90 % der Familien in den KSNP-Randgebieten. Dabei wird für den Eigenverbrauch vor allem das Grundnahrungsmittel Reis angepflanzt, je nach geomorphologischen Gegebenheiten im Trockenfeld oder bewässert. Für den Verkauf kultivieren die Bauern im Tiefland überwiegend Kautschuk (*Hevea brasiliensis*) und im Hochland Zimt (*Cinnamomum spp.*). Je nach Preislage existiert dazu auch mehr oder weniger intensiver Kaffeeanbau. Aufgrund positiver Preisentwicklung breitete sich der Zimtanbau in den vergangenen zehn Jahren verstärkt bis in die Hügelzone aus. Er stellt in seinem gesamten Anbaugebiet einen Hauptfaktor für die kleinbäuerliche Erschließung neuer Felder im Nationalparksgebiet dar.

[1] D.h., sowohl mit matrilinearen, als auch patriarchalischen Zügen.

3. Beteiligung der lokalen Bevölkerung an der KSNP-Planung, Einrichtung des Parkes und dessen Management

Staatlicher Naturschutz in Indonesien reicht zurück bis in die holländische Kolonialherrschaft, während der 1889 das erste Naturreservat eingerichtet wurde. Bei der nationalen Unabhängigkeit besaß das Land bereits mehr als 100 Naturschutzgebiete, die bis 1998 auf 375 anwuchsen. 36 davon sind Nationalparks. Der faktische Schutz der sich über 21,2 Mio. Hektar und 11,2 % der Staatsfläche erstreckenden Reservate jedoch ist schwierig. Es gibt nicht nur viele Interessensgruppen, die sich dem Naturschutzanliegen an den einzelnen Orten entgegenstellen, sondern auch Schwächen in der Ausführung der Naturschutzgesetzgebung. Dieses ist auf der einen Seite durch mangelnde Kapazitäten und Mittel auf Seiten der Naturschutzbehörde bedingt, auf der anderen Seite durch fehlende Ausführungsbestimmungen zur Umsetzung der einzelnen Gesetze.

Bereits in den 1920er Jahren wurden Teile des heutigen KSNP von den Holländern zu Schutzgebieten erklärt. Ein Entwurf für einen Management Plan durch UNDP/FAO im Jahre 1981 schlug die Zusammenlegung mehrerer Schutzgebiete zum KSNP vor. Grund dafür waren vor allem die Abnahme zusammenhängender Regenwaldgebiete auf Sumatra, die Vielfältigkeit der Habitate, der Artenreichtum des Gebiets und der Schutz von Tieflandgebieten vor Überschwemmungen. Ein Jahr später bereits schlug der Landwirtschaftsminister Indonesiens KSNP als Nationalpark vor. Der darauf folgende Prozess der verbindlichen Festlegung der Parkgrenzen war jedoch erst 1999 abgeschlossen, nachdem mehrmals Gebiete abgetrennt und anschließend wieder andere hinzugefügt wurden.

Leider wurde die lokale Bevölkerung bei der Grenzziehung fast überhaupt nicht beteiligt. Von 486 Dörfern, die gemeinsame Grenzen mit dem Park besitzen, haben 134 landwirtschaftliche Flächen innerhalb des Parkgebietes. Die Parkgrenzen wurden nach traditioneller Naturschutzmanier am “grünen Tisch” festgelegt und auch so im Feld, ohne vorherige Absprache mit den Anwohnern, implementiert. Die Tatsache, dass die Bauern über den Park dadurch erfuhren, dass sich plötzlich Grenzlinien häufig quer durch ihre landwirtschaftlichen Nutzflächen zogen, schaffte keinen guten Start für eine Akzeptanz des Parkes.

Ein 1996 von WWF und Weltbank begonnenes integriertes Schutz- und Entwicklungsprojekt (*Integrated Conservation and Development Project*, ICDP) bemühte sich, mit partizipativen Methoden die Bauern stärker in die Planung und den Schutz des KSNP einzubeziehen. Dafür wurden (und werden noch) in jedem Dorf gemeinsame Schutzabkommen mit den Bauern geschlossen, worin diese sich im Gegenzug für Entwicklungshilfeleistungen zu einer Respektierung der Grenzen und zu Nutzungsbeschränkungen inner- und außerhalb des Parkgebietes bereit erklärten. Außer dem KSNP gab es 1997 noch 20 andere ICDPs. Diese Projekte kombinieren Entwicklung, vorwiegend außerhalb des Parks, mit Naturschutz innerhalb des Parkgebietes.

Von illegalem Holzeinschlag und Zimtanbau ausgehende Einkommensanreize und die durch Mangel an Parkrangern (100 für 3.000 km Grenze) eingeschränkte Möglichkeit des Parkmanagements, Verstöße zu überprüfen und zu ahnden, bedingen jedoch, dass es an vielen Orten auch nach Inkrafttreten der Schutzabkommen weiterhin Übergriffe auf das Parkgebiet gibt. Die Tatsache, dass Holzkonzessionen, Plantagenfirmen und Bergbauunternehmen sich Waldgebiete nahe des KSNP aneignen und dass illegaler Holzeinschlag oft Militär und Bürokratie als Hintermänner hat, trägt dazu bei, dass die lokale Bevölkerung den Park oft nur als ein weiteres Mittel sieht, sie ihrer Landreserven zu enteignen.

4. Traditionelle Landnutzung an der östlichen Tieflandgrenze des KSNP

Das Landnutzungssystem an der östlichen Tieflandsgrenze des KSNP ist vorrangig bestimmt durch den kleinbäuerlichen Anbau von Dauerkulturen für den Markt und Reisanbau für den Eigenverbrauch.. Dabei gibt es sowohl regionale Unterschiede hinsichtlich der dominierenden Dauerkultur als auch der Art des Reisanbaus. Das typische "rolling hill"-Relief bietet kaum die Möglichkeit für den bewässerten Reisanbau, weshalb in diesen Gebieten üblicherweise Trockenreis angebaut wird. Wenn vereinzelte flache Senken zwischen den Hügeln zu finden sind, gibt es dort zusätzlich Nassreisanbau im Regenstau. Nur in Gegenden mit weiten Ebenen findet sich der bewässerte Nassreisanbau. Wenn durch Nassreisanbau eine Selbstversorgung mit dem Grundnahrungsmittel Reis problemlos gewährleistet werden kann, hat die Intensität der Pflanzung von Baum- und Strauchkulturen eine geringere Priorität im Vergleich zu den Orten, wo Trockenreis dominiert und die Erlöse der *cash crops* teilweise zum Kauf von Reis verwandt werden.

Auch die Kultivierung von Baum- und Strauchkulturen variiert nach Region. Die Dominanz einer Kultur wird hier jedoch hauptsächlich von der Nähe zu einem Anbauzentrum beeinflusst. Tieflanddörfer an der Straße zur Kerinci-Enklave, wo Zimtanbau groß geschrieben wird, lernten von dem Erfolg der Bauern dort und versuchen, es ihnen nachzumachen. In Dörfern nahe eines Hochland-Zentrums der Kaffeeproduktion wird ebenfalls viel Kaffee gepflanzt. In einem anderen Dorf nahe einer Hybrid-Kautschuk kultivierenden Transmigranten-Siedlung war dafür das Interesse an verbesserten Kautschuksetzlingen sehr groß. In allen Dörfern besetzte traditionelle Hevea-Gärten noch den überwiegenden Flächenanteil. Der derzeitige Entwicklungstrend war jedoch aufgrund der jeweiligen nahegelegenen Anbauzentren verschieden.

Kautschuk wird, wie auch andere Dauerkulturen, Reis und Gemüse, in das im Schwendbau vorbereitete Trockenfeld gepflanzt. Nach der Reisernte beginnt der Brachezyklus, wobei die Dauerkulturen zusammen mit der Sekundärvegetation aufwachsen. Diese wird bei Kautschukgärten je nach Distanz des Feldes zum Dorf, mehr oder weniger häufig abgeschlagen, solange die Setzlinge noch klein sind. Wilde Nutzbaumarten werden dabei jedoch stehen gelassen. Im Alter von zehn Jahren wird mit dem Zapfen der Bäume begonnen. Die Mehrzahl der Bauern zapft alte Kautschukgärten weiter, welche die durchschnittliche Produktivitätsspanne von 15-25 Jahren überschritten haben . Die aktive Pflege der Naturverjüngung sowie das Pflanzen von Setzlingen in Lücken des Bestandes ermöglichen eine fortgesetzte Leistungsfähigkeit dieser Gärten.

5. Botanische und bodenkundliche Eigenschaften des Trockenfeldbau-Systems

Das Verständnis des oben vorgestellten Landnutzungssystems und der damit verbundenen stehenden Praktiken ermöglicht eine Kommunikation darüber mit den Bauern. Eine weitere Voraussetzung ist die Kenntnis der örtlichen Umwelt und deren Prägung durch die Landwirtschaft, die in diesem Kapitel behandelt wird. Die landwirtschaftlich genutzten Gebiete im östlichen Tieflandgrenzgebiet des KSNP bestehen außerhalb der Nassreisgebiete aus einem komplexen Patchwork von Trockenfeldern, verschiedenen Brachestadien sowie Kautschuk-, Kaffee- und Zimtgärten. Da Brachevegetation und Kautschukgärten den größten Teil der Flächen ausmachen und den höchsten Artenreichtum haben, konzentriert sich diese Studie auf dessen Analyse.

Bei der Untersuchung von ein- bis 65-jähriger Sekundärvegetation und Kautschukgärten konnten vier Brachestadien identifiziert werden. Ähnlich wie auch in anderen Gebieten der humiden Tropen handelt es sich dabei um eine von Kräutern, Gräsern und Sträuchern dominierte Phase mit mehreren darauf folgenden Sekundärwald-Stadien. Übergänge zwischen den einzelnen Stufen sind immer fließend. Das erste Brachestadium dauert zwei Jahre, wobei 2/3 des Bestandes oder mehr Sträucher, Kräuter und Gräser sind. In der bis zum siebten Brachejahr andauernden jungen Sekundärwaldphase beginnen Pioniergehölze die krautige Vegetation auszuschatten. Die Weiterentwicklung von Phase zu Phase ist immer mit einem Anstieg der Biodiversität sowie der Höhe und des Durchmessers der Gehölze verbunden. Während des ca. bis zum 19. Jahr andauernden, dritten Stadiums findet ein Wechsel von einer Dominanz der Pioniergehölze hin zu Hartholz-Bäumen statt. Nach diesem Übergangsstadium hat sich ein alter Sekundärwald etabliert, dessen Struktur anfängt der des Primärwaldes zu ähneln. Der Stockwerksbau beginnt sich auszubilden, und es siedeln sich auch immer mehr Arten des Primärwaldes an.

Neben dem Alter der Sekundärvegetation gibt es weitere Faktoren, die eine Zusammensetzung des Bestandes beeinflussen. Dazu gehört die Bearbeitungsgeschichte eines Feldes, da diese maßgeblich die Zusammensetzung der sich im Boden befindlichen Samenbank beeinflusst. Selektive Reinigungsmaßnahmen in Kautschukgärten, wobei manche Arten unerwünscht sind, andere hingegen gefördert werden, sind ein weiterer Faktor. Ebenfalls ausschlaggebend sind bodenphysikalische und –chemische Faktoren, sowie die geomorphologische Situation, die unterschiedliche Arten verschieden beeinflussen. Auffallend ist insbesondere dass unterschiedliche

Ausgangsgesteine und bodenchemische Bedingungen mit einer deutlich verschiedenen Biodiversität der jeweiligen Flächen und der Ländereien als Ganzes einhergehen.

Die Bodentypen des Untersuchungsgebietes gehören nach der USDA Soil Taxonomy (Soil survey Staff 1997) zu drei *soil orders*:

- Inceptisols, die von der *great group* der Dystropepts repräsentiert werden,
- Ultisols, repräsentiert durch die Paleudults
- Oxisols mit den *great groups* Hapludox und Kandiudox als Vertretern.

Die Böden sind generell von guten bodenphysikalischen Eigenschaften, aber einer nur geringen bodenchemischen Fruchtbarkeit gekennzeichnet. Im Vergleich gesehen sind jedoch die bodenchemischen Eigenschaften einiger Böden besser als andere, gekennzeichnet vor allem durch höhere Austauschkapazitäten und Nährstoffgehalte. Das Vorkommen der Bodentypen in den jeweiligen Dörfern bestimmt die Qualität der dortigen Nutzflächen. Die wichtigsten Einflussfaktoren auf die Bodeneigenschaften sind Ausgangsmaterial, Geomorphologie und der Bracheprozess.

6. Traditionelles Umweltwissen

Um ein Verständnis darüber zu ermöglichen, wie Bauern die örtlichen natürlichen Ressourcen betrachten, was den Hintergrund ihres Umweltmanagements darstellt, beschäftigt sich dieses Kapitel mit den lokalen Bewertungskriterien für die landwirtschaftliche Eignung eines Feldes. Diskutiert werden auch die traditionelle Nutzung von Pflanzen und die lokale, botanische Taxonomie. Ein weiteres Thema ist die bäuerliche Wahrnehmung der Auswirkungen ihres Umweltmanagements. Als Letztes werden die wissenschaftliche und die traditionelle Umweltklassifikation einander gegenüber gestellt.

Ausschlaggebend für die Auswahl eines Trockenfeld-Standortes sind die Böden, die geomorphologische Situation, der Zustand und die Zusammensetzung der Vegetation sowie pragmatische Kriterien. Die Böden werden von den Bauern ihrer Erfahrung entsprechend in mehrere Typen unterteilt, wobei gering fruchtbare Böden nur für wenige Anbauprodukte als geeignet gelten (vor allem Nutzbäume), auf fruchtbaren aber alle Pflanzen gut wachsen. Hinsichtlich der Geomorphologie wurden Senken und Ebenen den Hanglagen bevorzugt, während Hangkuppen als am wenigsten fruchtbar angesehen wurden. Die Hangposition wirkt sich den Bauern nach deutlich auf die zu erwartenden Erträge von Reis und anderen Anbauprodukten aus. Was die Vegetation eines zukünftigen Feldes angeht, wird sowohl auf das Alter der Brache geachtet, wie auch auf gute Standortbedingungen hinweisende Zeigerarten bzw. ihre Abwesenheit, die auf das Gegenteil deutet.

Bei der Untersuchung der Wahrnehmung hinsichtlich der Auswirkung von Nutzungsmethoden auf die Umwelt wurde deutlich, dass das Verständnis ökologischer Zusammenhänge Bestandteil des traditionellen Umweltwissens ist. Die Anwohner des KSNP empfinden sich als Teil der Umwelt, und glauben, dass sich deshalb Umweltzerstörung auch negativ auf ihr Leben auswirken würde. Der Wald wird hierbei als "Quelle des Lebens" (*sumber kehidupan*) betrachtet, aber nicht im Sinne einer traditionellen Naturschutz-Ethik, sondern als Landreserve, die schonend genutzt werden muss. Ein geschädigter Wald gefährdet die Lebensgrundlage der Bauern, da dann in der Zukunft keine neuen Felder mehr erschlossen werden können.

Die wissenschaftliche und die traditionelle Taxonomie weisen viele Gemeinsamkeiten in ihrer Struktur und der Position der einzelnen Taxa darin auf. Dies ist Berlin (1992: 25 f.) zufolge ein generelles Merkmal aller traditionellen biologischen Klassifikationssysteme. Hierbei fiel weiterhin auf, dass trotz nur geringer räumlicher Distanz zwischen den untersuchten Dörfern (im Mittel 50 km) die Benennung identischer Arten meist unterschiedlich war. Auch zwischen den Ergebnissen der bodenchemischen und –physikalischen Untersuchungen und der traditionellen Bodenklassifikation gab es Übereinstimmungen, jedoch nicht mit der Einteilung der Bodentypen nach der USDA Soil Taxonomy. Bodenchemische und –physikalische Unterschiede zwischen Bodentypen der traditionellen Klassifikation bezogen sich insbesondere auf die Austauschkapazität, Textur, organischen Stickstoff und Kohlenstoff, sowie pflanzenverfügbares Magnesium und Kaliumreserven.

7. Traditionelles Umweltwissen und –Management Systeme für eine verbesserte Kommunikation in Umweltschutzprojekten

Obwohl amtlichen Äußerungen zufolge die indonesische Regierung sich der Wichtigkeit lokaler Beteiligung im Naturschutz bewusst ist, findet diese Erkenntnis in staatlichen Programmen bisher nur geringe Umsetzung. In Projektkonzepten internationaler Organisationen hat sie jedoch schon mehr Verbreitung gefunden. Die Verwendung von traditionellem Wissen, einschließlich TUWMS, im Naturschutz ist jedoch auch dort bisher nicht üblich. Wenn landwirtschaftliche Berater traditionelle Wissenssysteme, Ressourcen und Praktiken ausblenden, da sie diese für unwichtig erachten, kommt es jedoch zu Widerstand gegen Entwicklungsprogramme (Ashley 2000: 20). Partizipative Ansätze, die heutzutage in der Planung und dem Management von Entwicklungsprojekten verwandt werden, beschränken sich üblicherweise auf sozio-ökonomische und management-bezogene Aspekte des dörflichen Lebens. Ein Mangel an Umweltkenntnis auf Seiten der Projektmitarbeiter plus eine Ignorierung von TUWMS in Landwirtschafts- und Naturschutzprojekten hat jedoch gefährliche Konsequenzen: bei der Behandlung von Problemen wie Umweltdegradation, Landerschließung in Parks oder Wilderei wissen Projektmitarbeiter nie, ob sie über dasselbe sprechen wie die Bauern. Wie können sie sich so sicher sein, dass alle wichtigen Probleme angegangen und passende Lösungen gefunden wurden?

Die vorliegende Arbeit rät zu einer Integration von TUWMS in Entwicklungs- und Naturschutzvorhaben sowohl in der Forschung als auch in der Praxis. Im Zusammenhang mit dem KSNP wurden exemplarisch das Agro-Ökosystem, die damit verbundenen Landnutzungspraktiken sowie traditionelle Klassifikationssysteme von Böden, Vegetation und damit zusammenhängende Umweltwahrnehmungen untersucht. Die Ergebnisse ermöglichen einen verbesserten Planungsmechanismus für Dörfer im Park-Randgebiet. Projektmitarbeitern wird dadurch ein besseres Verständnis der Ergebnisse partizipativer Planung und Datenerhebung vor Ort ermöglicht, ebenso eine Übermittlung ihrer eigenen Gedankengänge zu den Bauern.

Trotz der offensichtlichen Vorteile, die eine Verwendung von TUWMS in der Projektplanung und im –Management bietet, stehen dem in der Praxis noch viele Widerstände entgegen. Dazu gehört unter anderem das Projektkonzept von ICDPs. Trotz ihres erklärt partizipativen Ansatzes von ICDPs im Allgemeinen und dem ICDP-KSNP im Besonderen sind die grundlegenden Entscheidungen bereits im Vorfeld der Naturschutzprojekte gefallen, ist der einer Bevölkerungsbeteiligung zur Verfügung stehende Raum von vornherein festgelegt. Bauern können an der Grenzfestlegung mitwirken, aber diese nicht ablehnen. Sie können ein Landnutzungskonzept für die Pufferzone außerhalb des Parkes erarbeiten, dessen Regeln jedoch vom ICDP bereits festgelegt wurden.

Ein weiterer Hinderungsfaktor sind die politischen Rahmenbedingungen. Sowohl das Verwaltungs- und Rechtssystem als auch die im Widerstreit liegenden Interessensgruppen stehen dem Naturschutz in Indonesien im Allgemeinen und im KSNP im Speziellen im Wege. Eine aktive Bevölkerungsbeteiligung im Naturschutz wird weiterhin durch das gültige Entwicklungs-Paradigma in Indonesien eingeschränkt. Dazu gehört die Einschätzung, dass traditionelle Kulturen und Lebensformen ein Zeichen von Unterentwicklung und Hindernis für die notwendige sozio-ökonomische Entwicklung darstellen (Dove 1988: 5), sowie ein *top-down* Planungsmechanismus. Auch die Weigerung der Regierung, Landeigentum nach dem Gewohnheitsrecht anzuerkennen, behindert eine partizipative Planung.

Abschließend soll die Wichtigkeit der Anpassung des Projektansatzes und des Musters der Bevölkerungsbeteiligung an die sozio-kulturellen Gegebenheiten betont werden. TUWMS und auch der Einfluss der Ressourcennutzung auf die Umwelt variieren von Ort zu Ort, ebenso wie die Fähigkeit und der Wille der Anwohner, am Naturschutz teilzunehmen. Von Einheitskonzepten wird deshalb abgeraten.

Wird es gelingen, die politischen Hemmfaktoren für einen Wandel des Naturschutzes Indonesiens zu beseitigen, bevor es zu spät ist? Die Anfang 2001 in Kraft getretene Regionalautonomie in

Indonesien stellt in diesem Zusammenhang Gefahr und Chance zugleich dar. Jetzt haben lokale Regierungen die Möglichkeit, “Schlupflöcher” der Gesetzgebung für Alternativen zum gängigen Naturschutz-Paradigma kreativ zu nutzen, wobei eine spezifische Entwicklungshilfe aus dem Ausland helfen kann. Erfolgreiche Fälle von verbesserter Bevölkerungsbeteiligung unter Integration von TUWMS können dann als Modelle für einen Wandel des Entwicklungsparadigmas und des Managements natürlicher Ressourcen auf nationaler Ebene verwendet werden.

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LANGUAGES :	German (mother tongue) English (excellent) Indonesian (excellent)

EDUCATIONAL BACKGROUND

1973-1986	primary school and high school
1986-1987	study of social sciences, University of Hannover
1989	B.A. in Geography (main subject), Soil Science and Landscape Planning (minor subjects), University of Hannover
1993	M.Sc. in Geography (main subject), Agriculture and Tropical Ecology (minor subjects), Free University of Berlin
1993-2001	Ph.D. candidate, Department of Environment and Society, Technical University of Berlin, Germany: "Agroecosystems, environmental knowledge and traditional resource management at the eastern fringe of Sumatra's Kerinci-Seblat National Park. Towards an improvement of communication between local people and park management".

EXPERIENCE

1987	Volunteer at the Institute for Ecological Perspectives (SYNÖK), Barsinghausen, Germany.
1989	Volunteer at the Lower Saxon Office for Soil Science (Niedersächsisches Landesamt für Bodenkunde), Hannover, Germany.

1990	Research associate at the Sukarami Food Crop Research Institute, West Sumatra. Conducting a Rapid Rural Appraisal for farming techniques on critical upland soils in Minangkabau and transmigration villages.
1991	Research associate at BIOTROP/ORSTOM in the Tropical Forest Research Program. Conducting research on biodiversity in indigenous complex agroforestry systems (*damar* gardens) in Krui, Lampung to assess its buffer zone potential for the Bukit Barisan National Park.
1991	Junior assistant of the GTZ/GOI Social Forestry Development Project in Sanggau, West Kalimantan. Responsible for conducting resource management-related soil scientific surveys and ethno-botanical inventories of indigenous agroforestry systems to assess the local potentials for social forestry development.
1993	Academic assistant for the "Training course on Urban-Industrial Environmental Protection" organised by the Carl Duisberg Gesellschaft e.V. and Technical University of Berlin.
1993-1994	Ph.D. candidate and research fellow at BIOTROP (Southeast-Asian Regional Centre for Tropical Ecology), Bogor. Sponsored by NaFöG (Ph.D. scholarship of German Universities). Conducting human ecological research in lowland boundary villages of the Sumatran Kerinci-Seblat National Park to assess the interactions between local people and their environment.
April 1998 – now	Freelance journalist for the news agency Nicole Reuters, Germany (formerly: Agentur Daniel Schwarzstein).

CONSULTANCY WORK

Oct. 1996	Consultant for the World Bank, Environmental and Social Impact Unit. Conducting Rapid Rural Appraisals in Kerinci-Seblat National Park boundary villages. Assessing the impact of the park on local communities as well as problems related to park establishment.
Nov. 1996 - Oct. 1998	Consultant for the World Bank, Environmental and Social Impact Unit. Responsible for data collection and evaluation in the the frame of the

	Study on Local Level Institutions and Development Participation. Conducting/supervising Participatory Rural Appraisals as well as interviews with households and local institutions in Jambi, Sumatra. Assessing the role of local institutions in village development as well as their problems and potentials.
April 2001 – June 2001	Consultant for the South/Central Kalimantan Production Forest Programme, carried through by the association Jaakko Pöyry – Agrer – Scot Conseil and the European Commission. Responsible for analysing agroforestry practices in the project area, identifying constraints to the increase of agroforestry outputs, and recommending improvements to current agroforestry practices from a microfarming perspective.

SEMINARS AND WORKSHOPS

February 1993

Tagung der Deutschen Gesellschaft für Tropenökologie, held in Berlin, Germany. Paper held: "Sukzession nach Wanderfeldbau in den humiden Tropen (am Beispiel von West-Kalimantan, Indonesien): Bestimmende Faktoren für Artenzusammensetzung und Vegetationsdynamik"

July 1994

International Seminar on Indigenous Knowledge: Adaptation and Development, held in Bandung, Indonesia. Organized by: Padjajaran University UPT. Indonesian Resource Centre for Indigenous Knowledge (INRIK).

November 1995

Global Biodiversity Forum (Second Meeting of the Conference of the Parties to the Convention on Biological Diversity, COP II), Jakarta, Indonesia.

June 1997

Regional Workshop on Indigenous Strategies for Intensification of Shifting Cultivation in Southeast Asia, held in Bogor, Indonesia. Organized by ICRAF and Cornell University. Paper presented: 'The Development of Central Sumatran Traditional Fallow Systems in a Changing Environment'.

August 1997

Penyelamatan Ekosistem Leuser (Saving the Ecosystem of the Sumatran Mt. Leuser National Park), held in Medan, North Sumatra. Organized by Walhi, North Sumatra.

September 1997

SRAP Workshop on 'Rubber Agroforestry Systems in Indonesia', held in Bogor, Indonesia. Organized by: IRRI, Gapkindo, CIRAD, USAID and ICRAF.

October 1997

Workshop on Local Level Institutions. Exchange of study results of Indonesia, Bolivia and Burkina Faso Country Teams. Held at World Bank Headquarters, Washington DC, USA.

November 1997

CIFOR/USAID International Workshop on 'Management of Secondary Forests in Indonesia', in Bogor, Indonesia. Paper presented: 'Management of Secondary Forests in Indonesia' (co-author: Eric Penot).

CIFOR/IFRI International Workshop on 'Local Institutions for Forest Management: How can Research Make a Difference ?', held in Bogor, Indonesia.

October 1998

Final Presentation of the Results of the World Bank Study on Local Level Institution. Jakarta.

PUBLICATIONS

SCIENTIFIC ARTICLES

Werner, S., in print. The Development of Central Sumatran Traditional Fallow Systems in a Changing Environment. Paper presented at at the 'Regional Workshop on Indigenous Strategies for Intensification of Shifting Cultivation in Southeast Asia', Bogor, 23-27. 6. 1997. Proceedings forthcoming.

Penot, E. and Werner, S., in print. Prospects for the Cnservation of Scondary Frest Bodiversity within Poductive Rbber Aroforests. Paper presented at the CIFOR/USAID International Workshop on 'Management of Secondary Forests in Indonesia', Bogor, 17-19. 11. 1997. Proceedings forthcoming.

Werner, S., 1999. The Impact of Management Practices on Secondary Forest Species Richness within Productive Rubber Agroforests. In: Sist P, Sabogal C and Byron Y (eds.), *Management of secondary and logged over forests in Indonesia*, pp.33-44. Selected proceedings of an international workshop. CIFOR/CIRAD/USAID.

NEWSPAPER ARTICLES

1. National parks policy a conondrum. The Jakarta Post 13. 8. 1994.
2. Defining the new middleclass. The Jakarta Post, 23. 6. 1997.
3. Doing your bit to save the environment. The Jakarta Post, 4. 1. 1998.