Traditional Agroforestry and Ecological, Social, and Economic Sustainability on Small Tropical Islands

A Dynamic Land-use System and its Potentials for Community-based Development in Tioor and Rhun, Central Maluku, Indonesia

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Zusammenfassung

Obwohl sie viele Gemeinsamkeiten mit kontinentalen, peripheren Landschaften der Tropen aufweisen, sind kleine tropische Inseln mit zusätzlichen, spezifischen Umwelt- und Entwicklungsproblemen belastet. Für die menschliche Nutzung stehen auf diesen kleinsten Landeinheiten nur sehr begrenzte Ressourcen – wie z.B. Süßwasser, Vegetation und Land – zur Verfügung. Darüber hinaus werden die fragilen, auf engem Raum vernetzten terrrestrischen und marinen Ökosysteme durch unangepaßtes Ressourcenmanagement nachhaltig und z.T. irreversibel gestört. So hat vielerorts die Praxis der Rodung von Wäldern zur Urbarmachung von Ackerland zu Bodenerosion und zu Sedimentation geführt – mit nachteiligen Folgen für die Landwirtschaft sowie für die subsistenzorientierte Fischerei im Küstenbereich, welche zur Deckung des Proteinbedarfs der lokalen Bevölkerung von Bedeutung ist. Aufgrund der Bindung von Kohlendioxid durch die Karbonatbildung der sie umgebenden Korallenriffe spielen kleine tropische Inseln zudem eine wichtige Rolle im globalen Klimahaushalt.

Die Arbeit hat zum Ziel, traditionelle Land- und Ressourcennutzung auf kleinen tropischen Inseln anhand zweier Inseln im östlichen Indonesien zu analysieren, deren Stärken zu identifizieren sowie diese, zusammen mit Verbesserungspotentialen hinsichtlich ihrer Schwächen, in auszuarbeitende und von der Dorfgemeinschaft getragene (d.h. kommunale) Land- und Ressourcennutzungspläne einzubringen. Damit soll ein Beitrag zu der Frage geleistet werden, ob und unter welchen Bedingungen nachhaltige, ländliche Entwicklung auf kleinen tropischen Inseln erreicht werden kann.

Über ein induktives Verfahren – mit *Methoden* der qualitativen Sozialforschung, des RRA und PRA, und der Kartierung, sowie mit der Erhebung von boden- und vegetationskundlichen Daten und der Auswertung von Sekundärquellen – wird gezeigt, daß die in beiden Inseln praktizierte traditionelle Agroforstwirtschaft sowohl den Bedürfnissen und Möglichkeiten der Bevölkerung weitgehend entgegenkommt, als auch ökologisch nachhaltig ist (Bodenschutz, Küstenschutz, Stabilisierung des Wasserhaushalts). Allerdings stößt die Erweiterung der Agroforstwirtschaft auf Hindernisse, u.a. weil andere Landnutzungssysteme (z.B. Brandrodungs-Wanderfeldbau, permanenter Trockenfeldbau) mit ihr konkurrieren. Deshalb wird analog der FAO ‚Guidelines For Land-use Planning' (1993) ein Planungsverfahren vorgestellt, mit dem Agroforstwirtschaft auf kommunaler Basis ausgeweitet werden kann. Des weiteren werden die Nutzung der Küstengewässer (mit ‚sea-use planning', verstanden als Erweiterung des FAO-Ansatzes) und institutionelle Gesichtspunkte (z.B. Landrecht, Regelungen, traditionelle Institutionen) bei der Entwicklung von kommunalen Landnutzungsplänen berücksichtigt.

Die Studie kommt zur Schlußfolgerung, daß nachhaltige Entwicklung auf kleinen tropischen Inseln nur über kommunale Landnutzungsplanung, mit der gleichzeitigen Sicherung der exklusiven Nutzungsrechte von Ressourcen in traditionellem Dorfterritorium einschließlich der Küstengewässer, erreichbar ist. Mit partizipativer Planung können lokal spezifische Problemlösungsmöglichkeiten identifiziert werden, weil einerseits indigenes Wissen eingebracht wird, und andererseits die lokale Bevölkerung Zugang zu externem Wissen erhält. Außerdem wird mit Partizipation die Akzeptanz der Bevölkerung für eine veränderte, nachhaltige Land- und Ressourcennutzung erhöht.

Abstract

Although small tropical islands share many characteristics with continental, peripheral landscapes of the tropics, they are confronted with additional, specific environmental and development constraints. On these smallest land units only very limited resources – such as fresh water, vegetation and land – are present to draw on for human utilisation. Furthermore, their fragile, interdependent terrestrial and marine ecosystems, that are co-existing in a limited area, will be severely, and partly irreversibly disturbed by unsuitable resource management. In many places, the usual practice of clearing forests to reclaim arable land has caused soil erosion and sedimentation – with adverse impacts on both agriculture and subsistence-oriented fisheries in coastal waters, which is important for islanders as these resources are the major source of proteins. Moreover, small tropical islands have a significant function for global climate as carbon dioxide is being fixed in the calcium carbonate of the islands' coral reefs.

The purpose of this thesis is to analyse traditional land and resource utilisation on small tropical islands with the help of two island case studies in East Indonesia. Furthermore, merits of traditional resource management as well as potentials to deal with its shortcomings are identified and discussed concerning its inclusion in community-based land and resource management plans. Thus, it is intended to contribute to a clarification of the question, if and under which conditions sustainable rural development on small tropical islands can be achieved.

For this purpose an inductive approach is chosen, which includes methods of qualitative social research, RRA and PRA, as well as the collection of soil and vegetation data and the evaluation of secondary sources. It is shown that traditional agroforestry is practised on both islands. These land-use systems are adapted to the needs and capacities of the local population, while being ecologically sustainable (soil conservation, coastal protection, protection of freshwater resources). However, the extension of agroforestry runs into difficulties, also because other land-use practices (e.g., shifting cultivation, permanent dry field agriculture) are competing with it. Therefore, a planning process, derived from the FAO's Guidelines for Land-use Planning (1993), is presented, by which agroforestry can be extended on a community level. Additionally, the utilisation of coastal waters (with 'sea-use planning', understood as an extension of the FAO's approach) and institutional aspects (land tenure, regulations, traditional institutions) are discussed and considered for the development of community-based land-use plans.

The study concludes that sustainable development on small tropical islands can only be achieved with community-based land-use planning, along with the islanders' exclusive access to resources in customary territory including coastal waters. With community participation in planning, locally specific conditions and possibilities to tackle problems are easier to be identified: On the hand indigenous knowledge can be tapped by local participation, and on the other hand the local population gets access to external knowledge. Furthermore, locals' acceptability of modified, sustainable land and resource management is increased by participation.

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1. BACKGROUND AND OBJECTIVE OF THE STUDY

In the past decades, the globally occurring overexploitation of natural resources (e.g., soil, fresh water, forests, and fishery) has contributed greatly to: ecological problems, increasing conflicts over their utilisation, and processes of impoverishment and marginalisation of communities. This trend particularly affects the so-called developing world, as well as resource-poor regions to which most small tropical islands can be counted. Although these islands share issues with continental landscapes, they are further exposed to specific constraints. Especially: their small land area, the network of different fragile ecosystems, the limited and precarious freshwater resources, and their isolation are emphasised at this point. Furthermore, locally caused ecological problems take effect on the spot rather than being transferred into other regions.

One central issue is land use. The usual practice of clearing forests to reclaim arable land reaches its ecological limits in much of the tropical world including small islands. Degradation and erosion of soil, hydrological disturbances, and a weakened buffer function of dwindling forests are the most serious ecological effects. Additionally, coral reefs of coastal areas and small islands may be badly disturbed by sedimentation of eroded soil material. In combination with overexploitation of marine resources or on account of destructive fishing methods, the coral reef quickly comes across the verge of collapse. This ultimately would threaten the subsistence of coastal communities depending on inshore fishing. Moreover, the carbon dioxide fixing coral reefs play a significant role in global climate. Thus, the management of coastal waters is a second issue, with high relevance for small tropical island communities.

However, there are also positive examples showing that land and coastal waters can be managed in a way without endangering the ecological base in the long run. Examples include traditional agroforestry systems developed by tropical farmers, as well as customary institutions, such as *sasi* in the Moluccas, with the purpose of sustainable management of marine and terrestrial resources.

At a closer look, however, both of these strategies are also confronted with shortcomings, which may complicate or even prevent their enhancement *in-situ*, or their transfer to other places, for instance by development projects. Issues such as the construction of institutional arrangements in communal resource management, diverging interests and entitlements of individuals and groups, economic feasibility and an optimal management of woody perennials, land and tree tenure, and the acceptability of the concerned communities have a decisive influence on success – or failure – of any project. It is not enough to simply transfer positive examples, experiences and derived theoretical reflections and assumptions to other regions. Rather, specific local features will have to be taken into consideration to successfully establish or promote sustainable resource management at a larger scale. This is a simple, but central demand to land-use planning. The inclusion of participatory, target group-oriented approaches in planning (and research as well) is therefore regarded as a necessary measure to effectively avoid shortcomings of – and often negative experiences with – technically oriented top-down approaches. In this context, community-based resource management planning, integrated into regional development plans, may be a possible and useful way: If indigenous knowledge of local people could be tapped for planning, their acceptability of strategies towards sustainable resource management could be increased.

The *purpose* of this study is to analyse land use – with a focus on traditional agroforestry – and resource management on small tropical islands. On the one hand, benefits and merits of traditional agroforestry are to be identified, in order to include this land-use system in community-based resource management plans. On the other hand, its drawbacks also have to be taken into account, for widening local acceptability, and for improving and eventually modifying traditional agroforestry. Thus, it is intended to contribute to a clarification of the question, if and under which conditions sustainable development on small tropical islands can be achieved.

For this purpose, a quasi-inductive approach is chosen, i.e. the discussion first focuses on the two island case studies of Tioor and Rhun in Maluku.[1] The central part of the analysis deals with traditional agroforestry which is practised on both islands, and – as will have to be shown – which is widely suited to the needs, conditions, and potentials of the local population. However, the enhancement of agroforestry meets with obstacles and limitations, also because other land-use systems compete with it, such as permanent dry field agriculture and shifting cultivation. Moreover, the utilisation and management of coastal ecosystems, as well as institutional aspects with regard to the construction of community-based resource management plans, are considered.

The following *specific questions* are formulated to form the scope of this study:

- What course did the historical genesis of land use take, and what role did traditional agroforestry play?
- Which structures, functions, practices and problems of present land use can be identified?
- How do cultural, economic, political, institutional, and ecological factors influence traditional agroforestry and resource utilisation?
- Can traditional agroforestry and traditional institutions contribute to conservation of natural resources?
- Can traditional agroforestry guarantee a stable or even increasing income for the population? Which systems with which tree species show the potential for that criterion?
- Are both agroforestry and sustainable resource utilisation adaptable and acceptable by the local population?
- Which strategies seem to be promising for achieving sustainable land use and rational resource management? Is a community-based resource management plan an important precondition for that?

The *central hypothesis* of this study is derived from the objective and the specific questions outlined so far:

Traditional agroforestry systems are a suitable or even superior basis for sustainable land use, and therefore have the potential to be included in the construction and implementation of community-based resource management plans for sustainable development in small tropical island communities.

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[1] *Maluku* is the Indonesian term for the Indonesian province of the Moluccas, the archipelago in the east of Sulawesi and in the west of New Guinea, and will be used in this study. During the Dutch colonial period, the term 'Maluku' referred to only five islands in the westside of Halmahera, namely Ternate, Tidore, Makian, Moti, and Kayoa. It is derived from the word 'molòko' (literally meaning 'mountain'), which was originally used by the indigenous people of Halmahera to name the volcanic island of Ternate as 'mountain island' (Watuseke 1977, 308). The research area for this study was also chosen against the background of research on agroforestry in Indonesia, which so far has been predominantly carried out in the *western* part (Sumatra, Java, and Kalimantan) of this huge archipelago.

Following the specification of the objective and specific questions, the study is structured in three parts. The first part is an introduction into the general framework of the study. *Chapter 2* examines basic topics such as ecosystems, resource management and sustainable development on small tropical islands, and agroforestry, and summarises the current state of scientific research. *Chapter 3* presents a clarification of the study's methodology, i.e. *how* the results have been achieved.

In the second and main part of the study, land use and resource management in Tioor and Rhun are analysed and evaluated. In *Chapter 4*, attention is turned to the geographical position and the biophysical environment of both island case studies. The social and economic framework of the communities, and off-farm activities, including fishery, are described in *Chapter 5*. *Chapter 6* focuses on an analysis of land use including traditional agroforestry in its historical genesis and in its structures, dynamics and functions. The final sections of that chapter offer a synthesis of examined factors and effects of land-use change, as well as case studies of two peasant households. In *Chapter 7*, traditional agroforestry is evaluated concerning its merits and drawbacks.

Analysis and evaluation of land use in the second part show the necessity of actions and changes to achieve sustainable development. The third part of the study therefore deals with possible strategies. *Chapter 8* examines principles and goals of land-use planning and community-based development, clarifies steps of the planning procedure for the construction of community-based resource management plans in the local context, and provides a discussion of their contents and an evaluation. Furthermore, the role of traditional agroforestry for sustainable production and conservation, and potentials and requirements of its extension, as well as improvement of agricultural management, are subject of that chapter. *Chapter 9*, the final chapter, concludes with reflections on the relevance of the results for small tropical islands *in general*. This includes a consideration of the implications of traditional agroforestry and complex resource management for a developing country like Indonesia which consists of hundreds of inhabited small islands, and where destruction of tropical forests and coral reefs is a major challenge to look for practicable solutions.

2. SMALL TROPICAL ISLANDS AND AGROFORESTRY

2.1 What is a small tropical island?

Article 121 of Part VIII of the International Convention on the Law of the Sea defines an *island* as "... a naturally formed piece of land surrounded by water on all sides emerging above the surface of the sea at the highest tide, capable of sustaining human habitation or economic life on its own and whose dimensions are smaller than those of a continent" (cited from Granger 1996, 158). *Tropical islands* are thus islands within the equatorial and tropical zones, which generally stretch along both sides of the equator as far as the tropics of Capricorn and Cancer, and where daily temperature variations are higher than seasonal ones.[2]

Contrary to the simple definition of tropical islands, it is more complex to define *smallness* of an island. As Kakazu (1994, 4) states, "smallness is a relative and not an absolute idea". Nevertheless, various criteria have been deployed for a definition. From a *hydrological perspective*, it is considered by a UNESCO report (Falkland 1991) that the *area* is the major determining factor on classifying islands as small or not: "It was decided that the term 'small island' should apply to islands with areas less than approximately 1,000 km² and to larger, elongated islands where the maximum width of the island does not exceed 10 km" (Diaz Arenas and Febrillet Huertas, 1986; cited from Falkland 1991, 1). "A further distinction is made between small and very small islands. Although it is not intended to apply a rigid definition, a very small island would generally have an area of not greater than 100 km² or a width not greater than 3 km" (Dijon, 1984; cited from Falkland 1991, 1). Another area concept is used by Hess (1990, 3), who includes the *size of population* as well: Small islands are "those with approximately 10,000 km² or less and approximately 500,000 or fewer residents".

Besides land area and population of an island, smallness can be defined – from an *economic perspective* – in terms of "GNP (or GDP), or a combination of these variables as attempted by Taylor (1971), depending upon the purpose of the analysis. Most of the arguments favor using the concept of national income as the most appropriate one to measure the size of an economy" (Kakazu 1994, 3). Shand's (1979) systematic classification of selected small island economies of the South Pacific and Indian Oceans demonstrates that a small population in general corresponds to a small land area and also to a small GDP.[3]

For the purpose of this study, which focuses on land-use systems and on sustainable resource management, land area of an island is regarded as the most significant factor to classify smallness. The size of population is also considered as relevant, because it determines how many people live off an island's resources. In terms of land area, the approach of the UNESCO report will be singled out here (less than 1,000 km² for small, less than 100 km² for very small islands), because the islands of Maluku are – with the exceptions of Halmahera and Seram – smaller than 10,000 km². Analogous to Hess (1990), a small island's population then does not exceed 50,000, and a very small island is populated by 5,000 or fewer inhabitants.

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[2] Characteristics of tropical islands, which could be used for a more profound definition, are discussed in Ch. 2.3. See also Arnberger and Arnberger (1993, 46).

[3] Shand classifies islands in the categories of *land area* (small: 10,000-30,000 km², very small: 500-10,000 km², micro: 0-500 km²), *population* (small: more than 250,000, very small: 25,000-250,000, micro: less than 25,000) and *GDP* (small: more than 100 million Australian $, very small: 25-100 million Australian $, micro: less than 25 million Australian $) (from Kakazu 1994, 17).

2.2 "Island matters – islands matter"[4]

Is it justified to consider small tropical islands as a special category in sustainable development research?[5] Most of island literature takes a position somewhere in between two controversial poles:[6] One extreme viewpoint is somewhat 'special case'-oriented. Bertram and Watters (1984, 1985 and 1986), for instance, argue that "some rent-driven island economies depend, by necessity, on freedom to emigrate, remittances from the emigrants, aid and a subsidised bureaucracy, and that any rational planning for their future must take these factors into account" (Brookfield 1990, 24). Bertram and Watters, and Cameron (1992) use the acronym MIRAB – migration, remittances, aid and bureaucracy as the *fundamentals* (and *not* as supplementary functions) of the local economy – for those islands, although the same dependency is true for many peripheral regions in larger countries.

The other extreme is an 'anti-island' perspective. In the eyes of some of these advocates, islands connote smallness, which is then interpreted as being equivalent to the *unimportance* of islands. This opinion would mean to ignore islands as an irrelevant scientific topic.[7] In a more extenuated stereotype, islands are regarded as not being specific or exceptional, because they are just as unique as other isolated regions and continental areas with development constraints, economic problems, and environmental pressures (see Ratter and Sandner 1996, 64-5). As Brookfield (1990, 24) puts it, "the fact that our rural societies are peripheral and insular in location is a conditioning variable; it is not the central issue. What happens in these islands is different in degree but not in kind from what happens in changing rural societies elsewhere in the world".

Most of these understandable arguments concerning islands *in general* are of socio-cultural, political, institutional and economic kind. Yet the ecological framework has to be brought into the discussion, showing that *small tropical* islands are neither 'entirely special cases' in development, as they indeed share many problems with continental landscapes, nor 'unimportant and irrelevant'. To make progress in verifying the latter assumption, one can approach by asking a simple, hypothetical question. How would Earth look like *without* any small tropical island? If these islands were really unimportant, their existence or non-existence obviously would not make any difference at all.

Regarding small tropical islands, there are at least three objections to be raised to the opinion of their 'unimportance'.[8] Above all, it is their biophysical environment which *is exceptional and specialised*

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4 "Island Matters – Islands Matter" was the subject of a conference held in Okinawa in June 1994 (see Hills 1996, 67).

5 Since the first report of the Club of Rome on the limits to growth (Meadows 1972) there is an ever growing literature on the concept of sustainable development. The definition of the phrase 'sustainable development' as "development which meets the needs of the present without comprising the ability of future generations to meet their own needs" (Brundtland 1987, 43) is rather optimistic, because it implies that development, and protection of resources and the environment are consistent. It is problematic and misleading, however, if the concept of *growth* is considered as a precondition to (economic) development. This problem and the relevance of sustainable development concerning small tropical islands are discussed in detail by Granger (1996, 178-85).

6 Since the 1960s, the literature on small island nations, and to a less extent on small islands themselves, has grown in volume. A collection of writings include: Demas 1965, Benedict 1967, Selwyn 1975, Dommen and Hein 1985, Bayliss-Smith et al. 1988, Beller et al. 1990, and Maul 1996. In those reports, small *tropical* islands are subsumed into the broader category of small islands, but not considered a special category. Although this study will focus on small tropical islands, some of the explored characteristics in Ch. 2.3 may be true also for small islands in general.

7 Lowenthal (1992, 18) concedes that this stereotype holds some truth. However, it may be misleading and therefore should not be exaggerated, as a calculation shows: The combined 1980 population of islands with a size between 1 km² and 1,000 km² in the Indian and Pacific Oceans amounts to some 22.5 million inhabitants (Arnberger and Arnberger 1993, 79). If an annual population growth of 1.5% (2%) is suspected, the total 2000 population will be approximately 30 (33.4) million inhabitants, which roughly equals the combined population of the fifth continent Australia (including New Zealand, Papua New Guinea, and the South Pacific Islands)!

8 The emergence of a programme by UNESCO-MAB (www.unesco.org/mab/activity/ibisca/ibisca-h.htm) on integrated bio-diversity strategies for islands and coastal areas, as well as of several (international, regional, governmental and indepen-

when compared with continental landmasses. Moreover, the ecosystems of small tropical islands are very vulnerable and fragile, and are threatened world-wide by anthropogenic degradation. This combination of exceptionality, vulnerability, fragility and degradation of ecosystems will justify the attention to small tropical islands by sustainable development research, governments, and aid donors because the protection of natural resources is an increasingly important global management issue.

Secondly, if islands *were* unimportant *at present*, this would not necessarily mean that they would be unimportant *in the future*. For instance, some islands have gained strategic importance since the Convention of the Law of the Sea (1994) and the creation of the Exclusive Economic Zone (EEZ). "The convention has enhanced the value of many small islands, some so small they amount to no more than rocks in the ocean such as Rockall, ... which enables the UK [United Kingdom] to justify fishing rights further into the [North] Atlantic than would otherwise have been possible" (Hills 1996, 73). The EEZ is also the reason, why insular micro-states have transformed themselves into maritime vast countries, such as Kiribati (690 km²; EEZ: 3.55 Mio. km²) and Tuvalu (24 km²; EEZ: 0.9 Mio. km²) in the South Pacific Ocean (von Krosigk 1994, 299 and 325). The EEZ of states and dependent territories in the South Pacific Ocean (except Hawaii, Eastern Island, and Papua New Guinea) amounts to 26.8 Mio km². This is nearly 40% of the total area of the South Pacific Ocean, which is about 70 Mio. km² *including* Hawaii and Eastern Island (von Krosigk 1994, 298 and 325).

A third, *supportive* argument for island *research* is given by Bayliss-Smith (1988, 283): Islands offer an exceptional opportunity to study the whole range of ecological, economic and social factors. Their relatively controlled and finite conditions make them interesting laboratories for man-environment relationships.

In the next paragraph, these objections will be explored in more detail. To reduce complexity, small islands in tropical rivers and lakes (e.g., Lake Victoria) are excluded from the upcoming discussion. These islands lack the most significant feature of tropical island ecosystems in oceans: coral reefs.

2.3 Man-environment relationships on small tropical islands

The main goal of this chapter is to explore the typical features of man-environment interactions on small tropical islands. This comparative analysis of a small tropical island's system should also serve as a systematic framework for the discussion on the island case studies in the main part of this study.

Fig. 2.1 shows the chosen framework of analysing man-environment relationships on small tropical islands. The island system can be divided into several subsystems: the *biophysical environment* with the subsystems geology, topography, climate, soils, vegetation, fauna, and littoral ecosystems, and the *society*, which in turn can be further differentiated into the subsystems culture, demography, economy, the political system, and institutional arrangements. These subsystems are interdependent, and interacting spatially and dynamically, i.e. in a continuous temporal change of the system's factors. The analysis of subsystems, and of their interactions should identify bottlenecks, risks and potentials of sustainable development. It therefore must consider the needs, desires and perceptions of the islanders, as well as the current use and management of resources.[9]

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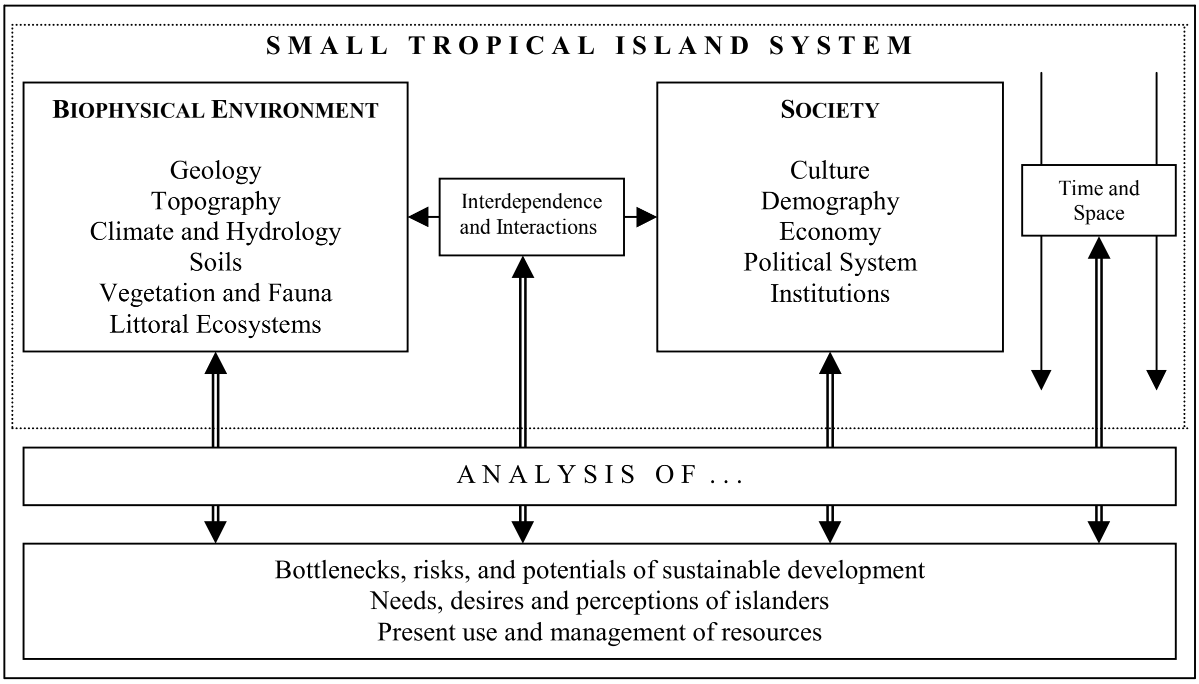
dent private) *organisations* focusing on issues of islands may be regarded as another indicator for the importance of islands. For more details on those organisations (e.g., International Small Island Studies Association ISISA, International Scientific Council for Island Development INSULA, and Alliance of Small Island States AOSIS) see Hills 1996.

[9] A quotation of Mitchell (1989, 2) underlines this necessity: "... natural resources are defined by human perceptions and attitudes, wants, technological skills, legal, financial and institutional arrangements, as well as by political culture. What is a resource in one culture may be 'neutral stuff' in another culture. Resources ... are subjective, relative and functional". Examples of resources then do not include only natural resources such as fresh water, minerals, fish and the like, but also – for a potential development of tourism – sand, sun, sea, natural beauty, and endemic species (see Ratter 1996, 117-8).

Figure 2.1: Analytical framework of man-environment relationships on small tropical islands



Note: Interactions occur also within the biophysical environment and within the society.

Source: Stubenvoll 2000.

However, small tropical islands are so numerous[10] and diverse, that it is difficult to derive generalisations of their ecosystems and their societies. Thus, the approach is first to present a *typology* based on geological criteria which should then provide a reasonable basis *for an assessment of development potentials and constraints* on small tropical islands. For instance, on islands with a comparable climate, diversity of existing land use and agroforestry systems, and differences in the agricultural utilisation potential are expressed by different geological factors, topography, soils, water availability, flora and fauna, and culture.

2.3.1 A geological typology

In their compendium on islands in the Indian and Pacific Oceans, Arnberger and Arnberger (1993, 192-6) distinguish more than 60 (!) island types, which – for reasons of simplification – are classified into seventeen groups along geological-petrographic and climatic-ecological criteria.[11] Most other island typologies make use of geological, topographic and geographical features as the criteria of a grouping. Falkland and Brunel (1993, 136) for instance classify islands into volcanic (andesitic or basaltic), limestone (old carbonate or uplifted), bedrock and unconsolidated types, and add distinctions between islands of high and low type, and between small, very small and tiny islands. Granger (1996,

[10] Arnberger and Arnberger (1996, 4 and 32) count about 38,000 tropical islands with an area of more than one hectare. The majority of these islands is considered very small. For instance, in the equatorial and tropical zones of the Indian and Pacific Oceans only 103 (large and medium-sized) islands are larger than 1,000 km², and another 359 (small) islands have an area between 100 km² and 1,000 km² (Arnberger and Arnberger 1996, 79).

[11] In the tropics, twelve of these seventeen groups are found: (1) low and unconsolidated alluvial islands; (2) rocky islands and islands with sparse vegetation and soil development; (3) arid and semi-arid islands; (4) islands composed of Quaternary and some Tertiary consolidated sediments; (5) coral islands; (6) lifted coral islands; (7) younger volcanic islands with widely distributed young lava layers and tuffs; (8) islands composed of mostly Mesozoic sedimentary and calcareous rocks; (9) granite and syenite islands; (10) islands of the humid tropics; (11) islands of the semi-humid tropics; and (12) large islands with great ecological disparities (see Arnberger and Arnberger 1993, 192-6).

159-66) distinguishes between islands of trench/arc systems, oceanic islands, and islands associated with continental plate dynamics, due to the association of the island's *location* and island chain location on earth with similar sets of *geological* conditions.

For simplicity's sake, and as climatic conditions in the humid tropics do not differ (with few exceptions) as much as geological and topographic structures, the geological classification of Pacific islands by Clarke and Thaman (1993, 4-9) will be followed here and supplemented by types occurring in Maluku (see also Fig. 4.1).

(1) *Continental islands*, such as New Guinea, are composed of geologically-ancient sedimentary, metamorphic, and igneous rocks of continental origin. These islands can be neglected for this study due to their large area and their often high elevations. The only true continental islands in Maluku are the Aru Islands, whereas others (e.g., Obi) are *continental crustal fragments*. These islands have originated when breaking off the main mass, and when shifting sometimes several hundreds of kilometres away from the place of origin (Monk et al. 1997, 41-5).

(2) *Andesitic-arc islands* have been built up by recent andesitic volcanic activity in proximity to the subduction zone, where two plates are colliding and normally oceanic crust with its higher density is being subducted. In Maluku, most of the volcanic islands of the Inner Banda-Arc belong to this type (see Ch. 4.2.1).

(3) *Basaltic volcanic islands* are high oceanic islands, such as Samoa and Hawaii, and have emerged through the extrusion of magma from active 'hot spots' in the Earth's mantle. 'Hot spot' islands are missing in Maluku: Although the Banda volcano is basaltic, it was not built up by a 'hot spot' (see Ch. 4.2.1).

(4) *Raised limestone islands* have been considerably uplifted as a consequence of tectonic activities. Examples are Nauru, some Tonga Islands, and Rhun in the Banda Islands (see Ch. 4.2.1).

(5) *Coral islands and atolls*, such as the atolls of the Maledives, are low-lying islands with coral reef structures; atolls are surrounding a central lagoon. Included in this category are 'almost atolls' with remnants of a volcanic peak above sea level in the central lagoon, such as Bora-Bora in French Polynesia. In Maluku, the Lucipara Islands in the Banda Sea are an atoll (Monk et al. 1997, 39), whereas Uran (near Tioor) is a coral island with an extended coral reef (Fig. 4.2).

(6) *Composite islands*, such as Halmahera in Maluku, consist of a complex combination of continental crustal fragments, andesitic and basaltic volcanic material, limestone and sedimentary rocks (Monk et al. 1997, 43). Most of the Outer Banda-Arc in Maluku are also islands with a complex geology, mostly dominated by Tertiary and Quaternary sedimentary, metamorphic, ultrabasic and limestone rocks, such as Tioor (Fig. 4.4).

It must be noted that some of these geological groups could be further divided into subgroups, which would complicate the typology. For instance, "raised limestone islands, atolls, and reef islets can be found on both sides of the subduction zone, thus adding considerable ecosystemic and environmental diversity" (Clarke and Thaman 1993, 7).

2.3.2 Scale, space and ecosystems

Despite this diversity, most small tropical islands share common characteristics. Concerning *scale and space* these factors are obviously *smallness*, and – with the exception of islands near continents – *isolation*. "A third factor is age. So-called continental islands like Ceylon exist that are as old geologically as the continental landmass from which they originated. However, many oceanic islands are of volcanic origin. If they are still mountainous, they are, as a rule, geologically of relatively recent origin" (Mueller-Dombois 1975, 354).

These three factors have consequences for the *biophysical conditions*. Small tropical islands are specialised environments. As Hess (1990, 4) points out, “insular natural resources – waters, vegetation, soil, air, nearshore systems, and wildlife – ultimately dictate the capacity of an island to accept and sustain development.” Of course, it is not specific for islands that natural resources play an important role in development. However, the *scarcity and vulnerability of natural resources* are common features of islands, which are directly linked to their size. For example, the amount of water used for consumption and irrigation is limited and water development methods have to be carefully considered in the vulnerability of freshwater resources.

Other typical examples of many small tropical islands are the littoral ecosystems. Coral reefs especially underlie immense human disturbances through overexploitation and depletion of natural resources, which underline the *strong interaction* between the different, sensitive ecosystems that are co-existing in a limited area. For instance, deforestation as a consequence of agriculture will cause a loss in forest and stream fauna and bio-diversity, an increase in soil erosion and sedimentation in estuarine and marine ecosystems (Hess 1990, 4; cf. 2.2). Thus, on the one hand, environmental disturbances caused by locals (and by outsiders as well) will be immediately effective on site, and ecological limits will be reached much quicker than on continents. On the other hand, islands are very *vulnerable to external forces*, such as cyclones, storms, storm-driven waves, volcanic eruptions, strong regional earthquakes, and droughts. These events “may disrupt both biotic and human life for months, if not years” (Hills 1996, 70). A continual exposure to the marine environment imposes extreme conditions on material and equipment (Falkland and Brunel 1993, 135). Moreover, low-lying coral islands and atolls may be among the major victims of a global rise of the sea level, now projected as a serious threat for the future of mankind.

Possibly the most striking issue of many islands is their biological *isolation*. Since the introduction of alien plants and animals into small tropical islands, a lot of endemic species have vanished (Harris 1965; cited from Brookfield 1990, 29). For example, “in the last four centuries about 200 species or races of the world’s island birds have become extinct. Most of these were endemic to a single island” (Poulsen and Purmiasa 1996, 17). Although this does not constitute a specific subject for small tropical islands (as endemic species also occur in isolated continental areas), the conservation of surviving endemic species is important for genetic, medical and scientific reasons. Thus, small tropical islands are of global value, and not ‘unimportant’.

The conservation of genetic resources is also an issue with regard to time-tested varieties and cultivars of certain tree species, which are a basis of traditional land use since times immemorial. As Clarke and Thaman (1993, 14-15) point out, traditional agroforestry systems on many Pacific Islands are being gradually replaced by commercial livestock and the expansion of mono-cultures, thereby degrading the local food production system, with implications for local food self-sufficiency and nutrition.

However, the limiting factors scale, space, and natural resources differ in their extent due to the range of geological diversity of small tropical islands. This has implications for freshwater resources, soils, vegetation, fauna, and the development constrains and potentials of small tropical island communities.

Freshwater resources and climate

The limited land area of small islands “generally mean[s] that very limited surface or groundwater resources will be present. Hence, there are very limited options for the development of freshwater resources as a consequence of very small size” (Falkland 1991, 1). This statement must be specified due to a different geology of the various island types. Most vulnerable to freshwater shortage are low-lying coral islands, atolls, raised limestone islands, and isolated summits of large basaltic volcanoes of oceanic islands, due to the porosity of their parent material. Low-lying coral islands and atolls are especially sensitive to drought due to the very little relief.

On larger coral atolls limited freshwater availability is relieved by basal aquifers, called Gijben-Hertzberg lenses, although these are vulnerable to saline intrusion.[12] Moreover, uncontrolled over-extraction and contamination of groundwater by pesticides, fertilisers, waste disposal and excrements, could lead to the destruction of the Gijben-Hertzberg lens. This demonstrates an additional issue of high relevance: the *quality* of fresh water for human consumption. Contamination of fresh water may have other causes as well. For instance, soil erosion material may pollute streams during the rainy season. Exemplary for this development are some Pacific Islands: “The intensification of subsistence and cash crop agriculture has been accompanied by the use of imported pesticides and fertilisers, ... and has resulted in soil erosion. ... Mining operations in the region have resulted in the cutting of native forest and the pollution of rivers, streams, and reef areas” (Hamnett 1990, 245).

Freshwater occurrence depends on the variables precipitation, evapotranspiration, surface runoff, and recharge to groundwater.[13] This determines water use (consumption and irrigation), and water resource development methods such as rainwater and surface water collection, groundwater abstraction, desalination, importation and substitution. Despite limited water supply, there is a lack of data on evapotranspiration and recharge from small tropical islands (Falkland and Brunel 1993, 137-48).

With a few exceptions, density and amount of *precipitation* is generally high in the humid tropics. Thus, distribution and variability of rainfall, and geological and topographic conditions in a tropical island are crucial for the freshwater supply: For instance, on islands with a “distinct or sometimes prolonged dry period the moisture balance between rainfall and evapotranspiration losses are critical” (Granger 1996, 169). Falkland and Brunell (1993, 143-4) estimate that “on small islands, evapotranspiration can be more than half of the total rainfall on an annual basis and often exceeds the rainfall for individual months during dry season or drought periods”. A critical factor is the type of vegetal cover, because e.g. plants with large total foliage surfaces, composed of broad, thin leaves, have relatively high transpiration losses. Thus, in terms of transpiration, trees may have an adverse impact on freshwater resources on small islands, while surface runoff is slowed down. *Surface runoff* and *recharge to groundwater* depend on geology, permeability of soils, vegetal cover and topography. Surface runoff is most significant on high islands that are characterised by streams with small-sized catchments, and steep slopes, going hand in hand with peak flooding, increased soil erosion and silt load in streams, vegetation loss and sedimentation problems in periods of intensive rainfall.

Quantity and quality of fresh water are probably the most crucial single factors of land use and sustainable development on small tropical islands. Thus, geology and topography, linked with climatic and microclimatic variables – rainfall, temperature, solar radiation intensity, humidity, soil moisture, evapotranspiration losses, and their duration and variability – are of utmost importance for islands.

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12 See Frevert 1987, and Falkland and Brunell 1993. “In practice, many freshwater lenses are less than 5 m thick although the islands may be 300-500 m wide... For small coral islands, an empirical relationship has been derived ... between freshwater lens thickness, annual rainfall and island width” (Falkland and Brunel 1993, 138):
$HP^{-1} = 6.94 \log a - 14.38$ (with H = lens thickness [m], i.e. depth from the water table to the sharp interface or the midpoint of the transition zone; P = annual rainfall [m]; a = island width [m]).

13 Following equations are cited (from Falkland and Brunel 1993, 139-40):
(1) $P = Et_a + SR + R + dv$ (water balance at the surface of an island) [precipitation = actual evapotranspiration (including interception) + surface runoff + recharge to groundwater + change in soil moisture store];
(2) $R = GF + D + Q + dS$ (water balance within the groundwater system of an island) [recharge to groundwater = groundwater outflow to the sea + dispersion at the base of the groundwater body + abstraction (normally by pumping) + change in freshwater zone storage].

Soils

Besides climate and topography, type and fertility of soils have to be taken into account, when dealing with the agricultural utilisation potential. Although tropical soils are generally of low fertility (see e.g., Weischet 1980), some exceptions exist. Some frequently occurring soils on small tropical islands, such as *andosols* and *rendzinas*, are very productive, although they have their particular limitations as well. These are, for example, the high soil erosion potential of dried up andosols, or the limited rooting space and therefore low amounts of plant-available water due to the frequently existing shallow profile of rendzinas (see Ch. 4.2.3). However, the periodical addition of nutrients to the soil by volcanic ash is an essential feature in active volcanic islands, *contributing* to the soil chemical fertility of the affected areas. An example is the Tonga Islands. Not only the volcanic islands in the western part of Tonga (called Tofua Ridge), but also the lifted coral islands in the eastern part (called Tonga Ridge) in a distance of 50 to 100 km are covered with volcanic material. These islands 'are the source of richness of good, agricultural productive soils' (Arnberger and Arnberger 1993, 252-8).

However, not all small tropical islands are blessed with these preferable soils. For instance, in atolls and low-lying coral islands, "the highly alkaline, calcareous, and rocky soils are among the most infertile on earth, with very low water-holding capacity, little organic material, few available soil macro- and micro-nutrients, apart from calcium, sodium, and magnesium, and restricted availability of iron and other micro-nutrients because of the high pH" (Thaman 1993, 131). An interesting point in terms of *soil fertility* is, that small tropical islands may have a complex range of different soil types, such as Tioor (see Ch. 4.2.3; Tab. 4.1).

An immense problem on small tropical islands is *soil erosion*, particularly in high islands with steep slopes, and on islands with intensive or less adjusted agriculture. Most of the eroded material is carried directly into the sea instead of being deposited in the plains, and thus adversely affecting littoral ecosystems and their productivity as a consequence of sedimentation.[14] Moreover, soil erosion is a major factor of *soil degradation*, and is therefore a threat to maintaining soil productivity. Therefore, any agricultural development has to take into consideration measures against degradation of soils.

Vegetation and fauna

As the availability of water in the soil is the most crucial factor for *tropical vegetation*, its classification has to take into account the interaction of topography, geology, soils and the amount and distribution of rainfall. The most significant vegetation types on small tropical islands are lowland tropical rain forests (in the humid tropics) and deciduous monsoon forests (in the semi-humid tropics). Another important factor is the temperature, and thus in tropical regions, the elevation. On high islands, such as Hawaii, further vegetation classes are joining the lowland forests due to the vertical arrangement of landscapes, e.g. montane forest formations (Henning 1974).[15]

Forests serve a multitude of functions: control of soil erosion and degradation; soil improvement; regulation of microclimate and water supply; protection from natural calamities (wind, flood, salt spray, frost in higher elevations); provision of food and habitats for animals; and provision of timber and non-timber forest products for humans. In case of anthropogenic deforestation or natural disturbances, the climax vegetation may be replaced by various re-growth stages, which is particularly

[14] Productivity in the *littoral* ecosystems is decreasing by sedimentation, *despite a transport of nutrients* into the sea, because corals need constantly *clear* water to grow and to reach full productivity (see the section on 'littoral ecosystems' below).

[15] It is beyond the scope of this study to provide a detailed account on all vegetation types occurring on small tropical islands. See Monk et al. (1997, 187-300) and Dahl 1980 (from Clarke and Thaman 1993, 9) for a discussion on vegetation in Maluku and the South Pacific, respectively. Ch. 4.2.4 treats the vegetation types in the two island case studies.

difficult to classify. Examples include *Imparata cylindrica* grasslands, and fern, bush and shrub associations. These degraded areas are extremely difficult to be put into agricultural production.

Further terrestrial ecosystems are found in rivers and streams, lakes, estuaries and swamps. An example is freshwater swamp forests that usually occur in alluvial plains, estuaries and inter-river basins being permanently or seasonally inundated.

As already mentioned, biological isolation and *endemism* are specific characteristics of many islands due to poor dispersal of species. The longer a flora and fauna has been isolated, the higher is the taxonomic level of endemism. Birds, for instance, are a class of vertebrates having been intensively studied on small tropical islands,[16] and are frequently used as indicators of bio-diversity and environmental change (ICPB 1992; from Monk et al. 1997, 344).

As many islands in Maluku have recently emerged in terms of geological history, endemism occurs here mainly at species and subspecies level (Monk et al. 1997, 306). The archipelago is also characterised by high bird endemism. Although it cannot be considered a small island, Buru (7,814 km²) is home to ten endemic species of birds, and a further 24 endemic races (Poulsen and Purmiasa 1996, 17). Maluku and the Lesser Sunda Islands together support 144 endemic bird species and seven endemic bird genera (Jepson and Sujatnika 1997, 350).

The littoral

The littoral refers to ecosystems near the shore, either occurring above (supra-littoral) or permanently below (inner-sublittoral; outer-sublittoral in 60 m and deeper) the tide line, or in the zone being subjected to the changing tide (eulittoral). The most significant ecosystems in the inner-sublittoral of small tropical islands are *coral reefs* and *seagrass and seaweed beds*, while *mangroves* in the inter-tidal zone may provide nutrients for the development of eulittoral and sublittoral ecosystems (Vicente 1996, 267-9). They are among the *most productive* natural ecosystems in the world and fulfil similar functions. Thus, the stereotype of ‘resource-poor’ small tropical islands needs to be qualified, although these ecosystems are very vulnerable and fragile, and threatened by human activities.

Coral reefs are growing from the sea bottom in a maximum depth of 70 m towards the surface of clear and warm water of at least 20^{O} C. The massive calcium carbonate ($CaCO_3$) structure of the reef is mainly formed by polyps (coral animals, e.g., *Acropora* spp.), but also by other reef building organisms, such as coralline algae (e.g., *Lithotamnia*) and molluscs. The *symbiosis of polyps and algae* is the major factor of the reef’s growth: The algae supply photosynthetic products, and obtain carbon dioxide and hardly accessible nutrients (e.g., phosphor) through degradation of zoo-plankton being caught by the polyps. This short nutrient cycle in coral reefs is comparable with the conditions in tropical rain forests (Heinrich and Hergt 1990, 129). The vertical accretion of coral reefs depends on several factors,[17] average rates are 0.1 – 3 cm per year. As a major primary producer, coral reefs play an important role in the food chain: “Coral reefs have been able to support small island fisheries resources, protect the shoreline from erosion, create and/or nourish sandy beaches, ... represent an invaluable, perhaps most valuable, coastal resource of many small island[s], ... and support a wide diversity of taxa, many of which have commercial or recreational value” (Vicente 1996, 271). Small

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[16] The well-known example of endemic birds of the *Emberizinae* on the Galapagos Islands provided evidence for Charles Darwin’s theory ‘On the Origin of Species by Means of Natural Selection or the Preservation of Favoured Races in the Struggle of Life’ (1859).

[17] As Heinrich and Hergt (1990, 129) point out, an absence of algae reduces reef growth to some 10%, probably because molecular calcium carbonate is almost not released due to lacking consumption of carbon dioxide by algae ($Ca^{2+} + 2\ HCO_3^{-} \rightarrow \mathbf{CaCO_3} + CO_2 + H_2O$). Furthermore, reef growth is restricted by reef erosion, sedimentation, coral feeders, chalk destroyers, and human disturbances.

tropical island communities depend heavily on fish and other marine species for their livelihood, as these resources are the major source both of proteins and of food security in times of crop failure.

Moreover, it is calculated that the carbon dioxide being fixed in the calcium carbonate of coral reefs is twenty times the amount of that in the atmosphere (Heinrich and Hergt 1990, 13). Thus, coral reefs have a significant global function for the protection of the atmosphere. In the face of global warming and an increase of the oceans' temperature, however, coral reefs are threatened with destruction (e.g., coral bleaching, i.e. the collapse of the symbiosis polyps-algae). Furthermore, man-made threats are also leading to coral reef deterioration, such as poison fishing, coral mining, blast fishing, sedimentation and pollution. For instance in Indonesia, which holds approximately one-eighth of the world's coral reefs, only 29% of the reefs are currently in good condition, i.e. with more than 50% live coral cover (cf. Cesar et al. 1997, 345).

Seagrasses "are aquatic higher plants (Angiospermae) which are adapted to live fully submerged in the sea" (Monk et al. 1997, 149). *Seagrass beds* are usually found on sheltered, shallow island shelves with sandy or muddy bottoms, which are protected from high wave action and where water is clear and oligotrophic. They have a multitude of functions: provision of trapped nutrients, primary energy and habitats for invertebrates and fish populations; provision of forage for endangered species; enhancement of water quality by precipitating suspended matter and by transforming nutrients into bio-mass; collection and stabilisation of sand and sediments; and protection from coastal erosion (Vicente 1996, 269-70). *Seaweeds* (or macro-algae) "are lower plants which have no distinct roots, stems, or leaves. Seaweeds occur in seagrass beds, on shallow coral-reef flats, and among mangrove communities" (Monk et al. 1997, 150). Anthropogenic threats to seagrass and seaweed resources may take three forms: overexploitation of seaweed for human consumption (both for subsistence and marketing purposes), sedimentation, and pollution and destruction of habitats.

Mangroves are tree species of the tropics and subtropics being adapted to the saline conditions in the inter-tidal zone. They occur most frequently in sheltered coastlines, bays and estuaries. Of the 80 species of mangroves known world-wide (Vicente 1996, 273), 30 are found in Maluku (Monk et al., 1997, 163). Each mangrove species occupies a certain zone due to a specific adaptation to and preferences of salinity, substrate, wave exposure, frequency of inundation, and terrestrial influences, such as freshwater runoff (Arnberger and Arnberger 1993, 205-10). For instance, *Avicennia* and *Sonneratia* species are most resistant to high salt concentrations and do not tolerate heavy shade and siltation. Thus, they are settling in narrow strips at the seaward area, whereas others (e.g., *Bruguiera* spp., *Ceriops* spp.), which are less tolerant to salinity and need a steady freshwater supply, are found in the landward zone of the mangrove.[18]

Like coral reefs, and seagrass and seaweed beds, the functional diversity of *mangroves* is critical to fishery, wildlife, and bio-diversity. Mangroves transform nutrients into bio-mass (leaves, twig litter) that are also nourishing open water systems, and provide nursery grounds, food, shelter and habitat for reef fish, invertebrates, shellfish, wildlife, and endangered species. They filter sediments, contribute to neutralise contamination, control flood conditions, protect the coast from erosion and saline intrusion, stabilise the shoreline, and will become even more important if the sea level rises. Compared to coral reefs, seagrass and seaweed beds, mangroves are more eurytopic, more resilient and restorable (Vicente 1996, 273-4; Kaly and Jones 1998, 656-7). However, stands of mangroves are threatened world-wide by felling to accommodate human activities such as charcoal production, and coastal shrimp farming.

[18] This is a simplistic image of mangrove zonation, which can vary extremely due to specific local conditions (Monk et al. 1997, 159).

2.3.3 Economic and socio-cultural considerations

The typical factors of isolation and smallness are also *economic constraints* for most small tropical islands and island nations. Except for those very close to continental areas, small islands are usually dependent on transportation by air and water. “The heavy burden of transportation costs may be the single most important barrier to the socioeconomic development of small islands. ... [A] UNECOSOC report (1974) states that the transportation problem is due not only to the high cost of shipping resulting from extremely small-scale operations but also to ‘the irregularity of supply which leads, even in the absence of any balance of payments constraints on imports, to periodic shortages and erratic price movements’...” (Kakazu 1994, 7). “Although water transport is supposed to be cheap when compared with land transport, the outer islands of archipelagoes [sic!] get little benefit from this cost advantage. Expensive fuel and high cargo handling costs at small island ports and landings make journeys to the outer islands hopelessly uneconomic” (Newitt 1992, 12). In general, provision of utilities and public services is difficult and costly, due to the *diseconomies of scale* in production, investment, consumption, transportation, education, and administrative services, especially on islands far from larger continental markets.

The high costs of transportation and a small domestic market are combined with less diversified economic activities to draw on for economic development. Additionally, the meagre resource base, and the vulnerable and fragile ecosystems of many small tropical islands pose difficulties for islanders to achieve economic development, and may make them permanently dependent on migration, remittance, aid, and bureaucracy. The potential to utilising natural resources for growth and economic development may be limited, if the resource base itself is to be maintained for future generations. As a consequence, small island economies depend upon a few primary products for their export earnings while importing a wide range of consumer as well as capital goods (Hein 1990a; Hess 1990, 4-5; Kakazu 1994, 4-8).

An economic advantage of some islands is their strategic location within a huge expanse of ocean, with rich marine resources like fish, oil and gas (e.g., the Spratley Islands in the South China Sea), and sea-bed minerals. The latter could be of significant value, if future economic developments would make their tapping feasible (Buchholz 1987, 30; Kakazu 1994, 8). However, as history has shown, such advantages may lead into a dependency (Hess 1990, 5), which might not be constant. For example, some islands “attracted plantation capital at times when world prices for tropical raw materials were high. They temporarily enjoyed considerable prosperity, only to be marginalised as irrelevant when world prices fell” (Newitt 1992, 3). Dependency on natural resources, raw materials and agricultural products, and volatile world market prices are general problems for many – even larger – developing countries. However, the *limited range* of primary products intensifies these problems for small countries and islands.

Valuable mineral deposits may turn out to become the curse of islanders, however. Well-known examples are the phosphate deposits in Nauru and Banaba (both in Micronesia). In Nauru (21 km²), phosphate mining has brought considerable wealth for the islanders, although the deposits are now widely exhausted. However, the excavation of phosphates has had disastrous environmental effects on the lifted coral island. With the exception of limited cultivation of coconut palms along the narrow coastal strip and of bananas and vegetables near the Buada lagoon in the centre of the island, agriculture is virtually impossible in the former mining sites which resemble a “moonscape” (Hein 1990b, 58; Arnberger and Arnberger 1993, 258-59; Hiery 1994, 397). Phosphate mining is probably linked with increasing periods of droughts, and the tiny island nation has to import fresh water and food. As a consequence of nutritional degradation, diseases such as diabetes are widespread in Nauru (Hiery 1994, 408), as well as in other Pacific Island societies (Thaman and Clarke 1993, 25-30). Thus, "even seemingly beneficial changes can have catastrophic effects in highly vulnerable island societies" (Lowenthal 1992, 19).

Strategic location is also relevant for *transportation* and for the *military*. Likewise primary export products and the dependency on world market, advantages of strategic location might not be constant. For instance, during colonial times some islands gained importance for intercontinental shipping as stations to replenish fresh water and food, whereas modern cargo shipping is steadily abandoning these ports. In some cases, strategic location has proved to be disadvantageous for small tropical island communities: Nuclear bomb testing in the Pacific Ocean atolls of Bikini and Moruroa has been largely possible as these islands are isolated and far from the continental edges, and "out of sight, and therefore out of mind, of the rest of the world" (Newitt 1992, 3).

The scale factor means that human resources are scarce, too, being one reason why development on small tropical islands has been seldom achieved with outside intervention. Tisdell (1993) for instance argues that indigenous knowledge about local conditions is certainly considerable and sufficient for environmental protection and sustainability as long as local techniques are deployed. However, this knowledge might be insufficient "to realize the impact of imported technologies. ... Smallness of a community may actually be a disadvantage when new technologies have to be assessed for application under local conditions. The number of local technical experts can be expected to be fewer ... [and] the level of technical/scientific training or education ... is often less than in large nations, e.g., due to the effects of economies of scale and scope on education system. Thus, uncertainty or imperfect knowledge about changes emanating from the external world is likely to be greater in small nations than in larger ones" (Tisdell 1993, 214). Therefore, small island nations depend more heavily on foreign experts for advice than larger nations. These experts are commonly of continental origin, however, and may have little experience of island environments and local conditions. Thus, the scope of transferring new, foreign technologies adapted to the circumstances of small islands is limited. In extreme cases, this asymmetric knowledge may lead to aid packages for small island nations not being fully put into operation by the recipient (see Tisdell 1993, 214-5).

Another characteristic of small islands is that most people are either closely related or know each other well. This may have some positive effects such as prevention of crime, and control of anti-social behaviour. In very small islands it could turn out, however, as a problem, when sanctions are difficult to be enforced, e.g. in situations when an offender belongs to the same clan. In terms of administration and management, a high degree of interpersonal relationship combined with transparency on small islands also creates certain problems (see e.g., Hein 1990a, 37-8; Farrugia 1993). For instance, policy-making and decision-implementing processes are easily influenced by informal contacts, as well as personal and kinship considerations. In extreme cases this may lead to nepotism and corruption. On the other hand, the transparent and often informal communication network on small islands is advantageous. Communication between administrators and people, and feedback as well, are usually quick and efficient. This more likely leads to a quick adjustment, modification, revision or even rejection of inadequate or misfired policies and decisions.

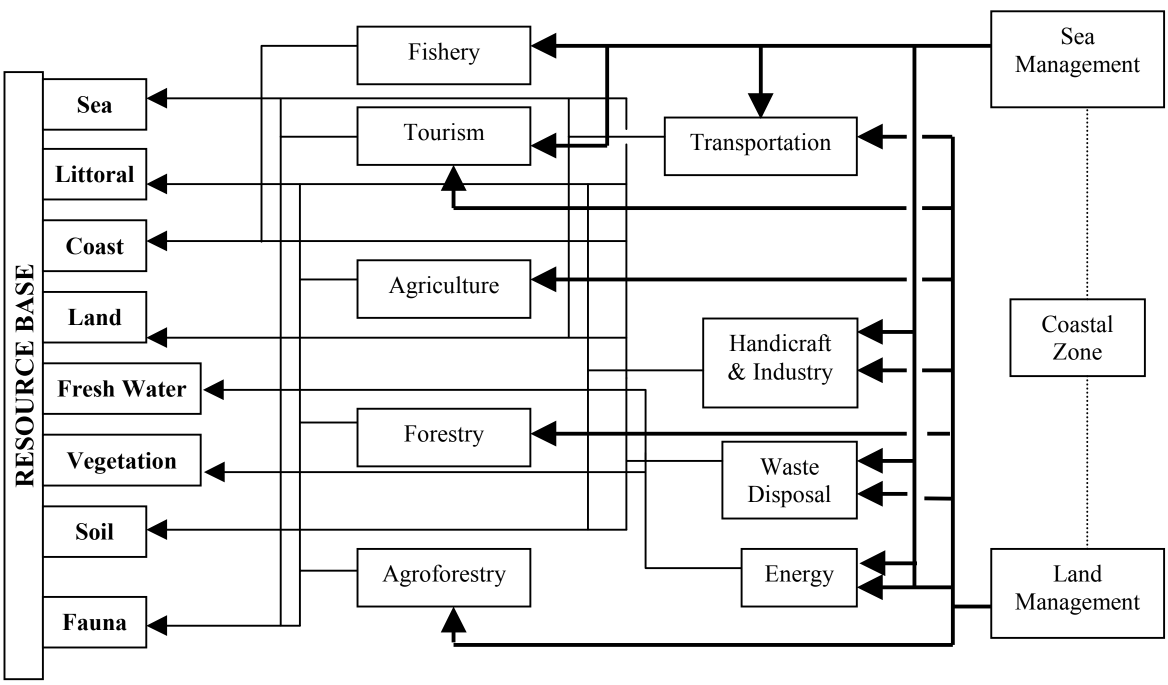
Social cohesion is usually strongly developed within small islands and small island communities. "Once the social unity is ruptured, however, the divisions that ensue run deep and take many years to heal. Minor issues which are easily absorbed in larger states, assume national dimensions in small states" (Farrugia 1993, 223). Such divisions may lead to community rivalry, which often results in boycotts and disapproval of even useful ideas and projects of a rival group. In the long run, this undermines local efforts and decreases the influence of indigenous values, thus leading to dependency on outsiders and their ideas, transplants and projects, despite strong cultural identity of islanders.

As mentioned in Paragraph 2.2, most of these economic and socio-cultural characteristics and limitations are found in peripheral regions of larger countries as well. It is therefore their biophysical environment, which makes small tropical islands really exceptional and worthy of study. Moreover, bio-diversity is an urgent global issue, so that small tropical islands with their coral reefs and endemism are to be included in efforts towards sustainable development and conservation. The relatively stronger degree of economic and socio-cultural bottlenecks, and the more rapid impact of policy decisions (Farrugia 1993, 225), must be taken into account, however, when dealing with sustainable development and conservation on small tropical islands.

2.3.4 Conclusion

How can sustainable development and conservation on small tropical islands be achieved, despite the multitude of biophysical, socio-economic, and political-cultural constraints? Would a MIRAB society be the last resort, as most efforts lead into the usual small island development dilemma?: "Aspirations [of islanders] renders self-sufficiency unacceptable, but attempts to gain or maximize wealth by economic specialization tend to render the society and economy unstable. ... Those most injured by an unmanaged drive for growth are the island's fundamental resources – natural and human. Those injuries can be lasting or even fatal to an island's future development" (Hess 1990, 6). Another possibility to conserve a small tropical island's environment is to resettle its population to continental areas or larger islands, and to create a strict island nature reserve, such as in Aldabra, Seychelles (cf. Hein 1990b). However, this does not constitute island development, and would neither be acceptable by the islanders, nor a practicable solution on a broad level.

Figure 2.2: Resource management and sectors on small tropical islands



Notes: Sector dependency or influence on resource base; Rational management in sector; Both land and sea management are relevant for the coastal zone (e.g., mangroves, coral reefs)

Source: Stubenvoll 2000.

A key issue in balancing development and conservation – and for the discussion in this study – is then a rational management of limited land and natural resources in each sector (Fig. 2.2). As pointed out in Fig. 2.1, this must not be restricted to a resource analysis, but must also consider the institutional and political framework, people's perceptions (Ratter 1996, 115), land tenure, labour systems, and the relation of subsistence and cash cropping (Ward 1987). A potential advantage is that "islanders' control of their environment and cultural assets helps to safeguard both ecology and ambience more effectively than less discrete mainland communities can do. Communal ownership and control ... help to promote insular conservation measures" (Lowenthal 1992, 27).

The most important natural resources and ecosystems to be included in an approach of development and conservation on small tropical islands are littoral, coast, land, fresh water, forests, and soil. Rational marine and coastal management, for instance, are essential for fishery, coastal protection, and tourism. In terms of the protection of freshwater resources, measures to protect forests, to ensure safe waste disposal, and to decrease pollution and contamination are crucial. With regard to sustainable land use and soil conservation, agroforestry (which is also of central interest in this study) is now widely seen as one way to combine production and sustainability. Thus, the next paragraph will provide the scientific basis of agroforestry and then discuss its role on small tropical islands.

2.4 Agroforestry for sustainable land use

Definitions

Since agroforestry as a concept has been put on the agenda of scientists, development agencies and politicians in the 1970s, a lot of definitions have been formulated. They represent the different views and priorities given to agroforestry by scientists,[19] but also by those, who practice it – the farmers. Two general, non-restrictive definitions, which are used as a basis of this study, are presented here.

> *"Agroforestry is a collective name for all land-use systems and practices in which woody perennials are deliberately grown on the same management unit as crops and/or animals. This can be either in some form of spatial arrangement or in a time sequence. To qualify as agroforestry, a given land-use system or practice must permit significant economic and ecological interactions between the different components"* (Lundgren 1987, 48).

This older definition puts emphasis on the integral part of trees in agroforestry, and the economic and ecological interactions of its components, whereas the latest definition by ICRAF explicitly stresses the important socio-economic and ecological functions:

> *"Agroforestry is a dynamic, ecologically based, natural resources management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels"* (ICRAF homepage 1998).

Thus, agroforestry is *per se* regarded as a sustainable land-use system, that could help to rehabilitate degraded land or to prevent deterioration of the environment and of the life basis of farmers, caused among other reasons by unadjusted land use such as mono-cropping or mono-cultural plantations.

[19] See Somarriba 1992 who analyses concepts by various authors in order to define agroforestry.

Approaches and classifications

Principally there are two distinct, although not always entirely separated, *approaches to agroforestry*: (1) the modern, institutional; and (2) the traditional, indigenous (Clarke and Thaman 1993, 2). *Institutional agroforestry* is based on modern agronomic science and field experimentation. Its purposes are for instance: assessing yields of crops, trees and animals in varying combinations and under varying conditions; seeking maximisation of aggregate production; determining competition or complementary functions of system components. *Traditional agroforestry* arises from cultural geography and ecological anthropology. It seeks to record the attributes of traditional agroforestry systems that are in use now and that may have been practised by tropical people for centuries.

Although the value of the indigenous systems is widely acknowledged, most government-supported, aid-funded projects lean heavily on the *institutional approach*, which leads also to the introduction of non-indigenous trees (Clarke and Thaman 1993, 2-3). One disadvantage of the institutional approach is the long time span that is needed to assess the potentials of certain tree species. This has led to a limited number of species used in institutional agroforestry, while the potentials of hundreds of other tree species remain unused, if not forgotten. Because ecological problems need a fast response, it would be imprudent or even dangerous to rely only on long-term experimentation with all the possible tree species. By using the approach of *traditional agroforestry*, the potentials of much more tree species can be assessed in a shorter time, due to the fact that the indigenous systems already exist and work – and therefore have proved their productivity, sustainability and adaptability. Although agroforestry is generally regarded as a useful and productive land-use practice, it would have negative consequences if locally unadapted species and management practices were used, and if the farmers were lacking knowledge and motivation (Nair 1993, 13). This is another, potential drawback of introduced, institutional agroforestry. On the other hand, traditional agroforestry systems are not immune to pressures that may arise in the face of modern land-use options, or from changing economic, political and social values, population growth and increased land shortage. Thus, there might be potentials for an improvement of existing traditional agroforestry, also by means of institutional techniques, underlining that the distinction between institutional and traditional agroforestry should not be overworked; rather they should be seen as complementary.

The *possibilities to classify agroforestry systems* are at least as manifold as the definitions (Nair 1993, 21-34; Künzel 1990, 12-4). Depending on the priority, a classification can be based on: the systems' structures, its functions, as well as on ecological and socio-economic criteria.[20] Each of these possibilities has its values and shortcomings. The choice of a classification must be considered as site-specific and purpose-orientated.

Nair (1993, 31-2) provides a pragmatic framework that attempts to integrate all classificatory aspects: "Since there are only three basic sets of components that are managed by the land user in all agroforestry systems (woody perennials, herbaceous plants, and animals), a logical first step in classifying agroforestry should be based on the nature of these components. ... There are three major

[20] The *major types* are (Nair 1993, 23 and 27; FAO and IIRR 1995, 25-7; Michon and de Foresta 1996a):
Structure (components): agrisilvicultural (crops and trees), silvopastoral (animals and trees), agrosilvopastoral (crops, animals, and trees), or others (apiculture and trees, aquaculture and trees, sericulture and trees, etc.);
Structure (arrangement of components): spatial or temporal;
Structure (complexity): simple or complex (e.g., agroforests);
Function: productive or protective;
Ecology: lowland humid tropics, high humid tropics, lowland subhumid tropics, highland subhumid tropics; and
Socio-economy: based on level of technology input (low, medium, or high input), or based on cost/benefit relations (commercial, intermediate, subsistence).

categories: agrisilvicultural, silvopastoral, and agrosilvopastoral [cf. footnote 20]. Having done such a preliminary categorization, the system can be grouped according to any of the purpose-orientated criteria [protective, or productive]. Each of the resulting groups can have one of the above three categories as a prefix, for example ... agrisilvicultural systems for soil conservation and food production in tropical highlands" (Nair 1993, 32).

Social scientists (e.g., Dove 1992) stress that the functions of agroforestry are more relevant for a classification than the structural and ecological criteria, because farmers view and value agroforestry for the products and services it provides to their livelihood. In fact, the central issue in social forestry, community forestry and farm forestry is not "what tree species in what combinations should be planted?".[21] Rather, the socio-cultural framework, and the priorities, needs and perceptions of farmers have to be understood *first*, in order to be able to derive conclusions on adaptable tree species in a *second step*. Accordingly, ICRAF developed the diagnosis and design (D & D) methodology for agroforesty extension (Raintree 1987), following up on the farming systems research/extension and the land evaluation methodology (cf. Shaner et al. 1982). The philosophy of the problem-orientated, holistic D & D methodology is that research and diagnosis of land-use problems have to be carried out before any design of agroforestry and its implementation can be successful (Nair 1993, 347).

Attributes and functions

Beneficial ecological characteristics and the diversity of socio-economic functions and services of agroforestry are two of the realms why these systems are advantageous for small-scale farmers. Agroforestry systems possess the three attributes productivity, sustainability and adaptability as its main aims (Farrell and Altieri 1995, 247-48). Combined *production* is expected to be greater than in conventional land-use systems due to improved growing conditions and a more efficient use of natural resources (space, soil, water, light). As agroforestry systems contain trees, the time-span of production and protection is lengthened and an inherent basis for *sustainability* is provided. This is particularly important in areas with unfavourable conditions, such as unproductive soils. And last but not least, it is difficult, if not impossible for small-scale farmers to use expensive inputs like commercial fertilisers and pesticides. Agroforestry is particularly *adapted* to the circumstances of these farmers, because they can widely use traditional inputs, so that risks and dependencies can be reduced.

The diverse functions of agroforestry systems are briefly summarised here according to Thaman and Clarke (1993, 17-25), and will be of major interest in Chapters 6 and 7 of this study. Ecological, protective functions include: the provision of shade, control of soil erosion and degradation, soil improvement,[22] wind and frost protection, provision of food and habitat for animals, control of floods and water supply, and control of weeds and diseases. Socio-economic, cultural, and productive functions are the fundamental to a wide range of products and food (e.g., timber, fuelwood, construction and handicraft materials, staple, emergency and supplementary food stuffs, forages, medicines, dyes, tannins, resins, stimulants, perfumes), the provision of security (through a diversified reserve of foods should annual crops fail, and through trees/animals serving as a savings account), and the provision of food/animals for ritual (e.g., weddings) and social purposes (e.g., reciprocal help).

[21] Agroforestry is a practice, which can be used in various management forms, depending on the existing land tenure system. *Farm forestry* could be practised in situations where individual land holdings are dominating, and *community forestry* on communal lands. All forms are different institutional arrangements in *social forestry for rural development* which aims at community participation to widen the range and distribution of benefits for local people (cf. Noronha and Spears 1985, 229; Momberg 1993, 28-37; Sharma 1993; Sudrajat 1995).

[22] Processes by which trees improve soils are described by Young (1989, 93-103).

Drawbacks

Regarding this multitude of functions, the extension of agroforestry should be in theory easily achieved. For instance, the extraction of highly valued non-timber forest products (NTFPs) – such as rattans, resins, latex, and medicines – will inevitably reach its limits in the face of dwindling tropical rain forests. The domestication of these resources will be therefore an increasingly important management option and raises the question under which system it can best be achieved. By providing existing examples from Indonesia, Michon and de Foresta (1996b) argue that complex *agroforests* of smallholder farmers provide an elaborate alternative to pure plantations for domestication and commercialisation of NTFPs, also because the former incorporates not only the forest resource into this arboreous land-use system but also the true forest structure.

However, agroforestry has its ecological, socio-economic, and cultural drawbacks also, so that agroforestry extension projects often fail. In terms of ecology, several quoted advantages of agroforestry will be only valid, if suitable tree species are chosen (Künzel 1990, 6-11). For example, competition for soil, water, light, and space must not predominate complementary functions of agroforestry components. Künzel (1990, 9-10) points out, that many farmers still perceive trees as competitors to annual crops for sunlight, although trees may improve their growing conditions due to the provision of shade, and the preservation of moisture in the upper soil layer *during dry periods*. Another potential advantage, not specifically demonstrated yet, refers to the absorption of nutrients from deeper soil layers by deep-rooting trees ('nutrient uptake') and their transformation to bio-mass which is then made available to annuals through litterfall (dead branches, roots, leaves, etc.) (Young 1989, 154). This is only partially true, because many (but not all) tree species are developing tap roots only in forests, where competition with other trees is dominating, for instance pioneer species in secondary forest. Since trees are often spaciously planted in agroforestry systems, superficial roots may dominate, and trees are then competing more with annuals for nutrients in the upper soil layers than fulfilling their potential of nutrient uptake in the sub-soil (Nair 1985, 27). "The key to making the best use of the root systems in agroforestry lies in maximizing their positive effects while reducing tree-crop competition for moisture and nutrients. The basis usually quoted is to combine shallow-rooting crops with deep-rooting trees" (Young 1989, 156).

In terms of socio-economy and culture, it is essential that agroforestry is practicable and acceptable for the farming families, who are the principal target group of such a strategy. However, farmers and scientists/extension workers do not necessarily view and value agroforestry in similar categories. For the farmers, the provision of products and services from a land-use system, which contributes to their livelihood, are of utmost importance. Any positive ecological effect is seen as a welcome spin-off, but in most cases it is not the essential issue for them. Thus, there is a need to find ways of convincing farmers why the planting of trees offers great opportunities to them. However, economic constraints often complicate these efforts. These are, for instance, the long period of time until returns from planted trees can be obtained, price fluctuations of cash crops, difficulties in marketing due to a perishable nature of many tree products, and irregularity of supply (of products) due to a concurrent harvest season in a whole region. Additionally, land tenure is often insecure and detrimental to tree planting. Diverging interests of groups involved may hinder an extension of agroforestry as well. Furthermore, it must be stressed that agroforestry is hardly a realistic option in certain places, such as in areas with a high cultivation potential of a specific product (von Maydell 1982, 240).

Another disadvantage of agroforestry is its potential contribution to driving back natural forests. Mary and Michon (1987) illustrate this by a rice-agroforest system in Lampung (Sumatra), where traditional, man-made Dipterocarp forests (*Shorea javanica*) for *damar* resin production have been continually enlarged after clearing of primary forests and planting of rainfed rice in an initial stage to meet peasants' rice needs. The system is now expected to reach its limits, as the remaining forest is entirely situated within a national park. The *damar* agroforests, although individually bearing ecological and economic advantages, might therefore come under pressure due to land shortage and competition with other land-use systems. This indicates the need of an evaluation of the whole farming system, and demonstrates that "the value of an agroforestry system depends on demographic and socio-economic conditions under which it is practised" (Mary and Michon 1987, 54). Tabora (1991, 62) goes even further by stating that "agroforestry can also be abused as in the following: 1. The release and exploitation of large protected forested land in critical condition, [being] a grave loss of natural ecosystems. 2. Many landless workers could be instigated by unscrupulous speculators to occupy and cultivate forest lands even in critical areas using agroforestry programs as the excuse or rationale."

Agroforestry on small tropical islands

The limitations of small tropical islands pointed out in Chapter 2.3 – scarcity and vulnerability of natural resources, limited land area, isolation, small domestic market, less diversified economic activities – and the general remarks on agroforestry have implications for the further discussion and the methodology of this study. Indeed, it is remarkable that many examples of elaborated traditional agroforestry have been developed by local farmers in areas with high population density, such as the home gardens in Java (e.g., Christanty 1990), in areas with unfavourable ecological conditions such as the *lembo* agroforests on poor soils in East Kalimantan (Sardjono 1990), and *on small tropical islands*. On islands in the Pacific Ocean, traditional agroforestry is well documented, e.g. in Tonga (Künzel 1990), in Pohnpei, Micronesia (Raynor and Fownes 1991a and 1991b), and by Clarke and Thaman (1993) who provide examples of traditional agroforestry in Papua New Guinea, the Solomon Islands, Vanuatu, Fiji, Tonga, the Cook Islands, the Marquesas Islands, and Micronesia.

Generally, as von Maydell (1986, 172) puts it, the value and importance of agroforestry will increase as much as land resources will become scarcer. Thus, and according to the central hypothesis of this study, agroforestry has the potential to be a suitable or superior land-use system for small tropical islands regarding their limited land area, and their meagre and vulnerable resource base.

Some of the pro-agroforestry arguments stated above are especially important for small tropical islands (Thaman and Clarke 1993, 24-33):

- the diversification of agricultural and arboreal products instead of an emphasis on mono-cultural export crops, so that a decrease in nutritional degradation and food dependency could be anticipated, self-reliance could be strengthened, and income alternatives could be created;
- a contribution to sustainable resource use through conservation and improvement of soils, and through stabilisation of water resources;
- creation of greater environmental awareness;
- a more equitable and balanced development, due to the feasibility of agroforestry for even the poorest families, and the scope for increasing local participation; and
- eventually spin-offs of coastal agroforestry for tourism through conservation of beaches and littoral ecosystems.

However, some of the contra-productive issues of agroforestry are intensified on small tropical islands. Most significant are the isolation and the small domestic markets, so that marketing of perishable products will reach its limits much earlier, and transportation and exports are more costly than in continental areas or regions near larger markets.

2.5 Summary and conclusion

Because of the diversity of small tropical islands, only their typical features are briefly summarised: scale (or smallness), space (or isolation), young age, natural hazards, and some precious ecosystems. The scale factor has far-reaching consequences both for the natural resource base, which is limited, fragile and vulnerable, and for island economies (e.g. in the agricultural sector), that depend on these resources. The diseconomies of scale add limitations in terms of economy (production, investment, consumption), education, and administration. These bottlenecks are directly linked to the size of an island, and thus demonstrating the usefulness of separating small from very small islands.

Isolation means a high level of endemism, making small tropical islands valuable environments for bio-diversity, and hence worth protection. Isolation also creates transportation problems which may be the single most important hindrance to economic development.

The young age of many islands is due to tectonic and volcanic activity, which poses one of several natural hazards to island communities. On the other hand, volcanic activity contributes to maintaining soil fertility, an important factor in the agricultural utilisation potential. Other hazards include cyclones, storm-driven waves, droughts, and the predicted anthropogenic sea level rise.

Coral reefs, mangroves, and seagrass and seaweed beds are very productive ecosystems and crucial factors for the subsistence activities of the islanders. Moreover, coral reefs contribute to fixation of carbon dioxide. However, human disturbances, such as overexploitation of natural resources, destruction, sedimentation and pollution, threaten these precious ecosystems.

Small tropical islands are complex environments. Sustainable development efforts on small tropical islands require an integrated approach of research and planning which covers all sectors (Fig. 2.1 and Fig. 2.2). In terms of land management, traditional agroforestry is supposed to offer great opportunities for island communities. It has the potential to counteract soil degradation, deforestation, destabilisation of freshwater resources, and sedimentation. Thus, the research on traditional agroforestry systems on small tropical islands, and in general as well, should set priorities to:

(1) the analysis of the systems' functional and structural characteristics and their components;

(2) the identification of ecological, socio-economic, demographic, cultural, and institutional conditions by *putting the focus on the farmers' needs, perceptions and aspirations*;

(3) the evaluation of potentials and requirements of modification, improvement and extension of traditional agroforestry systems *in-situ*; and

(4) the assessment of possibilities to use promising tree species in institutional agroforestry elsewhere.

The latter would be a combination of the two approaches to agroforestry. The analysis of further dissemination of traditional agroforestry seems an especially important step towards the enhancement and enlargement of these land-use systems. This could be one fundamental for land-use planning, e.g., for the formulation and implementation of community-based resource management plans. The other basis of such a strategy would be the *rational management of littoral and marine ecosystems*, in order to anticipate human disturbances of mangroves, seagrass and seaweed beds, coral reefs, beach vegetation, as well as overexploitation of fish resources (which are a primary source of proteins for islanders) and coastal erosion. This kind of a holistic strategy will be required, if the objective of sustainability is to be achieved, i.e. if future generations are to be left no worse off than present generations.

3. RESEARCH PROGRESS AND METHODOLOGY

3.1 Research progress and involved organisations

Selection of the first research site and research permission

During a visit to Maluku in 1987, I gathered my first experiences in Banda. Then, in 1992 and 1993, I carried out research in Banda for my master thesis at the Freie Universität of Berlin. The results of that thesis (Stubenvoll 1994) justified further research activities on traditional agroforestry in the Banda Islands, particularly in Rhun, at a broader and deeper level. For this study, I was financially supported with a two year scholarship by the federal state of Berlin and an additional scholarship by the German Academic Exchange Service DAAD (*Deutscher Akademischer Austauschdienst*).

In November 1995, I became an associated student at ICRAF (International Centre for Research in Agroforestry, Bogor), where I received administrative, logistic and scientific support. ICRAF assisted me in finding the Indonesian sponsor of my research, namely *Pusat Penelitian Pengembangan Kehutanan* (Forestry Development Research Centre, Ministry of Forestry). Such a sponsor is the one requirement in order to apply for research permission from the responsible government body, in this case the Indonesian Institute of Sciences LIPI (*Lembaga Ilmu Pengetahuan Indonesia*). The research permit was submitted in April 1996, after approval of the research application by the Indonesian State Intelligence Co-ordinating Agency BAKIN (*Badan Koordinasi Intelijens Negara*). After one year, the permit was then extended. Research documents and a visa had to be organised again from the Ministry of Internal Affairs and the Immigration office, respectively.

Selection of the second research site

After finishing data collection and the construction of a community-based resource management plan in Rhun (Masyarakat Pulau Rhun 1996) (cf. Ch. 8.2), more research on another island had to be carried out to derive more general results. Hence, I visited several islands in January and February 1997 to identify a suitable second research site and to get a general overview about traditional agroforestry in parts of Central Maluku. Several *criteria* were employed to select the second island:

Climate: The island should be situated in the same climate zone as Rhun. This reflects both the assumption that climate has an important influence on the choice of trees, and the interest in analysing traditional agroforestry systems which consist of, for the most part, the same species.

Land use: Deforestation by agricultural activities should be one issue of land use. Similarly to Rhun, traditional agroforestry, which is partly an adjustment to driving back natural forests, should be an integral part of the agricultural landscape.

The *land area* should be similar to Rhun. This would allow for an easier comparison, as well as to facilitate the research process and the construction of a community-based resource management plan.

Furthermore *logistical demands* (transportation, accommodation) and *social access* to the involved communities played an important role in the choice of the island case studies.

Collection, analysis and interpretation of data

Empirical research activities were carried out in Rhun from May until December 1996, and in Tioor from June 1997 until February 1998. During the campaign for the parliamentary election in May 1997, any type of data collection was prohibited by the Indonesian authorities. Regular stays in the provincial capital Ambon and in the regency capital Masohi, were necessary to: look for secondary sources, meet and interview Government officials, contact the scientific community and non-governmental organisations (NGOs), and write quarterly research progress reports to LIPI.[23] Analysis and interpretation of data was carried out after returning from field work in March 1998. However, as described in the next section, data was also preliminarily evaluated in the research sites during data collection, in order to adapt methods to the social field.

3.2 Methodology and methods

This research is based on the concept of cultural geography, and includes approaches to related disciplines such as human ecology, ethno-botany, and new institutional economy.[24] It was mainly carried out with a qualitative methodology, although quantitative data was also collected. Principles of the respective *methodologies* are briefly outlined in the following.

A qualitative methodology[25] stresses several principles: Firstly, the *flexibility* of using adequate methods during the research process, because *methods should be adapted to the empirical world*, and not the other way round. A strict quantitative methodology would not easily fit to this demand, because it needs a *set of ex ante hypotheses to be tested* in the social field thereafter. Thus, the concept of this study is restricted to a set of questions revolving around one central hypothesis (see Ch. 1), with the objective of *generating more hypotheses*. Furthermore, flexible methods enable the researcher to use latest findings of the research for the follow-up procedure. Closely related to flexibility is a second principle of the qualitative methodology: its *openness* towards people, research situations and research methods. With an open concept it is easier to get unexpected but important information, than it would be with a quantitative methodology and its *ex ante* hypotheses. Since perceptions by locals are an important aspect of sustainable resource use, qualitative methodology allows for this group to be better understood. This information can then be used to generate hypotheses and to adapt methods for further research activities. Thirdly, *interaction and communication* between researcher and the people involved is seen as an integral part of the qualitative research process. Thus, the interview or the observation should be carried out as naturally as possible.

This methodological position had consequences for the employed research *methods*. Qualitative methods (Lamnek 1988 and 1989), accompanied by techniques of rapid rural appraisal (RRA; cf. e.g., Chambers 1985; Khon Kaen University 1987) and participatory rural appraisal (PRA; cf. e.g., Chambers 1983; Mosse 1994), dominated the research. Qualitative methods and collection of quantitative data were not strictly separated from each other.

Interviews

The peasant household as the decision-maker of land-use activities is seen to be the central unit of this study. Thus, the *interview with the household head* was the single most important method. Almost all

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23 The following organisations and persons were involved: The Agencies for Regional Development (*BAPPEDA*) at provincial (*Tingkat I*) and regency (*Tingkat II*) level; Government Departments (*Kanwil*) and Services (*Dinas*) of Agriculture (*pertanian; perkebunan*), Forestry (*kehutanan*) and Fishery (*perikanan*); the Regent (*Bupati*) in Masohi; the Land Evaluation Unit at the Faculty of Agriculture, University of Pattimura in Ambon; the Statistical Office in Ambon; NGOs in Ambon: *Baileo Maluku*, *Birdlife International*, and *Hualopu*.

24 Human ecology can be defined as the study of the behavioural and biophysical interactions – in terms of the flow of energy, material, and information – between people and their environment (Rambo and Sajise 1984). As behaviour of people is influenced by culture, the discipline of cultural geography, which studies the relationship of man and the natural and cultural landscape, is the main concept of this study. Ethno-botany was deployed for an analysis of plants' functions and of indigenous knowledge about plants, whereas the approach of new institutional economy, which focuses on institutions "as the rules of the game in a society" (North 1990, 3), was useful for the analysis of traditional institutions.

25 For a comprehensive discussion of qualitative social research – both methodology and methods/techniques – see e.g. Lamnek 1988, and 1989.

interviews were carried out in Indonesian language (*Bahasa Indonesia*).[26] Two interviewed household heads in Tioor could only speak the local language, so that an interpreter had to be consulted. A part of the interviews was recorded and transcribed as soon as possible. When the household head did not agree on recording, and in situations where the author's social access was limited, notes on provided information were taken during the interview. During island excursions, interviews with farmers were spontaneously carried out; obtained information was written down in brief outlines and completed in the evenings.

Household interviews were carried out at three different levels. In a *first step* almost 10% of the households were selected – 25 households (out of 330) in Rhun and 40 households (out of 360) in Tioor (by definition for Rhun: HH 1, HH 2, ... HH 25; by definition for Tioor: HH 26, HH 27, ... HH 65). This first sample should represent each community by using a *quota selection*. For that purpose, sketched maps of settlements were produced to obtain a complete list of households by interviewing key informants. Basic information on all households – e.g., age of household head, number of children, main economic activity, agricultural activities – were additionally provided during these interviews. After quota selection, households were interviewed by using a *manual*, which is provided in a translated form in App. 5.1. If a selected household head was absent for a longer period, another household *with similar socio-economic features* was selected to replace the absentee. This was particularly important in Rhun, where men often leave the island to fish for some weeks in the region. At the end of each interview the household head was asked, if he/she could be accompanied to his/her fields at a later time. From those who agreed on a joined field excursion, 22 households were selected in a *second step* (by definition for Rhun: HH 1, HH 2, ... HH 10; by definition for Tioor: HH 26, HH 27, ... HH 37). With *semi-structured interviews* more information was obtained (translated version of the concept in App. 5.1). Additionally, sketched maps of the visited fields were drawn, redrawn and analysed later on. The *third and last step* resulted in the selection of four households from those of the second step (by definition for Rhun: HH 1, HH 2; by definition for Tioor: HH 26, HH 27). *Narrative interviews* with these four household heads (or key farmers) and their family members were carried out at several sessions and more detailed land-use maps of fields were recorded. Additionally, field experiments and crop yield measurements supplemented information.

This selection process aimed at the collection of as much information on land use, resource management, and traditional agroforestry as possible and thus, deepening the knowledge about these realms. This procedure had an advantage because the farmers in the second and third step had shown a greater trust which proved essential to talk about more sensitive issues. However, as this is a time-consuming procedure, larger numbers of households could not be selected.

Interviews with key informants and opinion leaders were a second source of information, and were helpful to integrate information from household heads into a greater context. The selection of members belonging to this rather heterogeneous group[27] could be carried out just shortly after their identification. For each of these *intensive interviews*, a distinct concept with its own set of topics was formulated. The advantage of this procedure was to include already collected information into each concept. Key informants were the only source of oral information during the visits of islands for the identification of the second research site (Ay, Banda Besar, Gorom, Kasiui, Kur, and Saparua).

Narrative interviews with experts and administration officers were carried out in Banda Neira, Banda Besar, Ambon, Masohi, Geser and Gorom. Their purpose was to collect information and data as openly and extensively as possible.

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[26] The author speaks Bahasa Indonesia fluently. Thus, it was not necessary in most cases to consult an interpreter.

[27] Examples of this group include village authorities, religious and traditional leaders, persons with a profound knowledge in certain realms, older people, teachers and traders.

Participant observation and excursions

Participant observation was carried out in the social field, and can be characterised as *open, unstructured and direct*. Observation was the most important method during *island excursions*, although additional interviews were carried out, when farmers were met by chance. Contents of participant observation were all realms of social and economic life to which I had access (i.e. in the village, in the fields, and during interviews in houses). During short excursions, observations were also conducted in islands that were not chosen as in-depth research sites.

Mapping

Maps should record and show spatial phenomena, and underline certain findings of the study. They are an aid in verifying collected information. Maps include forms of land use, location and arrangement of settlements, autochthonous names of localities, and topography. Maps of settlements and of fields had to be recorded without any topographical base map (blind mapping). For participatory mapping in Rhun and Tioor, and for the land-use map of Tioor base maps could be used, although their scale is not entirely satisfactory.[28]

Sketched maps of settlements (Maps 6) were drawn after recording each house with compass (direction) and by counting steps (length; distance). The recording of *sketched maps of fields* (concerning farmers of the second step of the selection process) was carried out with compass (direction) and by counting steps (length; distance) with regard to the field boundaries. Land-use features (e.g., trees, annuals, huts, paths) were then recorded by estimating distances, directions and slope gradients. For distances between trees (e.g., in coconut groves) spot checks were carried out by using a tape measure. *Detailed land-use maps of fields* (concerning farmers of the third step of the selection process) were drawn after measurements with compass (direction), clinometer (height of trees; slope gradient), tape measure (length of plots; distance for 10 m grid squares), string (to mark grid squares).[29] Each farmer assisted me in doing measurements in his fields, so that he simultaneously could give information on land use.

Land-use maps of both islands were drawn for the development of community-based resource management plans (see Ch. 8.2). Base maps[30] provided the shape of the islands by enlarging the scale to 1 : 12,500. With participatory rural appraisal (PRA), land characteristics (slopes, soil fertility, tree cover, land use) were recorded in several group discussions with key informants and farmers, and during workshops for the construction of community-based resource management plans. This resulted in maps, which were then cross-checked by numerous field excursions. In Tioor Island it was then decided to produce a land-use map (Map 3) by use of transect measurements in east-west direction in a distance of 150 m to 200 m. Two teams, each consisting of three persons, measured and recorded

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[28] It was impossible to find topographical maps of reasonable scale. The islands Neira, Banda Besar, and Ay are mapped in a large scale (1: 20,000), but not Rhun and Tioor. Even in the Dutch archives good topographical maps of the islands do not exist. Another source might have been aerial photographs taken by the US Air Force in Maluku during World War II. Unfortunately, most of the photos were taken in North Maluku, and none in the Banda nor the Watubela Islands (cf. Keogh 1995), although the US Air Force carried out military operations there. The maps with the largest scales available were made by the Dutch Hydrographic Service in 1928/29, with a scale of 1 : 100,000 for Rhun, and 1 : 200,000 for Tioor (Algemeen Rijksarchief, Den Haag, Microfilm Map No. 2462). However, these maps do not provide exact contour lines.

[29] These maps are definitely more detailed and accurate for Rhun, because there the field area is comparatively smaller. Similar mapping activities proved to be too time-consuming in Tioor, so that it was decided to record details in only a representative part of the fields. Another reason for this different approach is, that land-use features could not be accurately recorded in steep terrain, which is most common in Tioor.

[30] Base map for Rhun Island was the already cited map of the Dutch Hydrographic Service, scale 1 : 100,000 (Algemeen Rijksarchief, Den Haag, Microfilm Map No. 2462). The RePPProT Map Series 1988 in a scale of 1 : 250,000 covers all Indonesia and was used for Tioor Island as the base map (Map No. 2811).

topography, vegetation and land use. Additionally, the course of major streams and ridges were measured. All measurements were carried out with a tape measure, clinometer and compass. With this method, topography and land use could be mapped more exactly than with PRA methods only. [31]

Workshops and group discussions

Methods of participatory rural appraisal and *Zielorientierte Projektplanung* (ZOPP; target-orientated project planning; cf. GTZ 1987) were employed for the construction of community-based resource management plans during *workshop* sessions. A detailed account of this procedure will be provided in Ch. 8.2.2. *Group discussions* were performed by chance, usually when several farmers were sitting together in the fields after their fieldwork. I could obtain additional information, predominantly about farmers' perception, motivation and different opinions regarding trees, land use and land tenure. Additionally, group and individual opinions could be compared. I chose not to intervene too much in group discussions, but rather let the conservation be led by the locals. Collected information was noted later at home, because immediate recording would have affected the discussions.

Vegetation and soil sampling

I employed a botanical key, based on vegetative characteristics (Keller 1992), for *identification of trees* during field work. The result was checked with a tree list of Maluku (Whitmore et al. 1989), the PROSEA handbook, and the 'Tree flora of Malaya'.[32] If not possible to be identified during field work, parts of major plants were collected for a herbarium. In the field, additional information on collected plant material – e.g. uses, plant community – was written into a notebook. After conservation, the plant material was brought to Bogor, were it was dried at ICRAF and then identified by the staff of *Pusat Penelitian dan Pengembangan Biologi*, LIPI (Research and Development Centre for Biology). Most of the herbarium collection was carried out in Tioor.

Roberth Liang, a student of agriculture at the Pattimura University in Ambon, collected *soil samples* for his BSc thesis in Tioor Island in October and November 1997. His samples were analysed by the Soil and Plant Laboratory of Pattimura University in December 1997. I was allowed to use data of these samples (App. 2.1; App. 2.2) and some of the written preliminary results from that thesis (Liang 1998). Additionally, we carried out qualitative soil analysis during island excursions (App. 2.3).

Use of secondary sources

Secondary sources consist of official statistical material, archive material, scientific publications, maps, travel reports and newspaper reports.

Measurement of rainfall

For the purpose of rainfall measurements, a simple rain gauge in form of a pan was set out in which rain accumulated. To avoid serious evaporation losses in the daytime, the pan required frequent emptying of water into another receptacle protected from insolation. The amount of accumulated water was then measured twice a day, in the morning (7 am) and in the afternoon (6 pm), and calculated into units of millimetres by considering the surface area of the pan's upper side (App. 2.4). Additionally, qualitative observations about intensity and length of rainfall, intensity of wind, and smog condition during the 1997 fire disaster in Indonesia were recorded.

[31] For more details see Ch. 8.2.2 and App. 5.3.

[32] A monography about the tree flora of Maluku does not exist yet, so that the 'Tree flora of Malaya' [edited by Whitmore: Volumes 1 and 2 (both 1983), and Ng: Volumes 3 (1978) and 4 (1989)] had to be consulted as well. However, these volumes could be only employed with restrictions, because the tree floras of both regions differ widely.

3.3 Scientific criteria and restrictions

The most important scientific criteria – validity, reliability, inter-subjectivity and representivity – have to be checked separately. The mainly used methods of qualitative social research seem very likely to meet the criterion of *validity*. For instance, Lamnek (1988, 159) generally regards qualitative methods more valid than quantitative ones, because: data is generated closer at the social field, methods are used more flexibly and more openly, and communication between researcher and people is an integral part of the research. However, evaluation and interpretation of empirical data are better standardised with quantitative methods, which therefore are more *reliable* than qualitative methods. Without knowledge of empirical data it is impossible to check validity and reliability. Thus, only the author is able to do that. Nevertheless, the explication of the research progress, methodology and methods should make it possible to understand the extent of validity. The same is true for the criterion of *inter-subjectivity*: Research results cannot meet objectivity, but with more or less transparent explication of the research progress, methodology and methods, it should be possible to understand them in the sense of inter-subjectivity.

The research results are not *representative* in a statistical sense, because the island case studies were not selected randomly and the household interviews were carried out by the use of quota selection. It was more important, however, to examine the typical features, so that the household selection followed a systematic classification of different types. Furthermore, excursions and interviews in other islands should support the assumption, that some results can also be applicable there.

A serious disadvantage, which must be accepted, was the fact that most interview partners were men. In Indonesia, it is the social norm to interview the man, who is the representative and head of the household. In several cases, women were present during the interview. Sometimes they participated in the interview. In those cases, comments, additional information, and comparisons with the male view could be obtained. Interviewing widows (as the household head) and wives of the key farmers HH 1, HH 2, HH 26, and HH 27 (third level of household interviews), and PRA with female groups were the only possibility to directly include women.

Between 1997 and 1999 Indonesia's contemporary history underwent most incisive upheavals and transformations in the political and economic system. These major events are closely related to each other, and are dealt with in detail by several authors (cf. Bird 1998; Cole and Slade 1998; Evans 1998; Gellert 1998; Johnson 1998). They had an impact on methodology and certain findings of this study.

(1) *Climatic events and forest fires*: The prolonged drought in Indonesia (including Tioor and Rhun) that was caused by the El Niño Southern Oscillation, and the forest fire crisis[33] in 1997 had serious consequences for the Indonesian economy, and for millions of Indonesian farmers and forest dwellers. Also, the forest ecosystem was profoundly disturbed. Both the methodology and the research progress of this study had to be modified. For instance, measurements of crop yields resulted in untypical, not representative low levels, and transportation was hindered by the thick 'haze' covering Southeast Asia.

(2) *Economic events*; i.e. the economic turmoil and the devaluation of the Indonesian Rupiah (Rp.) beginning in July 1997: If not otherwise stated, all price calculations in this study are based on the pre-crisis value of the Rupiah (roughly 2,500 Rp. per 1 US \$). The expected rampant increase of prices for goods based on world market prices in US \$ (imports, exports) may make some of the findings obsolete, especially the economic evaluation on agroforestry. Thus, the expected change of price relations are considered in the relevant sections, although this can only be tentatively carried out.

[33] For an analysis of related causes see e.g., Gellert 1998.

(3) *Political events*, particularly the resignation of General Soeharto in May 1998, Indonesia's second president for more than three decades, and the democratic parliamentary election in June 1999: Political transformation, possible democratisation, a weakening political influence of the military, and a decreasing influence of cronies and family members of the Soeharto clan on the economy will very likely have impacts on the regional level as well. An example of the latter is the abolishment of the state monopoly in clove trade under the control of one of Soeharto's sons in 1998, which might lead to increasing floor prices for cloves.

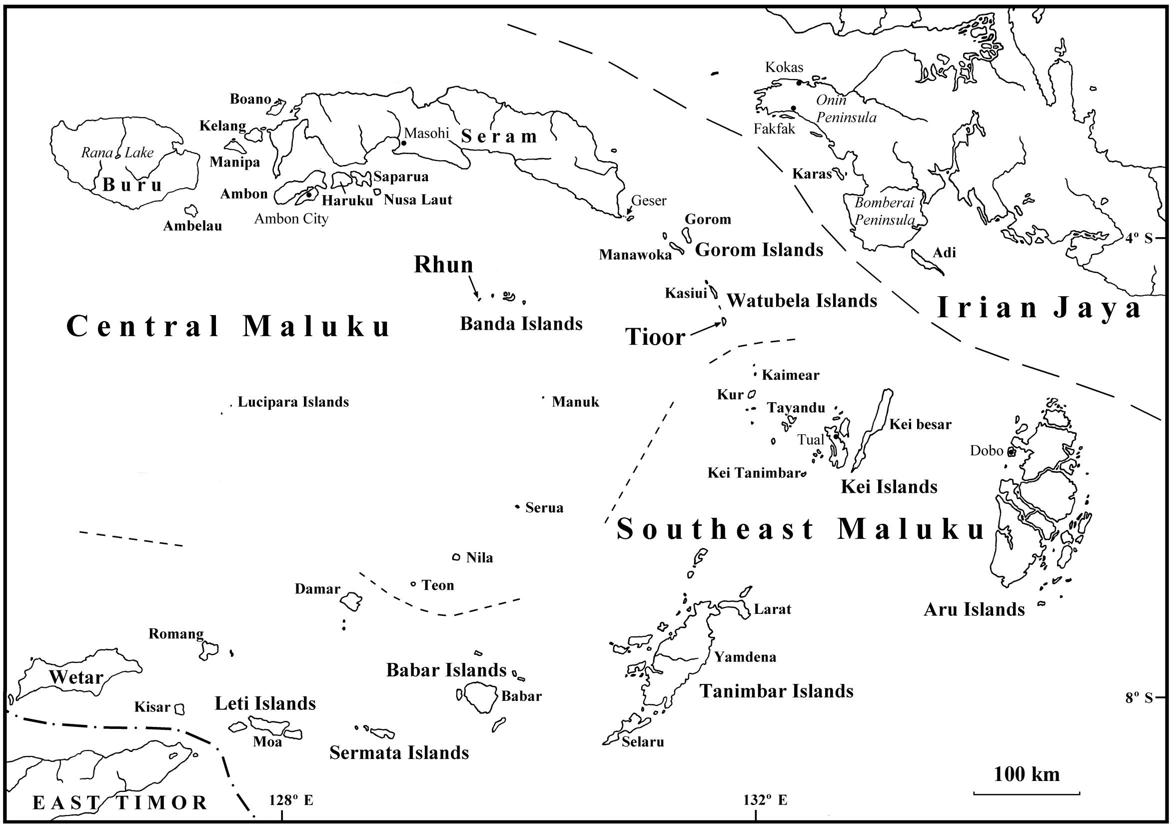
In summary, the analysis and certain findings of this study, which are based on data collection prior and during the early period of transformation, may have to be qualified with these exceptional events in mind. Moreover, the riots in Ambon and other Maluku towns since January 1999, will have unpredictable social, economic and political implications for the future of Maluku's societies. I will attempt to take into account the possible implications of these tremendous upheavals.

4. PHYSICAL OVERVIEW OF TIOOR AND RHUN

4.1 Geographical position

The province of Maluku which lies in the east of the Indonesian archipelago stretches about 1,100 km between the latitudes of 3° N and 8° S, and approximately 700 km between the large islands of Sulawesi (in the west) and New Guinea (in the east). Maluku covers a total of about 780,000 km², but only 10% of it is land area (77,990 km²) (Monk et al. 1997, 9). Two islands – Halmahera (20,000 km²) and Seram (17,429 km²) – are larger than 10,000 km², another 30 are larger than 100 km².[34] Arnberger and Arnberger (1993, 92 and 96) count a total of 1,098 islands in Maluku, of which 310 islands are larger than 1 km², 187 have an area between 25 and 100 ha, and the other 601 between 10 and 25 ha.[35] The large proportion of the sea area and the frequency of small islands emphasise the importance of marine resources for the livelihood of the people and for economic development, as well as the very insular character of Maluku.

Figure 4.1: Sketched map of Central and Southeast Maluku



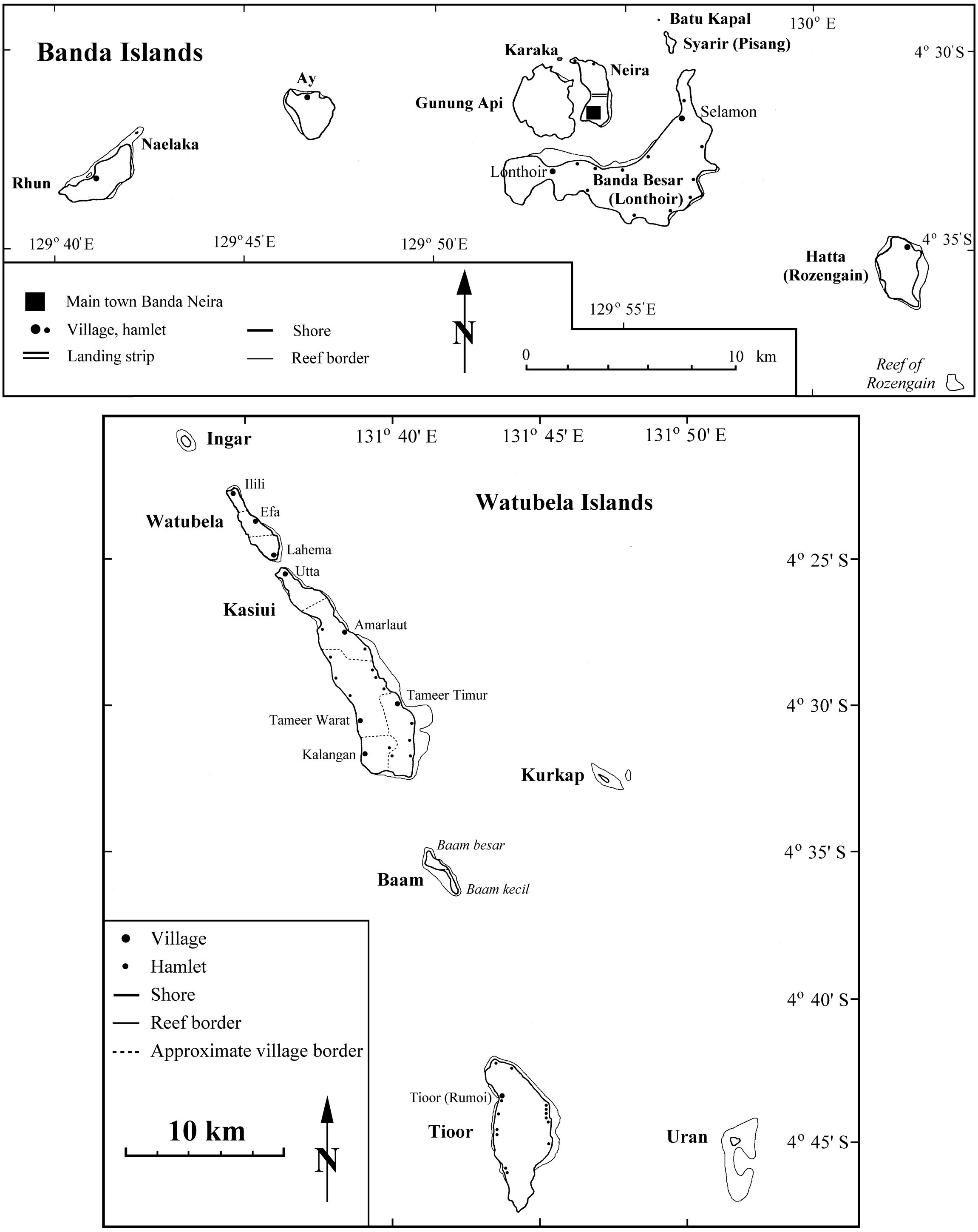
Notes: The Indonesian province of Irian Jaya is the western part of New Guinea.
East Timor is independent since 1999.

Source: Nelles Map Series 'Southeast Asia' (no date), supplemented and updated by Stubenvoll 2000.

[34] For further details see Monk et al. (1997, 8).

[35] Islands smaller than 10 ha are not included by Arnberger and Arnberger 1993.

Figure 4.2: Sketched maps of the Banda Islands, and the Watubela Islands



Notes: **Banda Islands**: Manukang Island (17 ha) is situated 25 km north of Rhun, and is not shown for simplicity's sake. Some islands bore other names during the colonial period, given in brackets. Villages' names as the respective island's name, except in Banda Besar.
Watubela Islands: The area of the coral reef of Uran Island has substantially changed since 1922, and is shown in its present extent (drawn from PRA).
Note the different scale of both sketched maps!

Sources: Dutch Hydrographic Service 1928/29; RePPProT 1988; PRA with villagers (Stubenvoll 1997).

Exemplary for these small islands, two island case studies have been chosen for this research, both of them being a part of an archipelago in Central Maluku (Fig. 4.1): *Tioor* (2,394 ha; up to 358 m above sea level) in the Watubela Islands, and *Rhun* (465 ha; up to 180 m above sea level) in the Banda Islands (Fig. 4.2). Inhabited islands are Watubela, Kasiui, and Tioor in the Watubela Islands (6,200 inhabitants), and Neira, Banda Besar, Ay, Hatta, and Rhun in the Banda Islands (14,000 inhabitants) (KS 1990a and 1990b).[36]

4.2 Biophysical environment

It is indispensable to provide an overview of the environmental conditions in these two island case studies, because they are important factors of the agricultural utilisation potential. Geology, geomorphology, flora, fauna, and climate form the basis of soil development, and influence the distribution and amount of plants and animals. Additionally, the coastal ecosystems as crucial factors of the livelihood of the populations will be explored.

4.2.1 Geology and geomorphology

An explanation for genesis and evolution of Maluku's islands is provided by the theory of plate tectonics.[37] Four plates – the Eurasian, the Pacific, the Indo-Australian, and the Philippine plates – and the Asian and the Australian continental blocks are interacting in the region of Maluku, making it one of the most complex regions on earth in terms of tectonics. Besides the collision of Taiwan with the Luzon Island Arc, the collision of the Sahul and Arafura Shelves with the Banda Island Arc is the only present example of an *island arc-continent collision* (Bowin et al. 1980, 869). The result is an orogenic belt in *status nascendi*, which forms the area of Central and Southeast Maluku (van Bemmelen 1949, 48).[38]

Fig. 4.3 illustrates the geological features in the region. Before Pliocene, *oceanic crust* of the Indo-Australian Plate was subducted by oceanic crust of the Eurasian Plate. But since Pliocene, *continental crust* of the former plate is interfering with the oceanic crust of the latter plate along the up to 3000 m deep Timor and Tanimbar Trenches (von der Borch 1979, 169). This *subduction process* has resulted in an emergence of two island arcs, which have been uplifted as continental crusts with its lower density pressing upwards. The up to 7000 m deep Weber Trench is situated between these two island arcs.

(1) The *Outer Banda Island Arc* (Timor, Leti Islands, Sermata Islands, Babar Islands, Tanimbar Islands, Kei Islands, Tayandu, Kur, Watubela Islands, Gorom Islands, and Seram Laut) has a complex non-volcanic geology, dominated by metamorphic and Tertiary and Quaternary sedimentary rocks, such as melange and uplifted reef limestone, which are overlying basement and cover rocks of the Australian continental margin (Audley-Charles 1993, 13; Monk et al. 1997, 39). The presence of the latter in most, if not all, of the outer Banda arc islands gives room for a continuing debate about their origins, which is summarised by Bowin et al. (1980, 905-12), who conclude (page 907) "... that the outer Banda arc from Buru around to Timor, and possibly to Sumba, contained Australian continental crustal blocks and fragments *prior* to its collision with the Australian margin in the last 3 to 5 m.y."

[36] The grid co-ordinates of the village heads' houses are: lat. 4^{O} 33' S, long. 129^{O} 41' E (Rhun); and lat. 4^{O} 43' S, long. 131^{O} 44' E (Tioor). Two villages in Gunung Api Island were evacuated after the last volcanic eruption in 1988.

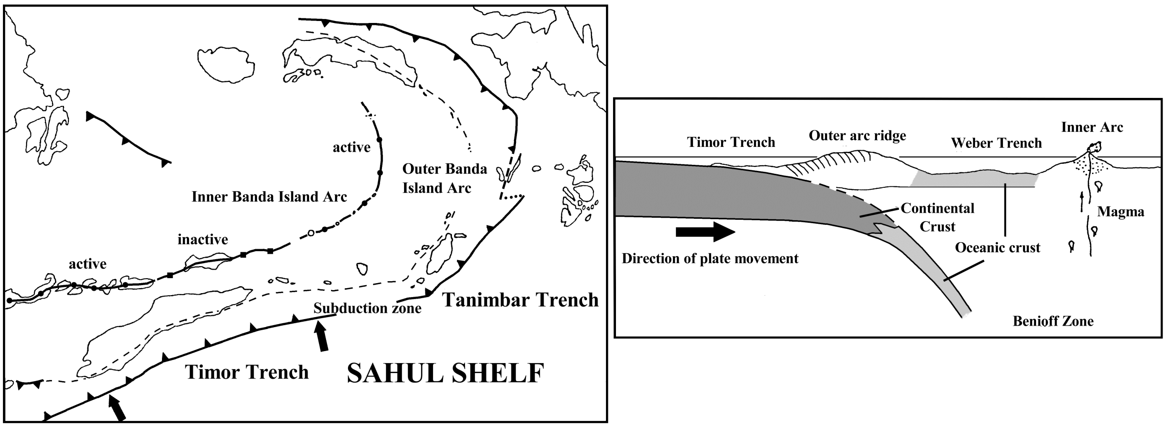
[37] For a detailed account of this theory see e.g., Frisch and Löschke 1993. Overviews of geology and geomorphology of Maluku are given by van Bemmelen 1949 and Hutchison 1992.

[38] The region of North Maluku is not treated here, as it is not scope of this study.

(2) The *Inner Banda Island Arc* is volcanic, either inactive (e.g., Wetar) or active (Damar, Teon, Nila, Serua, Manuk, and Banda, and additionally several young and growing submarine volcanoes along the island arc). The volcanically active islands are composed primarily of andesites, with the exception of Banda (Bowin et al. 1980, 903; see below), and fed by magma from the wedge of the earth mantle in the Benioff Zone.

The non-volcanic *Watubela Islands* are part of the Outer Banda Island Arc. The islands consist of a complex association of metamorphic (gneiss), igneous ultrabasic (serpentin, peridotite, dunite) and calcareous (limestone) rocks, which makes it difficult to estimate their age. Probably, they emerged above sea level once the Australian continental margin has arrived in the subduction trench about four million years ago (Harris 1991; cited from Monk et al. 1997, 39). Fig. 4.4 shows this association for Tioor Island, which is overlain with alluvial material along the coastal strip. Along with the emergent reef atolls in the Gorom Islands, the tiny coral islands of Kurkap and Uran are probably geologically the youngest islands in Maluku (Monk et al. 1997, 40).

Figure 4.3: Plate tectonics in Southern Maluku



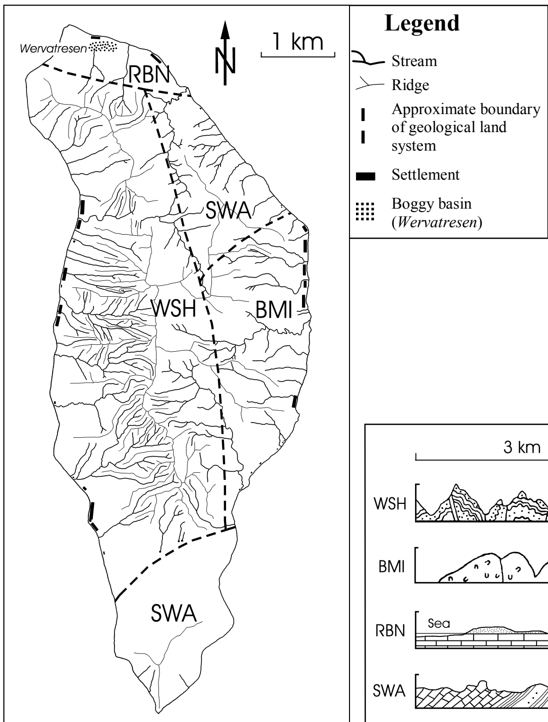
Sources: From von der Borch (1979, 189); Bowin et al. (1980, 885); Monk et al. (1997, 12-3).

A cross-section of Tioor Island in Fig. 6.3 illustrates its typical *geomorphology*, which after the emergence of the island above sea level has been formed by erosion (largely made by running water) and sedimentation along the coastal strip. The sketched map (Map 1) and Fig. 4.4 reveal the existence of numerous streams and their branches, with small catchment areas being separated by very narrow ridges and divides, especially in the western part of the island. Slopes with high relief energy of 50% are common, but may even reach gradients of up to 80%. In the eastern part of Tioor, ridges and divides are generally wider, and slopes have a lower gradient. The southern part of the island is capped with a raised limestone plateau in some 140 m above sea level that drops either steeply or in cliffs towards the coast. The coastal plain is largely varying in width, with a maximum of some 400 m at parts of the north-east and east coast. It is overlain by alluvium, i.e. erosion material being carried by the streams, and deposited there. A coastal bank is formed at the eastern seashore, and bordered with shallow basins of coastal plains further inland. In the north, one of these basins is boggy because it is filled with fresh water of a stream (*Wervatresen*) without an estuary, and thus without surface runoff to the sea.

The *Banda Islands* are part of the Inner Banda Island Arc. The inner Banda Islands are of volcanic origin, while the outer islands Rhun, Ay and Hatta are lifted limestone islands. “The central Banda volcano is composed of an old caldera wall (represented by Lonthor (518 m), Pisang, and Kapal), and the central younger volcanic group (Banda Neira and the cone of the active Api volcano, 658 m). The rocks are andesites and scarce basalts" (van Bemmelen 1949, 464). This observation of andesites in Gunung Api is supported by other sources as well (cf. Udin 1997, 7). On the contrary, Bowin et al. (1980, 903) ascertain an *absence of andesites* in the inner Banda Islands, but an existence of basalts on Neira and dacites on Gunung Api. The islands emerged during the late Pliocene or early Pleistocene (Bowin et al. 1980, 903). Since 1700 AD, fourteen eruptions of Gunung Api have been recorded (Macdonald 1972, 432), the last one in 1988. Warburg (1897, 155-57) describes eruptions and earth- and seaquakes, which partly caused great damage and sometimes claimed casualties.

The limestone islands emerged and were pressed upwards in several (sometimes sudden) tectonic uplifts (e.g., Reiner 1956, 26; Arnberger 1986, 335),[39] resulting in terraces in different levels – especially in Rhun and Hatta. The cross-section of Rhun Island (Fig. 6.4) illustrates the existence of up to seven terraces alternating with steep walls or slopes; and two basins, where eroded material has been trapped (*Kolam Pisang, Kolam Durian*). All Banda Islands have been covered to a varying degree by eruption material of the Gunung Api volcano. Unlike the raised limestone islands with their terraces and the coastal plains of Neira, Gunung Api and Banda Besar show a high relief energy.

Figure 4.4: Geology of Tioor Island



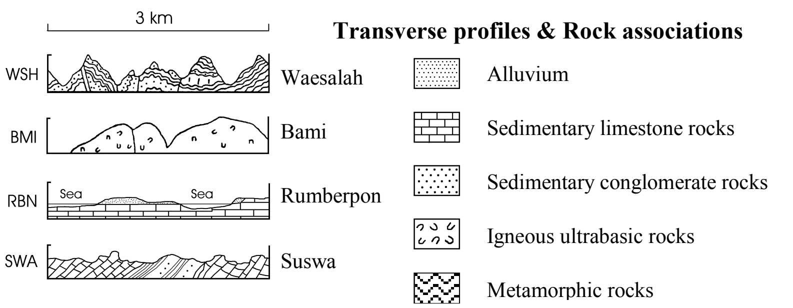
Geological land systems

General description of geological land systems

Geological Land System	Gradients (%)	Width of ridges (m)	Width of valleys (m)
Waesalah WSA	> 50	< 50	< 25
Bami BMI	[25; 60]	[201;500]	< 10
Rumberpon RBN	< 2	none	none
Suswa SWA	[16;25]	[51;200]	[25;200]

WSA: Steep hills, metamorphic rocks (gneiss)
BMI: Obtuse hills, igneous ultrabasic rocks (serpentin, peridotite, dunite)
RBN: Low-lying coral islands and low-uplifted coral rocks (coral rocks, alluvium)
SWA: Low hills, carstic slopes (coral rocks, limestone, sandstone)

Transverse profiles & Rock associations



Sources: Adapted from RePPProT 1989; Transect mapping and measurements (Stubenvoll 1997 and 1998).

39 Rates of emergence (uplift) and submergence in the region are shown in Monk et al. (1997, 47).

4.2.2 Climate and fresh water

The Köppen climate classification system classes the Banda and Watubela Islands into an Afa-climate (moist tropical climate with hot summers) (BAPPEDA 1982, 7), but this must be specified. Reiner (1956, 43) distinguishes three climate types in Maluku: the inner-tropical and the outer-tropical climate type, and additionally a type with orographic precipitation, which according to Troll (1964, 25-6) can be defined as a moist tropical climate of the outer tropical zone. The Banda Islands can be classed into the latter type: Although a real dry season is missing, periods with high and low rainfall can be distinguished, and the temporary distribution of rainfall is strongly influenced by the topography of Seram (Reiner 1956, 44). The climate classification of the Watubela Islands poses considerable difficulties, because they lack systematic data on precipitation. The islands are likely situated in the transition zone of the latter to the outer-tropical climate type, to which precipitation data (Tual; about 160 km southeast of Tioor) are added in Fig. 4.5.

The climate of the whole of Southeast Asia is largely affected by monsoon and trade winds with a seasonal rhythm, which is described in detail by Uhlig (1987, 49-52). The originally dry south-east continental trade wind from Australia, which may bring *cool* air masses, blows from May until September. It then picks up moisture in the Banda Sea, so that south of the up to 3000 m high central ridge in Seram rainfall is due to condensation of rising winds (Reiner 1956, 47).[40] The west and north-west monsoon from Central Asia in November till March brings steady and high precipitation for Central Maluku, often in combination with high wind forces and waves. In April and October, the region is situated in the equatorial belt of variable winds and calms (or doldrums), a zone of a wide trough of low pressure, with little rainfall. The change from the inter-monsoon period to the west and north-west monsoon is quicker than to the southeast trade wind. Occasionally, the Banda and Watubela Islands are hit by tropical cyclones or storms, which cause a lot of damage, like recently in December 1996.

Fig. 4.5 shows the temporary distribution of the mean monthly precipitation in Banda and Tual. Additionally, variances in precipitation are considered for Banda. Total annual precipitation is 2,656 mm in Banda, with two maxima in December and May, and 2,470 mm in Tual, with one maximum in March. The drier period lasts in both places from July and August till October and November, with more than 100 mm monthly rainfall, except in August in Tual. In the dry year of 1987, only 1,190 mm rainfall was recorded in Banda, without any significant precipitation from June until September (BPS 1987, 23), whereas in 1989, Banda received 3,910 mm rainfall (BPS 1989, 24). Even in that wet year, it rained less than monthly 100 mm in August, October, and November. Both examples underline the great variability in amount and distribution of precipitation, which is not a rare phenomena. Prolonged droughts are often caused by the El Niño Southern Oscillation, for instance in 1982 (nine months), in 1987 (four months), in 1993 (five months) and in 1997 (eight months). Thus, the distribution of rainfall has a greater influence on agricultural activities, utilisation potential and productivity than the total annual amount.[41]

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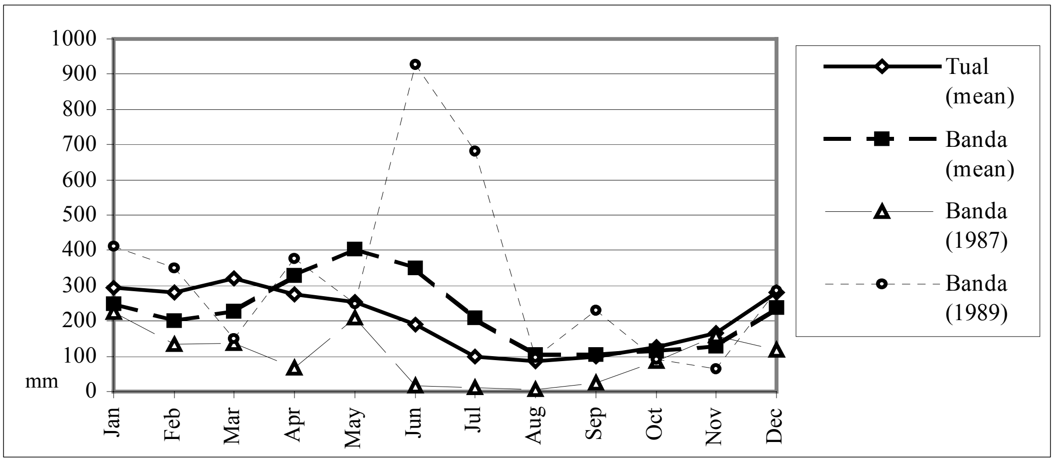
[40] In Banda, temperatures are uniformly high at a mean annual figure of about 26^{O} C. Average relative humidity is 83% (KS 1990a).

[41] In App. 2.4, additional data on rainfall during the field stay of the author is provided, which underline this result (being derived from statistical data of secondary sources), and which illustrate the precipitation conditions at the time of the field study. By using material from Dutch archives, Loth (1996, 3) points out that prolonged droughts hit the Banda Islands in the seventeenth century as well, namely in 1620, in 1630-31, in 1635-36, and in 1660. Thus, it seems that at that time droughts occurred less frequently than during the 1980s and 1990s.

The hydrological situation of Tioor is characterised by fresh water being provided by streams and groundwater. However, a prolonged drought restricts this availability, particularly in areas in which forests have been cleared. On the contrary, the lifted coral island of Rhun does not have a groundwater table, and the Gijben-Hertzberg lens is hardly reachable, so the community uses rainwater collected in water tanks. Only Neira and Banda Besar provide groundwater for usage during droughts, although there is growing demand, e.g. by tourism. Data on the *quality* of fresh water is not available and was not collected.

Figure 4.5: Mean monthly precipitation in Tual and Banda, and monthly precipitation in Banda in 1987 and 1989



Sources: From Rismunandar 1992, 30; Monk et al. 1993, 72-3; BPS 1987, 23; BPS 1989, 24.

4.2.3 Soils

Depending on the parent material and geomorphology, various soil types have been formed in Tioor and Rhun. Climate, flora, fauna (including human activities), and time are further soil formers, although they can be considered as relatively homogeneous on either island (Conradinus Ufie, personal communication 1997). However, the relative importance of each of these factors and their interactions is site-dependent and may change with time, indicating that soil is a dynamic body. Tab. 4.1 lists soil types of the four distinct geological areas in Tioor, which are outlined in Fig. 4.4. In Rhun, two soil types are occurring: *lithosols* and *rendzinas* (BAPPEDA 1982, 10; UP 1989, 10). In the following, these soil types (FAO-UNESCO classification) are described and interpreted in accordance with Pagel (1981), Schmidt-Lorenz (1986), Landon (1991), and preliminary results of the recent soil study in Tioor (Liang 1998).

Cambisols are moderately developed, well-structured, well-draining, neutral to strongly acid soils (pH 7.0 – 5.0) with a medium texture, an ocric or mollic A horizon, an cambic B horizon, and an extremely variable content of weatherable minerals. In Tioor, three variations are distinguishable: the eutric, dystric, and lithic. The structure of *eutric cambisol* is angular blocky and sub-angular blocky. With few exceptions of clay soil, it falls into the texture class known as silty clay loam. Eutric cambisol has a high production potential, because it is high in fertility (base saturation more than 60%), and relatively rich in humus in the dark-brownish to brownish upper layer.[42] *Dystric cambisol* has a base saturation of some 40%, and is more acid and less fertile than the eutric type. Like lithosols, *lithic cambisol* has a very limited effective depth (solum < 50 cm), although other soil characteristics (e.g., base saturation) might be favourable for agricultural production. The main drawback of cambisols is an accelerated erosion in sloping terrain, unless being covered with forest or well-adapted agroforestry systems.[43]

Fluvisols are recent alluvial loams (about 40% sand, 40% silt, 20% clay) and occur with two variations in the coastal plains of Tioor: Dark brown coloured and fertile eutric fluvisol has a base saturation of 65% and is associated with coral rocks and uplifted limestone (geological classification RBN and SWA), whereas reddish coloured dystric fluvisol – with a base saturation of less than 50% – is found on metamorphic and ultrabasic rocks (WSH and BMI). Both variations have a stratified structure (crumb in the A horizon, angular blocky in the B horizon), an irregularly arranged organic C content (less than 2.18%), which might be covered with rocky material. Of all soil types in Tioor, fluvisols have the best agricultural production potential due to the level topography. The lower fertility of dystric fluvisol can be easily dealt with organic and chemical inputs, e.g. by the use of improved agroforestry techniques and composting. The main drawback of fluvisols is related to the critical water supply during prolonged droughts due to rapid infiltration rates.

Lithosols are recent, less developed mineral soils with A-C horizons and a coarse texture, and are formed on slopes and steep terrain above coherent rocks, such as limestone or metamorphic rocks. Although certain soil parameters might be acceptable for agricultural production, these soils are difficult, if not impossible to be cultivated due to their very thin solum – a maximum of 10 cm is defined by FAO/UNESCO – and imminent accelerated erosion. Only extensive grazing is of some relevance.

Table 4.1: Soil types in Tioor

Geology / Geomorphology	Alluvium associated with coral rocks (RBN)[1]	Metamorphic rocks (WSH)[1]	Ultrabasic rocks (BMI)[1]	Uplifted limestone (SWH)[1]
RePProT 1989[2] (without a distinction in geomorphology)	Troporthents Tropudults Tropupsamments	Tropudults	Acrorthox Haplorthox Dystropepts	Rendolls Tropudults Eutropepts
Rigdes (Liang 1998)[2]	Eutric Cambisols Lithosols	Lithosols Lithic Cambisols	Dystric Cambisols	Eutric Cambisols Lithosols
Slopes (Liang 1998)	Eutric Cambisols Lithosols	Dystric Cambisols Lithic Cambisols Lithosols	Dystric Cambisols	Eutric Cambisols Lithosols
Lower slopes and plains (Liang 1998)	Eutric Fluvisols	Dystric Fluvisols	Dystric Fluvisols	Lithosols Eutric Fluvisols

Notes: **1** For an explanation of geological abbreviations see Fig. 4.4.
2 For a correlation of USDA soil classification (used by RePPProT) with FAO/UNESCO soil classification (used by Liang) see e.g., Schmidt-Lorenz 1986, 59-61.

Sources: From RePPProT 1989; Liang 1998.

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[42] In App. 2, data of soil parameters – texture, base saturation, pH (in a range of 5.36 – 4.06), CEC, organic C, total N, available P, Ca, Mg, Na, K, and the like – are provided for all soil types occurring in Tioor. Preliminary pH-measurements in the field (with litmus paper) resulted in less acid pH-values, all in a range of 7.0 – 6.0.

[43] Imminent accelerated erosion in the upland and on slopes is a problem for all soil types, although to a different degree.

Rendzinas (*rendolls*, USDA classification) are shallow soils with a mollic A horizon overlying calcareous material, and have a medium to fine texture. In Tioor, they occur on uplifted limestone (SWH), although being classified by Liang (1998) as lithosols in places where the solum is extremely thin. In fact, in some parts of rendzinas, the thin solum is the major limiting factor of this soil type. In Rhun, rendzinas have developed on the porous uplifted coral rocks, and have been additionally covered with eruption material of Gunung Api volcano. This soil type possesses a high content of nutrients and humus, a high CEC and base saturation, medium pH values (range 5.5 – 6.5), in addition to a good permeability, so that it is very useful for cultivation.

The description of soil types has to be qualified along with the topography in the two islands. In the coastal plains of Tioor, parent rocks are covered with alluvial material. On steep, hilly terrain water surface runoff prevails against infiltration (accordingly soils are quickly drying up in the dry season), and soils have a limited effective depth and are being eroded at a high rate, especially where forests have been replaced by annual crops. Exceptions are the coastal plains and limestone terraces and plateaux. In Rhun, soil fertility is strongly improved by eruption material of Gunung Api volcano, as it has happened during the eruption in 1988. In basins without any runoff to the sea eroded soil has been trapped, so that the A horizon there is thickest, and the agricultural productivity among the highest on the two islands.

4.2.4 Natural vegetation

The classification of the natural vegetation is difficult. Several reasons for this must be mentioned:

(1) Natural vegetation has been largely removed to make place for agriculture in Rhun, so that it is unsafe to carry out reliable studies on natural vegetation.

(2) Tioor and Rhun are situated in a region with a seasonal climate. Thus, natural vegetation is more influenced by the distribution and variability of rainfall than by its annual total amount, which is almost approaching levels of everwet tropical climate.

(3) A differentiation of tropical rain forests from monsoon forests is especially complicated on small tropical islands with a seasonal climate *and* a reasonable annual amount of rainfall.

(4) Tropical vegetation formations are also influenced more by available water in the soil than by the annual total precipitation. Hence, other factors, such as topography, soil type, evapotranspiration, and recharge to groundwater, are further complicating a classification of the natural vegetation.

(5) And, as Monk et al. (1997, 188) stress, the forest classification system used by them (Monk et al. 1997, 190-91) is "based on a body of knowledge obtained from the two main blocks of Southeast Asia's tropical rain forest", i.e. mainland Southeast Asia with the Sunda Shelf, and the Sahul Shelf. Thus, "it is important to ask whether these classifications, which are based on continental vegetation formations, are appropriate for small-island ecosystems" (Monk et al. 1997, 188).[44]

The vegetation study carried out in Tioor and Rhun suggests that in both islands the *original, climax vegetation* is lowland semi-evergreen forest, which in turn can be categorised along with topography and the parent material, i.e. forests on ultrabasic, limestone and metamorphic rocks. This conclusion is derived from the existence of certain tree species being found in evergreen and/or deciduous rain forest (including pioneer species in secondary forest), such as *Antocephalus chinensis, Alstonia spp.,*

[44] This differentiation is particularly important for aseasonal montane forest formations, because in small island ecosystems these forests can occur at much lower altitudes, from 500 m to 900 m above sea level, than in larger landmasses and massifs (900 m to 1200 m above sea level), due to the so-called *Massenerhebungseffekt* in massifs (cf. Monk et al. 1997, 188 and 192). However, this reflection can be neglected for the island cases of Tioor and Rhun, which are both lower than 500 m above sea level.

Intsia bijuga, Paraserianthes falcataria, and *Terminalia catappa*. *Secondary vegetation* is mainly a result of deforestation, but occasionally of natural disturbances, such as the degraded area around the highest peak in Tioor, where *Imparata cylindrica* grassland, mixed with ferns and *Pandanus* species, has developed since "times immemorial".[45] In Tioor, much of the secondary vegetation is secondary forest, due to the usual long fallow periods of shifting cultivation. Only in case of short fallow periods and frequent burning, secondary vegetation has started to degrade, such as spots of *Imparata cylindrica*. In Rhun, the area occupied by secondary vegetation, which consists most often of bush and shrub associations, is limited, as most land is devoted to mixed gardens and permanent dry fields.

4.2.5 The coastal environment

General characteristics and functions of littoral ecosystems of tropical islands were discussed in Ch. 2.3.2. As these important ecosystems are present in both islands, the following description can be restricted to specific local features, whereas the use of marine resources is the subject of Ch. 5.5.2. Additionally, beach vegetation formations are briefly discussed. Ecosystems of minor importance for the livelihood of the local population are just mentioned here: (1) nearshore submarine mountains, where deep sea fish (*mora*) live in a depth of an estimated 150 m; (2) swamp forest in a boggy basin in the north of Tioor (cf. Ch. 4.2.1); (3) estuaries of major streams in Tioor; (4) stream ecosystems, where freshwater crustaceans live; (5) and the sea bird nesting island of Manukang (17 ha), 25 km north of Rhun.

The *coral reefs* in Tioor and Rhun are fringing reefs, which closely follow the shoreline (see Map 1 and Map 2). They stretch into the sea in varying distances, with a maximum at Rhun's northwest coast, and Tioor's east coast. There are narrow, and mostly shallow gaps between the reef and the shoreline, where *seagrass beds* grow, and lagoons may form. In front of Rhun village a lagoon, as deep as about 30 m, provides a natural harbour for small vessels being protected by the coral reef. The islands of Baam and Uran are surrounded by large coral reefs, which equal (Baam) or by far exceed (Uran) the respective island area. Naelaka Island is connected with the northeastern tip of Rhun Island by the coral reef. Species of coral reef formers, seaweeds and seagrasses were not inventoried during field work. Sutarna (1991), for instance, found 90 species of living corals within 15 zoological families (e.g. *Acroporidae*, *Poritidae*) in the littoral of the inner Banda Islands. *Mangroves* are restricted to Tioor Island, and are found in estuaries and along the seashore at the east coast. Two species – *Sonneratia alba* and *Avicennia marina* – could be identified during field work (cf. Ch. 6.2.1).

Beach vegetation can be distinguished between (1) the *Pes-caprae* formation at sandy beaches, where sand is being accumulated, with an open community of sand-binding and erosion-controlling herbs and grasses (such as *Ipomoea pes-caprae*), and (2) beach forest (called *Barringtonia* formation) on stable soils behind the Pes-caprae formation or on rocky beaches without sand deposits (cf. Monk et al. 1997, 154-7). Both types occur in Tioor and Rhun.[46] Dominant tree species in beach forests are *Barringtonia spp., Calophyllum inophyllum, Cordia subcordata, Erythrina variegata, Hibiscus tiliaceus, Inocarpus fagiferus, Pandanus spp., and Terminalia catappa*. Seeds are dispersed by sea and by bats. However, much of the beach forest was replaced by coconut tree gardens in Tioor. Some of these tree species provide valuable timber for boat construction, such as *Calophyllum inophyllum* and *Cordia subcordata*, and have been heavily exploited by the local population, especially in Rhun (cf. Ch. 6.3.6).

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[45] Interviews with key informants and village leaders.

[46] *Pes-caprae* formation is more common in Tioor, where most of the coast consists of sandy beaches, whereas in Rhun cliffs are dominating.

4.3 Summary

Geological conditions and seasonal climates have provided soils of good and medium quality. These soils and sufficient precipitation are usually favourable conditions for the agricultural utilisation potential. However, the unpredictable distribution of rainfall is the most important restriction on the suitability for agriculture, and prolonged droughts have serious impacts on freshwater supply and agricultural production. Worst affected is the uplifted coral island of Rhun, with no groundwater and a hardly reachable Gijben-Hertzberg lens. In Tioor, steep and sloping terrain sets additional limits to agriculture due to the high erosion potential. On top of this is the thin solum in certain places, especially of the lithosols. High wind speeds, strong wave action, and volcanic activity (in Rhun) are natural hazards for the communities, which are typical for small tropical islands. The biological environment is characterised by a high bio-diversity, and partly high productivity as well. However, it has come under pressure by human activities. Especially natural vegetation has been driven back to make place for a man-made environment consisting of fields, tree gardens, and settlements. The man-environment interactions in Tioor and Rhun will be of central concern in the following chapters.

5. THE COMMUNITIES OF TIOOR AND RHUN

This chapter describes the historical, cultural, socio-economic, and institutional framework of the communities of Tioor and Rhun. It is intended to include those factors which have an influence on present land use and resource management, and which may limit or facilitate both the extension of resource-caring land-use systems like agroforestry, and the construction of community-based resource management plans.

5.1 Historical introduction

For the Banda Islands, numerous literature provides information on land use during the colonial period. Compared with Banda, sources about history and former land-use systems in Tioor are hardly available, so that information on this has been mainly drawn from interviews, and from the few travel reports of the nineteenth century. Of further interest would be the land-use systems that were practised in the Banda and Watubela Islands before the arrival of European conquerors and traders. However, no extensive chronicles of the Portuguese, the first European power to arrive in Banda, bear witness to this period.[47] And Tioor was discovered by the Dutch more than a century later, in 1633 (Riedel 1886, 188).

Pre-colonial period

As Rhun and Tioor belong to the Spice Islands, their history and the genesis of land-use systems is closely linked with the pre-colonial and colonial spice trade. In medieval times, Malayan traders brought clove, nutmeg and mace to Java. Here Indian, Arabian and Chinese traders bought the products. From about 1200 AD on, the spices were carried by Arabian traders from India via the Arabian peninsula, the Gulf of Persia, and the Black Sea or Syria to Europe, where the spices experienced a wider distribution for the first time (Warburg 1897, 35-43).[48] In 1500, the price of nutmeg in Europe was ten times higher than in India (Burkill 1935, 1525). This gave a great incentive to European powers to search for the legendary Spice Islands.

In 1512, the Portuguese Antonio de Abreu was the first European to reach the Banda Islands from the Southeast Asian trading centre of Malacca (Hanna 1978, 7; Röpke 1982, 134). At that time, the Islamic Bandanese had signed a treaty with the Sultans of Ambon, Tidore and Ternate. This guaranteed a production monopoly on nutmeg for the Banda Islands, and on clove for the Sultanates. As Warburg (1897, 67) points out, ‘the land on the Banda Islands was widely occupied by nutmeg trees without being planted by anyone. These nutmeg forests belonged to the communities and were not inherited. June and September were the months of harvest, and the one who picked most of the

[47] As van Fraassen (1989, 8) puts it, “the quantity of Portuguese source material for the Ambonese islands ... compares favourably with the scant 16th-century data we possess about the Banda Islands. The Portuguese purchased some nutmeg and mace in Banda, so that they definitely had some contacts here. They never had a fort or any other kind of permanent settlement here, however, and were unable to make any converts among the Muslim population of Banda. Accordingly reports on the Banda Islands are lacking in the Portuguese sources.” Recently, field work for a doctoral thesis on historical land use in the Banda Islands was carried out by a scholar of archaeology (Peter Lape), whose results contribute to an understanding of pre-colonial land-use systems (see Lape 2000a, 2000b, and 2000c).
With regard to the Watubela Islands, a citation in a report of Bickmore (1868, 243) provides a hint to the insufficient knowledge on these remote *non-volcanic* islands even in the nineteenth century: “On the island on Teor, or Tewer, in the last of the (Matabello) group, there is a volcano [sic!] which suffered a great eruption in 1659”. See also Riedel (1886, 188) and his description of Tioor’s “vulkanischen oorsprong” (volcanic origin). Both authors apparently quote from Valentijn’s “Oud en Nieuw Oost Indie”, published in 1724 – 26 (drawn from von Rosenberg 1865, 87).

[48] In the fourth century AD, clove was quite well known in the Mediterranean (Burkill 1935, 961), whereas nutmeg and mace were first mentioned in Europe, namely in Constantinople, only in 540 AD (Flach and Tjeenk Willink 1989, 193).

nutmegs, had the greatest income'. Other sources state that property of nutmeg trees was in fact communal, but usufructuary rights were passed on along genealogical lines (Leupe 1855, 80 – cited from Loth 1996, 3; Villiers 1981, 729). Hanna (1978, 23) calculates about 500,000 nutmeg trees in Banda in 1600. The islands were populated by some 15,000 inhabitants, and were governed by a council of elders (*orang kaya*) whose decisions had to be approved by Islamic priests and free citizens. Each community had certain sole rights (cf. Warburg 1897, 70) and was a member of one of two rival alliances (van Martens 1889, 85).[49] On the contrary to other islands in Maluku, both Bandanese alliances defended themselves jointly against external enemies (Warburg 1897, 69; Villiers 1981, 730).

Colonial period

The colonial era of the Banda Islands begins after the first circumnavigation of the globe (1519-22) by Fernão de Magalhães[50] and the accompanying chronicler Antonio Pigafetta. From 1522 onwards, Portugal and Spain attempted to get control over the trade of nutmeg from Banda and clove from Ternate, Tidore and Ambon. After the Spaniards retreated to the Philippines in 1529, the Portuguese succeeded in holding a clove trade monopoly by taking advantage of the rivalry between the Sultanates of Ternate and Tidore. In 1572, they were finally forced to retreat from Ternate, so that they had left bases in Ambon and Tidore. In the Banda Islands, the Portuguese attempt to establish a nutmeg trade monopoly failed, primarily because the Bandanese settled their internal differences again (see above). Until the end of the sixteenth century the Portuguese could only *participate* in nutmeg trading.

The situation abruptly changed in 1621, when the Dutch trading company VOC (*Vereenigde Oostindische Compagnie*, established in 1602) conquered the Banda Islands (except Rhun), killing or slaving a tremendous part of the Bandanese. An estimated 10,000 people escaped to Seram as well as the Gorom, Watubela and Kei Islands, so that Banda was virtually wiped out of its indigenous population.[51] In the following period, the VOC adopted the indigenous cultivation practice (Loth 1995, 23-4), increased production in the islands of Neira, Banda Besar, and Ay by removing a great part of unproductive vegetation and propagating of nutmeg tree seedlings. This way a strict production monopoly was established for nearly two centuries.[52] The plantations (called *perken*) were leased in hereditary leasehold to European immigrants (called *perkeniers*) who were mostly deserving soldiers or servants of the VOC (Zimmermann 1988, 40). Plantation work was carried out by slaves, who were caught by the VOC in the so-called *hongi* expeditions in surrounding islands, or were acquired from regional slave markets. The more important purpose of the *hongi* expeditions, however, was the

[49] In Central Maluku there were two rival alliances in the sixteenth century: uli lima and uli siwa (cf. van Fraassen 1983, 5).

[50] Magalhães was a Portuguese sailing under Spanish flag, and was killed in the Philippines in 1521. His expedition was brought to an end by his deputy J. S. Elcano (cf. Schmitt 1984, 186-210).

[51] The first Dutch ships arrived in Banda in 1599. For more than two decades, the VOC repeatedly forced the Bandanese authorities to sign treaties on a trading monopoly for the Dutch ships, which were all breached by the indigenous population, however. To break the resistance of the Bandanese, the governor general of the VOC, Jan P. Coen, decided to conquer Banda, leaving Rhun Island to the English (see e.g., Warburg 1897, 85-108; Hanna 1978; and Loth 1995, 16-21). In the peace treaty of Breda, 1667, England abandoned Rhun, parts of the Guayana coast (presently called Surinam) and several Caribbean islands to get all Dutch North American territories including Manhattan (Clark 1961, 68).

[52] The clearing of bushes, shrubbery, and – in the eyes of the VOC – useless trees in the nutmeg forests of the three islands, and the subsequent planting of nutmeg and protection tree seedlings, was a major difference to the indigenous cultivation practice, which was based on the transplanting of *naturally* established nutmeg seedlings in a *multispecific* forest (Loth 1996). Details on the structure of a colonial nutmeg plantation are provided in Ch. 6.1.1. At the same time, a clove production monopoly was set up in Ambon and the Lease Islands (Haruku, Saparua and Nusa Laut) (Paulus 1918, 457; cited from Zimmermann 1988, 40).

destruction of spice trees on other islands, in order to keep prices high by a restricted production. Slave trade and *hongi* expeditions had a ruinous impact on the cultural landscape in Maluku, which was prospering before the arrival of the VOC. For instance, sago trees, the life basis of the indigenous population, were often destroyed to punish involved communities for ignoring the Dutch monopoly (Reiner 1956, 108).

Tioor provides an example of the *hongi* events. According to Kolff (1840, 294), Anonymous (1881-85, 15), and Riedel (1886, 190), the indigenous people of Tioor emigrated to Seram, Kasiui, and Gorom in the seventeenth century. A legend that is being told by contemporary Tioorese describes this emigration as a result of the marriage of the Tioorese king (*raja*) with a Bandanese princess, after which Tioor Island had to be entirely delivered as the bride price to the immigrating Bandanese who fled the Banda massacre of 1621 (cf. also Anonymous 1881-85, 30). In this period, all settlements were situated in the mountains, probably to provide shelter from slave traders and in times of regional wars, whereas the Bandanese founded settlements along the coast. During the VOC era, Tioor and other Watubela Islands were several times called at by *hongi* expeditions. Riedel (1886, 190-1) and Warburg (1897, 126) describe these events in Tioor in the seventeenth and eighteenth century. According to both authors, Tioor was once famous for its abundance of nutmeg trees. A first destruction of the trees was carried out in 1645 without any resistance of the population, but in 1656, 1659, 1660, and 1670 several Dutch soldiers were killed in the *hongi* expeditions to Tioor. Only in 1671, the Tioorese had to submit to the superior Dutch force, and were forced to plant coconut palms and to deliver 4,000 cans of coconut oil per year for a payment of three *stuiver* per can (Warburg 1897, 126).[53] In 1746, the Tioorese finally forced the VOC out of Tioor after an ambush on the small garrison stationed in the island. Thereafter, the VOC had no longer contacts with the islanders.

The *perkeniers* in Banda could not gain much from the plantations, as they had to sell the harvest at fixed and relatively low prices to the VOC, whose servants and shareholders got the bulk of the profits. In case of violation, such as smuggling of nutmeg, other servants took the place of offending *perkeniers*. Moreover, the *perken* were frequently damaged by earthquakes and volcanic eruptions. A disastrous typhoon destroyed 95% of the nutmeg trees in 1778 (Hanna 1978, 89). At the end of the eighteenth century, the *perkeniers* and the VOC were badly in debt. In 1798/99, the VOC had finally gone bankrupt, their debts and plantations were being taken over by the Dutch Government.[54] After the bankruptcy of the VOC, the smuggling out of nutmeg seedlings and the successful establishment of nutmeg plantations by England in its colonies (about 1810), and the end of slavery (1850), the Dutch Government as the legal successor of the VOC finally abolished their unprofitable nutmeg and clove monopolies in 1872. The *perkeniers* got the plantations in Neira, Banda Besar, and Ay as landed property in 1824, whereas further plantations in hereditary leasehold were established in Rhun and Hatta in the beginning of 1874 (Warburg 1897, 153).

In the nineteenth century, a second immigration to Tioor took place, as some people from the Kei Islands settled on the island. In addition, people from the Onin peninsula in Irian Jaya were brought in as slaves. At the end of the nineteenth century there were two settlements in Tioor – Rumoi and Rumalusi – with an estimated 250 inhabitants, who lived off sago and tubers (Anonymous 1881-85, 1 and 15). Riedel (1886, 189 and 192a) mentions also Luturleen, a settlement at the east coast. The Tioorese had cultivated various tree species, which were also cut down in a specific number to

[53] A can (*kan*) is an old Dutch liquid measure and amounts to 1.212 litre (1 *kan* = 2 *pintje*; cf. Boekenoogen and van Lessen 1931, 1927; Kahnt and Knorr 1987, 226). In the late seventeenth century, the price of 1 Amsterdam pound (equivalent to 0.4941 kg) of nutmeg amounted to 3.25 *florin* (or 65 *stuiver*) in the Netherlands (Warburg 1897, 141-2).

[54] Reasons for the insolvency were among others: high dividends for the shareholders; high costs for maintaining the monopoly; corruption and illegal trading practices by servants of the VOC (Warburg 1897, 136-144).

represent a symbolic burial object of a deceased (Riedel 1886, 211; Körner 1936, 52): *Areca catechu* (5 trees), *Canarium* sp. (4 trees), *Inocarpus edulis* (6 trees), *Artocarpus altilis* (2 trees), *Gnetum gnemon* (5 trees), *Artocarpus integer* (2 trees), *Cocos nucifera* (6 trees), and *Musa* L. (1 tree).

In Banda, the exports of nutmeg and mace decreased dramatically during the world recession of the 1930s, as well as the income of the contracted workers (Zimmermann 1988, 41), who had immigrated from Java, Southeast Sulawesi, and South Maluku.

Post-colonial period

The Japanese occupation during World War II (WW II) marks a turning point in both Bandanese history, and in Bandanese land use. As exports to the occupied Netherlands were interrupted, and the import of food was hindered by a blockade of the Allies (Australia and the USA), the Bandanese people had to grow staple food-crops like cassava on small plots (0.1 to 0.2 ha each). The *controlled* clearing of these plots was ordered by the Japanese military administration and led to the destruction of some 20,000 nutmeg trees (or 5% of pre-WW II level) and hundreds of protection trees. Propagation material was taken from Gunung Api, where Butonese immigrants had already cultivated cassava before WW II (Burger 1912, 15). Additionally, sago flour was bartered with fish in Seram, and traded in with canoes and boats.

After WW II, some *perkeniers* came back to the Banda Islands and tried to rehabilitate their *perken*. But in 1958, the Indonesian President *Soekarno* nationalised all Dutch plantations in Indonesia (cf. Wilkens 1974), which were taken over by state enterprises. In Banda, the *PPN* (Centre for National Government Estates) got the former land property plantations in Neira, Banda Besar and Ay, whereas the *PPD* (Centre for Regency Government Estates) was put in charge of the former hereditary leasehold plantations in Rhun and Hatta. From then on, the land and all trees have belonged to the Government. Cultivation was practised like during the Dutch era, except that the number of protection trees was reduced to some 75%. The unfavourable world market situation for nutmeg and a ruinous economic policy of the young Indonesian Government caused plantation work to be less important, while the Bandanese people began to extend the cultivation of cassava. With the reorientation of the economic policy after 1966, the state enterprises were reorganised, managed by army generals and renamed: the *PPN* to *PNP XXVIII*, and the *PPD* to *Prajakarya*. However, corruption, low world market prices, smuggle of nutmegs, and the land-use change resulted in a continuing decline of the nutmeg culture (see Ch. 6.4.2). In 1987, the state enterprises had gone bankrupt. An effort by the private enterprise *PT Perkebunan Pala Banda* (1987 to 1990) to make profit from the run-down plantations was also not successful. In the long run, the plantation enterprises could not guarantee a socio-economic development of the Bandanese people (Stubenvoll 1994, 44-9).

Unlike Banda, where the Japanese occupation during WW II and the post-colonial plantation enterprises had a great influence on the land-use pattern, Tioor's settlement structure and land use was more affected by immigrants, who came to Tioor from different parts of the Indonesian archipelago during the twentieth century. In the very late days of the Dutch colonial era, and in the 1940s and 1950s, people from the nearby islands of Kur, Kaimear, Manawoka and Gorom established further settlements there (Tab. 5.1), and obtained land tenure on a part of the main island (Fig. 5.1d). And in the early 1970s, men from Flores immigrated to Tioor for seasonal work in the coconut tree gardens of the Tioorese. Some of them married a Tioorese, and have settled down in Tioor. Until the 1950s, the main economic activities of the Tioorese were seasonally performed in other islands, such as turtle-hunting in Kur, machete-forging in Seram and Gorom, and sago-processing in Seram.

5.2 Settlements, village administration and infrastructure

Tioor is part of the administrative district *(kecamatan)*[55] *Seram Timur*, and has a distance of 130 km to the district's main town *Geser*. The village is divided into five communities (*dusun*),[56] each comprising of several settlements and hamlets (*kampung*) (Tab. 5.1; Map 1 and Maps 6.1 to 6.3). The society of Tioor is ethnically heterogeneous[57] due to several waves of increased immigration, as previously described. In 1922, there were 262 inhabitants in Tioor (Sachse 1922, 202), while in 1997 the island was populated by 1,580 inhabitants (66 inhabitants/km²).[58] This is equivalent to an annual population growth of 2.48% since 1922.

Table 5.1: Communities of Tioor village, and origin of their inhabitants

Origin of inhabitants → Community (Dusun)	Settlements (Kampung)	Tioor, Banda	Irian Jaya	Kei	Kur	Kaimear	Manawoka, Gorom	Flores	No. of households (1997)	No. of inhabitants (1997)
Rumoi [1P]	Rumoi [3]	x					(x)		48	177
	Duryar	x		(x)				(x)	17	91
Kerkar [1C]	Kerker		x	(x)				(x)	21	120
	Kar		x					(x)	48	223
Kelvow [2]	Kelvow, Nama				x				71	353
	Wertac			(x)	x		(x)		21	123
Wermaf-tengah [2]	Laganymatiny, Jawa, Lapang						x		39	142
	Tengah	x						(x)	9	26
	Wermaf	x				(x)			11	29
	Baru, Mamur					x	(x)		50	191
Rumalusi [1C]	Rumalusi [3]	x						(x)	18	69
	Nama		x	(x)				(x)	8	36
Period of immigration		1621	19th century	since 1850	1900 till 1950	1950s & 1960s	1940s & 1950s	1970s		
Sum TIOOR									361	1,580

Notes: **1** Christian community (**C**: Catholics; **P**: Protestants);
2 Moslem community;
3 Settlements in Tioor before 1890;
x Majority of population; **(x)** Minority of population.

Sources: Mapping and interviews with village leaders (Stubenvoll 1997).

Two other islands are under traditional control of Tioor (Fig. 4.2 and Fig. 5.1a). One of which is *Uran*, a tiny, low-lying coral island (some 20 ha) with an extended coral reef (about 8 km²), 11 km to the east of Tioor. The other is Baam, an uplifted coral island with elevations up to 80 m above sea level, 10 km to the north of Tioor. The southern part of Baam (*Baam kecil*) is under traditional control of Tioor, whereas the northern part (*Baam besar*) traditionally belongs to the village of Tameer Warat in Kasiui Island. Baam besar and Baam kecil were formerly two separated islands, connected by the coral reef

[55] Maluku province is administratively divided into four regencies (*kabupaten*) and its provincial capital, the municipality (*kota madya*) of Ambon. *Kabupaten Maluku Tengah* (Central Maluku; administration centre Masohi) in turn is subdivided into 18 districts (*kecamatan*), including *Kecamatan Seram Timur* and *Kecamatan Banda*.

[56] The expression *dusun* is used both for tree gardens and for the communities in Tioor.

[57] Ethnic classification of Tioor's present population poses considerable difficulties. For instance, the identified original ethnic groups have frequently intermarried during the centuries, so that heterogenousy has become a relative idea.

[58] Tioor Island had 200 inhabitants in 1872 (Lans 1872, Bijlage 1e), and 258 inhabitants in 1882 (Riedel 1886, 189).

(Sachse 1922, 21). Although the land area of Baam Island (some 120 ha) is divided between Tioor and Tameer Warat, both villages have traditional fishing rights all over the island's coral reef (Fig. 5.1a).

Rhun is part of *Kecamatan Banda*, at a distance of 25 km to the main town *Banda Neira* (Fig. 4.2). Rhun is divided into three neighbourhoods (*rukun tetangga, RT*), and has a total population of 1,290 inhabitants (1996; 277 inhabitants/km²) in 330 households. The society of Rhun is relatively ethnically homogenous. The people are descendants of plantation workers, who for the majority were immigrating from Southeast Sulawesi (Buton, Tukang Besi Islands), or sometimes from Java and Southeast Maluku. This started in 1874, when the Dutch planted the first nutmeg trees in Rhun. After the Indonesian independence, immigration continued, although to a lesser degree. In the 1980s, some twenty households took part in an intra-provincial transmigration to Seram. In 1950, there were 600 residents in Rhun, which is equivalent to an annual population growth of 1,68% until 1996.[59] In both Tioor and Rhun, around 35% of the population is younger than 15 years. The tiny coral island of Naelaka (approximately 2 ha) is situated within the administrative border of Rhun.

With the Government Act No.5/1979 on *village administration* all autonomous organisations of any local community have been united into a single agency, which is composed of 9 to 15 prominent village leaders. This agency carries the title 'Village Deliberation Council' (*lembaga musyawarah desa, LMD*), and includes bodies such as the customary council and village committees. This act did not only standardise the administrative structure in Indonesia, but also dissolved customary leadership, thus weakening traditional resource management systems (cf. Sirait et al. 1994, 413). Theoretically, the LMD makes decisions in concurrence with the village head (*kepala desa*). Additionally, a Village Development Council LKMD (*lembaga ketahanan masyarakat desa*) has been formed "... whose task is to promote social-economic conditions such that the village becomes a viable rural community" (GOI 1997, 51). Actually, members of both LMD and LKMD are appointed and led by the village head, who is assisted by a secretary and supervised directly by the heads of the district (*camat*) and of the regency (*bupati*). Although the *kepala desa* is elected by the village's adult population for a eight years term, the candidates have to be selected and approved by the *camat* and the *bupati* before the election. After the election the candidate is then appointed by the *bupati* on behalf of the provincial governor (Topatimasang 1997).

Additionally, each of the five communities (*dusun*) in Tioor, and each of the three neighbourhoods (*RT*) in Rhun, is headed by a *kepala dusun* (community head) or a *kepala RT*, respectively, who are representing the *kepala desa* at community (neighbourhood) level. A military person, usually a sergeant, is appointed as the *babinsa* (*bintara pembina desa* = petty officer for village supervision and law enforcement) to watch over the village head, thus being practically the "real ruler of the village" (Topatimasang 1997).

The *village budget* depends on several financial sources (GOI 1988, 331-347; GOI 1997, 51-2):

(1) the annual budget allocation from the Central Government by presidential instruction (*Inpres*), for communication, village co-operatives, social affairs, elementary schools, basic health centres, and family welfare promotion *PKK* (*pembinaan kesejahteraan keluarga*);

(2) taxes and rates collected by the village with the approval of the Government at regency level; and

(3) emergency funds in case of natural calamities such as the devastating storm in Tioor in 1996.

59 In 1840, Rhun Island had 42 inhabitants (de Steurs 1843). Another source (van Martens 1889, 86) states, however, that the *uninhabited* island of Rhun was often visited by fishermen.

The Indonesian Government launched the IDT (*Inpres Desa Tertinggal*) development programme for a total of 20,633 *least-developed villages* all over Indonesia during the sixth five year development plan (*Repelita VI*, 1994-1999) (GOI 1993; GOI 1997, 52). In both Rhun and Tioor, IDT spent Rp. 60 million each, distributed evenly over three periods in 1994 until 1996. Poor families, forming co-operative-like IDT groups, have been the target group of IDT. Funds were delivered after an evaluation of planned activities by the village head in consultation with the LKMD, the PKK, and after an approval by the Government at regency level (GOI 1993, 13). IDT funds are actually interest-free credits, since they should be reinvested through production. Surpluses should repay other IDT groups at a later stage, so that all poor families would benefit from this programme. Three IDT groups in Rhun are still operating in fishery.[60] In Tioor, the IDT fishery group in Mamur is strictly organised and supervised by the Islamic leader (*imam*) and one of two IDT groups still functioning – the other is an agricultural group in Kar – whereas the other thirteen IDT groups [fishery (4 groups), agriculture (6), and forging (3)] collapsed due to embezzlement of a part of the funds by IDT chairmen and treasurers, consumption of remaining capital by members, and unprofitable activities. Corruption has had a serious impact on social life in Rumoi, and on the construction of the community-based resource management plan (cf. Ch. 8.2.4).

The *infrastructure* of both villages has been set up with Government funds. It is supplemented by facilities of non-governmental organisations and of individuals. An example is the primary schools in Tioor (two from the Government, two from Christian foundations, one from an Islamic foundation) and in Rhun (two from the Government, one from an Islamic foundation).

Since 1994, a passenger ship of the provincial shipping line *Perintis* is anchoring every ten days at Tioor's coast, going either to Ambon (via Geser) or to Saumlaki (Yamdena Island; via Tual, and Dobo). The only other possibility to come to or leave Tioor is to charter a longboat with an outboard motor. Private motorised ships of ethnic Chinese and Butonese traders are only transporting goods and agricultural products. In Rhun, private motorised ships (*perahu motor*) of some Rhunese stop almost daily, except during times of strong wind. These ships conduct the bulk of the trade between Ambon and Banda, and also take passengers. Banda Neira is connected with Ambon by a small aeroplane three times a week since 1982. Additionally, four passenger ships stop in Banda Neira port: two *Perintis* ships, and two ships of the national shipping line *Pelni* (the first since 1993, the second since 1997). The village heads of Tioor and Rhun have small radio sets with energy from solar power and can communicate with Government radio stations in Ambon and Banda Neira, respectively. One ethnic Chinese trader in Tioor uses his radio set for communication with his motorised ships, and also with the *Perintis* ship.

A public health station (*puskesmas pembantu*) in each village supplies the islanders with basic medical treatment. The physician in Tioor is often absent for several months in a row, so that people rely on traditional medicine, i.e. medicine collected from naturally established as well as cultivated medicinal plant species (cf. App. 1.6). In Rhun, medical service is better, not only due to a better sense of responsibility on the part of the physician,[61] but also as medicine can be adequately stored. The health station is equipped with a refrigerator, run by solar power.[62] Governmental programmes include family

[60] In Rhun, each group received 20 million Rupiah, in Tioor's dispersed settlements 4 million Rupiah.

[61] Civil servants, such as the medical staff, have to look for other income sources as well, as their salaries are insufficient to guarantee a secured livelihood. This may include activities outside the village where they serve, especially in their home villages, in order to secure the co-operation and the care they will need after their retirement. In this study, it is not intended to provide a detailed account on the role of civil servants in Maluku, as this is well furnished for example by Benda-Beckmann and Benda-Beckmann 1996.

[62] Additionally, the hospital in Banda Neira is relatively close to Rhun. To reach the nearest hospital people in Tioor would have to go to Tual.

planning (*KB*) and polio vaccination. The latter was carried out in both villages in 1996, whereas KB is somewhat successful only in Rhun.

In Tioor, *drinking water* is provided by streams, either collected directly with canisters or, in the case of Kelvow, Kerker and Rumalusi, by the use of communal (*swadaya masyarakat*) bamboo and plastic water conduits from the stream to the settlement. Rumoi and Duryar are supplied with fresh water via a plastic water conduit constructed under a governmental project in 1997. The community of Rhun depends completely on rain water, which is collected in private water tanks by each household. All public water tanks are out of order, because they were badly managed and not repaired. In case of water shortage during prolonged droughts, the households have to take water in canisters from Neira. Most of the *electricity* is generated by privately owned Diesel engines. Solar power is restricted to the already described uses (radio stations, health station in Rhun). Since 1995, Rhun village is protected from storm-driven waves by a concrete *dam* (3 m high, 400 m long) (cf. Map 6.4).

5.3 Social organisation

The three main elements of social organisation – household, family, and clan – have to be differently considered in both islands, when dealing with their implications for traditional law, institutions, land use and resource management in later chapters. In the following, some basic ideas are outlined.

(1) The couple and their children form the nuclear family or *household*: As the household head, the man represents the household externally. Division of labour between husband and wife is clearly defined – *although it is not rigidly practised*, especially when one partner is absent or incapable of performing his/her tasks, and the children are unable to assist yet. The man's tasks usually include fishing, earning money, or house building. The woman is mainly responsible for housekeeping. Agriculture is performed by both, but also with different, individual responsibilities (cf. Ch. 6.3). A young couple lives in the house of the man's parents until they are able to afford the construction of a house on their own. The house is a status symbol in the community, so that a great part of the cash income is reserved for buying modern building materials such as cement, corrugated iron, and high quality timber. The *construction method of a house* is one indicator of the household's income, and has been included in the maps of the settlements (Maps 6). In Rhun, the costs of constructing a house are higher, because it additionally needs a water tank of about 10 m^3 for rain water storage.[63]

(2) The *family (keluarga)*, which is defined here as all households of relatives to the third degree of relationship: In some Tioorese settlements, and in Rhun, clans are not represented. The family and the household are then the only elements of social organisation. The society of the settlements Mamur and Baru, for instance, are made up of nine families, and fifty households, which originate from Kaimear Island. In Rhun, the family is relevant in the few cases of a cultivation of commonly held fields (Ch. 5.4.3; Ch. 6.5.1).

(3) The *clan (marga)*, or kinship group, i.e. all households in blood relation: In Tioor, five original clans exist – Kolatlena, Kolatfeka, Rumakilrat, Rumagiar, and Rumatora – each with a patrilinear common ancestor, and an exogamous clan system. The Rumakilrat, literally meaning 'the king stops there' ('*raja singgah disitu'*), are the descendants of the Tioorese *raja* who married a Bandanese princess in the seventeenth century (cf. Ch. 5.1). Interestingly, an outsider can become a member of the clan even without marriage, nor without any blood relation to it. To be sure, this

[63] Average costs are some 1.5 to 2 million Rupiah for a simple house built with modern building materials.

is made by definition, and important for the *pela* institution (cf. Ch. 5.4.2); it also happens out of hospitality.[64]

Overall, the society in both villages is relatively egalitarian like in other Central Maluku societies (Topatimasang 1997), and characterised by strong family ties due to the dominance of marriages with partners of the respective community. This is also true in Tioor, despite the ethnically heterogeneous society. The phenomena of strong family ties is somewhat diminishing, however, partly as a consequence of people's mobility. One could expect a great social cohesion, which should strengthen the respective communities. But this is only valid in Tioor (and mostly dominating in the settlement of Mamur), where kinship considerations are in most cases as relevant as household matters for the decision-making. On the other hand, the nuclear family (household) is the leading element of social organisation in Rhun, whereas the extended family plays only a minor role.[65]

Like the household, each family and clan has a head. Actually, it is difficult to exactly define 'clan' and to draw a clear dividing line between 'family' and 'clan',[66] but both categories have implications for the social security arrangements and traditional law (*adat*). Thus, an understanding of traditional law is essential to delve further into social organisations.

5.4 Traditional law (*adat*)

5.4.1 What is *adat*?

As Monk et al. (1997, 525) put it, a definition of *adat* "overlaps both a moral or ethical code and a legal system". *Adat* "included everything we call law nowadays; and it went much further than law in determining the needs and the actions of the individuals and the community. It ordained the ceremonies of marriage, birth, and death, the times and the methods of sowing rice, building a house, praying for rain, and many other things. Economics, politics, and the arts all came within its sphere. Indeed, from one point of view, adat was simply a social expression of the community religion, in as much as it was not a human creation, and in its exercise men were still constantly watched over by the spirits and supernatural powers ruling the community" (Alisjahbana 1969, cited from Monk et al. 1997, 525-6). As it is not the scope of this study to provide a full account of *adat* in the two societies in accordance with this definition, there remain three issues, which have to be considered as relevant for the discussion of resource management, land use and agroforestry systems.[67]

The first question is, if *adat* and its institutions either would persist or would weaken in a society being influenced by any developments being brought to and experienced by the local people. For them, *adat* is a heritage of their ancestors. As the society develops the local people's perspective underlies permanent change, and this will ultimately influence and change the *adat* system. On more isolated islands, such as Tioor, the pressures to *adat* from external forces and developments have been

[64] Even the author was offered to become a member of the Kolatlena clan in Tioor.

[65] An interviewed household in Rhun stated: "*Any co-operation among carpenters would be good, because then expensive tools could be bought. But in Rhun this is extremely difficult, because it is a society in which everybody lives on his own.*" The different importance of household, family and clan in Tioor and Rhun is also expressed by the surname of an individual: In Rhun, the surname is taken from the father's *prename* to which the Butonese prefix La- (for a male), or Wa- (for a female) is added. In Tioor, a child's surname is taken from the father's *surname*, representing the name of the clan.

[66] According to Monk et al. (1997, 480) the "terms are defined differently in specific anthropological studies, and hence cause great controversy". For instance, in Rumoi community, the clans are even associated to a 'big family' (*margafam; soa*). As the division between 'family' and 'clan' is not clear, the used definitions have be regarded as a tool to facilitate the analysis of this study.

[67] The historical development and the ethical realm of *adat* are not discussed.

far less than on islands which have been part of the global economy for centuries, such as Banda. Indeed, Tioor's *adat* has been rather persistent, although the importance and influence of the market economy and the Indonesian political system has increased during the last two or three decades. On the Banda Islands, indigenous *adat* disappeared with the Dutch conquest in 1621, whereas the *adat* system of the immigrating people has been permanently influenced and weakened during more than three centuries of colonial nutmeg production and world trade.

The second question is, how *adat* has influenced land use and environmental management through the centuries. The answer will contribute to an understanding of present land-use patterns.

The third issue refers to the question, if existing *adat* could help accept strategies for sustainable land use and resource management. Or more specifically, questions like: What kind of strategies could be successfully designed? What kind of organisations can impose institutional arrangements and regulations? How are people perceiving environmental problems and could accept changes in environmental management and land use?

The following paragraphs will focus on the first two issues, especially with regard to three realms: (1) aspects of *adat* in both societies that are important for *present* land use and environmental management; (2) the role of *adat* in developing Indonesia; and (3) the contradiction between *adat* and the national legislation. The third issue is relevant in Ch. 8, in which strategic options of sustainable land use and resource management will be discussed.

5.4.2 Traditional organisations and institutions

Besides the formal organisations of the village administration (cf. Ch. 5.2), several traditional, informal and religious organisations exist in the communities of Tioor and Rhun. There are four reasons for this:

(1) Most of the traditional organisations have evolved over a long time, some of them for centuries, and are therefore tightly anchored in the traditional understanding of the society, despite the somewhat artificial creation of the village administration.

(2) The formal village administration is not capable of carrying out all development activities sufficiently, and cannot provide social security at a reasonable level in both villages. Thus, informal organisations can be seen as essential to fill these gaps. This fact can also be conversely interpreted, as informal organisations have already existed before the creation of the village administration which has taken over only a part of the functions of the former.

(3) Religious organisations are also participating in village development.

(4) Members of the village administration and civil servants from other villages (e.g., teachers) are part of the traditional society and depend on the traditional social security system of the village (cf. e.g., Benda-Beckmann and Benda-Beckmann 1996). Despite the clearly defined division between formal and informal organisations, decisions made by the village administration are strongly influenced by adat, kinship considerations and traditional values.

It is beyond the scope of this study to treat all organisations in detail, so that just the most important ones are described by focusing on the organisations on the one hand, and on the institutional arrangements of the society on the other hand. A couple of organisations and institutions being relevant for agriculture, land use, and land-use planning will be again picked up in later chapters. An overview about differences of traditional organisations and institutions between Tioor and Rhun is provided in Tab. 5.2 at the end of this chapter.

Customary organisations

Before the formation of the village administration in 1979, Tioor was governed by the *raja* (presently the village head) who was advised by an *adat* council (*sanere*). Both were being solely accountable to the community, and responsible for internal affairs, as well as cultivating good relationships with nearby islands. All clan leaders (*kepala marga*) and elected representatives of clan associations (*kepala soa*) were members of the *sanere*. These figures still exist in Tioor, although they are presently united in the Village Deliberation Council (LMD), and thus also being accountable to the Government. The traditional role of the *sanere* has most obviously persisted in the form of the *adat* court, who is a high authority and often more important in regulating disputes and in judging violations than the official jurisdiction.[68] The *kepala adat* (*adat* head) is another traditional, still existing duty, whose task is to monitor and preserve the society's traditions and communal ceremonies. In Tioor, he is neither a member of the LMD, nor the Village Development Council (LKMD).

Although certain regulations (e.g., land tenure) and communal ceremonies are performed according to Butonese *adat*, real *adat* organisations are not existing in Rhun. This has two reasons. Firstly, the new society of contracted workers, who left their homelands (Southeast Sulawesi) in the nineteenth century, was ethnically relatively homogeneous, being dependent on plantation enterprises and politics. As plantation work dominated the daily routine, and as economic and cultural influences were brought along by the long-lasting integration into the global economy, the immigrated society faced difficulties to preserve functioning *adat*. Secondly, as a consequence, religious organisations have taken over the part of *adat* organisations. Thus, the religious leaders of the Rhunese society play a crucial role in safeguarding traditional values.

Religious and self-help organisations

One of the principles of the nation's ideology of *Pancasila*[69] is that all people in Indonesia have to follow one of the religions: Islam, Christianity, Hinduism or Buddhism. The people of Tioor and Rhun are either Moslems or Christians. In Tioor, both confessions are of nearly equal importance (Moslems 55%, Roman Catholics and Protestants 45%), whereas Islam is the dominant religion in Rhun (98%, Protestants 2%). However, traditional beliefs are still important, especially in Tioor, despite the religious affiliation. After first verifiable conversions of some Tioorese in the 1890s (le Cocq d'Armandville, 1894 and 1898), missionaries successfully brought Christianity to Tioor in the 1920s and 1930s, where the people had lived in animism. Interesting is the question, how the Tioorese lost their affiliation to Islam, as the Bandanese refugees of 1621 were Islamic. According to informants, the descendants of these refugees turned their back on Islam, when they were not allowed to participate in an Islamic ceremony in Kur Island.[70] Islam in contemporary Tioor was brought along by immigrants from Gorom, Kur, and Kaimear, beginning in the early twentieth century. In Rhun, descendants of immigrants from Southeast Maluku are Protestants, whereas those from Southeast Sulawesi are Moslems.

Religion has an influence on environmental management, institutions, traditional jurisdiction, and land tenure. The very influential and highly respected religious leaders (*kepala agama*) are usually members of their society, except the two Catholic priests of Rumalusi and Kerkar, and the Protestant

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[68] Examples of *adat* hearings, which most often concern the regulation of land-use disputes, are given in Ch. 6.3.2.

[69] Pancasila ('five principles') is laid down in the 1945 constitution. The five principles are: "belief in one supreme God; justice and civility among peoples; the unity of Indonesia; democracy through deliberation and consensus among representatives; social justice for all" (Indonesia Source Book, National Development Information Office, Jakarta: 1992, 13; cited from Schwarz 1994, 10). See Schwarz (1994, 47) for a critique of Pancasila.

[70] Like with other legends, there are no indications of this by historical sources such as travel reports.

clergyman of Rumoi, who originate from Seram, and Ambon, respectively. Besides the religious activities such as praying, all *kepala agama* (the Islamic *imam*, the Catholic *pastor* and the Protestant *pendeta*) are organising several groups (including women and youth groups) for economic activities (e.g., land use).

The main purpose of *self-help groups* is to commonly carry out economic activities. Examples include: female rotational saving and credit groups; male groups for fishing, machete-forging, and boat construc-tion; and agricultural groups. The principal labour systems of self-help and religious groups are touched on in the following.

Group labour systems

Group labour systems are either of temporary or permanent character. *Kerja masohi* (or *gotong royong* in Rhun) refers to a temporarily limited self-help organisation of common labour with reciprocal character. It is deployed for all kinds of labour that require several individuals. Its most common use is for farming activities (clearing land, cultivating dry fields), but also extends to house construction and ritual purposes such as burials. The person who calls for *kerja masohi* provides food, coffee, tobacco and the like until the end of the activities in the afternoon of the same day. As common elsewhere in Indonesia (cf. Werner 1998), the same person is obliged to help the members of the group later on, whenever they need help.

Permanent groups are of three different kinds: self-help, religious and formal groups of the IDT programme. A permanent group (*kelompok tetap*) is restricted to its original members and is less flexible than temporary *kerja masohi* groups, but activities can span over a period of several days. In the agricultural sector, self-help and formal IDT groups commonly hold a field and equally share resource input (labour, capital) and output (yields). Each individual is responsible for self-catering. In Tioor, members of a Christian group (*kelompok gereja*) organise work in the same way as *kerja masohi*, but in addition to catering, the family that calls on help to work pays a fee of Rp. 7,500 to the church (*gereja*). Actually, this money is cumulatively saved by the individual family for usage later on in case of urgency.

Traditional intervillage co-operation (*pela*)

Pela refers to a traditional co-operation between two villages, confirmed by solemn oath, making the inhabitants of the related villages "bloodbrothers".[71] The *pela* ceremony is a requirement for the *pela* alliance. For example: Village A is in a *pela* relationship with the villages B and C; then, the villages B and C are not in a *pela* relationship *unless* establishing themselves *pela and* confirming it by the *pela* oath. To be sure, *pela* is a different form of co-operation than the two rival alliances of the 16th century, *uli lima* and *uli siwa* (cf. footnote 49), although the existence of *pela* can be traced back to this period and even earlier (Bartels 1977, 34-114). The situations in which pela alliances were established were manifold: in times of war, head-hunting, migration, flight, and natural disasters, or for reasons of friendship and economic advantages. In some cases, *pela* resulted as a post-war peace treaty among the villages (*pela tumpah darah*) (Bartels 1977, 182; Topatimasang 1997). The main principles underlying *pela* are (Stresemann 1923, 415; Bartels 1977, 29; Topatimasang 1997):

(1) villages of a *pela* alliance assist each other in times of natural calamities or war;

(2) if requested, one village has to assist the other *pela* village in the realisation of community projects;

[71] The ceremony of establishing the pela alliance is described by Stresemann (1923, 416-7). A comprehensive discussion on *pela* is provided in the thesis by Bartels 1977.

(3) visitors of a *pela* related village have got the right to take and consume food free of charge, especially agricultural products, chicken, and fish;[72]

(4) as *pela* is considered as blood relationship and intermarriage between *pela* partners as a sinful incest, members of two *pela* villages must not marry; and

(5) different religions or geographical isolation are not obstacles for a *pela* alliance.

Thus, *pela* acts as a counterforce to social fragmentation (Bartels 1977, 28), helps to avoid inter-religiously motivated clashes, and "has institutionalised an adequate form of territorial conflict or dispute resolution" (Topatimasang 1997). The fact that *pela* has survived almost four centuries of colonial history and modern development underlines its flexibility and adaptability (Bartels 1977, 28-31). It is still the most significant fundamental of traditional intervillage co-operation in Central and South Maluku, and is even practised – especially the ban on intermarriage – by the Moluccan immigrants in the Netherlands (Prins 1977, 39).

Tioor has *pela* alliances with several villages in Seram, Kei, Tayandu, Watubela, and Kasiui, probably dating back to pre-colonial wars (interviews with villagers) and to the *hongi* period. Although *pela* is regarded as an enduring and inviolable brotherhood (Bartels 1977, 29), a *pela* alliance can also be broken. For instance, Tioor refused to give evidence in a territorial dispute between Tameer Warat and the settlement of Guliar in Amarlaut (all on Kasiui Island) in 1985, because it had a *pela* alliance with both villages. As a result, Tameer Warat lost some hectares of traditional territory to Guliar within the scope of the *administrational* village boundary assessment, and broke the *pela* relationship with Tioor. Rhun has no *pela* alliances, because it was founded in the late nineteenth century, and is thus of a too recent origin for any *pela* establishment.

Traditional resource management (*sasi*)

Another traditional institution in Maluku is *sasi*, which has experienced considerable change over the past four centuries. It has become an example of a traditional way of environmental management, rediscovered by the scientific and political community since the phrase 'sustainable development' has been put on their agenda, and pressures towards resource-caring development have increased (Benda-Beckmann et al. 1995, 2 and 5). *Sasi,* in its main purpose, generally refers to the sustainable management of a natural (terrestrial or marine) resource through the *ban of its use* during a defined period of time. A *sasi* ban can be also imposed on certain areas, such as forests and parts of the coastal littoral, where conversion of any resource is a strict taboo for a period of time. Such a taboo or ban is publicly announced and marked with symbolic *sasi* signs. As *sasi* is temporarily limited, its lifting is called *buka sasi* ('opening *sasi*'), which in turn is again publicly announced by a ceremony and by removing the *sasi* signs until the ban is renewed by *tutup sasi* ('closing *sasi*'). In this way, *sasi* is a periodic "prohibition on the harvesting of specified domesticated and non-domesticated resources" (Ellen 1978, 232). Accordingly, *sasi* is further characterised by adding the name of the location where it comes into effect: *sasi laut* (in the littoral of the sea), *sasi kali* (in rivers and streams), *sasi hutan* (on land), and *sasi pantai* (on the shore).

Sasi includes other purposes than sustainable resource management as well. This is includes such issues as: crime prevention (e.g., theft of products); equal resource distribution; strengthening the

[72] "In theory, a visiting *pela* partner can take not only land products without consent but he can ask for anything he likes without fear of refusal. However, an unwritten code of ethics has developed in the Central Moluccas which limits the things one can take without permission to agricultural goods and those that one can request to small objects of little monetary or sentimental value which are easily replaceable. Nobody will ask for someone's cows, goats or pigs ... " (Bartels 1977, 211).

rights of elderly and women;[73] increasing the quantity and quality of harvested products; increasing the income of the community; strengthening traditional institutions and traditional communal rights over the community territory; and strengthening the relation between people, nature, god, spirits and the ancestors (Benda-Beckmann et al. 1995, 6-7; Pannell 1997; interviews with villagers). The ecological, economic, social, institutional and ritual purposes have been "'packaged' in historically specific and changing combinations" (Benda-Beckmann et al. 1995, 7) and are also correlated to the *various types of sasi* (interviews with villagers; cf. Monk et al. 1997, 537-9):

(1) *Communal sasi* (*sasi umum*) is imposed by the village head and policed by the *kewang* (the guardians of the land and the sea), and affects all individuals of the community. Offenders, who break *sasi umum*, are facing a defined sanction or a fine imposed by the *adat* council, either in form of a cash payment, public work, or public humiliation. Outsiders are also prohibited to break *sasi umum* and face heavier penalties than locals.

(2) *Sold or auctioned sasi* (*sasi bablian*, *sasi lelang*) are commercialised types of communal *sasi*, in which the *adat* council sells or auctions off to one or more individuals either the exploitation right of the coming *buka sasi*, or the exclusive right to buy products being collected by the villagers during *buka sasi* at a fixed price. The exact arrangement of rights and prices is included in the negotiation (cf. e.g., Pannell 1997, 295-7). When the ban is due to be renewed the buyer of *sasi bablian/lelang* has to pay an additional fee for *tutup sasi* (interviews with village leaders).

(3) *Individual sasi* (*sasi pribadi*) on certain tree products is announced by an individual with a prohibitory sign, such as a coconut palm leave tied around a coconut tree, and protects these resources of his individual property from the exploitation of other persons.

(4) *Church/mosque sasi* (*sasi gereja/mesjid*) is individualised *sasi*, which is requested by an individual paying a fee to the church/mosque, that then approves and emphasises *sasi* by placing the resource in question under divine custody. To the prohibitory sign a written announcement is added. This form of *sasi* is additionally made public in the church/mosque.[74]

(5) *Ancestors' sasi* (*sasi moyang*) is individualised *sasi* being emphasised by the possible revenge of the ancestors if a person violates the ban. An additional prohibitory sign is tobacco or betel-nuts (*Areca catechu* L.), betel-leaves (*Piper betle* L.), and chalk, being placed on a stone beneath the coconut palm leave.

(6) *Black magic sasi* (*sasi matakau*) is individualised *sasi* being emphasised by the feared revenge of spirits, such as illness, or a frog which will hop around in the stomach of a violating person. An additional prohibitory sign is a bottle or a piece of the midrib of a sago palm leave (*gaba-gaba*).

In Rhun, the Dutch plantation enterprises imposed *sasi* on harvesting unripe nutmeg fruits, whereas communal *sasi laut* on the mollusc species *Trochus niloticus* (*lola*) was practised in the 1970s and 1980s, as well as a *sasi hutan* on harvesting unripe nutmeg fruits in 1987 till 1990 by the plantation enterprise PTPPB (cf. Ch. 5.4.3). Tioor performed a sold *sasi laut* on *lola* in the late 1980s (cf. Ch. 8.2.4, Example 1.3). Presently, communal *sasi* has disappeared in both villages. However, many farmers in Tioor are practising all types of *individualised sasi* for their coconut and nutmeg groves. In Rhun, individualised *sasi* is not practised.

The deployment of *sasi umum* is also linked with traditional communal land and sea territories (cf. Ch. 5.4.3). The value of this institution for sustainable resource management largely depends on the socio-

[73] For instance, the prohibition to climb trees for picking fruits of *Canarium* spp., which would be usually done by men, enables all members of the community (including the elderly, the children and the women) to collect *fallen* fruits.

[74] Pannell (1997, 293) points out, that in Luang (Southeast Maluku) even the owner of the tree is prevented from harvesting the product that falls under *sasi gereja*, thus indicating its locally different forms.

economic conditions of the community, and on the capacity of traditional leaders and the *kewang* to impose and to enforce *sasi umum*. Its potentials seem to be promising, and many regulations of Tioor's community based resource management plan follow closely the principles of *sasi umum*. Thus, its potentials, pitfalls and drawbacks, and the reasons why *sasi umum* has disappeared in both villages are examined in Ch. 8.2.4.

Sacred forests (keramat) and other cultural beliefs

Cultural beliefs have to be regarded as relevant issues for forest protection, land tenure, land use, settlements, resource management, and the jurisdiction of disputes. In both islands, the societies respect several sacred forests (*keramat*), where the ancestors' souls and spirits are living (Map 3, Maps 7). In Tioor, these places are also seen as the – according to a legend 109[75] – former hamlets of the indigenous Tioorese, who left Tioor when Bandanese refugees arrived in 1621. In a *keramat*, it is a strict taboo to disturb the spirits and ancestors' souls in any way. This belief includes the prohibition of felling trees, cutting any vegetation, hunting, urinating, spitting, scratching signs on soil or trees, yelling, and the like. Thus, a *keramat* is a forest on which an 'eternal' *sasi* is imposed. It is a common cultural belief that an offender against the ban would be punished by the ancestors and spirits with illness or death, either to himself or within his family. In case of violating this ban *by mistake*, he could try to avert the revenge of the spirits and ancestors by laying a sacrifice onto a designated stone at the *keramat* site, most commonly in form of a larger quantity of food, coconut- or sugar-palm wine (*tuak*), tobacco, money, betel-nuts, betel-leaves, and chalk. Before entering or passing a *keramat* the person gives a similar symbolic present, although in smaller quantities, to placate the ancestors and spirits.

In Tioor, but not in Rhun, the general worship of land or soil is closely related to the sacred *keramat*. Like in other societies of Maluku (e.g., Buru)[76] the expression *timbang tanah* ('to weigh the soil') is part of a legend, which concerns the choice of settlements. While indigenous Tioorese had settled in the hillside, the immigrating Bandanese settled down at the coast, because 'here the soil weighs as much as in Banda'. A cultural belief related to this worship is also an event when *blood*, or *sweat* should touch the soil. The *former* would be the case, when someone was wounded in a fight. His blood touching the soil would represent his pain, so that the offender could expect a hard punishment by the *adat* tribunal. The *latter* is of importance for land tenure (see Ch. 5.4.3). Someone secures permanent traditional tenure rights on primary forest land cleared by him, because 'his sweat felt down to earth'. The cultural belief, that spirits are living in the strongest wild boars has also an influence on land use. The animals could easily jump over a fence or destroy it. In fact, most farmers of Rumoi, Kerkar and Rumalusi communities are protecting their fields from wild boars by other means (see Ch. 6.3.2).

75 This number seems high if compared to the existing *sacred groves*, which account to eight in Tioor. In Rhun, five *keramat* exist (see Tab. 5.2). The area of sacred groves varies considerably, and was not ascertained during field work.

76 Personal communication with *adat* leaders in Waereman (Lake Rana area).

Table 5.2: Traditional organisations and selected traditional institutions

Traditional organisations	**Tioor**	**Rhun**
Adat organisations	raja, clan leaders, kepala adat, adat council	not existent
Religious organisations (Islamic, Christian)	kepala agama, permanent groups with differing labour arrangements	kepala agama, temporarily limited groups with differing labour arrangements
Self-help groups	common: permanent and temporarily limited groups with differing arrangements	less common: permanent and temporarily limited groups with differing arrangements
Traditional institutions		
Pela	alliances with several villages	not existent
Sasi	individual sasi is practised; communal sasi laut was practised in the late 1980s	individual sasi is not practised; communal sasi laut was practised in the 1970s and 1980s
Keramat	sacred primary forest; eight locations	sacred primary forest; five locations

Sources: Interviews with villagers (Stubenvoll 1996 and1997).

5.4.3 Land tenure

The complex issue of land tenure has to be approached from three sides, because it is crucial for an understanding of land-use patterns, and it has consequences for any strategy option in land-use planning. Firstly, it is the *traditional system of land tenure regulated by adat*, which is, secondly, contradictory to the *official jurisdiction* of the Indonesian Basic Agrarian Law (1960) and the Indonesian Basic Forestry Law (1967).[77] Thirdly, this divergence between *de jure* and *customary* land tenure is further complicated by *de facto* land tenure arrangements, that could even violate *adat* regulations. Land tenure noticeably differs in both islands due to a different historical development, and thus it will be separately analysed. In Rhun, traditional land tenure has especially come in conflict with the official jurisdiction, whereas in Tioor *de facto* land tenure arrangements more often contradict *adat*.

Tioor

Traditional concept of communal land and sea territory (petuanan)

In most Maluku's communities, land and sea territories are seen as an integral common property of all people of the respective community. These territories are designated *petuanan*. Within the *petuanan* each clan holds tenure rights on a collective part of the *land territory*, called *tanah dati*, which is subject to the tenure arrangements for families and households belonging to that clan. This is illustrated below by the example of Tioor. The remaining land territory and forests, automatically belong to all people of the community. However, clan's land is not absolutely an owned territory of the clan, because other clans may have certain rights on it. Unlike the division of land territories into clan's land and common land, the *sea territory* is completely a communal territory of all people of the village. Nobody can claim any part of this territory as his private ownership. The sea territory generally stretches along the shore as far as the land boundaries to neighbouring villages, and from these edges straight into the sea. The outer boundary is determined either by the edge of the littoral (e.g., in North Maluku), or the location from where one cannot see the shore at daytime anymore (e.g., in Kei Besar) (Topatimasang 1997). The basic idea of the territorial concept is literally expressed by

[77] Some authors (e.g., Uhlig 1987, 158) mention, that traditional land tenure is recognised by the jurisdiction. However, if national or capital interests, such as in form of timber and mining companies, add to the scenario, customary land will not matter much. Similarly, traditional sea territories are not legally recognised by the Basic Fisheries Act (Undang-Undang No. 9/1985) or any other laws which delineate state control over marine resources and areas, and which constitutionally put the Central Directorate of Fisheries and its subsidiary offices at provincial and regency level in charge of all waters within the Indonesian territory (Pannell 1997, 290).

the term of the common 'laid table' (*meja makan*). Concerning communal *sasi* regulations, a ban on the use of certain resources can be imposed in any part of the *petuanan*, including in *tanah dati* of clans.

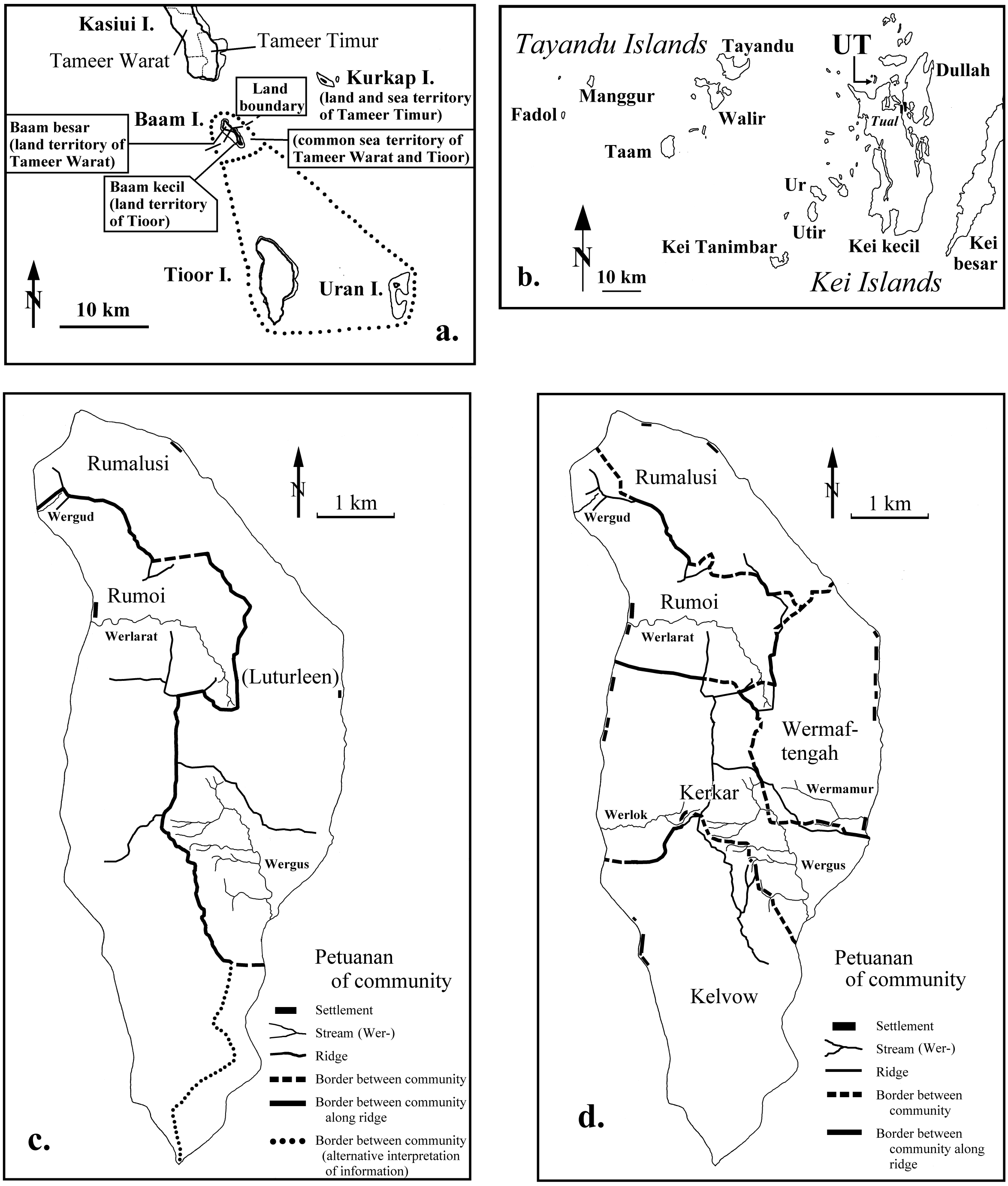
The development of the territorial concept of Tioor village is illustrated by Fig. 5.1 and Fig. 5.2. Originally, Tioor had two communities until the beginning of the 20th century – Rumoi, and Rumalusi. Until nowadays the *petuanan* of Tioor has comprised the islands and the sea territory of Tioor, Baam kecil, and Uran, and the sea territory of Baam besar (Fig. 5.1a). The clans in Rumoi regulated *tanah dati* in the western part of the main island, the clans of Rumalusi in the eastern part (Fig. 5.1c), whereas Uran has been apportioned as *tanah dati* among all five clans of Tioor. Additionally, Ut Island (Kei Islands) was under traditional control of Tioor. This small coral island (about 100 ha) was given to Tioor by the *Raja* of Dullah (Kei Islands) as a reward for its assistance in a war of Dullah against external enemies in pre-colonial times (interviews with villagers; Fig. 5.1b).

The immigration and the founding of new settlements in the twentieth century has led to an adapted territorial concept of *tanah dati*. Although the status of Baam kecil, Uran, and the sea territory has remained, the land territory of the main island had to be rearranged. On the condition that they acknowledged local *adat*, the immigrating families have been able to obtain *tanah dati* on land that had not been claimed yet by the five original Tioorese clans. This has resulted in the present apportioning of *tanah dati* in Tioor Island within the borders of the five communities (*dusun*) (Fig. 5.1d).[78] For instance, *tanah dati* of Kelvow clans is situated within its community area, except land that has already been *tanah dati* of Rumoi and Rumalusi before the immigration of the Kelvow people from Kur Island between 1900 and 1950.

Traditional control on Ut disappeared after the Indonesian independence and the administrational reform, when Ut has become part of Maluku Tenggara regency. Nonetheless, there are still strong ties between Ut and Tioor, and presently some households in Ut have tenure rights on certain *tanah dati* in Tioor. Fig. 5.2 illustrates the present arrangement of *tanah dati* in Rumoi community. The tenure arrangements of the clan's families and households are subject of the next section.

[78] Borders between the communities are also mental and cultural, and therefore they are subject to interpretation and change.

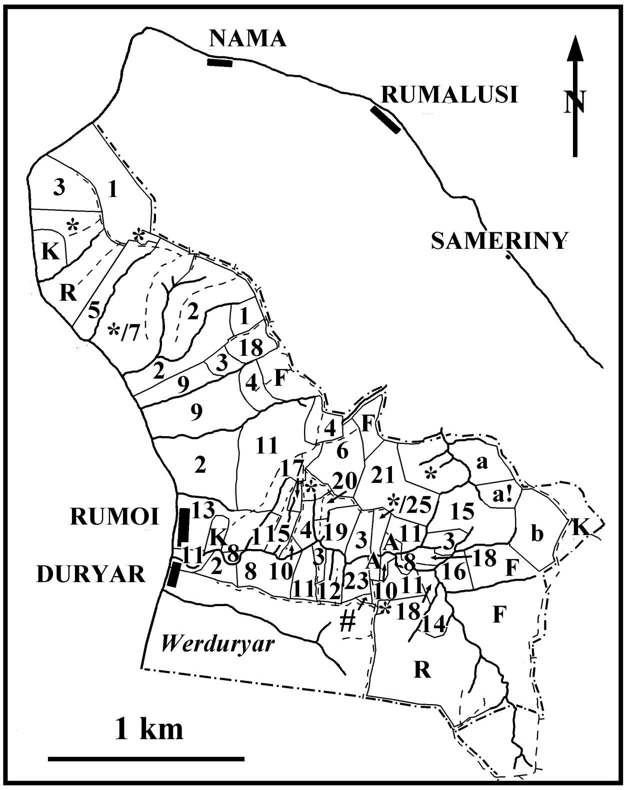
Figure 5.1: Traditional territory (*petuanan*) of Tioor



Notes: a. Complete present *petuanan* of Tioor community (cf. also Map 7.1.3);
b. Position of Ut Island (Kei Islands);
c. *Petuanan* of Tioor Island prior to 1900; the existence of *Luturleen* is only mentioned by Riedel (1886, 189);
d. Present *petuanan* of Tioor Island.

Sources: Interviews and mapping (Stubenvoll 1997 and 1998); RePPProT 1988; MoD (UK) 1971 (for Fig. 5.2b).

Figure 5.2: Clan's land (*tanah dati*) in Rumoi community



LAND HOLDINGS

Clans (families as numbers or letters)
Kolatlena clan: odd numbers (1 – 25)
Kolatfeka clan: even numbers (2 – 20)
Rumagiar clan: capital letter (A)
Rahayaan clan: letters (a, b)

OTHERS

R Village head (Kolatlena clan)
***** Immigrants from Flores
# Gift for village teacher (by village head)
F Freely accessible land
K Keramat (sacred primary forest)
a! Land is disputed between 'a' and '15'

Stream
Ridge
Approximate boundaries of land holdings
Approximate boundary of Rumoi community

Notes: The Rahayaan clan is not an original clan in Tioor. Data for Werduryar location is insufficient.

Sources: Interviews with village leaders and key informants, and mapping (Stubenvoll 1997 and 1998).

Land tenure at household, family and clan level

From a historical view, traditional land tenure in Tioor was not very influenced during the colonial period, although the Dutch VOC carried out *hongi* expeditions to Tioor during the seventeenth and eighteenth century, forcing the indigenous people to destroy their nutmeg trees and to cultivate coconut palms on a wider scale (cf. Ch. 5.1). Although there are slight differences in handling traditional land tenure among the people of different origin (see Tab. 5.1), under traditional law *land can be acquired in three main ways* (Tab. 5.3): (1) by securing claims and clearing of primary forest; (2) by inheriting from an ancestor who acquired the land formerly; and (3) as part of an economic transaction, e.g. as a gift, as its purchase, or to pay back a loan.

Table 5.3: Methods of land acquisition in Tioor

METHOD	No. of locations	%	Approximate area (ha)	%	Communities with relevant cases
Claiming of primary forest	10	7%	36.5	17%	Rumoi, Kerkar, Rumalusi, Wermaf
Clearing of primary forest	78	59%	118.8	56%	All communities
Inheritance with splitting of fields	29	22%	25.8	12%	All communities
Inheritance without splitting of fields	10	7%	25.5	12%	Rumoi, Kerkar, Kelvow, Wermaf
Gift	2	2%	1.0	1%	Rumoi, Rumalusi
Purchase	3	2%	2.0	1%	Rumoi, Rumalusi, Kelvow
Security	1	1%	1.0	1%	Rumoi
Sum	**133**	**100%**	**210.6**	**100%**	**All communities**

Sources: Household interviews (Stubenvoll 1997).

(1) Securing claims and clearing of primary forest

Until the 1980s and *within the community* (*dusun*) *area*, primary forest land could be cleared without any permission of the local authorities – i.e. the clan leaders and the community leaders (*kepala dusun*) – because much of primary forest was still freely accessible. The situation has changed now due to scarce land resources,[79] so that theoretically a peasant has to ask for permission. Traditional habits are still dominant, however, so that in practice this permission is seldom requested and primary forest land is freely accessible in those regions of the community area, where nobody else already claims tenure. Permission is needed, however, for land being situated *in the area of another community*, although this permission is usually rejected.

Claims can be acquired in areas still occupied by primary forest, on condition that there are no productive trees (e.g. nutmeg, sago) planted by somebody else within that area and that there is no open field belonging to somebody else near that location. The term 'near' is not exactly defined,[80] and thus gives room for subjective interpretation, so that disputes about field boundaries may arise. If both parties cannot solve this problem, a hearing of the *adat* council would be held (cf. Ch. 6.3.2). The claimed land is marked, with stakes or by planting productive trees, or it is simply cleared with the help of a group (*kerja masohi*). *On the cleared plot*, the person has theoretically acquired permanently undisturbed tenure rights.[81] *Kerja masohi* members do not have any right on that plot. *On the surrounding area of the cleared plot* and *on claimed land not being cleared yet* the person and his family have got the exclusive right to use it in the future. Hence, to acquire rights on a larger land area it is sufficient to claim several small plots *around it*, either by marking or clearing. Again, the person's family can acquire those parts of the land that has not been cleared yet. Thus, for acquiring tenure rights on land, it is not required to clear immediately all of the primary forest. To ensure land resources for the future (i.e. for the children) the struggle for accessible land has been high, what has also led to clearing of land even if it is not cultivated right away (*merebut tanah*, see Ch. 6.5.2). This fact partly explains the large area of secondary forest (42%; see Tab. 6.3).

Another possibility is a joint clearing of primary forest, either *by members of a clan, of a family* or *of a settlement*. The latter is only practised in Kerker, Rumalusi, Baru and Mamur, resulting in a field called *megawah ras* (Kerker, Rumalusi) or *manga ras* (Baru, Mamur). After the clearing of primary

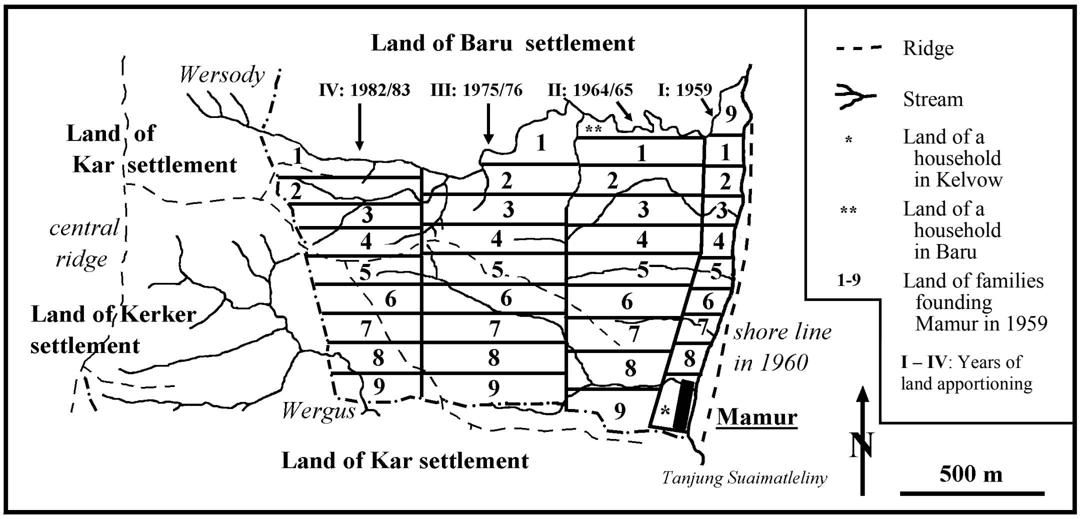
[79] In 1998, primary forest occupies 16% of the island's area (Tab. 6.3; Map 3; App. 3.2).

[80] According to several interviews and being supported by land-use maps, it is understood as approximately 100 m.

[81] However, as one case study of a peasant household will show (cf. Ch. 6.5.2), this *adat* regulation is not a rigid principle because it is *de facto* difficult to recognise boundaries in primary and secondary forest after one generation. Thus, the offspring may, wilfully or not, ignore previously held land tenure rights of other families.

forest, each participant acquires tenure rights on an equal share of the commonly cleared land, which he then individually uses. In Mamur, *manga ras* has been the only form of land acquisition by clearing. This has been ordered, organised and controlled solely by the Islamic leader (*imam*), in anticipation of land shortage and possible land conflicts. In the founding year of Mamur (1959), and in three further steps (1964/65, 1975/76, and 1984/85), the cleared land has been apportioned among the nine founding households (Fig. 5.3). Each household head has then arranged field inheritance among his offspring (see below). In Kerker and Rumalusi, there are furthermore communal fields, which are jointly planted with annuals, the yield being equally distributed among the participants.

Figure 5.3: ***Manga ras*** **fields of Mamur settlement**



Sources: Interviews with community leaders and key informants, and mapping (Stubenvoll 1997 and 1998).

(2) Inheriting from an ancestor

Inheritance of land rights is most commonly regulated by *adat*. *Tree gardens* are inherited in equal shares among all children, both males and females, as soon as they marry. Succession is regulated by the father in consultation with his wife as long as they are alive, so that they decide which share of their land will be passed to their married children. After the father's death, the eldest son takes his place in regulating the heritage. *Land being reserved for shifting cultivation* is apportioned in the same way. *Claimed rights on primary forest* cannot be split, because the (patrilinear) families of the father have still the possibility to acquire tenure rights there. If a daughter should marry and leave Tioor with her husband, her share of land would be managed by the father, or by the eldest son after the father's death. She (including her children) will not lose her share of her father's tree gardens, if she later returns to Tioor. However, she could lose tenure rights on land that was reserved for shifting cultivation, if it would have been planted with perennials by the eldest brother during her absence.

In theory, this method of inheritance will potentially lead to an increasing fragmentation of the land, bearing several disadvantages. For instance, communication between several locations could become time- and energy-consuming, so that agricultural activities (e.g., building of field huts, planting and harvest) could not be carried out in all locations. It could also lead to disagreements about the field boundaries if the land was not divided precisely. To avoid these shortcomings *adat* is flexibly applied, allowing other inheritance arrangements, too:

(a) Fields and tree gardens are managed together, harvest and products are equally distributed. This co-operation may be even true on split land units. Another advantage of this method is the equalisation of risks and profits for each party.

(b) Tree gardens are rotationally managed each year by another heir, who can take all products from it. Although risks and profits might be differing due to annual climatic variation, this method would make seasonal work migration easier.

(c) Only the number of trees in tree gardens is equally apportioned, not the land itself. Thus, misunderstanding about boundaries would be avoided, because *tree tenure* (see Ch. 6.3.3) must be precisely defined.

(d) In the case of the presence of exactly one female heir, she only gets a small share of the land, but inherits the parent's house and administers valuables such as gold and jewellery. This method is practised by the inhabitants of Kelvow, who immigrated from Kur and still apply Kur adat. This practice takes into account that men can more easily earn their living with seasonal work migration, while women are traditionally engaged in housework.

Moreover, management problems due to land fragmentation are eased by three other facts:

(e) Not all land can be managed at the same time, because a fallow period is needed in the rotational cycle of slash-and-burn agriculture. This fact will be discussed in Ch. 6.3.2.

(f) Most land – for the interviewed household 73% of their field area (cf. Tab. 5.3) – has been acquired by claiming and clearing of primary forest, and has not been inherited yet. Hence, land fragmentation is still at a low level, and might become more problematic in the future.

(g) An elder brother may refuse to let a returning female heir have her tenure rights on tree gardens, although it would inevitably lead to land disputes. Such an action would be designated 'the monopolising of land' (*monopoli tanah)*.

Nevertheless, land splitting is still the dominant form of inheritance in Tioor (cf. Tab. 5.3), indicating that until recently the availability of land resources still allowed the acquisition of most land by clearing of primary forest. In the future, however, heirs will no longer be able to rely on clearing, and thus, they will become more dependent on inheritance.

(3) Economic transactions

As shown in Tab. 5.3, economic transactions (gifts, purchase, loan repayment) of land rights seldom occur.[82] A *gift* will be given to someone not belonging to the clan or the family, if it is in the interest of the land-giver to get the land-receiver to stay in Tioor, for example a teacher or a physician (see Fig. 5.2). Another purpose is the sense of reciprocity, i.e. the land-giver could expect to be supported by the land-receiver later on, either financially, socially or politically. Land is also alienated as a gift *within* the clan or the family, for instance when a person without offspring should no longer be able to manage the transferred land.

Concerning the interviewed households, land was *purchased* in two cases by immigrants from Flores, who could not acquire land rights by inheritance yet or by clearing of primary forest without permission of the local authorities,[83] because their status was still that of a newcomer (*orang pendatang*). In both cases the sellers urgently needed money, either to buy medicine or to marry. Immigrants from Flores do not participate in *kerja masohi* either. Another motive for selling land is

[82] Another possible mode of economic land transaction – leasing – is not practised in Tioor.

[83] Sometimes a Tioorese provides primary forest land, where he has tenure rights, to an immigrant from Flores who clears the forest. The cleared land will then be equally apportioned among both parties.

emigration (work, marriage), for instance to Ut Island. The amount of money involved in a deal depends on the kind of land use of the transferred land. Secondary or primary forest land would be cheaper than tree gardens like a productive coconut tree garden (*dusun kelapa*).[84] The personal relationship between seller and purchaser also influences the price arrangement.

If someone would not like to sell his tree garden, he could leave it to a creditor for *loan repayment*. It is normally practised when the creditor is a merchant of Chinese origin. Depending on the negotiation of both persons involved, two possible systems are deployed in Tioor:

(a) The creditor uses the tree garden until labour costs deduced from the market value of cash crops outweigh the loan and its interest yield. With this system the creditor acquires tenure rights for a limited period of time. However, he can usually calculate a lower market value of the cash crops for loan repayment.

(b) The creditor uses the tree garden as long as the debtor has not fully paid back his credit. This method would have to be illegally practised. This practice is prohibited by the village administration since 1979, because it could lead to a long-lasting acquisition of a tree garden by the creditor.

Under the official jurisdiction all land is governmental land under the directive of the Ministry of Forestry (MoF), classified as protection forest (*hutan lindung*, RePPProT 1988), and thus being theoretically in contrast to traditional land tenure. By definition *hutan lindung* should protect water and soil, and must not be exploited in any form (Monk et al. 1997, 603). In practice, 16% of the land area has not been exploited yet, but 33% is occupied by permanent tree and mixed gardens, and another 49% is reserved for slash-and-burn agriculture – i.e. open fields (7%) and secondary forest (42%) (see Tab. 6.3).

This contradiction between the state legislation and the existing practice allows the conclusion, that the land area of Tioor Island is actually under the directive of the Ministry of Agriculture (MoA), and its Basic Agrarian Law of 1960. Hence, 82% of the land area is being used by the farmers with usufruct rights (*hak pakai*), which is acknowledged by the Government for the tree gardens (*dusun*) – especially coconut *dusun* for which the farmers have to pay taxes. Contrary to traditional law, usufruct right will expire under the Basic Agrarian Law, if land is not cultivated for more than two years. Thus, with the agreement of the head of the relevant community (*kepala dusun*), secondary forest older than two years could be used by anyone, including the former user of the land, who – according to traditional understanding – would be the only person with tenure rights.

Rhun

Indigenous Bandanese *adat* disappeared with the Dutch annexation of the Banda Islands in 1621, and the following establishment of plantation enterprises and the deployment of slaves under the VOC rule. After the abolition of slavery, immigrating workers could never acquire land rights during the colonial period. Consequently, a traditional concept of communal land and sea territory, which is so influential in Tioor, had never existed again during more than three centuries of colonial rule. *A traditional understanding of land tenure for families and households* has emerged after the Indonesian independence, however, and has developed to a complex and confusing system of land accessibility and tenure. Most of the land is being cultivated by the peasants. Three different types of land tenure can be distinguished:

[84] In one case secondary forest land was sold at Rp. 100,000 in 1995, in another case a productive coconut tree garden at Rp. 1,000,000 in 1982. The land area of each plot is around one hectare.

(a) The starting point of the development of present traditional land tenure was the Japanese occupation of Banda during WW II (1942-1945). The Japanese military administration ordered a part of the nutmeg plantations to be cleared, and subsequently planted with mainly cassava (*Manihot esculenta*) by the population. These plots were not reintegrated into plantations after the independence. Instead they have remained with the peasants, as the *status of usufruct right* (*hak pakai*) under the Basic Agrarian Law of the Indonesian jurisdiction.

(b) After the nationalisation of the Dutch plantations by Soekarno in 1958, the Government enterprise of the regency – PPD (*Pusat Perkebunan Daerah*) – managed nutmeg production on Rhun Island and Hatta Island. *The land and all trees have belonged to the Government*. From 1987 until 1990 a private limited liability company – *PT Perkebunan Pala Banda* (PTPPD) – leased the state land of all Banda Islands, which comprised 3,752 ha or 68% of the islands' area. The concession area in Rhun was 381 ha or 82% of the island's area. In 1987, the number of nutmeg trees was counted to be approximately 3,000, theoretically requiring an area of not more than 30 ha. Each household got the right and duty to manage 10 nutmeg trees, yields being shared between the enterprise and the households. After the bankruptcy of the PTPPD, the households still use the designated nutmeg trees, paying a tax of 1 kg nutmeg and 0.1 kg mace per year to the Government at regency level via the *kepala desa*. As this number has steadily declined over the past decade most of the *governmental land* is now occupied with peasant agriculture, falling into the following category.

(c) Both the governmental and the private plantation enterprises had difficulties in managing the plantation area. The peasant families have continued to cultivate their plots of the Japanese occupation period, and were at the same time working for the governmental plantation enterprise. Beginning in the 1970s, they enlarged these plots little by little into the plantation area, created new ones or planted clove trees on it. This practice was illegal, but ever since the 1980s it has had to be tolerated by the Government after serious disputes[85] with the peasants. The acquired governmental land is regarded by the peasants as land with the *status of usufruct right* (*hak pakai*). However, the difference to category (a) is a much weaker protection from a possible re-establishment of a nutmeg plantation by the Government or a private investor, because the land falls *de jure* into the category (b).

The peasant families recognise the problematic land tenure on governmental land, but they are treating fields of category (c) *de facto* in the same manner as those of category (a), specially concerning inheritance arrangements. Inheritance of fields is of great importance, because it is no longer possible to acquire land tenure by the clearing of nutmeg trees or enlarging existing fields. Like in Tioor, inheritance is flexibly regulated. It is the decision of the father, i.e. the head of the nuclear family, which of the three possible modes of inheritance is practised:

(1) *Splitting of fields (unequally)*: The Rhunese, most of them being descendants of immigrants from Buton and Tukang Besi Islands, usually deploy Butonese *adat* to inherit land. As soon as a child marries, a part of the field(s) is passed on by the father in a way, that the combined share of all daughters would be as large as the share of each son.[86] This means that the inherited field areas for daughters depend on the number of female offspring, because fields are apportioned equally among male descendants. After the father's death his widow would get a share as large as each of her female children. However, she can live off all fields that were divided among their children, especially with regard to the harvest of staple food for her subsistence. The main reason for this

[85] According to some farmers, the managing personal of the *Prajakarya* was threatened to be killed by some Rhunese, when they tried to pull out newly established clove seedlings in the plantation area.

[86] An example is given to illustrate this mode of inheritance. Supposing a total field area of one hectare would be apportioned among four sons and two daughters. Then each son would receive 0.2 ha, and each daughter 0.1 ha.

form of inheritance is the traditional understanding that a married woman leaves the father's household and moves to her husband. The husband has to take care of her including a sufficient provision of fields. In this way her share of the father's fields can be interpreted as a form of her dowry.

(2) *Splitting of fields (equally)*: The apportioning of land equally among all children is seldom deployed. In case of a marriage with an immigrating man, who does not have any possibility to acquire land tenure in Rhun, a woman would have more land resources than with unequal field splitting, and thus better possibilities in establishing a family. The same would be true, if the father decided on a joint management of fields.

(3) *Joint management of fields*: Less common in Rhun has been inheritance without apportioning of fields among the children, although this mode is less problematic regarding land fragmentation than field splitting. Only three of the 25 interviewed households are managing all inherited fields together with their siblings (*makan ramai-ramai*). Another four households are cultivating both on divided and jointly managed fields.

Inheritance is the single most important mode of land acquisition, but there are further possibilities. Temporarily limited, would be the management of fields of absent members of the family, if they were leaving Rhun together with their household for seasonal work. Should a household participate in transmigration, the land would be managed by the family as well. In case of returning to Rhun, the household's tenure rights would not be lost.

Purchase of land, and land as a loan security was not observed during field work, indicating the scarcity of important land resources and the availability of other forms of security. However, as being described in one case study of a peasant household (Ch. 6.5.1), a small plot is occasionally presented as a gift.

5.5 Socio-economy

5.5.1 Property structure

In both islands, the peasant households hold several, dispersed fields and tree gardens, which are in walking distance of not more than one hour.[87] Area of fields and tree gardens was investigated in the household interviews. However, given data differs often widely from the real area that was observed during field excursions, especially in Tioor (Fig. 5.4). A statistical calculation is therefore not deployable. Tab. 5.4 shows data on the area of fields and tree gardens provided by the 65 interviewed households. The great discrepancy between given and real land area in Tioor is due to its difficult estimation by the household head. This may be for several reasons:

(1) A part of the land area is held by the family or the clan.

(2) Not all land is presently cultivated, as a large part of it is in the fallow stage of shifting cultivation. In some cases fallow land was not mentioned at all, such as HH 32.

(3) An estimation of the land area is difficult in steep terrain.

(4) The shape of the fields and tree gardens does not always follow straight lines.

Following differences in the two villages with regard to area of fields and tree gardens are striking:

[87] Some households in Kar settlement hold fields in the east of Tioor (in Wergus location), in a walking distance of some 90 minutes. To save time and energy for the daily field work, they have constructed semi-permanent huts for staying overnight. In some references (cf. Ellen 1978, 133), the term 'pheric distance'; is used as a measure in unit-time to cover a specific distance.

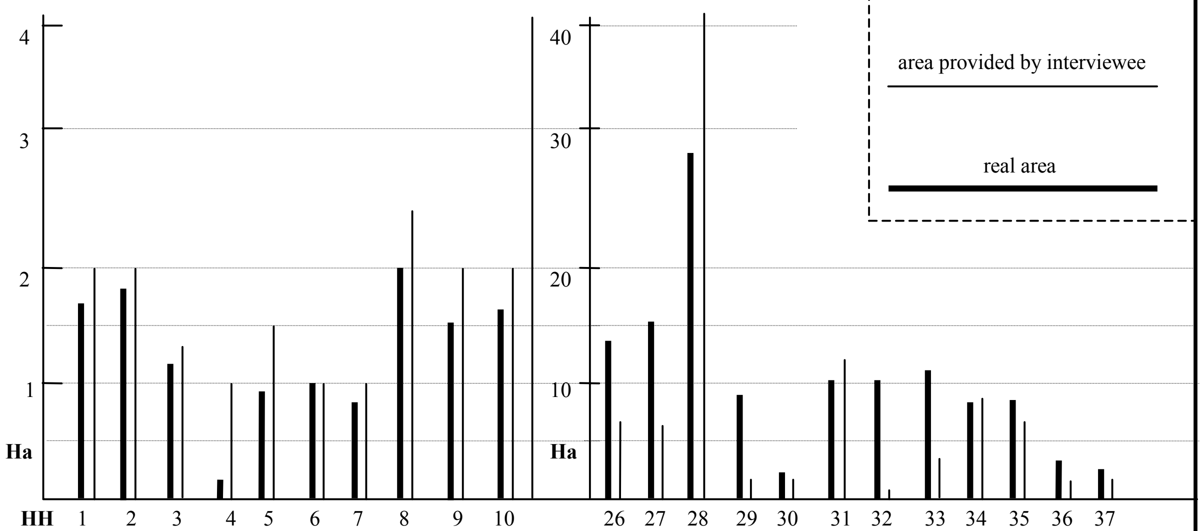
(1) The available land area for households is significantly larger in Tioor than in Rhun, in an average's ratio of some 3.3 : 1 (5.41 ha : 1.63 ha). This can be explained with the larger land area of Tioor (2.394 ha; Rhun: 465 ha; or a ratio of 5.1 : 1).

(2) Land is relatively equally distributed in Rhun, as 20 of 25 households hold land with an area between 1 and 2.5 ha, whereas in Tioor there are great differences. For instance, two of the interviewed 40 households hold land of less than 1 ha, but have no access to family's land. HH 28 has access to 30 ha, including family's land (both fields and primary forest) of 24.5 ha (Tab. 5.4; Fig 5.4).

The larger land holdings in Tioor have to be qualified, however. Soil is more fertile in Rhun, so that permanent cultivation is commonly practised, whereas in Tioor much land is devoted to shifting cultivation on relatively poorer soils. Moreover, several households in Rhun have obtained land in Seram through intra-provincial transmigration and a subsequent return to Rhun, and are leasing that land to other transmigrants.

The property structure of capital was not directly investigated in the household interviews. It can be indirectly deduced, however, from the used materials for house construction, from larger capital investments, and from annual income. In Rhun, most houses are constructed with walls made of imported cement, and a roof of high quality timber and corrugated iron (Map 6.4). In Tioor, three categories can be distinguished: Houses with walls made of cement and a roof of corrugated iron or tile (41 houses, or 15%); with walls made of cement or of lime from coral mining, and a roof of sago palm thatch (*atap*) (163 houses; or 59%); or with walls of *gaba-gaba* (the dried rachis of sago palm leaves), and a roof of *atap* (73 houses, or 26%) (Maps 6.1 to Map 6.3). The families are the owners of their houses and do not pay any rent. The land tax amounts to Rp. 3,500 per year and house.

Figure 5.4: Combined area of fields [in hectare; 22 households]



Notes: Households of the second step of the selection process: HH 1 – 10 (Rhun); HH 26 – 37 (Tioor). **Note the different scale!**

Sources: Interviews, observation and mapping (Stubenvoll 1996 and 1997).

Table 5.4: Field area classes [65 interviewed households]

Combined field area	Number and percentage of households							
	Tioor[1]	%	Rhun[1]	%	Tioor[2]	%	Rhun[2]	%
smaller than 0.5 ha	0	0%	1	4%	3	7.5%	4	16%
[0.5 ha; 1 ha[	2	5%	1	4%	2	5%	3	12%
[1 ha; 2.5 ha[	11	27.5%	20	80%	12	30%	17	68%
[2.5 ha; 5 ha[	11	27.5%	2	8%	10	25%	1	4%
[5 ha; 10 ha[	12	30%	1	4%	10	25%	0	0%
larger than 10 ha	4	10%	0	0%	3	7.5%	0	0%
Average	**5.41 ha**		**1.63 ha**		**3.90 ha**		**1.16 ha**	

Notes: **1** Land including family's or clan's land; **2** Household's land;
Tioor: n = 40, Rhun: n = 25. Classification according to data provided by interviewee.
Real land area according to field observation is not considered.

Sources: Household interviews (Stubenvoll 1996 and 1997).

Larger capital investments are made only by some wealthier Rhunese households (Fig. 5.6) in ship building, and in land purchase (e.g., in Seram) and house construction (e.g., in Ambon City) on other islands. The increasingly important role of ship building is discussed in Ch. 5.5.2. In Tioor, capital investments are lower, being generally performed in the productive sector, such as forging and joinery.

The annual income (based on data *before* the Indonesian economy crisis) of the interviewed households is shown in Fig. 5.5 and Fig. 5.6. In Tab. 5.5, this data is summarised by using income classes. On both islands, the majority of the interviewed households gain an annual income of less than Rp. 1.5 million. The major difference is found in the higher income classes of more than Rp. 1.5 million. These households have either large coconut tree gardens (Tioor; e.g., HH 35) or have performed larger capital investments (Rhun: HH 12, 13, 19). 25% of the interviewed households in Tioor, and 20% in Rhun, fall into these classes. In Rhun, maximum income is substantially higher (e.g., HH 12 with Rp.7.5 million).

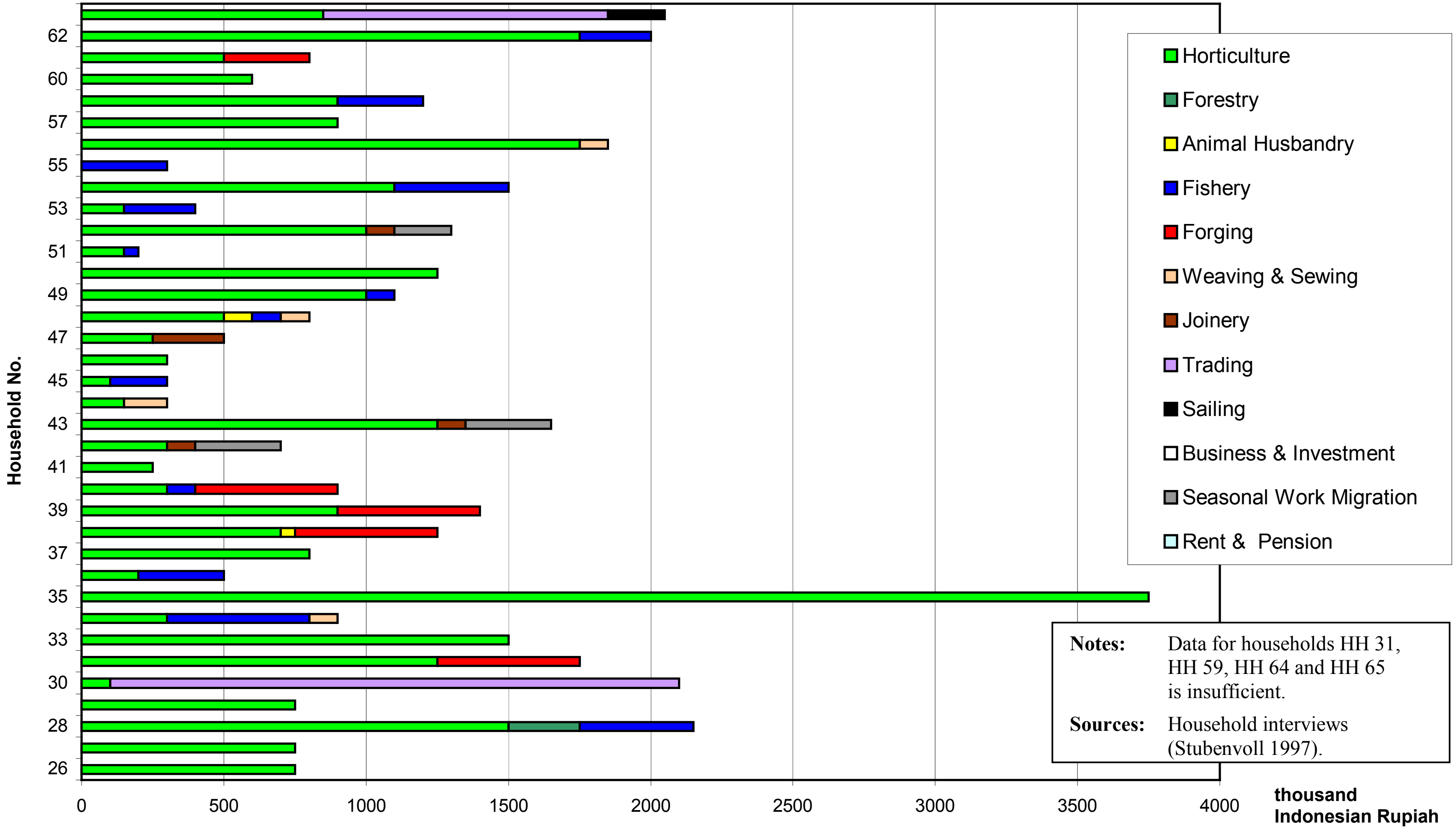
Table 5.5: Income classes [65 households]

Annual income (in million Rupiah)	Number and percentage of households			
	Tioor	%	Rhun	%
less than 0.5	7	17.5%	5	20%
[0.5; 1.0[	13	32.5%	8	32%
[1.0; 1.5[	6	15%	5	20%
[1.5; 2.0[	5	12.5%	1	4%
[2.0; 5.0[	5	12.5%	2	8%
5.0 and more	0	0%	2	8%
data insufficient	4	10%	2	8%
average	1.10 million		1.51 million	

Notes: Tioor: n = 40; Rhun: n = 25.

Sources: Interviews with households and key informants (Stubenvoll 1996 and 1997).

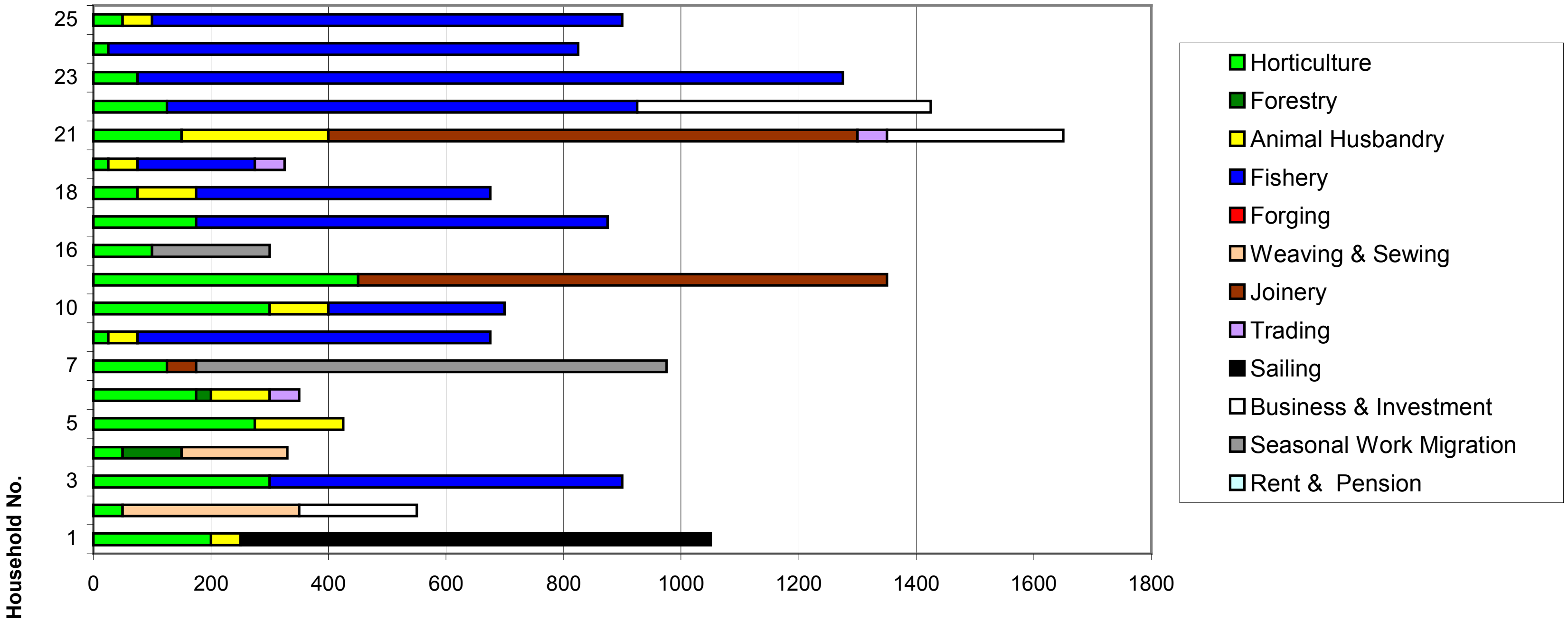
Figure 5.5: Annual income and income sources of interviewed households in Tioor

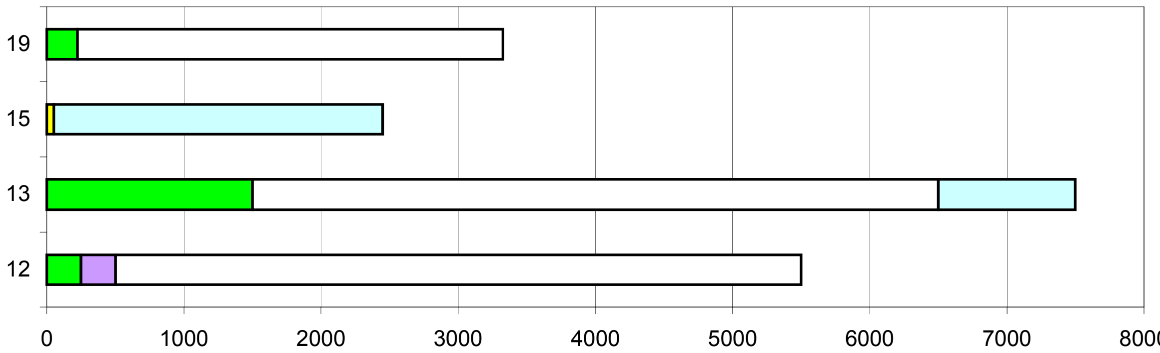


Notes: Data for households HH 31, HH 59, HH 64 and HH 65 is insufficient.

Sources: Household interviews (Stubenvoll 1997).

Figure 5.6: Annual income and income sources of interviewed households in Rhun





Notes: Data for households HH 9 and HH 14 is insufficient. **Note** the different scale.

Sources: Household interviews (Stubenvoll 1996).

5.5.2 Off-farm economic activities and resource utilisation

The people of Tioor and Rhun are pursuing a multitude of agricultural and off-farm economic activities which will be analysed accordingly to Fig. 5.5 and Fig. 5.6. In the following, the off-farm activities are dealt with, whereas the farming systems of the peasant households are thoroughly discussed in Ch. 6 and Ch. 7. As pointed out in Ch. 5.1 and Ch. 6.1, the people of Tioor and Rhun had less diversified income sources until the 1960s. Thereafter, they have exploited new ways of income generation, due to decreased earnings and, in the case of Rhun, insufficient wages of the plantation enterprises.

Fishery

Since ancient times, fishery has been a major subsistence activity of the people. Fish and non-fish organisms, such as prawns, crayfish, squids, crabs, marine turtles, nyale worms (*laur; Polychaeta*), and shrimps, are caught and collected by almost all villagers to serve as the most important source of proteins for their daily meals. Any haul surplus of fish is immediately bartered in the village, or salted and dried for storage (*ikan asin*) and later consumption during times of rough sea (commonly in the monsoon periods in June, July, and December until February) when fishing activities can be hardly performed, except the collection of invertebrates in the *eulittoral* during the low tide. Fishing for self-sufficiency is restricted to the coastal waters of the villages' sea territory. An inventory of marine species being caught and harvested by the people of Tioor involved some 115 fish species and 35 non-fish species.[88] Several fishing methods are deployed, such as the drive of fish shoals by a fishermen group, called *talikor* in Tioor, and tools such as nets, fishing lines, harpoons and self-made diving goggles, spears, fish traps, canoes and gas lamps, and traditional fish poison (e.g., *akar tufa*, i.e. pounded roots from *Derris elliptica* (Sweet) Bentham), largely depending on the species to be caught (see App. 1.8). It is important to stress, that women are intensely participating in fishing activities, especially in the *inner sub-littoral* and *eulittoral* (Fig. 5.7).

Unlike most fish species which merely serve the daily subsistence activities of the people, a couple of species are of high commercial value or regarded as a delicacy (Tab. 5.6). Thus, they are particularly searched for, both by the local population and by external fishermen who sometimes deploy destructive methods such as blast fishing (see below). It is the collection of certain molluscs and bêche-de-mer species, which are sold to traders, and the haul of sharks (caught for their fins), of turtles, and of fish that can be marketed as *ikan asin* to regional markets, which constitutes an often significant part of the household's income. However, there are remarkable differences in the role of market-oriented fishery: For ten of 25 interviewed households in Rhun fishery is the single most important income source, whereas in Tioor it is the dominant source of earnings for five of 40 interviewed households (Fig. 5.5 and Fig. 5.6). Two main reasons of this characteristic can be stated. Firstly, agriculture is the leading income-generating activity of most households in Tioor – in Rhun it is only a marginal one – and secondly, most of the Rhunese men are fishing pelagic fish species not only in Rhun's sea territory, but have extended their operations to other islands in the region as well, such as Wetar, Teon, Nila, Serua, Kaimear, and Tioor.

This impressive shift from local to regional fishing began in the early 1980s, and has been made possible by the steadily increasing number of motorised ships being constructed by the Rhunese joiners. The fishermen usually stay one month at sea, until their haul, which is preserved by salting and drying, has reached about 1 ton (dried weight). Then it is sold in Ambon or Dili (East Timor), the profit being shared between the ship-owner (one third) and among the five to seven crew members

[88] These species are listed in App. 1.8. Information on size, habitats, fishing methods, time and season of fishing, current state of resource depletion, and others are added.

(two thirds) after their return to Rhun.[89] In early years, this shift to regional fishing was basically a reaction to the decreasing wages from the plantation enterprise, but presently it has become essential due to subsistence-oriented agriculture in Rhun. Moreover, there is a high degree of competition among fishermen from all Banda Islands, who catch tuna and other pelagic fish species in the sea around the Banda Islands. They have been selling their haul to cold storage ships anchoring in the Selammegat between Neira and Banda Besar since 1989. In Tioor, the households of the east coast hamlets Jawa and Laganymatiny strongly depend on income from reef fishing with nets and pelagic line fishing, as well as a successful IDT group in Mamur, as the richest fishing grounds are situated at Tioor's east coast and Uran Island, both with extended coral reefs. However, external users are competing with Tioor's fishermen:

(1) Fishermen from Rhun and other South Maluku Islands including IDT groups: These groups are usually engaged in pelagic line fishing. Bait fish (usually *momar,* a *Decapterus* sp.) are caught with nets in the inner sub-littoral (Zone 2 in Fig. 5.7). Before carrying out their activities they look for a permission from the *kepala desa*, and pay a weekly fee of Rp. 20,000 for Tioor's village budget. Destructive fishing methods are not deployed by these groups. The only problem has been the decreasing stocks of bait fish.

(2) Fishermen from South and Southeast Sulawesi, and North Maluku:[90] These groups have to be regarded as a major problem with regard to sustainable use of marine resources, because they are both regularly poaching all kinds of economically important species without looking for permission from the *kepala desa*, and commonly deploying destructive fishing methods, such as reef blasting, and the use of fine-meshed nets (*jaring harimau*). They are mainly active in the islands of Uran and Baam, as it is difficult for Tioor's village authorities to effectively police that distant sea territory.

(3) Fishermen working for ethnic Chinese entrepreneurs: In 1994 until 1996, the enterprise *PT Bahtera Agung Bahari* had contracted Tioor's sea territory to catch valuable live reef fish,[91] such as the up to 2 m sized Napoleon wrasse (*Cheilinus undulatus*). These fish were stunned with potassium cyanide, and brought to and revived in basins on the ship. Then they were transported to Geser and put into floating pens in the central lagoon, waiting to be shipped to the main market Hongkong. Napoleon wrasse is fetching some US$ 150 per kg in Hongkong's restaurants. Their lips are sold for as much as US$ 225 per serving (cf. Cesar et al. 1997, 346; Monk et al. 1997, 591). An enterprise of another ethnic Chinese, officially owned by the wife of the then district military commander as a front woman, tried to get access to Tioor for the same purpose in November 1997, but failed due to Tioor's community-based resource management plan and its integrated *sasi* regulations (cf. Ch. 8.2.4). Potassium cyanide fishing is a very destructive method, that virtually kills all small and medium-sized fish and coral polyps in the affected locations. Moreover, those fishermen poached other marine resources as well, such as lobsters, bêche-de-mers and top-shells. Another recent development is the catch of deep sea fish (*mora*) living on

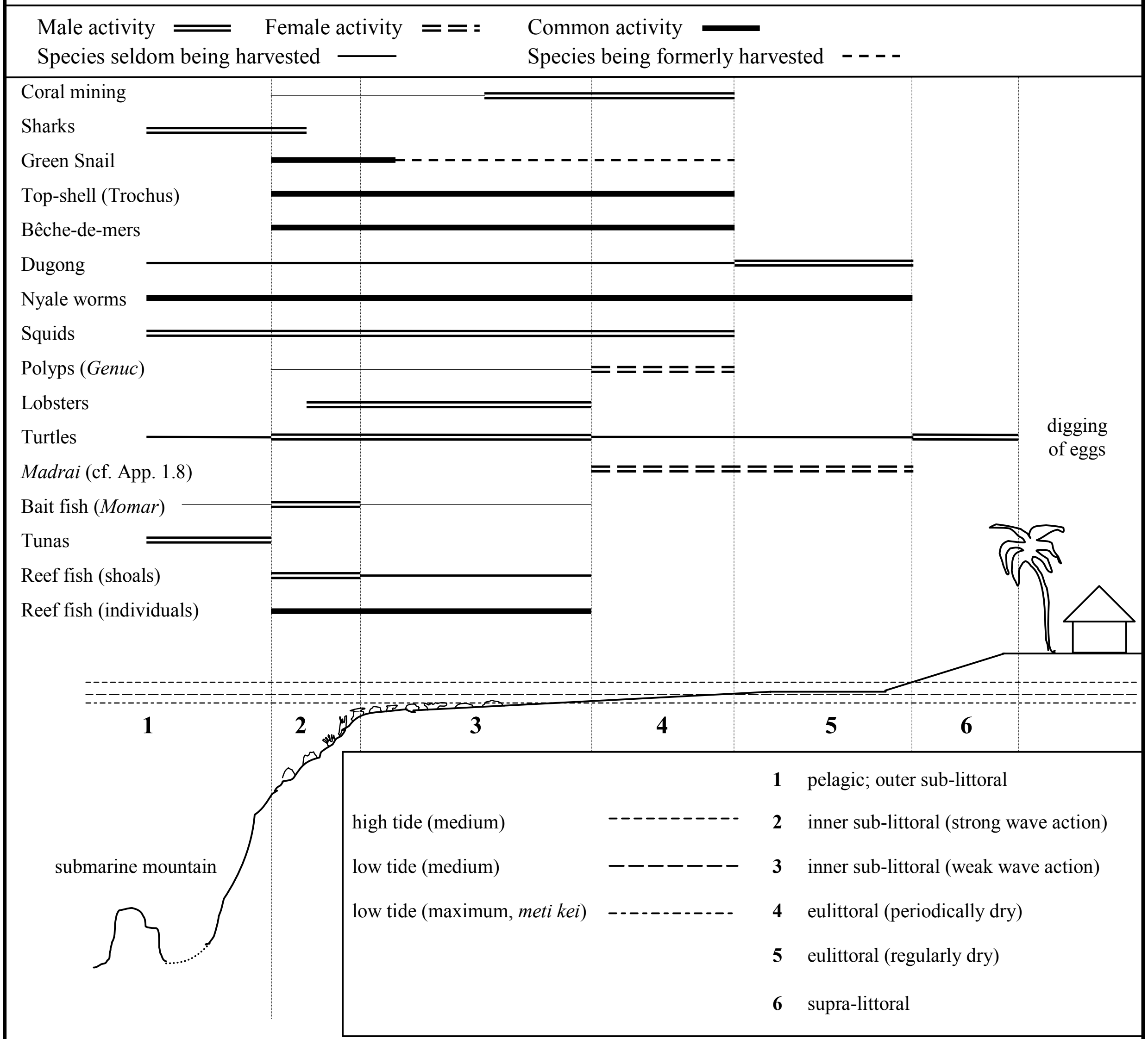
[89] 1 kg of dried *cakalang* (*Katsuwonus pelanus*) was sold at Rp. 3,500 in Ambon in 1996. A fisherman's share of the net profit from 1000 kg of dried *cakalang* (3.5 million Rp. minus costs for fuel, salt and the like) would be some Rp. 200,000 per travel.

[90] It is practically impossible to identify the exact origin of these user groups, because they usually arrive at night and leave Tioor in the next early morning without contacting the local people. Thus, a historically evident experience with poachers from a certain island, for instance Buton, may lead to the prejudice that *all* poachers come from there (cf. Pannell 1997, 305).

[91] The contract was forced upon the LMD of Tioor by the then district military commander in Geser. The enterprise paid a fee of three million Rupiah for a period of three years. Since then, the fish population of Tioor has substantially decreased (cf. App. 1.8 on state of depletion of fish resources).

submarine mountains near Tioor by fishermen working for an entrepreneur in Tehoru (Seram), without contacting the village head for a permission.

Figure 5.7: Harvest of selected marine resources in the littoral and the adjacent pelagic



Sources: Interviews with households and key informants, PRA, and workshop sessions (Stubenvoll 1997).

Until this point, it would seem that pressure on marine resources through overexploitation, depletion, and destruction of their habitat has been solely caused by external fishermen. In fact, marine resources are less threatened by destructive exploitation in the Banda Islands, as external fishermen are not yet fishing in its sea territory. The local elite in Banda Neira (see Ch. 8.3.3) is successfully rejecting them, also because of the possible dire consequences for tourism that depends on diving and snorkelling. To be sure, certain external user groups are less encouraged to deploy sustainable fishing methods than local people, because they prefer to harvest resources as much and rapid as possible, before leaving on to other areas.[92] However, some locals' activities are not sustainable in both islands, too. Two examples are outlined:

[92] This includes the fishing by Butonese and Buginese fishermen in Northern Australian territories (interviews in Rhun)!

(1) *Coral mining*: The production of lime by removal and burning of live and dead coral rocks and boulders has been a rationale of many household for the construction of their houses, although mining of live corals has been prohibited under Indonesian law. In Rhun, this practice had to be recently abandoned after disputes with the local elite of Banda Neira, who has tried in vain that the Banda Islands would be included in the UNESCO list of the world's cultural heritages. People in Mamur (Tioor), however, still destruct the coral reef by removal of boulders – and with it the protective function of the reef against coastal abrasion is removed. Ironically, it is this settlement, which is most suffering from the deleterious consequences: Mamur was founded in 1959, and since then coastal abrasion has led to a loss of an about 50 m width shore including some houses of the settlement (cf. Fig. 5.3; interview with the religious leader in Mamur).

Table 5.6: Major commercialised marine species

Scientific name [*Species*, (Family), **Order**]	**Vernacular names** [**English**, *Rhunese*, Tioorese]	**Remarks on** 1. habitat; 2. user groups; 3. most common harvesting season; 4. fishing methods	**Remarks on** 1. local price, 2. trade, 3. problems, 4. current state of depletion
Trochus niloticus (Trochidae)	**Top-shell** *Lola* Gir	1. sub-littoral, juveniles in the eulittoral; 2. local & external fishermen; 3. all months; 4. snorkelling, and diving	1. Rp. 10,000 – 15,000 per kg; 2. mother-of-pearl for buttons, etc.; 3. overextraction and extraction of juveniles, sedimentation of erosion material; 4. population depleted
Turbo marmoratus (Turbinidae)	**Green snail** *Batu lagar* Kifar	1. sub-littoral, hiding in tabulate corals and holes; 2. local & external fishermen; 3. January, February; 4. snorkelling, and diving	1. Rp. 40,000 per kg; 2. mother-of-pearl for buttons, etc.; 3. overextraction; 4. population heavily depleted
Holothuridea spp.; *Thelenota ananas* (Holothuridae) (five species)	**Sea cucumber, Bêche-de-mer** *Teripang* Keb	1. sandy substrates of seagrass beds, eulittoral of coral reefs; 2. local & external fishermen; 3. October, November (*meti kei*); 4. hand collection, and snorkelling	1. Rp. 400 – 50,000 per kg dried weight, depending on the species, 2. dried food regarded a delicacy, main markets Singapore, Hongkong; 3. overextraction; 4. population depleted
Selachiformes, sub-order Selachoidea (six commercialised species)	**Sharks** *Ikan hiu* Yeo	1. pelagic and outer sub-littoral; 2. local & external fishermen; 3. September, October; 4. nets, lines, canoes	1. Rp. 200,000 – 300,000 (Tual) per kg dried weight of big fins, depending on species; 2. dried fins a delicacy, main markets Singapore, Hongkong; 3. overextraction; 4. population heavily depleted
Eretmochelys imbricata (Cheiloniidae)	**Hawksbill turtle** *?* Keran	1. pelagic, outer sub-littoral, nesting sites at beaches in Baam and Uran; 2. local & external fishermen; 3. September, October; 4. lines with big hooks, nets, diving	1. Rp. 50,000 per big shell, Rp. 4,000 per small shell; 2. turtle shells and meat; 3. overextraction; 4. population depleted
Katsuwonus pelanus (Scombridae)	**Skipjack** *Cakalang* Dom	1. pelagic; 2. local & external fishermen; 3. inter-monsoon periods; 4. pole fishing with bait fish *(momar*)	1. 3,500 Rp. per kg of pickled and sun-dried fish meat (ikan asin); 2. marketed in Ambon; 3. overextraction of bait fish; 4. fish stocks decreased
Cheilinus undulatus (Labridae)	**Napoleon wrasse** *Mamin* Mamin	1. reef fish; 2. ethnic Chinese entrepreneurs; 3. inter-monsoon periods; 4. use of potassium cyanide for catching live fish	1. and 2. US$ 150 per kg of live fish in Hongkong; 3. destruction of coral polyps, and small to medium sized fish; 4. population heavily depleted

Notes: Following species of this list are protected under Indonesian law (Purnomo 1996, 2). Their trade is therefore illegal, although still being carried out: *Trochus niloticus, Turbo marmoratus, Eretmochelys imbricata, Cheilinus undulatus*.

Sources: Interviews with households and key informants (Stubenvoll 1997).

(2) *Resource depletion by overextraction* (Tab. 5.6): Economic valuable species, such as top-shell, green snail, sharks, turtles, and bêche-de-mers, have a long history of commercialisation, and have been severely overfished in both islands, although temporarily limited *sasi laut* on top-shell (*lola*) (cf. Ch. 5.4.2) had helped to slow down the collapse of this species. For instance, the yield of *lola* in Rhun reached around ten tons during one collection period of two weeks (*buka sasi*) every three years in the 1970s, whereas presently this species plays an insignificant role in the village economy (interviews with households and key informants; Arifin 1993, 100). Turtle-hunting was a major economic activity of Tioorese until the 1950s, but had to be abandoned when stocks have dropped to uneconomic levels. Green snail and certain shark species have probably reached the limits of extinction, as their harvest has become an extremely seldom event.

Another problem and a threat to the productivity of the coral reef and the seagrass beds – and therefore to the reproduction of species living in these ecosystems – is *sedimentation*: both a *steady* sedimentation of soil material caused by natural and anthropogenic erosion, and in the case of Rhun, a *periodic* sedimentation of volcanic eruption material in the littoral.[93] Thus, the interaction of land use and marine ecosystems on the one hand, and the loss of coastal land through removal of coral boulders on the other hand, are underlining the need for an integrated approach towards rational resource management in small tropical islands.

Handicraft

Handicraft (forging, weaving, sewing, joinery) is an important source of income for a couple of households. In Rumoi, Duryar and Rumalusi (Tioor), *forging* has a long tradition, possibly for three centuries. Some of the forgers are seasonally working in other places, such as Seram and Gorom. Main products are machetes, which are known for their best quality in Central and Southeast Maluku, and the Bomberai peninsula of Irian Jaya. Steel as well as most tools are imported. Charcoal is produced from *perai* (*Intsia bijuga* (Colebrooke) O. Kuntze) in the forests of Tioor. Timber from locally available *ninar* (*Hernandia ovigera* L.) is processed to machete handles. Permanent groups of eight to ten men are involved in the production process. The owner of the raw material is organising the work and – similar to *kerja masohi* – responsible for all costs. This includes input of material (steel, charcoal, cheaper tools), and food, tea, coffee and tobacco for the whole day. He then owns all the produced machetes and is later obliged to help the members of the group in forging their machetes. Expensive tools such as anvils, hammers, and air pumps are jointly owned by the group. Forging requires great strength and energy, and is therefore performed by the strongest men of the community. It will only remain profitable as long as charcoal can be locally produced, and if machetes can be sold in regional markets. Thus, the future of traditional forging depends on the availability of *perai* or locally available alternative raw materials for charcoal production.[94] Indicators for a decreasing supply of *perai* timber include: a doubling of the price of charcoal in recent years (presently Rp. 10,000 for one sack of approximately 50 kg); increasing distances to find adequate timber; and an exhaustion of formerly used timber species, such as *kei papua* (*Pemphis acidula* J.R. & G. Forster). At present, it takes a man two days to produce the quantity of charcoal that is needed for the one-day production of his machetes. Charcoal is presently not efficiently produced, as the timber is not burnt in airtight condition. Moreover, fire occasionally spreads to neighbouring forests, fields and tree gardens. An advantage of forging is that it is mainly carried out in the dry season, when agricultural activities can be kept to a minimum.

[93] The latter has also positive effects, however, as soil fertility is being improved.

[94] E.g., timber from *Diospyros* sp., *Calophyllum inophyllum*, *Casuarina equisetifolia*, and the hard shells of coconuts.

Some women, particularly in Rhun, Kerker, and Kelvow, are *weaving* mats from collected and dried leaves of naturally established or planted *Pandanus* species,[95] either for self-sufficiency or for the local market to generate additional income (e.g., HH 2, 48). Weaving might be the single most important income-creating activity of widows (e.g., HH 4, 44). A multitude of other household appliances, such as rattan baskets (*kamboti*) for transporting agricultural products, are woven by some women in Tioor. *Sewing* is another handicraft carried out by those women, who have access to mechanic sewing machines. Cloths are sold in the village.

Joinery (furniture, house construction and ship building) is done by some men in both islands by order of a client or as seasonal work migration into the main towns of Central and Southeast Maluku (Ambon, Tual, Dobo). A major difference between Tioor and Rhun is the origin of timber. In Tioor, it is most commonly obtained from local primary and mature secondary forests, and sometimes from agroforests, whereas in Rhun most of the timber has to be imported from other islands, such as Seram. Since the Government has prohibited timber trade between islands, joiners in Rhun risk the confiscation of imported timber by the police. Various species yielding high quality timber are processed, for instance: *Calophyllum inophyllum, Diospyros sp., Pterocarpus indicus, Tectona grandis, Terminalia catappa* (for furniture*), Intsia bijuga, Nothaphoebe calista, Pometia pinnata, Terminalia catappa, Toona ciliata* (for house building including doors, roofing, etc.), and *Calophyllum inophyllum, Hibiscus tiliaceus, Intsia bijuga, Neonauclea glabra, Tonna ciliata* (for ship construction) (cf. App. 1.5; Ch. 6.3.6). Some of these species have become almost extinct, such as *Cordia subcordata* Lamk, which is in great demand due to the resistance of its heartwood in sea water. Imported *Cordia* timber is used for the back part of the keel line. Like the forgers in Tioor, joiners and carpenters will therefore depend on the future availability of high quality timber. In this respect, Tioor seems to be in a better position due to remaining forest resources, although suitable timber may be soon exhausted without an effective resource management.

Sailing and trading

In Rhun, *sailing and trading* is another economic sector in which several households earn their living. Trade has been performed with sailing ships (*perahu*), and since the 1980s with motorised ships (*perahu motor,* some 20 t loading capacity) of the wealthier Rhunese, who have continued this long tradition of Butonese traders, sailors and ship builders. In the 1970s, nutmegs were smuggled out with these ships as far as Singapore, where motors could be purchased much cheaper. Starting capital was borrowed from ethnic Chinese in Banda Neira. Additionally, the crew took emigrants from Flores and Sumbawa for a fare of Rp. 80,000 (roughly US$ 100 in 1980) per passenger, who looked for work in oil palm and rubber plantations in mainland Malaysia. On the way back from Singapore, onions were bought in Sumbawa and transported to be sold in Banda Neira.

Since the collapse of the nutmeg plantation enterprises and the low nutmeg producer prices (until 1996) inter-provincial trade is presently limited to Sumbawa. The main route of the Rhunese trading vessels, however, is between Ambon, Seram's south coast and the Banda Islands.[96] As previously pointed out, the number *of perahu motor* has steadily increased and amounts to 40 vessels (1996; 20 vessels in 1993), which are employed both for trade and regional fishing. Thus, calculating an average crew of five sailors/fishermen per *perahu motor*, some 200 Rhunese households live off work on the vessels. The profit of the trade is shared in the same manner as the profit of regional fishing (2:1 for

[95] The preparation of leaves is time-consuming, and includes the removal of the prickles at the leaf margins and at the underside of the midrib. Hence, *Pandanus* species without prickles are preferably planted.

[96] Traded goods are mainly agricultural products (clove, nutmeg, bananas) and *ikan asin* to Ambon, and consumer goods and foodstuff (rice, sugar, salt, etc.) to Banda. Moreover, passengers can cheaply travel on these regularly operating vessels.

the crew). This profit sharing once favoured the ship owner. As one sailor put it: "*Nowadays the ship owners have difficulties to find enough sailors, because there are so many ships, and the crew will easily find work on other vessels if their profit is not acceptable. Formerly, in the 1980s, the profit was shared 2:1 in favour of the ship owner*."

Unlike Rhun, where trade is entirely carried out by members of the community, limiting profits of traders and ship owners due to mutual social obligations, trade in Tioor is dominated by three ethnic Chinese merchants, who are transporting copra directly to Surabaya (Java) with huge *perahu motor* (some 150 t loading capacity each). Two of them are settling outside of Tioor, and therefore have engaged middlemen in Tioor (e.g., HH 30, 63), who in their turn are committed to the price fixing by the merchants – relatively low floor prices for copra, and relatively high prices for imported foodstuff and consumer goods being sold in the village. The third trader lives in Tioor and operates without intermediaries, but in times of his absence the other two merchants are able to lower floor prices for agricultural products. Thus, trade provides a steady income for only a few households in Tioor, whereas some men can occasionally earn some money from loading and unloading of cargo.

Seasonal work migration

Some forms of *seasonal work migration* have been previously outlined (joinery, forgery, regional fishery, trade), and are still important for the village economies. Other forms were frequently performed in previous years, but have disappeared. An illustrative example is the clove harvest in the main clove producing areas of Central Maluku, i.e. Seram, Lease Islands and Ambon. Until the establishment of the state monopoly in clove trade and its body BPPC in late 1990, the seasonal harvest of cloves was a lucrative incentive to leave the home village, and to get half of the picked cloves from the clove farmers. The collapse of clove producer prices since 1991/92, as a consequence of the state clove monopoly (Schwarz 1992, 58; Schwarz 1994, 153-7), has made the harvest unprofitable for both clove farmers and pickers.[97] Remaining forms of seasonal work migration are sporadically pursued by the villagers, but can be of significance for certain households (e.g. HH 7, 16, and 42), for instance: work in restaurants, shops and private households in Ambon, Geser, and Tual; as communal taxi drivers in Ambon, and Tual; or as day labourers in governmental infrastructure projects in Irian Jaya.

Investments, rents and pension

Most of the investments and their related businesses were touched on previously, so that it is not necessary to wrestle with a further delving into every mode of investment. Various investments are generally the case in most sectors of the villages' economy, and in those parts of the infrastructure provided by private households (e.g., diesel engines, television sets). Investment is treated here as a separate category just for larger capital investment of certain households, in order to be able to distinguish it from *labour* input of other households in the respective sector. For instance, the most obvious case of an investment, a *perahu motor*, into which a ship owner had to put a large amount of capital – common are Rp. 10 to 15 million (1996) – is a requirement for labour input and income generation in regional fishery of the crew members. A fixed part (one third) of that income is submitted to the ship owner, who usually does not *actively* participate in fishery. After the break-even point of his investment has been reached, the profits are net proceeds of the ship owner (HH 12, 13, 19, 22). Another type of investment is a stake in an inter-provincial trade mission, such as buying onions in Sumbawa, which needs a lot of capital (HH 21). On the other hand, an investment has not

[97] In 1986, 1 kg of dried cloves was traded at Rp. 6,200 (then some US$ 5) (Godoy and Bennett 1990, 67), whereas since 1991 prices have fluctuated between Rp. 1,500 and 2,500 per kg (in 1996: US$ 0.6 to 1.0) (interviews with villagers).

been included in this category, if the household generates income with it on its own, such as a fishing net and a canoe, or tools for forging and joinery.

Although house construction in Ambon (HH 13) or other towns, and land purchase in Seram, are investments in the wider sense, they have been included in the category *'rent and pension'*, because a regular, fixed rent is fetched, which is not dependent on the performance and profits of economic activities. An exceptional case of income source is the pension of a retired army officer (HH 15).

Structure of economic activities

The information on off-farm income-generating activities provides an essential background to the analysis of the farming systems in both islands, for several reasons.

(1) It has to be stressed, that many but not all off-farm activities are performed in times, when intensive labour input into agriculture is not necessary, such as gardening during the dry season. Regional fishing, for instance, depends on a calm sea, usually in the drier months of April till June, and August till November. In December, the beginning of the rainy season and strong west monsoons with a rough sea, virtually all fishermen will stay in Rhun for gardening.

(2) The structure of off-farm economic activities may set limits to the extension of labour-intensive farming systems, especially in cases of absence for a longer period of time.

(3) Sufficient income from off-farm sources may have two different consequences for a farming household: Either, by making it easier to focus on subsistence agriculture as cultivation of cash crops can be reduced or foregone, and thus decreasing dependencies on food import; Or, by making it easier to enlarge the area of tree-based farming systems including cash crops, if cash from off-farm activities is used to buy imported food.

A summarising comparison of the structure of economic activities in both island communities does not only reveal considerable differences, but also common characteristics and trends:

(1) The main income source is agriculture in Tioor (28 of 36 households), and regional fishery, trading and sailing in Rhun (11 of 23 households). Thus, Tioor's economy, which was formerly dependent on migration (turtle-hunting, forging, and sago-processing in other islands) is presently island-based. The reverse development has occurred in Rhun, where people have shifted to activities outside the island. This result can be seen as valid for the communities, as households were chosen by quota selection. It is underlined by statements of interviewed households and key informants. As HH 2 in Rhun put it: "*Income sources have changed: formerly nutmeg, nowadays fishery. In the 1960s, there were enough nutmegs, but beginning in 1975, plantation life has become more difficult as wages were insufficient. From the island we could no longer earn our living. Therefore we have begun to fish. From 1985 on, we look for fish in other islands such as Wetar. ... And since the clove harvest in Seram has no longer been profitable, many of us are fishing there. Too many fishermen from Neira and Banda Besar are competing with us for fish in the Banda Islands*".

(2) Most households perform a multitude of economic activities, such as HH 48 who is a fishing *small-scale farmer with coconut plantings* and goat husbandry, and whose wife is engaged in weaving and sewing. However, twelve households in Tioor rely on a single income source (horticulture), whereas in Rhun this is not the case at all. Only HH 15 almost completely depends on his pension, because his husbandry fetches a marginal income.

(3) Most economic activities depend on the condition of the natural resource base. Even the secondary sector activity of forging draws on high quality timber for charcoal production. Hence, any further

depletion and degradation of these natural resources may have deleterious consequences for the livelihood of the people.

5.6 Summary and conclusion

The Dutch VOC's conquest of Banda had terrible consequences for the indigenous Bandanese, who were killed, slaved, or forced to flee the islands in 1621. In the aftermath of this event, communities on surrounding islands such as Tioor, although not directly integrated into the colonial spice trade, had to destroy all nutmeg and clove plantings. One result was a significant change of the agricultural landscape in the region. Another effect of the Dutch plantation system in Banda is related to land tenure. Unlike Tioor, where traditional land tenure is practically accepted by the Indonesian Government, the *de jure* status of governmental land in Rhun contradicts with traditional land tenure, which is therefore highly insecure. Despite this difference, which considerably influences cultivation patterns (see Ch. 6), *de facto* land tenure is flexibly and pragmatically arranged, because problems, such as land fragmentation, struggle for land and disputes about field boundaries, have to be constantly addressed. As these co-ordinates change over time, it is difficult to recognise some kind of 'universal autochthonous theory' of land tenure. Rather, traditional land tenure underlies subjective interpretation and social, reciprocal relationship. Moreover, it is interdependent with other tenure arrangements, such as tree tenure (see Ch. 6.3.3).

Adat is closely related to land tenure and history. It has a relatively strong and persistent influence in Tioor, although it is weakening as a result of administrational reforms at village level, strong influence of military persons and religious leaders, improved infrastructure, and commercialisation and integration into the domestic and global economy. To the contrary, *adat* is less important in Rhun, where *adat* organi-sations are not existing. The descendants of the Butonese, who were immigrating to Rhun at the end of the nineteenth century for plantation work, are at least practising some Butonese *adat* institutions such as land tenure. *Social organisation* is dominated by clan and family considerations in the ethnically heterogeneous society of Tioor, whereas in Rhun the household is the leading element in a ethnically relatively homo-genous society.

On both islands, limited natural resources are the life base for the people, who are engaged in a variety of agricultural and off-farm economic activities. Fishery is the most important economic activity besides agriculture, contributing to a balanced diet of the islanders, as well as to income generation, particularly for highly mobile Rhunese fishermen. However, pressures to resources have increased, especially to forests and coral reefs, partly as a consequence of population growth and increasing land fragmentation, but also by external fishermen and their destructive fishing techniques in Tioor's territorial waters.

These cultural, institutional, and socio-economic factors are important for the discussion on farming systems in the next chapter. Of particular interest is the question of how these factors affect peasant strategies and decision-making, cultivation patterns, labour arrangements, tree tenure, accessibility to natural and cultivated resources, and resource management.

6. SYSTEMS AND THE DYNAMICS OF LAND USE

In this chapter it will be shown that farming is a primary economic basis of the people in Tioor and Rhun. Although present land use in many details is differing between both islands, *recent developments and changes* illustrate the presence of major trends: the importance of subsistence-oriented farming, deforestation, and – partly as an adjustment to deforestation – an emergence of traditional agroforestry. Moreover, these transformations underline two limitations in small island agriculture: the scarcity of land, and the fragility of resources like soil and fresh water.

The analysis is presented in five steps. For an understanding of present agriculture, it is essential to begin with a brief account of *historical* land-use systems in Ch. 6.1. Ch. 6.2 gives an overview of the *present* land-use system as a whole and demonstrates, that in either island it consists of several land-use types. As the most common management unit in farming is the household, which is simultaneously practising the wide range of these – spatially, sequentially, ecologically, and socio-economically interdependent – land-use types, the *farming system of the household*, i.e. its structures, practices, functions and dynamics, and the role of traditional agroforestry within it, is of central concern in Ch. 6.3. A synthesis of the underlying peasant strategies, and explanatory factors and effects of land-use change in both islands during the past three decades are then subjects of Ch. 6.4. Case studies of farmers in Ch. 6.5 provide an even deeper insight into the decision-making of the households, and round off the analysis of farming systems.

6.1 Historical land-use systems

6.1.1 The nutmeg tree and its cultivation in the Banda Islands

As already stated in Ch. 5.1, the genesis of historical land-use systems in Rhun and Tioor is closely related with the pre-colonial and colonial spice trade. Before a description of historical land-use systems can be given, a brief review on the botany of the spice-producing nutmeg tree, which was historically most important in the Banda Islands, is outlined in the following.

Botany of *Myristica fragrans* Houtt.

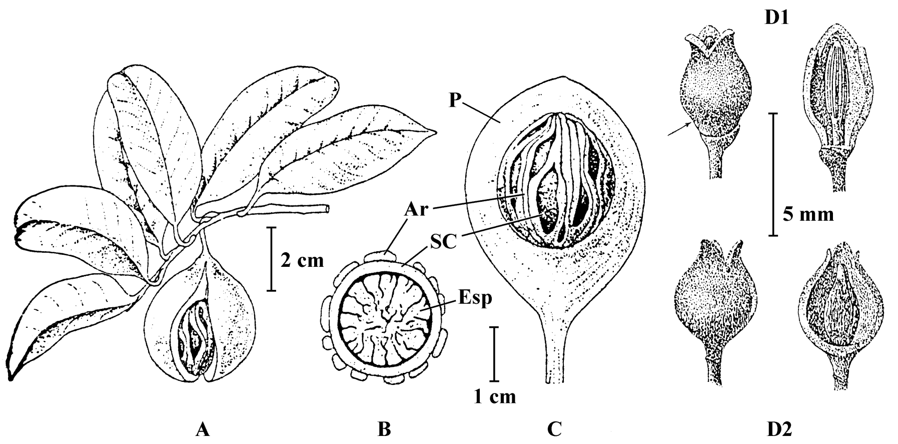
The nutmeg tree (*Myristica fragrans* Houtt.) grows to a height of up to 18 m and belongs to the *Myristicaceae*, which are indigenous to tropical rainforests. The root system consists of one tap root, and of 3 to 4 m long superficial roots, where nutrients and water are absorbed. Usually *Myristica fragrans* Houtt. is *dioecious*, but sometimes hermaphrodites are found. During the youth of the tree, the determination of its sex is not possible,[98] so that the first flowering at the age of six years is the earliest possibility to identify female trees and to cut out unproductive male trees. In plantations, only 10% of the trees should be male to guarantee pollination, which is effectuated by a moth (Flach 1966, 15). The fruits develop in 6 months if few fruits are growing, and it takes 9 months if there are many fruits on the tree (Flach and Tjeenk Willink 1989, 194). Within the pericarp of the yellow fruit is the kernel (Fig. 6.1), which consists of the seed, the dark brown, hard seed coat and the surrounding crimson aril. The mace of commerce is the dried aril and the nutmeg is the dried seed, often called a nut. The pericarp splits open into two halves when the fruit is ripe and shows the kernel. The true[99]

[98] The examination of the holokinetic chromosomes [2n = 44; Brücher (1977, 426) states 2n = 42] could be a hypothetical possibility, but this is not tested yet (Flach and Tjeenk Willink 1989, 194).

[99] Besides *Myristica fragrans* Houtt. other species of the genus *Myristica* produce nutmeg and mace either, such as *M. argentea* Warb., *M. fatua* Houtt., *M. malabarica* Lam., *M. schefferi* Warb., *M. speciosa* Warb., *M. succedana* Bl. (cf. Warburg 1897, 331-91; Deinum and Thammes 1949, 656-7). However, they are less important for the world market due to their lower quality. They are used locally or to stretch true nutmeg products (Brücher 1977, 426).

nutmeg tree is a slow grower and can be productive until the age of about 100 years, with highest yield between its 15th and 40th year. It originates from Southern Maluku, probably Banda and surrounding islands (Warburg 1897, 268-92). The Banda Islands, however, have been the centre of domestication of *Myristica fragrans* Houtt. for centuries.

Figure 6.1: *Myristica fragrans* Houtt.



Notes: **A** Twig with ripe fruit (pericarp split open); **B** Cross-section of a kernel; **C** Fruit, longitudinal view; **D1** Male flower; **D2** Female flower (flowers distinguishable by base of the perianth, see small arrow in D1); **P** = Pericarp; **Ar** = Aril; **SC** = Seed coat; **Esp** = Endosperm (seed).

Sources: Flach 1966, 12; and Rehm 1989a, 499.

The land-use system during the colonial era: nutmeg plantations

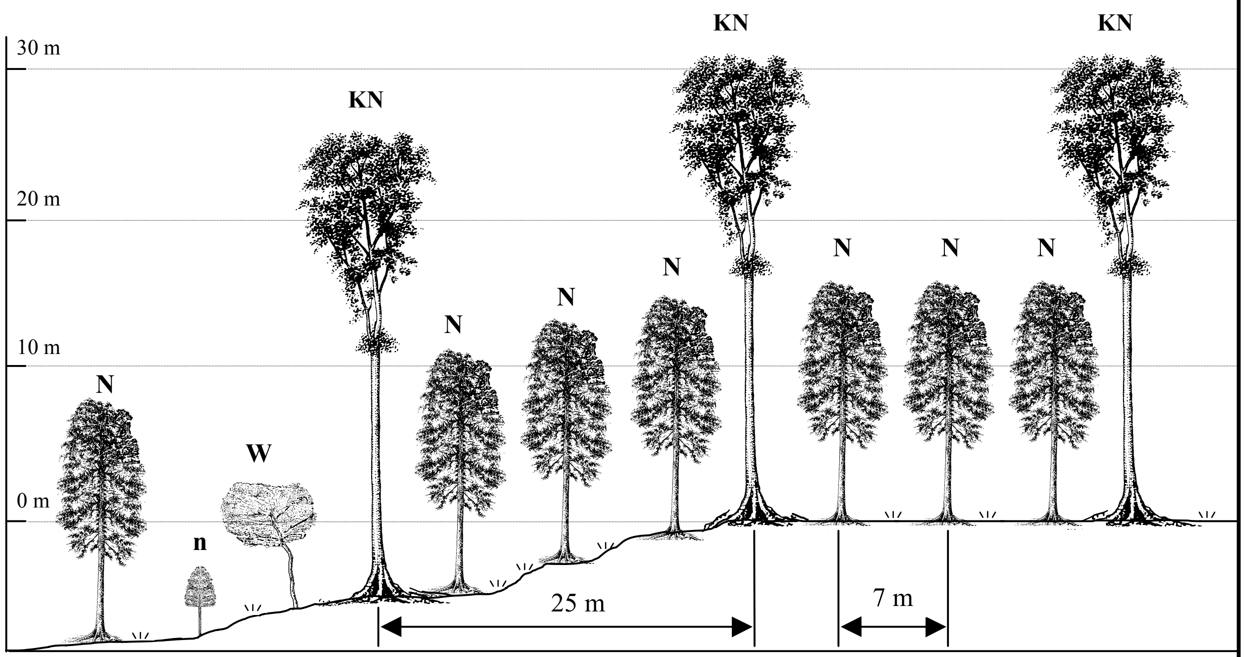
This paragraph pays attention to the structure and cultivation practice of a colonial nutmeg plantation by using a typical profile (Fig. 6.2). The forest-like multi-storey **structure**[100] of a nutmeg plantation contains four layers. The *upper layer* consists of treetops of protection trees in a height of 30 m to 35 m. The *perkeniers* cultivated kenari (mainly *Canarium vulgare* Leenh., but also some *Canarium indicum* L.), and to a lesser extent durian (*Durio zibethinus* Murray) and gayam [*Inocarpus fagiferus* (Parkinson) Fosberg]. The functions of this layer are manifold: *First* of all, it protects the nutmeg culture from strong wind which otherwise could cause unripe fruits to fall down or uproot nutmeg trees. Furthermore, flowers and unripe fruits are sheltered from heavy rainfall. *Secondly*, with increasing shade the trees are better protected from insolation, although yield is decreased. In this context Warburg (1897, 395-96) stresses the importance of a constant sufficient air humidity. At least during longer droughts shade becomes indispensable.[101] To avoid low yields, protection trees should not be planted too densely. A distance of 30 m, or 11 trees per ha, is probably enough (Warburg 1897, 397 and 410). In the Dutch nutmeg plantations of Banda, protection trees were planted at irregular distances of an estimated 25 m, or 16 trees per ha. *Thirdly*, water runoff is retarded, so that the groundwater reservoir is more quickly recharged, with a positive effect on soil moisture store during longer dry periods. And *fourthly*, old protection trees and cut out branches provide fuelwood, which was used by the *perkeniers* to dry nutmegs (see below).

[100] Although the *structure* is forest-like, bio-diversity in a nutmeg plantation is obviously poorer than in a primary forest.

[101] There are also other, diverging opinions about the question, if protection trees in nutmeg groves are necessary at all. Flach (1966, 7 and 10) points out, that in Grenada farmers do not plant protection trees, and that shade is only necessary during the growth stage of the nutmeg tree. Warburg (1897, 395-99) provides a detailed discussion about the requirement of shade.

In the second layer from above, nutmeg trees are situated with an optimal spacing of 7 m to 8 m, because roots and branches then do not touch against each other. This means a total number of about 130 trees per hectare, but not all of them being productive. Some fast growing *warok* trees (*Hibiscus tiliaceus* L.) shall shade young nutmeg trees, that are growing in the *two lower layers*. For it is impossible to distinguish the sex of young nutmeg trees, more seedlings than actually required are then planted. When these have reached maturity the warok trees and most of the unproductive male nutmeg trees are cut away. *The grass layer* on the ground has the functions of keeping superficial roots of the nutmeg trees moist and averting soil erosion in sloping terrain. It should be regularly cut to make the search for fallen kernels easier.

Figure 6.2: Cross-section of a colonial nutmeg plantation on the Banda Islands



Notes: **W** Warok (*Hibiscus tiliaceus*) **N; n** Nutmeg (*Myristica fragrans*) (fruiting tree; young tree)
KN Kenari (*Canarium vulgare*) ɩı/ Grass layer

Sources: Warburg 1897, 392-468; Syamsudin 1995, 107; Nurhaman 1995, 352, redrawn and adapted by Stubenvoll 2000; Mapping, interviews, and photographs (Stubenvoll 1996).

The **cultivation** of a nutmeg plantation is somewhat labour-intensive. For *propagation*, the biggest and roundest, maximally 3 day old seeds are put 5 cm deep into a shaded nursery, at a distance of about 40 cm, where they germinate after one or two months. After one year the 50 cm high seedling is transplanted to its designated place in the plantation, putting it into a prepared deep hole by taking care to not hurt its tap root (Warburg 1897, 401-10). To avoid the problem of dioecy, vegetative propagation of high yielding female trees by air-layering and approach-grafting has been developed in Grenada since the 1960s, but only to a limited success of maximally 60 to 70% of the cases (Flach and Tjeenk Willink 1989, 195). Natural reproduction of the nutmeg tree is secured by pigeons (*Columbidae*), which swallow the kernel, digest the mace but cast up the seed uninjured. *Husbandry* has to be regularly carried out. It includes the removal of unproductive male or old trees, and additionally trees, which are infested by diseases;[102] irrigation of trees during droughts; cutting off of

[102] Compared to other plantation crops, e.g. coconut or cocoa, pests and diseases are relatively seldom. Serious are the fungi *Corynium myristica* on twigs, leaves and fruits, which causes unripe fruits to open, and *Roselina pepo*, which destroys the roots. Pests include *Ischnapsis longitrostris* and the beetle *Phloeosomus cribatus*, which entirely destroyed the

lower branches to facilitate harvest; and removal of climbing plants. During the colonial era, fertiliser application was not practised due to the fertile volcanic soils of Banda. Manure was sufficient to keep the plantations productive for centuries.

Although the tree bears ripe fruits all over the year, *harvest* is worth to be carried out only if larger quantities are on the tree. In Banda, fruits are harvested twice a year, namely from June until August (big harvest), and from December until January (small harvest). During the colonial period, only fruits with a split pericarp were harvested, because an earlier picking would damage the tree and would decrease the quality of the products. The pericarp is left in the plantation as a manure, while the kernels are taken to the *perk* house for further processing. Here the aril is separated from the seed coat and sun-dried. The seed is dried in special drying rooms over a smoulder of fuelwood (mainly from *Canarium vulgare* Leenh.) for several days. Sun-drying could cause melting of fats, resulting in nutmegs of low quality. After drying, the seed coat is removed and the seed chalked to protect it from insect damage. Hence, the quality of products is not only dependent on natural conditions, but also to a great extent on the way of harvesting and processing. According to Warburg (1897, 434) the *perkeniers* could annually harvest *yields* of up to 200 to 250 kg per ha of nutmegs (30 to 35 kg per ha of mace). The most important yield factor is the number of female and hermaphrodite trees, because male trees are not productive. Some female trees produce annually 7,000 fruits (around 35 kg of dried nutmegs) or more, but the average is only 500 to 1,000 fruits. As pointed out above, fruits should be picked exactly when ripe, because then nutmegs and mace have the best quality, and also the highest weight. If all factors, including an optimal distance of protection trees, are taken into consideration, annual yields may be increased up to 500 to 1,200 kg per hectare of nutmeg and 80 to 170 kg per hectare of mace (Rehm 1989a, 500).

The number of nutmeg trees on the Banda Islands is well documented, and this allows a calculation of the area of the former plantations. Warburg (1897, 269) estimates the number to 350,000 productive trees, of which 38,000 were situated in Rhun. Thus, with an average of around 100 productive trees per hectare, 35 km² or 69% of the islands' area was cultivated with nutmeg plantations at the end of the nineteenth century.

6.1.2 Historical land use in Tioor

Unlike the comprehensive account of the domestication of nutmeg and the structure of the colonial plantations in Banda provided by numerous literature, rudimentary information on the historical land-use systems in Tioor by travel reports and other secondary sources is restricted to the description of some of the plant species that were cultivated in the eighteenth and nineteenth century. Thus, the following discussion on historical land use in Tioor has to focus on the information provided by interviewed key informants. This results in a strongly biased account of the dominant land-use patterns, which existed in the first half of the twentieth century before a major change in land use has emerged. As pointed out in Ch. 5.1, the Tioorese had definitively cultivated, at a substantial level, nutmeg in the seventeenth, and coconut in eighteenth century, and became a destination of the Dutch VOC *hongi* expeditions. In the nineteenth century, travel reports mention several annual and perennial species (cf. Ch. 5.1), although it is not clear if all tubers and sago were cultivated on the island or were, at least partly, imported. However, as the Tioorese were economically very active (forging, turtle-hunting) on many islands of the region (e.g. Kei, cf. Jacobsen 1896, 173-5), it is very likely (and backed up by information of key informants) that they bartered their products with foodstuff brought

plantations in Penang and Singapore in the nineteenth century (Burkill 1935, 1527; Rehm 1989a, 500; Flach and Tjeenk Willink 1989, 195).

back to Tioor. In first half of the twentieth century, the land-use system of Tioor had the following general characteristics (interviews with key informants):

(1) Shifting cultivation was not practised, as all annuals and perennials were permanently cultivated in mixed gardens in the fertile coastal plains near the settlements. As many Tioorese migrated seasonally to other islands and brought back sago starch, the area devoted to cultivation was limited[103] and merely served the subsistence activities of the people. Main staple crops were cassava, taro, bananas, and rice, which were grown in mixed cropping systems.

(2) Most of the sago and coconut tree gardens have been established since the 1950s, although some of these groves have existed for centuries.

(3) Primary forest had occupied most of the island's area, particularly on slopes and ridges. In 1980, primary forest still occupied an estimated 50% of the island's area (interviews with village leaders). The extension of fields into the slopes has emerged in the 1960s (in the western and southern part) and in the 1970s (in the northeastern and eastern part), since coconut tree gardens have occupied a considerable part of the coastal plains. Another reason for this extension was the increasingly important role of marketing of tubers, such as taro, to islands in the region, as a result of better transportation, and of the trading ships that have begun to stop in Tioor.

6.2 Overview about present land use

Present *land-use systems* in Tioor and Rhun consist of several major kinds of land use (here defined as land-use types)[104] of different importance in each island. In the following, these *land-use types* are described[105] by using typical transects (Tioor: Tab. 6.1 and Fig. 6.3; Rhun: Tab. 6.2 and Fig. 6.4).

6.2.1 Tioor

(1) A strip of coastal plain planted with *coconut tree gardens* (*dusun kelapa*; *Cocos nucifera* L.): Although mono-specific coconut groves exist, the integration of a variety of other trees and shrubs into a *dusun kelapa*, such as bananas (*Musa* spp.), betel-nut (*Areca catechu* L.), breadfruit (*Artocarpus altilis* Fosb.), nutmeg (*Myristica* spp.), and fruit trees like mango (*Mangifera* spp.) is more common. *Settlements* are also located in the coastal plain. Only few trees are planted in the settlements.

(2) *Tree gardens* (*dusun*) at the transition from the coastal plain to the slopes, at lower slopes, and along some streams as far as the upper watershed (Werkar, Werkilwer, Wertac), with following subtypes:

    (a) *Sago tree gardens* (*dusun sago*; *Metroxylon sagu* Rottboell) of spiny and spineless cultivars;

    (b) *Coconut tree gardens*: like (1).

    (c) *Mixed tree gardens*, consisting of a combination of coconut, sago, nutmeg and fruit trees: Most common of the latter are durian, jackfruit (*Artocarpus heterophyllus* Lamk) and mangos;

[103] Limited plant cultivation in natural sago palm areas of Seram is also observed by Ellen (1993, 199): "... [It] is undoubtedly the case that the ready accessibility of a palatable starch [provided by sago] cannot have provided much of an incentive for plant cultivation. Indeed, overall, Seramese patterns of subsistence can be characterised by a heavy reliance on non-domesticated resources ... "

[104] The expression 'land-use type' may be interpreted in two different categories: (1) *major kinds of land use*, i.e. the types of rural land use such as rainfed agriculture, irrigated agriculture, and forestry; (2) *land utilisation types*, i.e. the types of rural land use *including* technical (e.g., degree of mechanisation), economic (e.g., subsistence, market-orientation) and social (e.g., labour, knowledge) criteria (cf. FAO 1976, 12; Amler and Betke 1993, 114).

[105] In later sections all land-use types are thoroughly analysed.

(d) *Nutmeg tree gardens* (*dusun pala*): Two species are cultivated, namely true nutmeg (*Myristica fragrans* Houtt), and Papua nutmeg (*Myristica argentea* Warb.), either without, or with protection trees like *kier* (*Canarium indicum* L.), durian (*Durio zibethinus* Murray) and mainly naturally established *wepa* (*Paraserianthes falcataria* Nielsen);

(3) *Dry fields* (Indonesian: *ladang;* locally: *magowa*), *secondary forest* (*aung; pes*), pockets of *primary forest* (*ewang; kai kyakan*), and some *mixed gardens* and *tree gardens* on the slopes up to the central ridge: The dominant land-use practice in this area is *shifting cultivation*, but farmers have also extended tree gardens uphill by subsequent planting of perennials (coconut, nutmeg, fruit trees) into the dry field.[106] In the latter case, the plot is no longer abandoned for secondary forest to grow, so that the rotational cycle of shifting cultivation is interrupted. The first crop in a *ladang* is either a cereal, such as rice (*padi ladang*, *Oryza sativa* L.), maize (*Zea mays* L.), or foxtail millet (*Setaria italica* (L.) Beauvois), or a crop yielding non-seed carbohydrates like taro *(Colocasia esculenta* (L.) Schott), cassava (*Manihot esculenta* Crantz) and sweet potato *(Ipomoea batatas* (L.) Lam.), or a combination of these crops. Additionally, pulses [e.g., groundnut (*Arachis hypogaea* L.) and mung bean (*Vigna radiata* (L.) Wilczek)], and vegetables [e.g., chilli (*Capsicum* spp.), eggplant (*Solanum melongena* L.) and tomato (*Lycopersicon esculentum* Miller)] are grown.

(4) The central ridge is occupied by three different land-use and vegetation types:

(a) *Primary forest* (northern part of Tioor): It is situated in the headwaters of streams (Werkier, Wervurun, Werlarat) and plays a crucial function in freshwater supply during dry spells. Timber trees of economic importance include *perai* (*Intsia bijuga* (Colbrooke) O. Kuntze), *ton* (*Pometia pinnata* J.R. & G. Forst.) and *kai kuning* (*Nothaphoebe calista* Kosterm.).

(b) *Degraded land* (central part): *Alang-alang* grass (*Imperata cylindrica* Beauv.) is the dominant species in the area around the highest peaks (e.g., Gunung Ra, 358 m). Furthermore, *Pandanus* and fern species are widespread.

(c) A heterogeneous combination of *dry fields, secondary forest, tree gardens, mixed tree gardens* and *mixed gardens* (southern part): Especially in the community of Kelvow, farmers are using this land-use system, also with techniques not being observed in other communities (cf. Ch. 6.3.3). Besides shifting cultivation and mixed gardens like (3), and tree gardens like (2), they cultivate extensive coffee stands (*dusun kopi*; *Coffea* spp.) and clove tree gardens (*dusun cengkeh*; *Syzygium aromaticum* (L.) Meryll & Perry). Additionally, all of their nutmeg tree gardens are protected either by integrated *Canarium indicum* L., or by trees of primary forest spared from removal, like *luriah* (*Diospyros* sp.) and *ton* (*Pometia pinnata* J.R. & G. Forst.).

(5) *Primary forest* on upper eastern slopes: At headwaters (Wersody, Wergus) like (4a).

(6) *Dry fields* and *secondary forest* on lower eastern slopes: Shifting cultivation like (3), but *tumpangsari* is very seldom practised.

(7) *Mixed gardens* and *tree gardens* along the bottom of slopes, and along some streams (Wersody, Wermamur): Subtypes like (2), and additionally *clove tree gardens*, *coffee stands*, and clove and coffee integrated into *mixed tree gardens* like (2c).

(8) Large *sago tree gardens* in the basins behind the coastal bank: like (2b).

(9) *Coconut tree gardens* and *settlements* on the coastal bank: like (1).

(10) *Mangroves* (*bakau; manggi-manggi*) in the estuary and the mouth of streams (Wervurun, Wertengah, Wersody), e.g., *Sonneratia alba* J. Smith, and *Avicennia marina* (Forsskal) Vierh.

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[106] The Indonesian term for this practice is *tumpangsari*. For more information see Ch. 6.3.3.

Table 6.1: Land-use and vegetation types in Tioor

Land-use type Vegetation type	**Main species of economic importance**	**Area (%)**	**Characteristics, comments**
Primary forest (*ewang; kai kyakan*)	*Intsia bijuga, Notaphoebe calista, Pometia pinnata*	16%	Original vegetation; now restricted to mountain ridges, sacred places, headwaters of some streams.
Secondary forest (*aung; pes*)	*Calophyllum sp., Paraserianthes falcataria,*	39%	Growing on land abandoned from dry field cultivation, or in areas affected by accidental spread of fire.
Beach vegetation	*Hibiscus tiliaceus*	less than 1%	Mostly replaced by coconut tree gardens.
Mangroves (*bakau; manggi-manggi*)	*Avicennia marina, Sonneratia alba*	- - -	Restricted to Baam Island and some places in the east coast of Tioor.
Dry field* (*ladang; magowa*)	*Colocasia esculenta, Dioscorea spp., Ipomoea batatas, Manihot esculenta, Musa* spp, *Oryza sativa*	8%	Established mostly in hilly, also on steep terrain; shifting cultivation; abandonment of field after 3 to 5 years (rotational cycle), or integration of perennials.
Coconut tree garden (*dusun kelapa*)**	*Cocos nucifera, Areca catechu*	16%	Planted on coastal plains and now being established uphill.
Sago tree garden (*dusun sago*)**	*Metroxylon sagu*	4%	Planted along streams and behind coconut palms of the coastal plain.
Nutmeg tree garden (*dusun pala*)**	*Myristica fragrans, Myristica argentea*	3%	Planted mostly in the western part of Tioor.
Clove tree garden (*dusun cengkeh*)**	*Syzygium aromaticum*	3%	Planted mostly in the eastern and southern part of Tioor.
Coffee tree garden (*dusun kopi*)**	*Coffea* spp.	1%	Planted mostly in the southern part of Tioor.
Mixed tree garden	Species of **	3%	Dominance of coconut, nutmeg and clove.
Mixed garden	Species of * and **, trees yielding edible fruits and seeds	3%	Recent development, first being practised by the people of Kelvow.
Degraded land	*Imperata cylindrica*, ferns	4%	Occupying highest peaks (*Ra, Tar, Koly*).
Animal husbandry	Goats, poultry, dogs	---	Being kept in or near settlements.

Note: For further details on areas see also App. 3.2.

Sources: Interviews, observation, herbarium collection and mapping (Stubenvoll 1997 and 1998).

6.2.2 Rhun

Transects of Rhun Island do not provide a clear distinction between the various land-use types due to a geological and geomorphologic setting which is different from Tioor. Nevertheless, it is attempted to point out general features along two cross-sections (Fig. 6.4). Land-use types in Rhun depend greatly on the gradient of the landscape (Tab. 6.2) and on the associated soil type.

(1) *Original vegetation* on steep faces, cliffs, *keramat* areas, and slopes of high gradient: Species are not completely known, because herbarium collection could not be carried out in inaccessible places and in *keramat* areas. However, some material could be collected, e.g. species like *emeng* (*Neonauclea glabra* (Roxb.) Bakh.f. & Ridsd.), and *kayu besi* (*Intsia bijuga* (Colbrooke) O. Kuntze).

(2) *Permanent dry fields* (*kebun*) on terraces (plains), slopes of lower gradient, and in basins: Dominant cultivated crop is the perennial shrub cassava (*Manihot esculenta* Crantz) with two varieties. Other starch-producing crops are annuals, such as taro *(Colocasia esculenta* (L.) Schott var. *antiquorum*), at least three species of yams (*Dioscorea spp.*), and maize (*Zea mays* L.). Additionally, various vegetables and pulses are grown.

(3) *Dry fields of shifting cultivation* (*ladang*) on slopes of higher gradient, and seldom on slopes of lower gradient: Where soil fertility does not allow permanent cultivation or where fertility erosion has become too extensive, the field has to be left fallow after a short cultivation phase. Cultivation is restricted to cassava, vegetables are eventually inter-cropped. Common fallow species are *anoa*

(*Endospermum moluccanum* (Teijsm. & Binnend.) Kurz) and *kalamandingan* (Indonesian: *lamtoro*; *Leucaena leucocephala* (Lamk) de Wit).

(4) *Mixed gardens* (*kebun campuran*) in a heterogeneous combination of annuals and perennials on terraces (plains), slopes (of both lower and higher gradients), and in basins: Sub-types can be distinguished according to the variety of species and the presence of protection trees. Most common are the following sub-types:

(a) Cassava as major starch-producing crop and clove as the most important tree species: It is the least diversified sub-type, without protection trees.

(b) Cassava and taro as dominant starch-producing crops, and coconut, clove and coffee as the most important tree species: It is more diversified than sub-type (a), but with only few fruit trees and protection trees (e.g., *Canarium vulgare* L., *Dracontomelon dao* (Blanco) Merrill & Rolfe, *Toona ciliata* M.J. Roemer, *Alstonia scholaris* (L.) R.Br.).

(c) Mixed gardens with a wide range of plant species, including a number of protection trees: This sub-type is subject of one farmer case study (cf. Ch. 6.5.1, and Maps 4).

(5) *Tree gardens* (clove, nutmeg, coconut) and *mixed tree gardens* (in any combination of clove, nutmeg, coffee, coconut and sugar palm (*Arenga pinnata* (Wurmb.) Merr.), and fruit trees, although cloves being usually the most important species) on terraces (plains), slopes (of both lower and higher gradients) and in basins, and *coconut tree gardens* along the coastal strip: Pure stands of trees without an integration of annuals and cassava are predominantly established in small plots. All subtypes may include protection trees (species mentioned in (4b)).

(6) *Goat husbandry* on terraces (plains), slopes of lower gradient, and in basins. Goats are most commonly browsing in the fields, while put on a leash, although this is not necessarily sufficient to avoid damage to crops and tree seedlings. Some farmers have constructed stables and feed their animals with collected forages ('cut-and-carry').

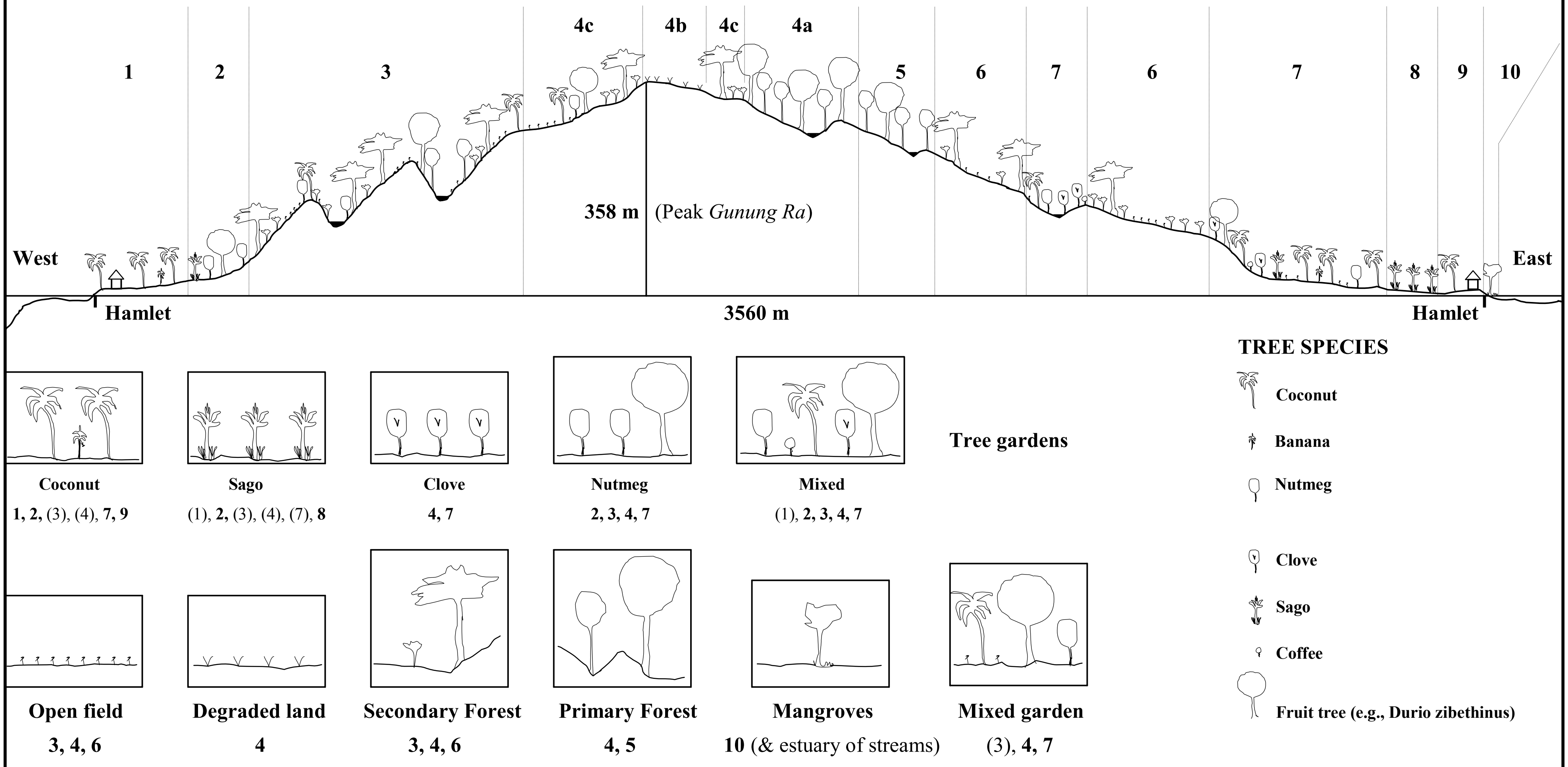
Table 6.2: Landscape and land-use types in Rhun

Land-use / Landscape type	Original vegetation	Permanent dry fields	Dry fields (shifting cultivation)	Mixed gardens	Tree gardens	Goat husbandry
Coastal strip – plains	-	-	-	-	x	-
Coastal strip – cliffs	x	-	-	-	-	-
Terraces – plains	-	x	-	x	0	x
Terraces – steep faces	x	-	-	-	-	-
Slopes of lower gradient	-	x	0	x	0	x
Slopes of higher gradient	0	-	x	0	0	-
Basins	-	x	-	x	0	x
Keramat areas	x	-	-	-	-	-

Notes: **x**: frequent; **0**: seldom; **-**: not existent.

Sources: Interviews, mapping and observation (Stubenvoll 1996).

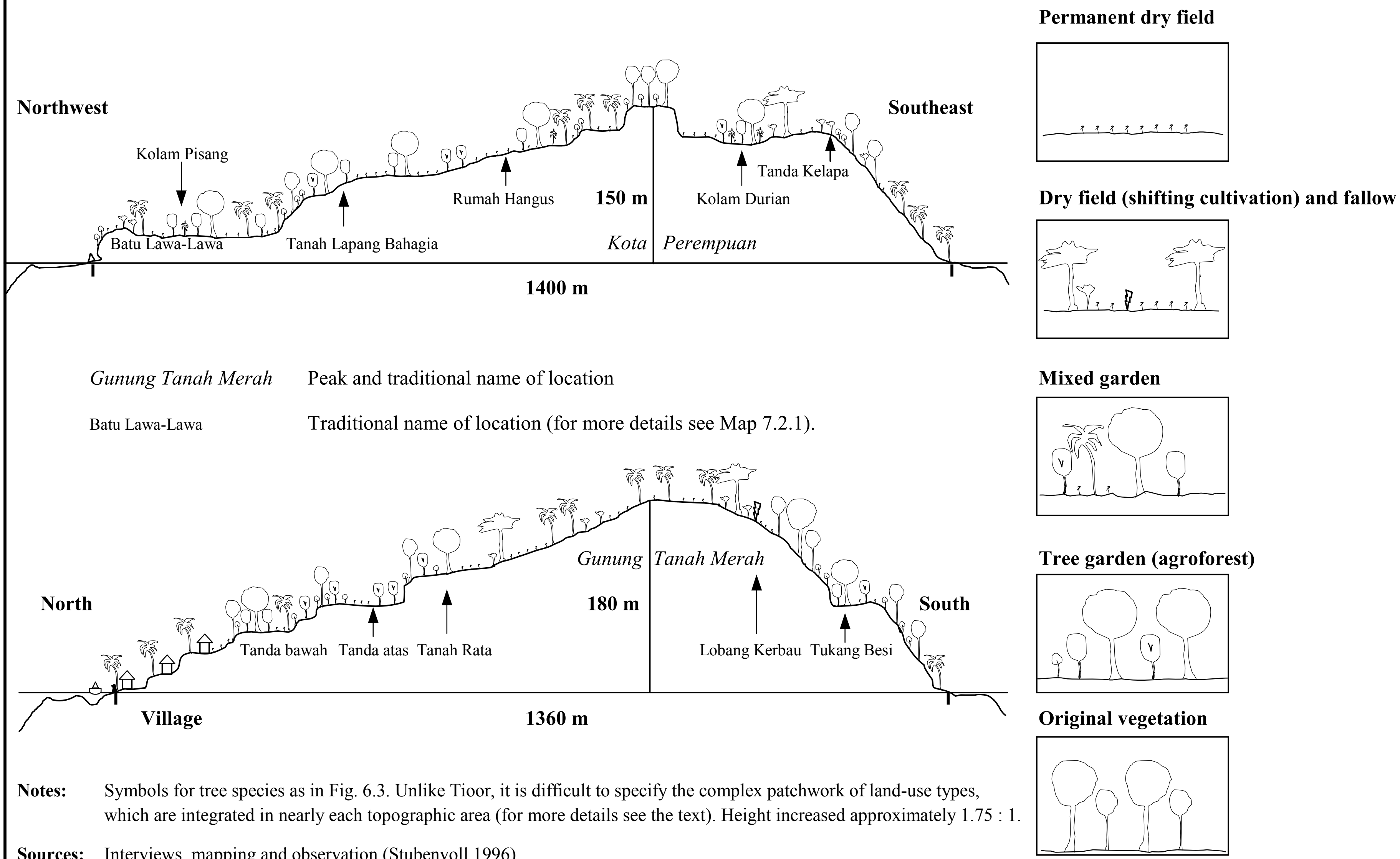
Figure 6.3: Tioor: Cross-section of the landscape and land-use types



Notes: Land-use types are common in the **boldly** given topographic areas. Otherwise, they are only found occasionally (in brackets). Height increased approximately 2 : 1.

Sources: Interviews, mapping and observation (Stubenvoll 1997).

Figure 6.4: Rhun: Cross-sections of the landscape and land-use types



Notes: Symbols for tree species as in Fig. 6.3. Unlike Tioor, it is difficult to specify the complex patchwork of land-use types, which are integrated in nearly each topographic area (for more details see the text). Height increased approximately 1.75 : 1.

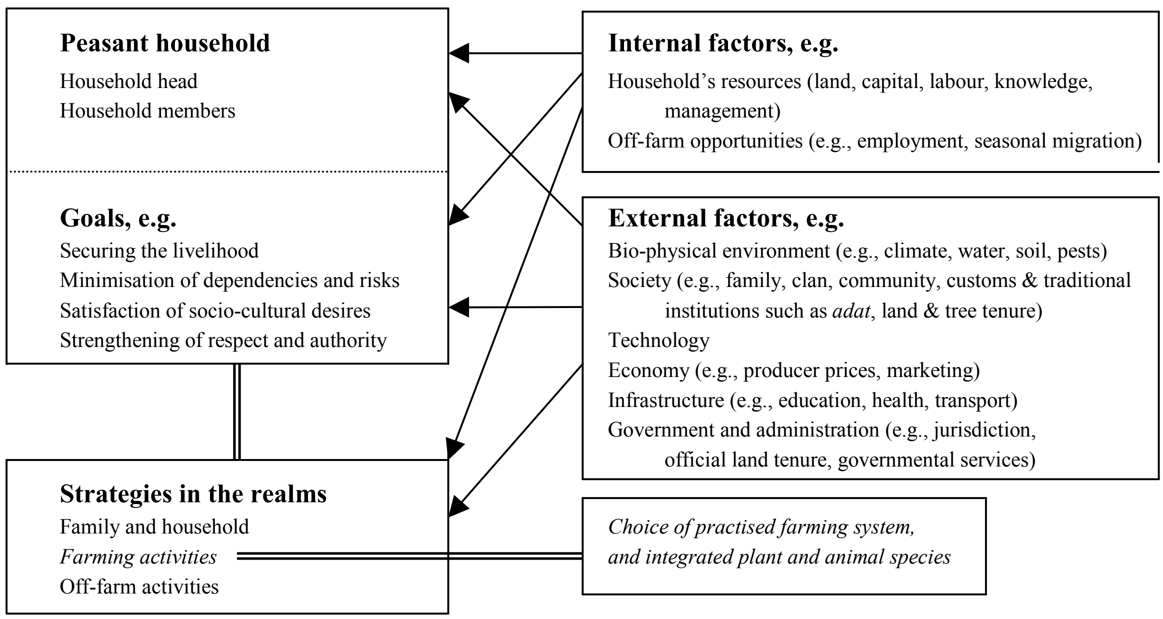
Sources: Interviews, mapping and observation (Stubenvoll 1996).

6.3 Structures, practices and functions of farming systems

The comparison between former and present land use in both Tioor and Rhun shows, that in each island a land-use system has emerged during the last three decades, that is *based on traditional agroforestry*. As cultivation options in traditional agroforestry are as manifold as the possible crop species and their combinations, it is hardly possible to describe the agricultural production system by the use of just a few parameters. In fact, it is the small-scale farmer and his household which is the central unit in farming activities,[107] and it depends on their *decisions* which crop associations are planted, and thus to which land-use type a certain plot will develop.

The coming discussion therefore sorts details into a general, simplified model of a peasant household's goals, factors influencing decision-making, and principal household strategies (Fig. 6.5). The household has several *goals*, which may have different priority. Most important is the security of the livelihood through the provision of vital goods (food, water, cloths, health, education, housing, etc.), being achieved by income generation, and also by keeping dependencies and risks to a minimum.

Figure 6.5: The peasant household – goals, influencing factors, and strategies



Notes: influences ——▶ decision-making ═════

Sources: Adapted from Shaner et al. 1982, 62-7; and Doppler 1991, 14-6.

However, the household is confronted with a multitude of biophysical, socio-economic and cultural influences – both internal and external – which might have adverse impacts on the realisation of these goals. Any household strategy in the major realms family and household, farming, and off-farm activities has therefore to take into account these factors. Concerning farming activities, the household has to opt for a certain farming system in which chosen species are integrated: products for subsistence activities, marketing purposes, or any combination of these. The choice of the cultivated products is crucial, as they contribute to the livelihood of the household.

[107] Nevertheless, farming is also carried out by groups comprising several households or even all households of a settlement (see Ch. 5.4.3).

6.3.1 Succession stages and importance of land-use types

Starting point is an overview about the general possibilities of garden development within the whole land-use system (Fig. 6.6). The historical land-use system of Banda (nutmeg plantations) is included in Fig. 6.6, although the transformation to peasant agriculture is completed. The process of this transformation will be analysed in Ch. 6.4, because it reveals several factors that can help to explain structures and functions of present farming systems. Although the number of chosen plant species might substantially differ among individual farmers, almost all peasant families are simultaneously practising the whole range of land-use types within their farming system.

Common characteristic features of agricultural land use is on the one hand dry field agriculture *without* an integration of trees, and on the other hand an emergence of gardens *by* integration of perennials into dry fields. These gardens can be distinguished between (1) *mixed gardens*, where annuals[108] and perennials are grown together on the same land unit; (2) *mixed tree gardens and agroforests*, where a variety of tree species is cultivated; and (3) *tree gardens*, where one perennial species is by far dominating the scenery, and where annuals are as absent as in mixed tree gardens.

But there are *differences* as well, what is represented by arrows of different thickness in Fig. 6.6. In addition, Tab. 6.3 shows surface areas, and area proportions of the total island area, which allow conclusions on the relative importance of land-use types on either island. A list of plant species, which are cultivated in various land-use types or of which products are collected, is provided in App. 1.1.

(1) *Mixed gardens* are a rather new development and occupy only a small area in Tioor (3% of the island area), but are most commonly found in Rhun (40% of the island area).

(2) *Tree gardens* (*dusun*) and *mixed tree gardens* (*dusun campuran*) are the dominating agroforestry system in Tioor, whereas in Rhun they play a minor role (30% and 5% of the island area, respectively). The importance of the species being cultivated in tree gardens is also different. The order of priority is in Tioor: coconut (55% of tree garden area), nutmeg, clove, sago, coffee;[109] in Rhun: clove, coconut, nutmeg.

(3) In Tioor, *dry fields* have been obtained by clearing of primary forest, in Rhun by driving back nutmeg plantations.

(4) The cultivation of crops yielding carbohydrates is of greatest importance, and a common characteristic of land use in both islands. About 50% of the respective island area is devoted to dry field agriculture. Nevertheless, several remarkable differences exist:
    a. The variety of these crops is greater in Tioor, regarding both species and cultivars. For instance rice, foxtail millet, sweet potato and sago are not cultivated in Rhun.
    b. Cassava is by far the most dominant plant yielding carbohydrates in Rhun, whereas in Tioor taro is almost equally important.
    c. The percentage of forest fallow area and of dry field agriculture is 85% (915 ha of 1080 ha) in Tioor, because plants yielding carbohydrates are mainly cultivated under shifting cultivation, whereas in Rhun permanent cultivation is dominating. Hence, the fallow area of dry field agriculture in Rhun is comparatively small (35 ha of 240 ha, or 15%).[110]

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108 For brevity, and if not otherwise stressed, the term *annuals* will stand for annuals, sub-annuals and bi-annuals. In Indonesia, a similar term, *palawija*, refers to all annuals, sub-annuals and bi-annuals for food production *except* rice (*Oryza sativa* L.).

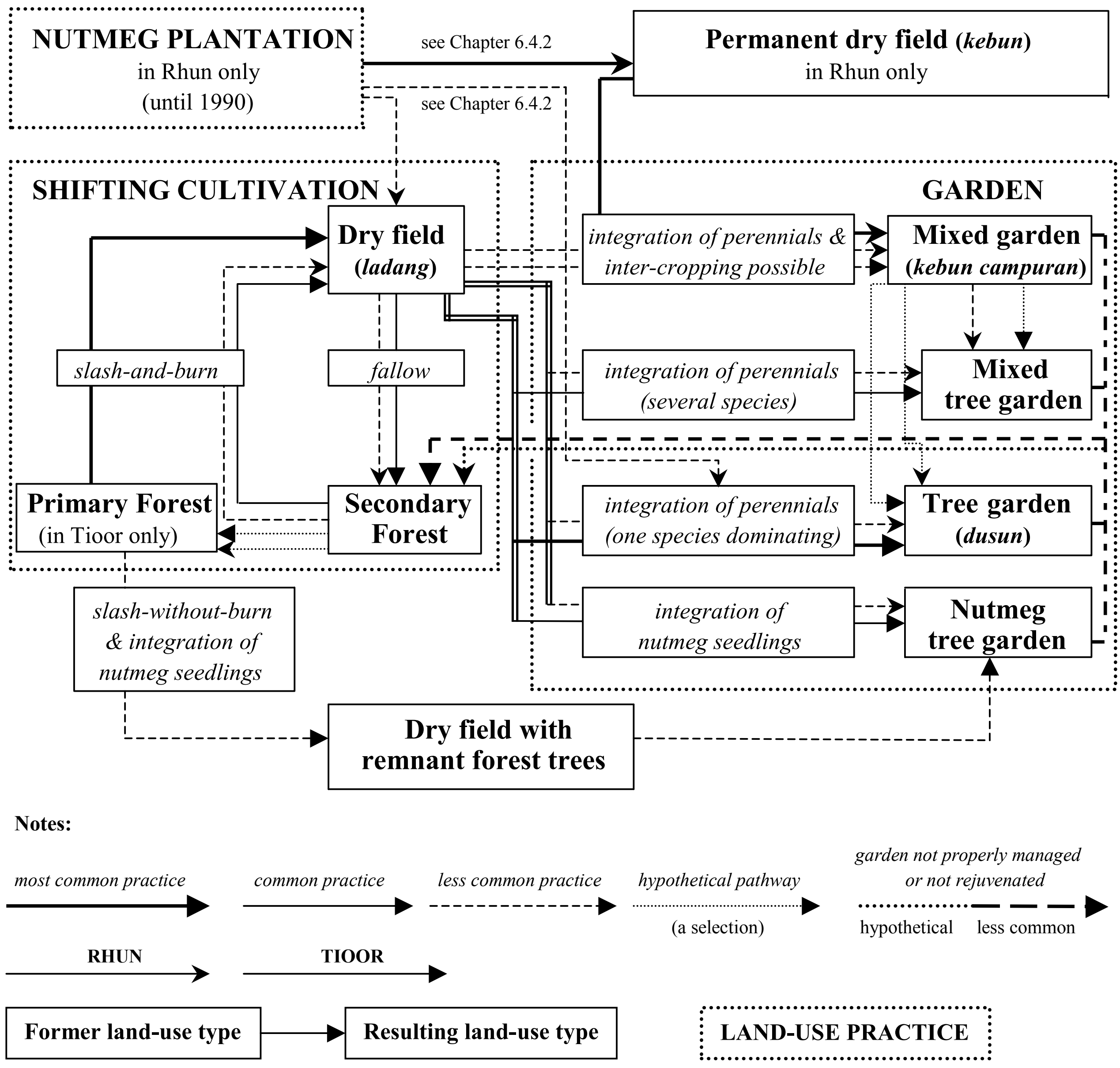
109 See App. 3.2 for a specification of tree garden area.

110 In the future this area will increase, if soils become less fertile after decades of permanent cultivation.

(5) In Tioor, goats are being *solely kept around the settlements and nearby coconut tree gardens* to a limited number, serving mostly self-consumption. In Rhun, farmers have integrated these animals *into the agricultural landscape*, predominantly for marketing purposes.
(6) A regression of gardens to secondary forest was only observed in Tioor.
(7) Forestry, gathering and hunting, plays a significant role in Tioor, as 16% of the island's area is still occupied with primary forest. In Rhun, only a few pockets of the original vegetation still exist, so that the collection of economic products available in forests, e.g. traditional medicines, fuelwood and timber, is very limited. Hence, these products have to be integrated into the fields.

Subject of the following section is one of the two major possibilities of agricultural land use: dry field cultivation *without* a deliberate integration of perennials into dry fields.

Figure 6.6: Succession stages of land-use types



Sources: Interviews, mapping and observation (Stubenvoll 1996 and 1997).

Table 6.3: Areas of present land-use types in Tioor and Rhun

Island	Tioor	Rhun	Tioor	Rhun	Tioor	Rhun
Land-use type	*Mapped area* (*2,200* of 2,394 ha)	Area (465 ha)	Percentage of mapped area	Percentage of area	Relative importance	Relative importance
Dry fields under shifting cultivation	163 ha	15 ha	8 %	3 %	+++	+
Permanent dry field agriculture	0 ha	190 ha	0%	41 %	0	+++
Mixed gardens	70 ha	185 ha	3 %	40 %	+	+++
Tree gardens	650 ha	25 ha	30 %	5 %	+++	+
Animal husbandry	not to measure				+	++
Secondary forest	914 ha	35 ha	42 %	8 %	+++	+
Primary forest	356 ha	10 ha	16 %	2 %	++	+

Notes: +++ very important; ++ important; + less important; 0 not observed;
percentages: rounded fractions. Areas of settlements and of *Imparata* grasslands are excluded.

Sources: Interviews, observation, and mapping (Stubenvoll 1996 and 1997).

6.3.2 Dry field agriculture

In Tioor and Rhun, annuals are produced in dry fields either under **shifting cultivation** (slash-*and*-burn) or under **slash-*without*-burn agriculture**. *Without* an integration of perennials, a cultivated plot of the former mode will be left fallow after a short period of time, whereas one of the latter form is of permanent character. The Indonesian term *ladang* refers to temporarily cultivated plots, which are present in both islands, while permanently cultivated plots – of which the Indonesian term is *kebun* – are missing in Tioor. Generally, annuals are cultivated in a countless variety of combinations: Sub-annuals may be inter-cropped with annuals or bi-annuals, crops may be alternately planted in a rotational cycle, or several crops may simultaneously occupy different plots of the field. Because of this complexity, it is attempted to sort out the general production process for (1) shifting cultivation and (2) slash-without-burn agriculture separately. As cropping procedures greatly depend on the selected plant species and associations, specific details on plant species are then provided for both land-use practices together, as well as the input of the means of production (labour, capital, and land). Economic results and functional diversity are treated together with other land-use types in Ch. 6.3.7.

In two other land-use types annuals are also cultivated, but both *with* an integration of perennials. In Tioor, slash-without-burn *always* includes a simultaneous planting of nutmeg seedlings, so that the plot will soon develop to a nutmeg tree garden. Another case is the cultivation of annuals in mixed gardens in both islands. For trees are integrated, these two land-use types will be examined in Ch. 6.3.3 and Ch. 6.3.4.

Production process

(1) **Shifting cultivation** (*perladangan berpindah-pindah*) is the most important farming system of the tropics and subtropics, being practised by an estimated 17 million people in insular Southeast Asia (Uhlig 1988, 154). This land-use practice is treated by a plethora of literature (e.g., Conklin 1957; Röll 1983; Scholz 1987; Inoue and Lahjie 1990). Although there are gradual differences, shifting cultivation generally follows a rotational cycle in which primary forest land is converted into a dry field (called *ladang*) with annual crops for a short period of time before leaving it fallow for a long period. On fallow land, secondary forest grows, allowing soil fertility to regenerate slowly. After abandonment of one plot, the farmer clears mature secondary forest in a nearby location to get a new dry field. As soon as mature secondary forest in one area is no longer available for clearing, the farmer

moves on to another area with primary forest and starts the rotational cycle again.[111] Shifting cultivation is qualified as an agroforestry system, because an integral part is the growth of secondary forest trees during fallow periods.

On the small islands of Tioor and Rhun, shifting cultivation is practised with some differences to the general pattern. Firstly, primary forest is very limited in Tioor, and almost non-existent in Rhun, so that a shift to new primary forest areas is hardly possible. Secondly, a part of the dry fields is put out of the rotational cycle by a soon integration of perennials into the plots, resulting in tree gardens or mixed gardens. And thirdly, in the case of Rhun, nutmeg plantations (not primary forest!) were the starting point of slash-and-burn agriculture.

The following examination of the production process focuses on the most common cultivation patterns in a given dry field in Tioor. There, shifting cultivation is more complex than in Rhun, where just two cultivation patterns are virtually practised. Although there is no rigid calendar of agricultural events, the timing of activities is closely related to one of the cultivation patterns, which are approximately outlined in Fig. 6.7.

Site selection

The production process of shifting cultivation begins with the assessment of a farmer, *if* a new plot has to be cleared. With the exception of few primary forest land in the hinterland of Rumalusi and Rumoi communities, and the degraded land around Tioor's highest peak (*Gunung Ra*), land reserves without any tenure claims are no longer existing on either island. Site selection for a new dry field is thus restricted to land, where claims have already been secured. The decision to clear a new plot does not only depend on physical factors like soil fertility and remaining productivity of the existing fields, but also on socio-economic conditions. These conditions may include: a prevention of another farmer to claim tenure on already secured forest land, a need for more staple food, and accessibility to labour and seed material.

In Rhun, shifting cultivation occupies a relatively small part of the island area (11%, Tab. 6.3), and primary forest is not available. Consequently, secondary forest land is scarce, and the options to select a new location are very limited. In most cases, a farming household has got tenure of just one or two locations under shifting cultivation.[112] Thus, length of the fallow period and soil fertility of the new plot are the most important criteria of site selection in the case of Rhun, whereas in Tioor, socio-economic factors have to be equally taken into account.

The farmer's preference, *where* the new location is to be situated, is not only a matter of its expected agricultural productivity. The very limited land area does not allow site selection that is solely based on criteria of relevant positive environmental factors, such as good soil, flat land, and good drainage. With respect to Tioor, the coastal plain, which has to be regarded as the most favourable site in terms of fertility and gradient, is almost entirely occupied by coconut tree gardens, and thus it cannot be claimed for the growing of annuals. In the most obvious case, a farmer selects land at the boundary of an already existing dry field in upland terrain. With this mode of extension, which usually follows an uphill direction, input of labour will be less intensive if a field hut in the former plot can still be used. The older plot may have been enriched with tree seedlings, developing to a tree garden.

[111] The scientific terminology of shifting cultivation is not consistent (see Sunderlin and Resosudarmo 1996, 5-6). For instance, movement to another area with primary forest may reach great distances, so that it would be necessary to build a new house. Older German sources (Waibel 1933) consequently distinguish between shifting cultivation *without* (*Landwechselwirtschaft*) and *with* (*Wanderfeldbau*) a periodic shift of settlements.

[112] Some households, however, are not practising shifting cultivation at all.

The land-use map of Tioor (Map 3) reveals a decentralised concentration of dry fields in certain areas (e.g., along Werlarat, in the headwaters of Werkar, Wersody and Werkilwer), whereas in other places they are almost not present. Thus, a farmer tends to select a new site near existing dry fields of other farmers. Three reasons can be stated: Firstly, by clearing of a plot, a farmer secures land tenure (cf. Ch. 5.4.3), and is thus minimising the area of land acquisition by other farmers in the concerning location. This is also true, if farmers belong to the same clan or family. Secondly, joint labour can be faster organised, because distances between fields are being kept to a minimum. And thirdly, fields are better protected from intruding wild boars, because the area is daily visited by several farmers.

In Tioor, another criterion of site-selection is the altitude of the plot and its distance to the village. A young farmer may first select a more distant and highly located site, while keeping sites near the village for his older days. He then would be too tired of managing the former one, which could be passed on to his offspring (see the case study of a peasant household in Ch. 6.5.2).

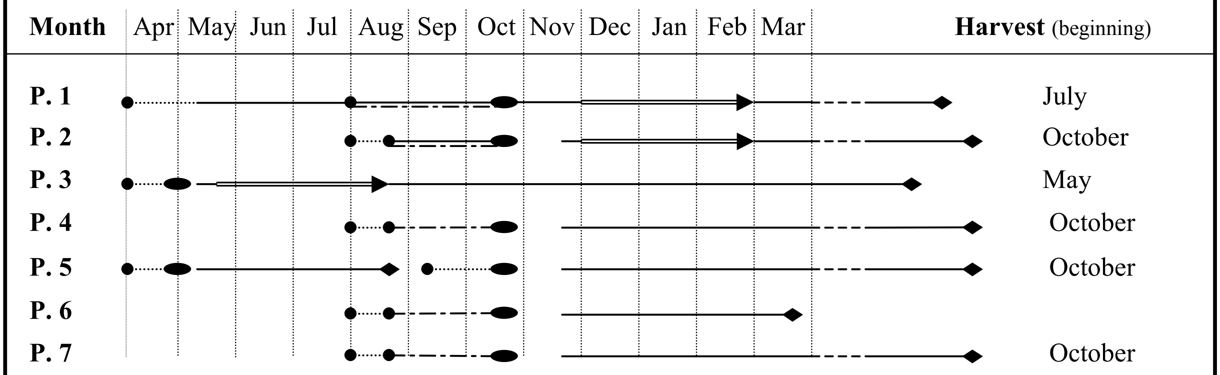
Clearing and burning

Tioor: In the *first year*, clearing is carried out either at the beginning of the long dry season (*musim kemarau*), i.e. in August, or at the beginning of the short dry period (*musim laur*) in April, depending on the chosen cultivation pattern (Fig. 6.7). The latter is the case, if secondary vegetation only consists of shrubs, herbs and small trees, or if taro or cassava will be later inter-cropped with maize or vegetables. Clearing activities in a new plot are carried out in two steps, either by the farmer alone, or with the help of a group such as *kerja masohi*. At the beginning, herbs, shrubs and small trees are cut down with a machete (*pamere*). When the plant debris has dried, remaining tall trees are then chopped down with an axe (*rubuh kayu*). In rare cases, valuable tree species are spared from cutting.

The dried plant debris is burnt once – or twice, if the cover is too thick – at the end of the respective dry season, with the exception of Pattern 1, in which herbs, shrubs, and small trees are cut in April, whereas burning is not carried out until October, when tall trees cleared in August have become dry. The accidental spread of fire frequently occurs, especially at the end of a prolonged drought, and has to be regarded as a serious disadvantage of burning activities because it has the potential to destroy tree gardens of other farmers and forest. In the former case the farmer has to quickly organise a *kerja masohi* group for fire-fighting operations, which include water collection and transport from a running stream to the plot and open strip cutting in wind direction. If the fire cannot be stopped, the responsible party will have to compensate the loss of crops and productive trees. Most common is a private settlement in form of a cash payment. If one party does not agree to this, a hearing of the *adat* council will have to be hold. The two disputing parties first pay a fee of Rp. 50,000 each to the *adat* council (*persiapan meja*), who then will hold the hearing. Additionally, they have to provide the costs for witnesses (*ongkos saksi*). The loosing party has to compensate the destroyed crops (*ganti rugi*) and the costs of *persiapan meja* (*ganti ongkos meja*) of the other party; the compensation is fixed by the *adat* council. Disputes about field boundaries are similarly settled. Should both parties wrongly claim land of each other, the *adat* council will draw the boundary in between the disputed area. In that case, each party will have to bear the costs of *persiapan meja* on its own.

Rhun: In the first year, the plot is cleared of secondary vegetation (herbs, shrubs, small trees, and in rare cases tall trees) all at once by the farmer in August. If the farmer happens to be absent (e.g., for regional fishing), it can be postponed until the beginning of October at the latest. Group work is seldom requested, and restricted to larger plots. The farmer can do without clearing in April, because cassava of the first cropping cycle is usually planted in December as the only crop yielding non-seed carbohydrates. Burning at the end of the dry season in October/November is done *once*, because of two reasons: Firstly, dry plant residues of cleared secondary vegetation is not as thick as those of primary forest in Tioor. And secondly, good quality fuelwood of cut trees has been already collected for the purpose of cooking in the household. The farmer has to very carefully execute burning activities due to a limited freshwater supply for fire-fighting operations. As pointed out in Ch. 4.2.2, the households even have difficulties in securing their drinking water supply at the end of the dry season. Damage to crops and productive trees of another farmer by accidental spread of fire would have the same consequences as it is with regard to Tioor.

Figure 6.7: Time calendar for most common cultivation patterns in a new *ladang* plot



Pattern 1: Taro and cassava, inter-cropping with maize, pulses or vegetables
Pattern 2: Cassava, inter-cropping with maize, vegetables or pulses
Pattern 3: Cassava, inter-cropping with maize, pulses or vegetables
Pattern 4: Taro or cassava, no inter-cropping
Pattern 5: Sweet potato, maize or pulses; thereafter cassava; (as Pattern 3, fallow vegetation consists of shrubs, herbs & small trees)
Pattern 6: Rice (*padi ladang*)
Pattern 7: Yam

Clearing & plant debris drying (*rubuh kayu*: trees)
Cutting & plant debris drying (*pamere*: herbs, shrubs & small trees)
Burning
Planting & growth of product
Planting of second product & growth of both products (inter-cropping)
Harvest of product
Harvest of inter-cropped product

Notes: In Tioor, all patterns are practised. Others have been observed, but these are rare cases. In Rhun, *shifting cultivation* is restricted to Pattern 2, and to Pattern 4 with cassava only.

Sources: Interviews and observations (Stubenvoll 1996 and 1997).

Tillage and planting

In both islands, the crop is planted soon after burning of the plot at the beginning of the rainy season, most common with one of the cultivation patterns shown in Fig. 6.7. The main factor of the selected cultivation pattern is the soil type and its fertility. Other factors include availability of seeds, of planting material (taro, cassava) and of labour force, and preferences in the daily menu. It is also possible to have the simultaneous deployment of two or more patterns in a single plot. However, in Rhun the choice is restricted to a cultivation of cassava either *with* or *without* inter-cropping of sub-annuals.

In Tioor, tillage is practised either with a hoe, or more common with a dibble. For taro and cassava both tools may be deployed, for maize and rice only the latter. Vegetables are predominantly cultivated in a small part of the field. The cultivation of taro and inter-cropping of maize, vegetables (e.g., eggplant) or pulses (e.g., mung bean) (Pattern 1) is most common in the western part of Tioor. Yams (Pattern 7) need fertile soils, and are cultivated on newly established plots in the western parts, although to a lesser extent. On the less fertile ultrabasic soils in the east of Tioor, cassava is the dominant product, either with inter-cropping of maize, vegetables or pulses (Patterns 2 or 3), or after an initial planting of sweet potato (Pattern 5). The cultivation of rainfed rice (*padi ladang,* Pattern 6) involves the risk of crop failure caused by storms in December and January. If the farmer lacks seed material or labour availability, he will have to forego inter-cropping (Pattern 4).

Farmers in Rhun only use the hoe for tillage. Just two patterns of shifting cultivation exist. Cassava is either planted in mono-culture (Pattern 4), or is inter-cropped with vegetables or pulses (Pattern 2). The latter crops are often found in spots of thin solum (lithosols).

Construction of field hut and fencing

Tioor: As soon as planting of the first crop is completed, the farmer begins with the construction of a field hut (*pondok*) in a less wind-exposed, flat site of the field, that is also not susceptible to flooding. The design of a hut depends on its intended functions and on the distance to the village, and is very dependent on if a fence will be constructed or not. Field huts are of two types: a semi-permanent, elaborated construction, and a less durable structure, that keeps off rain and insolation. Characteristic features of all huts are a foundation of vertical wooden piles, which are firmly driven into the ground and fixed together with more slender horizontal piles for the subsequent addition of a raised platform covered with split bamboo as the floor, in about 50 cm above the ground. The overhanging roof is made of sago thatch (*atap*), reaching a height at its apex of about 2.5 m. Walls are restricted to the semi-permanent type, and consist of sago thatch, dried rachis of sago leaves (*gaba-gaba*), or bamboo. Material for construction (sago leaves, timber, bamboo) and lashing (rattan) is collected from sago tree gardens, primary and mature secondary forest; nails may be additionally used. A hearth is situated at ground level under overhanging eaves near the entrance, that usually takes up a whole side of the hut, but in some cases it may only reach 1 m. The size of the hut depends on the type and on the number of farming individuals of the household. Semi-permanent huts normally measure 2.5 m x 3.5 m, less durable huts 1.5 m x 2 m.

Field huts have a wide range of functions: *storage* of seed material, raw material (timber, rattan, charcoal), tools, cooking utensils, crockery, food, tubers, drinking water, tobacco, and many other items; *preparation* of meals during field work; *shelter* from wind, rain and sun; for *resting* and as a *meeting point*; for the *manufacture* of baskets, mats, and the like; for *staying the night* to keep guard the field against intruding wild boars that may feed on tubers and young coconut trees. The latter purpose is restricted to semi-permanent field huts and save the farmer’s work of fencing, on condition that somebody is regularly present (for functions of similar huts in Seram, cf. also Ellen 1978, 142).

A less durable hut is erected, if the farmer will not stay the night in his field. In this case, he deploys other means to protect crops from wild boars. Most common is the construction of a fence, which is very labour-intensive (Tab. 6.6). This is mostly carried out by farmers in the Islamic communities of Kelvow and Wermaf,[113] either individually or by looking for help of other farmers (*kerja masohi*; paid labour). Main reasons for this are regular nocturnal fishing and the requirement to stay in the village for religious activities, like daily praying and going to mosque on Fridays. The fence reaches a height of approximately 100 cm and consists of slender wooden piles, taken from secondary forest and vertically driven into the ground in pairs, 15 cm apart. The 120 cm wide gaps between the pairs are horizontally filled up with piles of the same kind. The use of traps is seldom practised and restricted to burrowed holes. As an alternative to fencing, some farmers light up small fires in the garden just before returning to the village. The *smell* of a dead fire is said to prevent wild boars from consuming crops, as it usually remains until the next morning. Another method is hunting (cf. Ch. 6.3.6).

[113] There are very few exceptions in the other communities. These farmers usually have more important duties in the village, which hinder them to stay the night in the fields. An example is an intermediary who was immigrating from Flores in the 1970s. He lives in Rumoi community and must carry out his trade duties in the village (see Fig. 6.11).

Rhun: A field hut is constructed, whenever the former hut has fallen into disrepair, and in the same way as in Tioor, but in most cases it is limited to the less durable type without walls. The field hut meets all functions being stated with regard to Tioor, except from staying the night, which is actually not necessary due to the absence of wild boars. Sago thatch for roofing has to be traded, as sago trees cannot be grown in Rhun. Coconut and sugar palm thatch, although of lower quality, may be alternatively used. The construction of fences is carried out by some goat breeders (cf. Ch. 6.3.5).

Weeding, harvesting and post-harvest activities

Weeding, harvesting and post-harvest activities depend greatly on the cultivated crop. Information on these procedures is given in Tab. 6.5. Nonetheless, general characteristics are summarised here.

Weeding is usually performed twice, by the farmer and his household. In Tioor, it is carried out by a group as well. The growth of weeds depends on physical factors (amount of rainfall, soil, light), and planting density and growth of the crop, so that the timing, labour input and labour arrangement of weeding activities is varying from year to year. Most common is weeding in intervals of one to two months. *Harvesting* is done in two general patterns:

(1) the crop is completely harvested at one time, like rice, maize, pulses, and most vegetables; and

(2) the crop is progressively harvested bit by bit, whenever it is needed ('piecemeal harvesting'), like cassava, sweet potato and taro.

Most common labour arrangement is the harvest by the female members of the household, although cereals may be harvested by a group either. *Post-harvest activities* include processing, storage of seeds and tubers, and eventually marketing or bartering.

Continued cultivation after the first cropping period

Tioor: Rice, maize and yams require fertile soils of newly cleared plots, so that the following cropping cycle in *year 2* is restricted to cultivation of sweet potato and cassava, without any inter-cropping. The fast growing *sweet potato* can be planted at almost any date (except during the dry season), so that its cultivation is preferred in times of foreseeable food shortages. The dominant second year crop is *cassava*. As soon as the storage roots are removed for the preparation of food, the farmer immediately replants cassava by *vertically* placing a 20 cm long stem of the just harvested plant into the ground. If *taro* was the first crop, the farmer could replant it – in the more fertile areas of Tioor only – for a second, and even for a third time later in *year 3*. For getting reasonable yields, however, he has to put the propagation material (e.g., suckers or head-sets) *in between* the places that were occupied by the taro plants of the previous year. When taro yields are no longer satisfactory, after the *third year* at the latest, cassava is the single crop to be planted – and later replanted, as long as the yield is due to decline sharply. However, there is no clearly defined time limit when a *ladang* has to be left fallow. Likewise, with the variations of patterns in establishing a new plot, it is up to the farmer (and his assessment of soil fertility)[114] when to stop planting activities in the plot. To diversify crops for risk reduction and for variation in the daily menu, he will usually clear a second, and sometimes a third plot, before putting the first one out of production. Thus, a farmer is *simultaneously* planting several carbohydrate yielding crops in the different cultivation patterns shown in Fig. 6.7.

Rhun: As in Tioor, cassava is immediately replanted after harvest (without inter-cropping), as long as soil fertility will allow it. The only difference of this procedure is a *diagonal* position of the planted

[114] 'Soil fertility' is measured by the farmer in terms of yields relative to labour input, and differs therefore from the scientific concept, summarised e.g. by Young (1989, 81-2). Most of the statements about soil fertility in Ch. 6 are drawn from interviews and field observation. However, the results of a soil analysis (Liang 1998) underline the described trend of declining soil fertility (cf. Ch. 6.4 and Ch. 7.1).

material. The length of cultivation is usually two or three years, since slash-and-burn is practised on less fertile soils in sloping terrain.

Fallow period

The transition to a fallow period is not as abrupt as the shift from forest to cultivation, because cassava is progressively harvested. Accordingly, it can take several months until a plot is completely harvested without any replanting activities, so that *secondary vegetation* can gradually develop. In Tioor, the fastest growing and most abundant species of secondary forest is *wepa* (*Paraserianthes falcataria* Nielsen), while the emergence of *alang-alang* grass (*Imparata cylindrica* Beauv.) is a phenomena of minor importance. Although bio-diversity in secondary forest is by far poorer than in primary forest, several products of the former are of economic interest for the peasant. Most important is the wood of smaller trees, which is collected for fuelwood or as raw material for the construction of fences. In Rhun, *kalamandingan* (*Leucaena leucocephala* (Lamk) de Wit *var. leucocephala*), and another unidentified woody, spiny and straggling *Leguminosae* (local name: *gonggai;* probably *Mimosa diplotricha* C. Wright ex Sauvalle) are among the typical species of secondary vegetation (see, for example Map 4.1.2).[115]

It is practically impossible to provide an average figure of the length of fallow periods. As Tab. 6.4 suggests, most of the fields have been cultivated only once as a *ladang*. Either it has developed to a tree garden or a mixed garden, or the secondary forest of the subsequent fallow period has not been cleared yet. Only 10 of 133 fields of the interviewed households in Tioor (7.5%), and 2 of 94 fields in Rhun (2.1%),[116] are at least in the second cycle of *ladang* cultivation, but the length of former fallow periods shows great variations. For the concerning fields, a maximum fallow period of 32 years, and a minimum of 12 years were quoted by the interviewed households. Hence, it depends solely on the management decision of the farmer and his assessment of expected soil fertility, at which age secondary forest is cleared. Factors of this decision-making were previously outlined (see section on *site selection*).

Table 6.4: First clearing and present type of fields [65 interviewed households]

First clearing	prior to 1950	1950-59	1960-69	1970-79	1980-89	after 1990	primary forest	not known	Sum
Tioor (no. of fields)	16	13	20	25	22	10	10	17	133
Present type (no. of fields) [1]	11; 5; **0; 1; 3**	7; 5; **0; 1; 1**	13; 1; **0; 3; 6**	13; 12; **0; 1; 4**	12; 8; **0; 2; 4**	1; 4; **2; 0; 3**	primary forest	9; 5; **0; 2; 8**	66; 40; **2; 10; 29**
Rhun (no. of fields)	13	0	5	12	7	1	0	56[2]	94
Present type (no. of fields) [1]	2; 3; **8; 0; 3**	0	2; 3; **2; 1; 2**	6; 5; **8; 0; 4**	3; 1; **2; 0; 1**	0; 0; **1; 0; 0**	0	13; 25; **31; 1; 7**	26; 37; **52; 2; 17**

Notes: **1** Sequence of numbers: tree garden; mixed garden; **dry field (first cycle, or permanent); dry field (second, third, ... cycle); fallow** (many fields comprise more than a single category, e.g., dry field and fallow of secondary forest);

2 Most household heads in Rhun of the first selection process (HH 11 – 25) did not provide information on the year of the first clearing or of claiming plantation area – underlining that this is a sensitive issue.

Sources: Household interviews and mapping (Stubenvoll 1996 and 1997).

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115 Other species in secondary forest are specified in App. 1.1.

116 In Rhun, most dry fields are permanently cultivated, and eventually cut of growing secondary vegetation, whereas in Tioor most *ladang* fields have been established for the first time by clearing of primary forest.

(2) Slash-without-burn agriculture in permanent dry fields is seldom practised in the humid tropics, but more common in the semi-humid tropics. On fertile soils and in areas with high population density it has become the dominant form of cultivation, often in combination with irrigated fields (e.g., rice) (cf. Uhlig 1988, 533-4). Concerning the two island case studies, slash-without-burn without any integration of perennials is only practised in Rhun. It takes place most commonly in a permanent dry field with some interspersed perennials (*kebun*), which is the dominant land-use type for the production of annuals. These *kebun* occupy 40% of the land area (1996).[117] It is striking that permanent dry field agriculture differs from shifting cultivation by a few parameters only, so that it is sufficient to restrict the following description on these differences.

The product of utmost importance is cassava. Maize is also sometimes being planted, usually inter-cropped with cassava in the same way as it is done in shifting cultivation in Tioor (Fig. 6.7, Pattern 3). Pulses like groundnut and common bean (*Phaseolus vulgare* L.) are occasionally cultivated in a rotational period. Yams and taro are more common in mixed gardens, because they are planted in fertile soils of good water retention, and in the half-shade of *kenari* trees at the beginning of the rainy season in December.

As new sites for permanent dry field agriculture cannot be cleared anymore, factors of *site selection* are not relevant for a farmer in Rhun. *Cutting* is restricted to herbs and shrubs. The *production cycle* of cassava begins with the hoeing of the top soil and the forming of small mounds in which 20 cm long stems of the just harvested cassava plants are *diagonally* placed. Cut and *gathered* plant remains (herbs, shrubs) are used for mulching, or set on fire in a small part of the plot. Mulch and ash are subsequently spread onto the mounds. However, burning of the complete field is not practised. In this case it could be regarded as a land-use practice in between slash-*and*-burn and slash-*without*-burn. Weeding in a young cassava plot is necessary in intervals of four weeks. In a plot with old cassava it is practised less frequently, because the canopy will then completely cover the soil. Cassava for human consumption is usually harvested ten months after planting, although harvest can be delayed up to the twentieth month. However, a more delayed harvesting causes the storage root to become too woody and less tasty. Like in Tioor, the crop is immediately replanted after harvest, except during the dry period from August until November. Hence, one plot is usually occupied by cassava of different age (cf. Maps 4.1), although the bulk of planting occurs at the beginning of the rainy seasons in December and May. Post-harvest activities depend on the plant species (see Tab. 6.5). Occasional *fallow periods* are still rare, but will be necessary if fertility erosion becomes obvious.

Crops of dry field agriculture

The subject of this section is a further specification of characteristics of major annuals providing staple food that are grown in dry fields. Most of these crops are also planted in mixed gardens. Basic information on the origin of selected crops, their ecological requirements, and their features in the production process is given in Tab. 6.5, whereas other crops are listed in App. 1.1.[118] Scope and the limits of the crops to support a growing population are examined in the following, as well as specific conditions in the two islands. Information on yields and economic results is provided in Ch. 6.3.7.

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[117] It is somehow difficult to make a clear distinction between a permanent dry field (*kebun*) and a mixed garden (*kebun campuran*), because trees are often planted along boundaries around a *kebun*, or near a field hut. In other cases, a permanent dry field is situated on the same land unit together with a mixed garden, making it even harder to classify. Therefore, the percentage calculation follows the autochthonous understanding: Where the area reserved for starch-yielding crops is by far dominating, the plot usually refers to a *kebun*.

[118] The reader is recommended to consult the relevant volumes of the PROSEA (Plant Resources of Southeast Asia) handbook for a detailed account on the plants' characteristics (van der Maesen and Somaatmadja 1989; Westphal and Jansen 1989; Siemonsma and Piluek 1993; Flach and Rumawas 1996; Grubben and Partohardjono, 1996).

Cassava (*Manihot esculenta* Crantz): This perennial shrub of the *Euphorbiaceae* is indigenous to tropical America, from where it was distributed to the tropics of the Old World since the sixteenth century. It reached South-east Asia relatively late; probably it was brought first by the Spaniards to the Philippines, from where it spread to the eastern part of Indonesia and then westwards in the archipelago.[119] In Rhun and Tioor, two races of cassava are grown: A 'sweet' cultivar with low hydrogen cyanide (HCN) content which ripens in 5 to 6 months; its yields are lower than those of the 'bitter' cultivar, which grows slower, being harvested ten months after planting.[120]

Cassava has several advantages compared with other staple food crops. The fresh leaves contain the vitamins A and C, and up to 7% proteins (de Bruin and Veltkamp 1993, 176; cf. App. 1.7). In times of prolonged dry spells, when other vegetables are hardly available,[121] cassava leaves are often the only major source of vitamins, and therefore extremely important for the nutritional variety of the households. Pests and diseases still cause relatively moderate damage to cassava in both islands. As noted earlier, the only major pest are wild boars in Tioor, which often intrude into the fields and destroy all kind of tubers unless the farmer stays the night in the field, or deploys other modes of protection. Moreover, cassava starch yields are among the highest per hectare of all starch-producing plants. Even on marginal soils and with low input, yields are still quite reasonable. In Rhun, cassava is the single most important staple food. Even on the rocky island of Manukang, farmers plant cassava on top of the island to be autarkic for fishery activities that may extend for two or three weeks. In Tioor, cassava is the primary crop, although taro, bananas and sago play a significant role in the diet as well. Propagation of cassava is easily performed, and the flexible 'piecemeal harvesting' allows the storage of the yield directly in the field. The dried cassava starch is rather durable and can be taken along on longer trips, which is important for the Rhunese fishermen who are active in the Banda Sea region for several weeks (cf. Ch. 5.5.2).

In 1952, a special labour-intensive grafting method has been developed by a Javanese farmer named *Mukibat*, which can increase cassava production five- or even tenfold.[122] A scion of the latex-producing Ceara rubber-tree (*Manihot glaziovii* Muell. Arg.)[123] on a root stock of cassava is vertically

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[119] Cassava was known in Ambon by the late seventeenth century (de Wit 1959, cited from Monk et al. 1997, 708), although it is not described by Barchewitz' expedition to southern Maluku, undertaken in 1712 – 1720 (de Wit 1951). It reached Java only in the late eighteenth or early nineteenth century (Burkill 1935, 1413).

[120] As de Bruijn and Veltkamp (1989, 177) point out, "a satisfactory general classification of cassava below species level does not exist. ... Formerly cultivars were divided into two groups: 'sweet' and 'bitter' cultivars' according to their glucoside content in the central part of the storage root. This distinction is not justified as all kinds of intermediates occur and correlation between the glucoside content and the taste is far from general." As descendants of Butonese immigrants, the Rhunese prefer the 'bitter' race, because its starch is stewed for the preparation of the traditional Butonese cassava 'bread' (*soami*). The 'sweet' cultivar has only a complementary function in the diet of the Rhunese. In Tioor, both varieties are equally important, since the Tioorese frequently eat cassava after boiling of the peeled storage roots of the 'sweet' cultivar. The 'bitter' cultivar is prepared in different ways: After peeling and rasping of the storage roots, and the squeezing of the resulting pap, the starch is either stewed as in Rhun, boiled (product: *waiwajawa*), fried (product: *sinole*) or baked in forms made of baked clay (*porna*; product: *lempeng*).

[121] Exceptions are leaves of perennials, such as the small tree *kelor* (*Moringa oleifeira* Lamk), which is often planted along field boundaries, or the shrub *katuk* (*Sauropus androgynos* (L.) Merrill), which is grown in many mixed gardens in Rhun, and to a lesser extent in Tioor, and of which the leaves are very nutritious. *Katuk* grows best in somewhat shady places, and is thus particularly adapted for use in agroforestry (van den Bergh 1993, 245).

[122] In a not representative on-farm trial in Rhun, *mukibat* cassava yields were four times as high as yields of normal cassava plants (harvest in both cases 11 months after planting).

[123] Until the turn of the twentieth century, when the more competitive South American rubber tree [*Hevea brasiliensis* (Willd. Ex A. Jussieu) Muell. Arg.] was introduced into Southeast Asia, *Manihot glaziovii* had been highly valued for its latex production and was spread from South America throughout the tropics (Burkill 1935, 1409-10; de Foresta et al. 1994, 12). *M. glaziovii* is presently a common shade and ornamental tree in tropical home gardens. Its leaves are serving human (as a vegetable) and animal (as a forage) consumption. It was identified in Rhun, but not in Tioor (cf. App. 1.1).

planted in prepared 0.5 m deep holes (surface area 1 m x 1 m) being filled with a mixture of soil and moist organic matter – per hole 5 to 25 kg of banana leaves, kitchen waste, and the like. Usual spacing is 2 m x 2 m. Remaining space can be inter-cropped with sub-annuals. Harvesting is performed 8 to18 months after planting. Roots becoming too old will be too woody for human consumption (de Foresta et al. 1994, 12-3). Farmers in Rhun have tried the *mukibat* technique, but most of them presently neglect this high-yielding method due to its high labour input (grafting and soil preparation). In Tioor, *mukibat* is unknown. Other advantages of *mukibat* are its adaptation to a relatively shady environment, where normal cassava production would fail, and its resistance to major diseases of *Manihot esculenta* (de Foresta et al. 1994, 14), although the latter are not a problem in Rhun and Tioor yet. Ceara rubber is also a potential fast growing shade tree for tree seedlings that are usually vulnerable to insolation.

The main drawbacks of cassava are: the high soil erosion potential as long as young plants are only partially covering the soil, and due to the common practice of harvest – pulling the crop out of the soil is loosing its structure; the lack of proteins and other nutrients in the storage root, which should be balanced by sufficient consumption of protein-rich fish, and the like; and the preference of the farmer to cut out trees, which are seen as competitors for light, and thus, a tendency to establish open fields (cf. Hesmer 1966, 78ff).

Taro (*Colocasia esculenta* (L.) Schott): This herbaceous perennial plant of the *Araceae* is most often grown as an annual, and originates in Southeast Asia, where it was probably cultivated before rice (Wilson 1989, 103). In Tioor, it is the second most important staple food after cassava, especially in the western communities. It is cultivated in two varieties: the dasheen type and the eddoe type.[124] In Rhun, the cultivation of taro is restricted to the eddoe type, which is a supplement in the cassava-based diet. Some farmers however, even prefer to market the cormels instead of self-consumption. Taro is often grown as an inter-crop with woody perennials in mixed gardens due to its shade tolerance, and its vulnerability to drought periods. Hence, taro is probably less problematic with regard to soil erosion and deforestation than cassava. Moreover, the cormels are rich in vitamin C, trace elements, such as fluorides, and proteins (Wilson 1989, 103; Monk et al. 1997, 702; cf. App. 1.7), and thus more nutritious than cassava storage roots, and are easily digested due the smallest starch particles of all starch producing plants (Caesar 1986, 227). The potential of taro as a staple food for an increasing population is, however, limited: On both islands, most of the taro yields have decreased in recent years, because the plant not only requires a good water supply but also fertile soils. For instance, in the 1970s, Tioor was famous for its plentitude of regionally marketed taro, so that the island was literally named the granary (*gudang makanan*) of the islands between Seram and Tanimbar.

Yams *(Dioscorea spp.)*: About 600 species of the Old World genus *Dioscorea* (*Dioscoreaceae*) are known, and an estimated 60 species are gathered or cultivated for their edible tubers (Onwueme and Ganga 1996, 85). In Maluku, yams have been planted since ancient times, although cassava and sweet potato have presently become more dominant root storage crops. In Tioor and Rhun, at least three unidentified species of *Dioscorea* are distinguished. In Rhun, yams are grown in mixed gardens (cf. Map 4.1.1a). The crop is easy to grow and can be a food reserve in times of scarcity. The amount of vitamin C and proteins is comparable to taro, making yam an important supplement in nutrition (Onwueme and Ganga 1996, 86). Yams need high light intensities, fertile soils and a steady rainfall for maximum yields. Like taro they do not tolerate longer drought periods. Hence, the potential of yams depends much on maintaining soil fertility. Another drawback of yams is the relatively low reproduction ratio (weight ratio of propagated tubers to yield) of 1:5 (Leunufna 1996).

[124] "The dasheen type has a large central corm with a few small cormels which generally are not eaten. The eddoe type produces a smaller central corm surrounded by large, well-developed cormels which are the main harvestable yield" (Wilson 1989, 104).

Sweet potato (*Ipomoea batatas* (L.) Lam.): This perennial herbaceous plant of the *Convolvulaceae* is a native of Central America or northern parts of South America, and was brought by Columbus to Europe and then distributed in Asia.[125] Sweet potatoes are grown as sub-annuals in Tioor, but are less important than cassava, taro, and yams. The crop was not observed in Rhun. They are very nutritious (e.g., high vitamin C content in all cultivars; beta-carotene in orange-fleshed cultivars); the green parts (tender leaves, petioles, and young shoots) are rich in vitamins A and B2, iron and protein, and are consumed as a vegetable (Sakamoto et al. 1989, 167). Like cassava, sweet potato is vegetatively propagated,[126] and can grow on a wide range of soil types. During the development of the vines, it cannot tolerate long periods of droughts, but in the late phase of growth in which bulking of the storage roots occurs, rain will substantially decrease yields. Hence, it is preferably propagated in May or December to meet with the dry season in August or March, respectively. Until now, sweet potato serves as a supplementary food in Tioor, although it has a great yield potential (Sakamoto et al. 1989, 170). Its main drawback is the fast rotting of harvested storage roots, limiting sweet potato as a

Rice (*Oryza sativa* L.): This annual grass of the *Graminae* is cultivated in the humid tropics and in many subtropical areas in different systems, which have been developed to take specific ecological and socio-economic conditions into account (Vergara and de Datta 1989, 206 and 209-10; details provided by Uhlig 1987, 126-50). It is presently grown in Tioor to a limited extent as rainfed rice, propagated by seeds of traditional varieties[127] as the first crop in a *ladang* field, whereas it is not cultivated at all in Rhun. As the crucial factor of rice cultivation is a steady water availability by sufficient precipitation – irrigation or build up of small earthworks around the field is not practised in Tioor – rice has to be planted in early December. As previously pointed out, occasional storms of the west monsoon (December until February) may cause great damage to the yield. An advantage of rice is, however, that wild boars do not feed on the crop. As long as pest and diseases are still a minor problem, the outlook of rice, like of taro and yam, depends much on maintaining soil fertility. In Rhun, rice cultivation is practically less recommendable due to the abundance of mice on the island.

Maize (*Zea mays* L.): This annual grass of the *Graminae* originates from Central America, and was introduced in Southeast Asia by the Portuguese in the sixteenth century. It is less sensitive to drought than rice, and grows best on fertile, well-drained soils. In Tioor, and to a lesser extent in Rhun, maize plays a supplementary part in the subsistence activities and diet of the people, and is most commonly inter-cropped with cassava, taro and pulses, such as mung beans and groundnuts. Interestingly, maize was not quoted by any household as a staple or a supplementary diet, although it was frequently

[125] A prehistoric diffusion from America to Eastern Polynesia, and from America directly to the Philippines by the Spaniards in the sixteenth century have been additionally postulated (Sakamoto et al. 1989, 166-7). The Tioorese name for *Ipomoea batatas*, *kacela*, resembles its Malayan name (*ubi kastela*, or 'yam of Castile'), indicating that either the Portuguese (via Europe) or the Spaniards (via the Philippines) brought sweet potato to Maluku, as the indigenous people made no distinction between the Portuguese and the Spaniards (cf. Burkill 1935, 1246).

[126] According to indigenous knowledge, sweet potato should be propagated when *dur* (*Erythrina variegata* L.) is flowering.

[127] Commercial seeds will be occasionally used either if seeds of the former crop are not available, or if relatives in other islands send remaining rice seeds of their IDT group, such as the variety IR 64, to Tioor.

Table 6.5: Crops of dry field agriculture in Tioor and Rhun – a selection

Vernacular names of crop* *Scientific name of crop* **Origin**	**Ecology: optimal conditions (tolerance) 1. soil; 2. water requirement; 3. mean temperature**	**Propagation and planting**	**Husbandry and harvesting (no application of commercial fertilizer or pesticides; always hand-harvesting)**	**Post-harvest activities**
Cassava; Singkong; Kasbi *Manihot esculenta* Brazil, Central America	1. fertile sandy loams (depleted and eroded soils); stony soils are unsuitable 2. 1000-1500 mm/a; drought-resistant except at planting 3. 20-30°C	propagation from stem cuttings (20-30 cm long), vertically (Tioor) or diagonally (Rhun) planted by ♀ (occasionally by ♂) at distances of 1 m, immediately after harvest; tillage by ♂: dibbling, or hoeing and forming of mounds	weeding after 30 and 60 days, and eventually a third time after 100 days; harvest begins after 10 months (‘sweet’ cultivar after 5-6 months) by ♀, occasionally by ♂(‘piecemeal harvesting’)	Processing or consumption within a few days: storage roots are peeled, grated, squeezed and dried or prepared for food by ♀; danger of toxicity; in Tioor surpluses are marketed
Taro; Keladi; Huly *Colocasia esculenta* South-East Asia	1. fertile soils (variety of soils, tolerates pH 4.2-7.5) 2. 2000 mm/a, well distributed 3. 25-30°C, high humidity	vegetative propagation (larger, healthy head sets & suckers), shallow planting by ♀ (occasionally by ♂) at distances of 1 m into dug holes (with hand or crowbar by ♂)	first weeding after 30 and 60 days, eventually a third time after 90 days; harvest begins after 12 months by ♀, occasionally by ♂ (‘piecemeal harvesting’)	consumption after boiling or frying within 1-2 weeks, or storage (under high humidity & cool temperatures); surpluses are marketed
Yam; Ubi; Uf, Kumbili *Dioscorea spp.* Far East	1. loamy, well drained fertile soils; pH 5.5-6.5 2. 1500 mm/a or more, well distributed 3. 25-30°C during growth	propagation by tubers; planting by ♀ at distances of 0.5 m; tillage by ♂: forming of mounds or digging (with crowbar)	staking of plants by ♀ soon after emergence; weeding is done repeatedly at intervals of 30 to 90 days; harvesting (digging) after 12 months by ♀, occasionally by ♂	storage in cool, shady conditions; consumption of peeled, then boiled, roasted or fried tubers; part of the tubers are stored for the next crop
Sweet potato**; Patatas; Kacela *Ipomoea batatas* Central America	1. well-drained sandy loam (wide range of soil types), pH 5.6-6.6 (pH 4.2-7.0) 2. 600-1600 mm during growing season, well distributed; 3. 25-30°C	vegetative propagation (vine cuttings), planting by ♀ (occasionally by ♂) on mounds (tillage by ♂) at distances of 0.5 m, two or three cuttings per mound	weeding after 30 and 60 days; harvesting 3 months after planting by ♀, occasionally by ♂; ‘piecemeal harvesting’, but not later than 4 months after planting	consumption within one week; storage is difficult due to fast rotting and sprouting of the harvested storage roots
(Rainfed) Rice**; Padi; Pasah *Oryza sativa* Northern India, Himalaya	1. fertile heavy soils (variety of soil types), pH 6.5-7.0 (3-10); 2. at least 750 mm over a period of 3-4 months (water is the major limiting factor); 3. more than 21°C day temperature	propagation by seed; tillage by ♂ (dibbling of holes 15-20 cm apart), drilling and closing of holes by ♀ (3-5 seeds per hole)	weeding after 20 and 40 days; harvesting by ♀ & ♂ 3 months after planting: cutting of stems and threshing (to separate the paddy, i.e. the grain and its enclosing husks, from the stalk)	sun-drying of paddy, subsequent winnowing by shaking and tossing the paddy on a basket-work tray with a narrow rim; part of the seeds are stored for the next crop
Maize; Jagung; Sapulut *Zea mays* Central America	1. well-drained, well-aerated, deep soils (wide variety of soils), pH 5.5-7 (5-8) 2. 600-900 mm during growing season 3. at least 20°C average day temperature	propagation by seed; tillage by ♂ (dibbling of holes 60-80 cm apart), drilling and closing of holes by ♀(3-5 seeds per hole)	weeding after 30 and 60 days; harvesting by ♀ & ♂ 3 months after planting: cobs are removed	direct consumption (roasting or boiling), or storage (sun-drying of removed grain from cobs), part of the seeds are stored for the next crop
Foxtail millet**; Jawe; Botan *Setaria italica* Europe, Asia	1. fertile soil (wide range of soil types, even on marginal soils) 2. (100-125 mm during growing season) 3. not mentioned in PROSEA, Vol. 10	propagation by seeds; seeds either broadcast by ♀, or planted: tillage by ♂ (dibbling of holes 10-15 cm apart), drilling by ♀ (2-3 seeds per hole)	weeding after 30 days; harvesting by ♀ 4 months after planting: cutting of stems and threshing	husking just before consumption; part of the seeds are stored for the next crop
Eggplant; Terong; Toron *Solanum melongena* India, Burma	1. well-drained, sandy loam 2. drought-tolerant; 3. 25-35°C/20-27°C [day/night temperature]	propagation by seed; grown in seedbed; seedlings planted at distances of 1 or 2 m, 4 weeks later; often in inter-cropping with cassava or other vegetables	weeding after 30 days; progressive harvesting by ♀, occasionally by ♂ after 3 months, once or twice a week.	direct consumption after boiling; part of the seeds are stored for the next crop
Groundnut; Kacang tanah *Arachis hypogaea* Bolivia, Argentina	1. friable well drained soils; pH 5.5-6.5 2. 500-600 mm during growing season; drought-tolerant; 3. 30°C (20-30°C)	propagation by seed in December or May; sole cropping, or mixed/inter-cropping with taro, cassava, maize; dibbled in rows (dibbling by ♂, sowing by ♀)	weeding 30 days and 60 days after planting; ripening after some 100 days, harvesting by ♀, occasionally by ♂: pods are removed from bushes by hand	sun-drying of pods; part of the pods are stored for the next crop
Mung bean; Kacang hijau *Vigna radiata* India, Burma	1. drained or sandy loam; pH 5.5-7.0 2. 200-300 mm during growing season; drought-tolerant; 3. 28-30°C (20-40°C)	propagation by seed in December or May; mixed or inter-cropping with cassava, maize, taro; dibbled in rows (dibbling by ♂, sowing by ♀)	weeding 30 days after planting; ripening after 80 days; harvesting in 2-5 hand-pickings at weekly intervals by ♀, occasionally by ♂	sun-drying of pods; shattering; part of the seeds are stored for the next crop

Notes: * English; Indonesian; Tioorese; ** observed only in Tioor. Other annual crops are cultivated in dry fields as well (see App. 1.1).

Sources: Articles in PROSEA handbook, several volumes; Interviews, mapping and observation (Stubenvoll 1996 and 1997).

observed during field excursions in Tioor. Maize kernels are rich in provitamin A and proteins, despite a deficiency in the essential amino acid tryptophan (Koopmans and ten Have 1989, 275-6; Monk et al. 1997, 707; cf. App. 1.7). Soil erosion problems and water loss through increased surface runoff are constraints of maize cultivation, because much of the soil is uncovered during the young crop. In Rhun, maize is damaged by mice, so that farmers are only sporadically cultivating the crop.

Foxtail millet (*Setaria italica* (L.) Beauvois): This annual grass of the *Graminae* has been cultivated since ancient times in the Old World (Rahayu and Jansen 1996, 127). It is occasionally planted in Tioor,[128] but absent in Rhun. Foxtail millet can be grown in semi-arid regions and tolerates low amounts of rainfall (see Tab. 6.5). However, it is susceptible to prolonged droughts. Reasonable yields are obtained even on poor and marginal soils, although fertile soils will do better (Rahayu and Jansen 1996, 129). In Tioor, it does not suffer from serious pests and diseases. With regard to the variability of rainfall and to declining soil fertility, foxtail millet's importance may increase in the future. Moreover, seeds of foxtail millet may be broadcasted for propagation so that its cultivation is less labour-intensive than that of rice or corn.

Resource inputs

The production process is managed with an input of the means of production land, labour, and capital. Although *labour* seems to be relatively easily available (e.g., in form of reciprocal *kerja masohi*), it can be regarded as a *scarce* resource. Bottlenecks in labour availability occur, because farmers are often engaged in off-farm activities. Land and capital are scarce in either island, to a different degree, however. In Tioor, *capital* tends to be a more critical resource, whereas in Rhun *land* has to be regarded as the least available of the means of production. *Capital input* is small, and required for paid labour, group labour (food provision) and tools, whereas commercial fertilisers, pesticides and seeds are not used in both islands.[129]

Land resources and field size

Land tenure and the distribution of land were examined in Ch. 5.4.3 and Ch. 5.5.1, respectively. In Tioor, the size of a new *ladang* field is usually about 0.3 ha, although smaller and larger fields are found, depending on the number of individuals of a household. Fields extending 1.0 ha are either cultivated by several households of a family or of a clan, or are obtained in rare cases through the mode of annual extension by a single farming household (cf. Map 5.1.1). In Rhun, permanent dry fields of 0.2 to 0.3 ha are most common.

Labour arrangements

Cropping procedures are usually arranged and carried out by the household, but sometimes only by a single male adult. In fields belonging to several households of a family or of a clan the work unit is the family or the clan, respectively, unless the field is split among the households into several plots. Help of a group or individuals of other households is often (but not always) deployed for time- and energy-consuming activities. An exceptional case is paid labour, which is more common for tree garden management. Each existing form of labour arrangement is considered in the following.

Individual labour in a dry field by a male adult is a very rare case. It is only arranged in Tioor by those immigrants from Flores, who have limited access to land resources, and whose children are too young for any assistance, so that the wife is entirely engaged in upbringing of the children and in housework.

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[128] During field work in Tioor, foxtail millet was not observed, although it was frequently mentioned and described by interviewed key informants and farmers as being planted on a small scale.

[129] Commercial seeds (common bean, yard-long bean, rice) are occasionally used by a small minority of farmers, although this is a very recent development.

The *household* is the common work unit of agricultural activities, and its size and composition (sex, age) affects possible labour arrangements. *Sexual division of labour* concerning dry field agriculture is not rigidly organised, although it follows typical characteristics (see Tab. 6.5). The responsible person of a certain task is not necessarily the decision-maker concerning site-selection, growing of certain plant species, and timing of harvest. The wife is the most influential part of the household for decisions with respect to the production of annuals, and in case of conflicting interests her husband usually submits to her.[130] Typical male tasks require great energy and strength, and include clearing of medium-sized and tall trees, burning, arrangement of small mounds for the cultivation of yams and cassava, construction of field huts and fences, provision of cassava planting material and cereal seeds, soil preparation (tillage) with a hoe, a dibble or a crowbar (*linggis*, for digging holes), and eventually removing of disturbing roots. Female labour is more time-consuming and less energy-intensive than male labour. Female tasks are provision of taro and yams planting material, planting of all annuals except cassava and cereal seeds,[131] harvesting of tubers and vegetables, and processing of products. All other labour procedures are carried out by both males and females, like cutting of herbs, shrubs and small trees, planting of cassava, weeding, field check and sleeping in the field hut, fire fighting operations, planting and harvest of cereals and pulses, and transport of harvested products to the village. If under certain circumstances, like absence, illness, or the necessity to be engaged in other activities, a man cannot carry out his labour, his wife will only take on his part of the common tasks. To carry out typical male tasks would require his wife to look for help from another male adult – either by paid labour or by *kerja masohi*. Conversely, if a women is prevented from performing her tasks, her husband will accept not only to carry out common labour on his own, but additionally certain typical female tasks, such as the provision of planting material and harvesting of tubers and vegetables. To plant annuals except cassava, or to process products he would ask for the help from a group of females or a female relative. Sexual division of labour regarding dry field agriculture *and* rejection of taking on certain untypical tasks allow the conclusion, that both partners are dependent on the labour force of each other.

Age structure of the household is influencing cropping procedures as well. Children younger than 12 years support their parents in cutting, weeding and sometimes in field check. Their help is restricted to the afternoons, when classes of the primary school (*SD*) have ended. Children between 12 and 15 years can spend more time in the field, and carry out the same procedures like their younger brothers and sisters, unless they continue lessons in lower secondary school (*SMP*). In this case, they will have to leave the island. As soon as children are 15 years old, they participate in all adult tasks. Again, attendance of upper secondary school (*SMA*) until the age of 18 requires a child to be absent from the village. The lifespan of an individual for intensive agricultural work may reach 40 years. However, older men are no longer co-operating in energy-intensive labour, such as clearing, construction of fences and huts, and field preparation. Distant fields are cultivated by younger and stronger adults, whereas older men and women restrict their tasks to locations near the village.

On clan’s land in Tioor, labour is jointly carried out as long as the field is not split among the families, which is most commonly arranged after burning of the location. The clearing of tall trees and burning is a male task in which several male individuals of the clan’s families are involved, so that it is not necessary to organise a *kerja masohi* group. Group labour systems are either of temporary or permanent character (cf. Ch. 5.4.2). These groups are common in Tioor, but less often deployed in Rhun. The reciprocal system of temporary *kerja masohi* is not limited to farming activities, rather it

[130] An example of conflicting interests is provided with the case study of a peasant household in Ch. 6.5.2.

[131] Planting of cereal seeds is simultaneously carried out by both male and female, although with different tasks: The man prepares the soil (dibbling or hoeing), while the women puts in seeds or planting material.

extends to all kind of labour that requires several individuals. In dry field agriculture, a farmer in Tioor may call on *kerja masohi* for clearing, cutting, fire fighting operations, planting of all kind of annuals, part-time fencing, and harvesting of cereals; in Rhun, it is restricted to planting and fire fighting operations. Permanent groups consist of not interchangeable members and are less flexible than *kerja masohi*, but farming procedures can span over a period of several days. Agricultural self-help and formal IDT groups commonly hold a field and equally share resource input and output. Members of the group jointly carry out all cropping activities and bear costs for food equally. Paid labour with respect to dry field agriculture is restricted to cutting and fencing, involving an agreed piecework wage (cf. Tab. 6.6).

Table 6.6: Labour input and labour arrangements in a dry field (0.3 ha)

Work	No. of man-days	Comments	Sexual division of labour	Group labour	Paid labour (wages 1997)
1. Cutting	**3**	-	**M, F, (C)**	common; *n.o.*	Rp. 20,000
2. Clearing	7	-	M	common; *n.o.*	-
3. Burning	**1** - 2	max.: burning twice; **min.: burning once**	**M**	**fire fighting operations**	-
4. Planting	**10 - 24**	max.: taro (inter-cropping); min.: foxtail millet	**M, F**	common; *less common*	-
5. Field check	staying the night	if fence is not constructed	M, F, (C)	**not observed**	-
6. Fence construction	**0** – 20	facultative	M	less common; *n.o.*	Rp. 100,000
7. Field hut construction	**3** - 8	max.: semi-permanent type;**min.: less durable type**	**M**	**not observed**	-
8. Weeding	**6 - 21**	max.: taro (inter-cropping); min.: sweet potato	**F, M,(C)**	less common; *n.o.*	-
9. Harvesting	**3 - 9**	max: taro (inter-cropping); min.: sweet potato; **not to measure: cassava**	**F, (M)**	less common; *n.o.*	-
10. Processing	**3**	**not to measure: tubers**	**F**	**not observed**	-
SUM (min. – max.)	**41 - 92**				

Notes: Plot of 50 m x 60 m (0.3 ha), which is a common field size;
M male task; **F** female task; **(C)** supportive role of children, **(M)** supportive role of male;
bold: both islands; *italic*: Rhun; standard: Tioor; n.o.: not observed in Rhun;
Non-permanent agriculture in Rhun is restricted to cassava cropping;

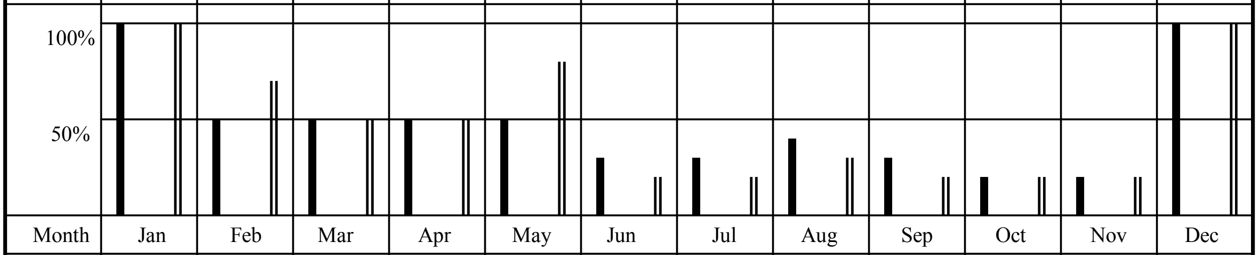
Sources: Household interviews and observations (Stubenvoll 1996 and 1997).

Labour input

Tab. 6.6 provides details on *labour input* and summarises labour arrangements for each step of the cropping cycle in a typical plot of 0.3 ha (50 m x 60 m). The labour input of fencing is facultative, and depends both on length of a fence – which itself depends on field area and shape (in this example it is 220 m, or a labour input of 20 man-days) – and availability of fence material like bamboo and poles. Labour input of cutting, clearing, burning and field check is equal for all annual crops, but differs for planting preparation, planting, weeding, harvesting and processing. The most labour-intensive pattern is the cultivation of taro inter-cropped with maize, vegetables and pulses: 92 days with fencing, the construction of a less durable field hut, and burning twice; 76 days without fencing, with the construction of a semi-permanent hut, and burning once. It must be stressed that these figures on labour input often include other activities in the field not being directly devoted to dry field agriculture. A farmer may perform other tasks at the same day, such as fuelwood collection, and the planting of a few tree seedlings. Moreover, certain activities do not span the whole day, such as weeding and processing. Agricultural labour input is also seasonally varying, reaching its maximum during the rainy season (Fig. 6.8).

Figure 6.8: Typical seasonal calendar of agricultural labour input in dry fields

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
main activities	4-5-8-9-10	5-8-9-10	5-8-9-10	1-5-9-10	1-3-4-5-8- 9-10	5-8-9-10	5-8-9-10	1-2-5-9-10	1-5-9-10	3-5-9-10	3-5-9-10	4-5-6-7-8-9-10



Notes: *Approximate* figures in percentage of all economic activities of a typical household (in Tioor: ▬▬ ; in Rhun: ═══);
Abbreviations of activities as in Tab. 6.6;
Agricultural activities that are not specified may be additionally performed, although to a lesser extent;
Considerable variations among households may occur due to socio-economic differences.

Sources: Household interviews and observations (Stubenvoll 1996 and 1997).

6.3.3 Tree gardens

After a general description of tree garden development, each type of tree garden (*dusun*) is analysed in its structure, practices and the use of its products. The description of perennials that are integrated into tree gardens, and the analysis of tree tenure, garden distribution, and resource inputs is presented thereafter. The following discussion must focus on tree gardens in Tioor, because there the *dusun* is the leading agroforestry system, whereas in Rhun it plays only a minor role.

Tree garden development

Tree garden development widely differs in Tioor and Rhun. In Tioor, the *integration of perennials into dry fields* (*ladang*) is a first step towards the establishment of permanent cultivation.[132] These plots will usually develop to a tree garden or a mixed tree garden, where annuals can no longer be cultivated. If perennials are integrated at spacious distances, however, annuals may be inter-cropped, even when perennials have reached maturity: This is the *mixed garden*, which is the dominating agroforestry system in Rhun. It is separately treated in Ch. 6.3.4. In Rhun, tree gardens are quite small in size and occupy just 5% of the island's area (Tab. 6.3): They have emerged either through *rejuvenating* of old tree groves (coconut, nutmeg), which have been occasionally enriched with other tree species, or through *inter-planting of clove seedlings into old nutmeg stands*.

Tioor: The tumpangsari farming system

In Tioor, garden development usually follows the *tumpangsari* farming system. It begins with a first cropping phase of an annual, sub-annual, bi-annual, or any combination of these, in a *ladang* field. In the second year, the farmer integrates a first perennial crop (coconut, clove, coffee, or a combination of these), which at a later stage of development form a tree garden or a mixed tree garden. In rare cases, inter-planting of tree saplings occur in the first or in the third year. The planting of other

[132] With the exception of permanent dry fields (*kebun*) in Rhun, any permanent dryland farming will ultimately result in soil degradation and in an emergence of critical land (*lahan kritis*) (see Ch. 6.4.3 and Ch. 7.1).

perennial crops at a later stage is possible, usually in the third year, but their growth phases take longer than that of the first perennial. Examples include trees yielding edible fruits (e.g., durian, jackfruit) and protection trees (e.g., *Canarium indicum* L.). Additionally, sago and nutmeg can be integrated at this stage, when partial, necessary shade is available. *Tumpangsari* is similar to the *taungya* system,[133] but it differs from the latter in *tree tenure*, because the obtained tree groves belong to the farmers. About three years after planting of the first perennial, annuals can no longer be grown on the plot, so that the farmer clears another location for their cultivation, where later perennials again may be integrated.

Tioor: Slash-without-burn and integration of nutmeg seedlings

In Tioor, *slash-without-burn agriculture* is practised in combination with propagation of nutmeg seedlings, occasionally mixed with sago palm seedlings. For nutmeg trees do better with protection trees (cf. Ch. 6.1.1) farmers in Kelvow have developed this mode of *tree garden* establishment. Hence, slash-without-burn agriculture can be classified as an agroforestry system. The plot is cleared with the exception of selected primary forest trees, like *perai* (*Intsia bijuga* O. Kuntze) or *dir* (*Diospyros sp*). When plant debris has decayed, taro is planted, usually at the beginning of the rainy season in December. One year later, taro is harvested and replanted in between the places that were occupied by the taro plants of the previous year. Additionally, 50 cm tall, naturally established nutmeg seedlings are transplanted into the plot, at a distance of 7 m x 7 m. The cultivation of taro is repeated year after year, as long as the nutmeg trees are not interfering with the taro plants. Yields of taro are continuously declining because planting density has to be adapted to the growing nutmeg trees. The field will develop to a nutmeg tree garden, and can be then referred to the term *dusun pala*.

Slash-without-burn has several *advantages* compared to shifting cultivation:

(1) Clearing is less labour-intensive, because tall forest trees are left in the plot.

(2) Due to the absence of burning, soil structure and soil microorganisms remain relatively undisturbed, reducing thereby soil erosion and having a positive impact on soil fertility and water retention.[134] For instance, farmers have reported more continuous taro yields *per plant* if the plot is not burnt. Thus, it is possible to consecutively plant taro for more than three years, which is the maximum under shifting cultivation.

(3) Forest remnant trees provide valuable timber and non-timber products (NTPs), which would be forfeit by slash-and-burn activities.

(4) These trees serve as protection trees for integrated nutmeg seedlings.

(5) An accidental spread of fire to nearby tree gardens is obviously not possible.

The *disadvantages* of this practice are on the one hand the lower annual *per hectare* yields of taro, and on the other hand – and this is common to all gardens – a reduction of the area being available for the production of staple food. Thus, the farmer has to make a compromise between shifting cultivation and slash-without-burn agriculture, in which he carefully considers the nutritional needs of his family.

Rhun: Rejuvenating and inter-planting of perennials into nutmeg plantations and coconut groves

Most of the Dutch *coconut groves* along the coastal strip, as well as in areas where natural conditions do not allow the establishment of nutmeg trees, have been rejuvenated and in some cases enlarged by the peasants. However, a land-use map (Map 4.1.1d, Batu Lawa-Lawa) reveals an example where

[133] *Taungya* has emerged in Birma in the nineteenth century, and refers to the development of state-owned teak plantations (*Tectona grandis* L.f.). The farmer gets access on governmental land to plant annuals, but has to integrate and care for teak seedlings. After two years, the farmer abandons the cultivation of his products and moves on to another plot, where the cycle is repeated. For more information on Taungya, see Jordan et al. 1992.

[134] This is underlined by a qualitative soil evaluation, carried out by the author with R. Liang. For more details see Ch. 7.1.1.

these plantings were replaced by an open field, now being in its first fallow stage. Although the *nutmeg plantations* disappeared from Rhun Island – in 1996, these were numbering to a total of 1,000 trees (or 5% of the colonial period) – some farmers have rejuvenated nutmeg trees reaching maturity.

During the 1970s, some farmers planted clove seedlings in between old nutmeg stands. When clove prices reached historical record prices in the 1980s, most other farmers followed this strategy of inter-planting despite clashes with the state-owned plantation enterprise *Prajakarya*.[135] Sometimes bananas were integrated. The farmers' calculation has proved to be effective, as the inter-planting has resulted in productive farmer-held clove tree gardens after the decline of the state-owned nutmeg culture and the wilful destruction of a great part of the *kenari* trees (*Canarium vulgare* L.). The number of clove trees in *all land-use types* in Rhun totals about 5,000 (interview with village head).

Where other tree species were inter-planted into existing and rejuvenated tree gardens, mixed tree gardens (in any combination of clove, nutmeg, coffee, coconut and sugar palm, and fruit trees) have developed. Fertility erosion in *Gunung Tanah Merah* (see Fig. 6.4) no longer allows the cultivation of nutmegs and cloves, so that the establishment of tree gardens is restricted to coconut and sugar palms.

Coconut tree gardens (*dusun kelapa*)

The coconut palm (*Cocos nucifera* L.) of the *Palmae* is the dominant tree crop in Tioor, and a major factor in the village economy. The palm has been mainly planted in large coconut tree gardens (*dusun kelapa*) along the coastal strip and on Uran Island. It is presently established from the coastal plain in an uphill direction and in the uplands, where it is still under-represented. Thus, the area of *dusun kelapa* is steadily increased by the farmers. In Rhun, the coconut palm is an integral part of mixed gardens in almost every spot of the island, whereas pure coconut groves only exist along the coast and on coastal terraces. In the following, the analysis is therefore focused on the *dusun kelapa* of Tioor.

In Tioor, coconut seedlings are originally planted at a spacing of 8 m x 8 m. As old coconut tree gardens are deliberately enriched with young seedlings, and as fallen fruits naturally germinate – which is the case if the mature coconut tree garden is less carefully managed – distances between trees will soon decrease to 6 m or even less. In fact, most of the older *dusun kelapa* along the coastal strip, which were mainly planted from the 1950s until the 1970s, show this yield-reducing, overcrowded spacing. Thus, the number of coconut trees per hectare is theoretically varying between 150 and 300. The integration of other tree species into a *dusun kelapa*, which is a common characteristic of its structure, substantially reduces this number. Most often betel-nut and banana cultivars, but also breadfruit, nutmeg, coffee, clove, durian, *Canarium spp.* and candlenut *(Aleurites moluccana* (L.) Willd.) are inter-planted. Furthermore, a wide range of naturally established plants are found in the medium and lower layers of a *dusun kelapa*, such as medicinal trees, shrubs, and herbs.[136] The multitude of integrated and naturally established species in a *dusun kelapa* depends on the

[135] "W*e thought, why should we always travel to Seram for the clove harvest? We also could plant these trees here in Rhun. But in the beginning, the Prajakarya removed all clove tree seedlings. So we fought with their employees, until the planting was finally allowed by the district administration in 1981"* (HH 2).

[136] Among others: *Acalphya caturus* Blume, *Archidendron ellipticum* (Blume) Nielsen, *Asystasia gangetica* (L.) T. Anderson, *Commelina moliflora* L., *Crinum asiaticum* L., *Erythrina variegata* L. *var. orientalis* (L.) Merrill, *Ipomoea pes-caprae* (L.) R.Br., *Kalanchoe pinnata* (Lamk.) Pers., *Melanolepsis multiglandulosa* (Reinw. ex Blume) H.G. Reichenbach & Zollinger, *Morinda citrifolia* L., *Operculina riedeliana* (Oliv.) V. Ooststr., *Scleria* sp., *Sida acuta* Burm.f., *Stachytarpheta jamaicensis* (L.) Vahl, *Timonius timon* (Sprengel) Merrill, *Urena lobata* L., *Vernonia cinerea* (L.) Less., and *Wollastonia biflora* (L.) DC. Some mentioned species have other, more important functions, like *Ipomoea pes-caprae* (L.) R.Br., which is found at sandy beaches and extends into coconut tree gardens (see also Ch. 4.2.5). Its main function is to stabilise the beach by binding the sand (Sunarno and Oyen 1997, 163). For further details see App. 1.1.

management activities of the farmer (see below). Parts of a coconut tree garden may equal extreme forms of complexity. As shown in Fig. 6.9 it may resemble an agroforest.

The *establishment* of a coconut tree garden follows the *tumpangsari* farming system. Coconut is propagated by locally available seed-nuts,[137] which after the harvest are being put on the banks of a stream for a period of several weeks. After germination they are transplanted into burrowed small holes in the field. Naturally germinated fruits may be additionally removed from a mature coconut tree garden for transplantation. During the growing phase of the young trees, weeding is essential and regularly carried out. Farmers sometimes protect coconut seedlings from predatory wild boars through fencing or by regular guard during the night. First flowering of tall cultivars takes place about five years after planting. The coconut palm grows up to a height of 30 m, dwarf forms up to 10 m. It reaches maximum yields with the age of 30 years (Burkill 1935, 600).

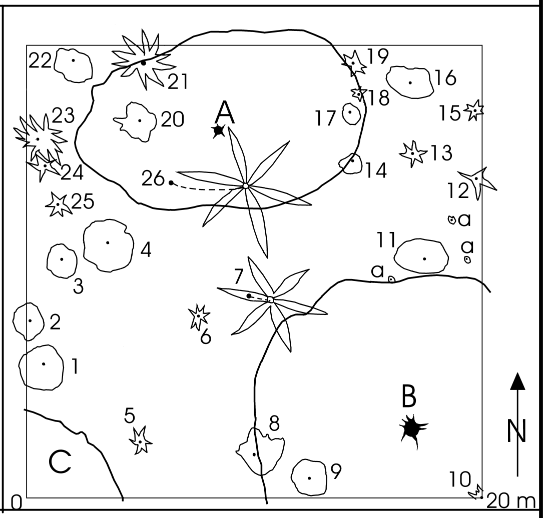
Figure 6.9: Horizontal structures of a coconut agroforest in Tioor – Kerker location

Legend: Tree species (height)

Coastal plain
Altitude: 5 m

1 *Cinnamomum burmani* (4 m)
2 unidentified (vernacular name: Fagic) (5 m)
3 *Syzygium aqueum* (2.5 m)
4 *Syzygium aqueum* (4 m)
5 *Cocos nucifera* (4 m)
6 *Cocos nucifera* (2 m)
7 *Cocos nucifera* (25 m)
8 *Syzygium aqueum* (4 m)
9 *Canarium indicum* (3.5 m)
10 *Cocos nucifera* (2 m)
11 *Syzygium aqueum* (3.5 m)
12 *Cocos nucifera* (4 m)
13 *Areca catechu* (5 m)
14 *Syzygium malaccense* (1.5 m)
15 *Areca catechu* (3 m)
16 *Syzygium malaccense* (4 m)
17 *Syzygium aromaticum* (2 m)
18 *Cocos nucifera* (1 m)
19 *Cocos nucifera* (2 m)
20 *Alstonia scholaris* (4 m)
21 unidentified *PALMAE* (4 m)
22 *Syzygium aqueum* (2 m)
23 *Areca catechu* (7 m)
24 *Cocos nucifera* (2 m)
25 *Cocos nucifera* (2 m)
26 *Cocos nucifera* (20 m)
a *Cinnamomum burmani* (1 m)
A *Durio zibethinus* (16 m)
B *Canarium indicum* (29 m)
C *Aleurites moluccana* (20 m) (trunk outside of plot)

Cover vegetation: unidentified fern species (40%), some *Piper betle*.



Sources: Mapping, household interviews, and herbarium collection (Stubenvoll 1997).

The *management* of the mature coconut tree garden includes: weeding, harvesting, processing and marketing of copra. *Weeding* is performed in one of three possible ways. The traditional *hand-cutting* (*pamere*) has lost its importance since 1985, when farmers have begun to practice annual *burning* (at the end of the dry season) of the complete cover vegetation in the *dusun kelapa*. The latter is less time- and energy-consuming, but actually decreases yields and negatively affects bio-diversity by destroying even useful medicinal plants. It is also the social factor, which has made burning very popular: A 'neat' *dusun kelapa* (without cover vegetation) is considered to be a proof of being a diligent farmer. Another reason of burning, which was brought on by the farmers, is the control of the leaf-eating bushcricket *Sexava* sp. This pest severely damaged all coconut groves in 1972/73. Only a governmental pest management programme[138] averted the complete destruction of the coconut tree gardens in Tioor. Nevertheless, *Sexava* sp. still represents a potential threat to the coconut palm. Other

[137] In Tioor, the vernacular name of the coconut is *nuar*, in Rhun it is the Indonesian word *kelapa*. Three tall cultivars of *nuar* are distinguished in Tioor according to their taste: *nuar biasa*, *nuar kier* and *nuar tef*. The latter two are seldom found and taste sweeter than the former one. Cultivars are also divided according to the shape of the fruit (triangular or round) and of the shell (oval or round). An oval shell may be used as a funnel by making a hole at the pointed end. Round shells serve as household utensils or pots. A dwarf cultivar of the coconut palm is additionally cultivated.

[138] The programme was carried out by officials of the *Dinas Perkebunan Tingkat II* (section for plantation crops of the agricultural service at regency level) for a period of two months in 1973. Pesticides were inserted into the trunk of all infested palms.

farmers prefer to carry out *hand-cutting with controlled burning*: Cut and gathered plant debris is set on fire each year in another part of the coconut tree garden. This method allows reasonable yields, and spares useful medicinal plants from removal, while the farmer can choose the right place for controlled burning.

The *harvest* is performed three times per year, if an individual *sasi* has been imposed (see Ch. 5.4.2). Climbing and cutting of ripe coconuts is the most common way of harvesting, accompanied by reaping of fallen nuts. The latter could be solely carried out because it is easier, but the nuts are susceptible to theft, and in hilly terrain they may roll into the *dusun kelapa* of another farmer. Furthermore, fallen fruits will germinate if missed during reaping. Harvested nuts are either carried to the village and sold to an intermediary, who continues further processing, or stored at a kiln[139] in the coconut tree garden. After storage until the husks are completely dry, the nuts are manually dehusked[140] and halved with a machete, so that the water is drained. The nut halves are stacked in the kiln and dried over a smoulder for 1 or 2 days. After, the endosperm is removed from the endocarp and dried further until the copra is ready to be put in sacks of about 85 kg each. Intermediaries are also storing the fruits first, but thereafter the halved nuts are completely sun-dried before being dehusked. Processing in the *dusun kelapa* has the advantage of returning nutrients from the rotten husks to the soil, so that little soil fertility is lost. Furthermore, the method of kiln-drying is superior to sun-drying, because the latter may lead to a deterioration of copra during the rainy season. Kiln-drying is especially preferred in tree gardens with greater distances to the village, as transport of the heavy nuts to the village is a burden. Despite these advantages of kiln-drying, many farmers sell their nuts to an intermediary, because it is less time-intensive, it guarantees reasonable producer prices, and it is a mean to barter coconuts with goods from the intermediary's store or to pay back loans.

Although yields are widely varying, an average acceptable yield is considered to be 50 to 75 nuts per year and palm, which is equivalent to about 10 to 15 kg of copra. In former years, however, annual yields reached up to 30 kg of copra per palm. The total annual exports of copra from Tioor Island was an average of 400 t on 180 ha (2.2 t/ha) between 1962 and 1971, 200 to 300 t on 250 ha (0.8 to 1.2 t/ha) between 1976 and 1987, and 400 t on 300 ha (1.3 t/ha) between 1987 and 1993 (interviews with key informants).[141] In recent years exports have reached 500 t on 380 ha (1.3 t/ha) of productive coconut tree gardens. The decrease in yields depends on numerous varying factors. The most important one is the coconut pest *Sexava* sp. Others are: the practice of burning the complete cover vegetation; the removal of husks from the coconut tree garden; the narrow spacing through less careful management; the ageing of a part of the coconut tree gardens; and the harvesting of premature fruits if individual *sasi* is not imposed. Additionally, ecological stress, such as prolonged drought, affects yield much more than it affects growth (cf. Ohler 1989, 92). Potential yield increasing management activities will be discussed in Ch. 8.3.1.

Copra is marketed in Tioor to one of three merchants of Chinese descent who directly transports the product with his ship to Surabaya (Java) for processing in oil mills. Two merchants have established a well functioning network of wholesale buyers (intermediaries) in Tioor and surrounding islands, to whom they provide credit and goods for their stores. Thus, the intermediary is also dependent on the merchant, who actually fixes the copra price, to which the intermediary calculates a small profit. Furthermore, the wholesale buyer has to consider weight loss of stored copra. Kiln-drying farmers may choose to sell their copra to an intermediary, or directly to the third merchant who is living in

139 The kiln is a simple field hut, similar to the construction of the less durable type (see Ch. 6.3.2).

140 The husk, i.e. the exocarp and the fibrous mesocarp, is separated from the endocarp ('shell') and the 1 to 2 cm thick endosperm by striking and twisting the nut on a steel point that is placed firmly into the ground (see also Ohler 1989, 94).

141 Between 1972 and 1975 exports collapsed due the pest attack of *Sexava* sp.

Tioor, and can offer better prices because he operates without an intermediary. In times of his absence, the other two merchants are able to lower producer prices.

Dusun kelapa and marketing of copra are subject to taxes and village fees, respectively. Each farmer has to pay a varying, annually fixed amount of tax to the administration at regency level, which depends on the size of his coconut tree gardens. Besides taxes, intermediaries pay village fees dependent on their store size, and merchants are charged by the village administration with Rp. 500 per sack of copra leaving the island. The wage for the loading of sacks onto the ships is also fixed by the village administration to Rp. 1,500 per sack.

In Tioor, a small part of the fruits is consumed by the household, whereas in Rhun fruits merely serve subsistence. Water of young coconuts (*kelapa muda*) is drunk as a refreshment during field work; the jelly-like fresh endosperm is a delicious snack. For oil extraction, the man transports dehusked ripe nuts to the village, where they are halved. The extraction of cooking oil and the preparation of meals with coconut 'milk' and flakes, are the only female tasks in the whole process of coconut tree garden management: The endosperm is scooped out, grated, mixed with water and pressed. The resulting liquid, which is called coconut milk, is boiled until the oil is floating on the top, from where it is skimmed off and filtered into bottles. To get purer oil for marketing at regional level, it has to be boiled for a second time. As a general rule, one litre of oil can be extracted from ten nuts. After oil extraction, skim milk and coconut flakes are used as ingredients of meals.

Besides the coconut fat, a wide range of other products are produced by the coconut palm, which contribute to making it a very popular and a most useful tree species. When the inflorescence is still in the spadix, it is tapped of selected palms and provides a sweet sap with a sugar content of about 15%. It is collected with receptacles made from bamboo, and then fermented to produce the popular *tuak*, a beverage of low alcoholic content, which can be distilled to spirits called *sopi*. In Rhun, *tuak* is predominantly produced from the sugar palm (*Arenga pinnata* (Wurmb.) Merrill). Leaves, leaflets and the hard wood of the coconut palm are widely used for local construction and household tools. The hard shell (endocarp) of the nut provides fuel for kiln-drying and could be a potential supplementation of Moluccan ironwood (*Intsia bijuga* (Colbrooke) O. Kuntze) for charcoal production. For more details on different uses of the coconut palm see Ohler (1989, 90-1).

Nutmeg tree gardens (*dusun pala*)

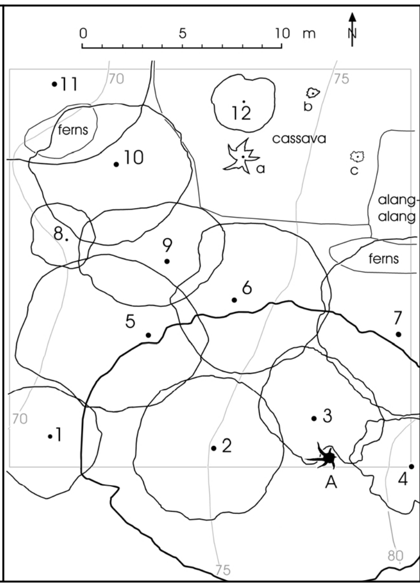
Botany of the true nutmeg (*Myristica fragrans* Houtt.), structure of a colonial nutmeg plantation in Banda, as well as practices and economic products are thoroughly discussed in Ch. 6.1.1. This section provides additional information on specific features of a *dusun pala* of the small-scale farmers. In Tioor, *pala panjang* (Papua nutmeg, *Myristica argentea* Warb.) is also cultivated for the production of nutmeg and mace. In the primary forest of Tioor a wild form of a *Myristicaceae, pala botan* ('forest nutmeg'), can be found, which has no economic value as a spice-producing tree, however, as it is *Horsfieldia bacanica*. Most of the *dusun pala* are found in the western and southern part of the island. In Rhun, colonial nutmeg plantations were largely replaced by peasant agriculture and mixed gardens, the remaining tree stands have only been partially rejuvenated. Thus, *dusun pala* is an exceptional feature in Rhun, and then comprising a quite limited number of nutmeg and protection trees.

In terms of garden structure, two types of nutmeg tree gardens can be distinguished: On the one hand, it is a mono-specific garden *without* protection trees, or a bi-specific one if *Myristica fragrans* Houtt. and *Myristica argentea* Warb. are planted together. This type is restricted to Tioor with the exception of the community of Kelvow, and results in higher yields. The trees, however, are vulnerable to long periods of drought. On the other hand, *if protection trees are integrated*, the structure becomes more complex. It then resembles the colonial nutmeg plantation of Banda (Fig. 6.2), although spacing is closer to an average of 6 m between nutmeg trees (see Fig. 6.10). In Tioor, most common protection tree species are *Alstonia scholaris* (L.) R. Br., *Paraserianthes falcataria* (L.) Nielsen, *Durio zibethinus* Murr., and *Canarium indicum* L. In Rhun, *Canarium vulgare* Leenh., and less commonly *Alstonia scholaris* (L.) R. Br., *Toona ciliata* M.J. Roemer, and *Dracontomelon dao* (Blanco) Merrill & Rolfe are planted.

Figure 6.10: Horizontal structures of a nutmeg tree garden in Tioor – Werkar location

Legend

1	*Myristica fragrans* (female)	height: 11 m	
2	*Myristica fragrans* (female)	height: 10 m	
3	*Myristica fragrans* (female)	height: 10 m	
4	*Myristica fragrans* (female)	height: 6 m	
5	*Myristica fragrans* (female)	height: 11 m	
6	*Myristica argentea* (female)	height: 16 m	
7	*Myristica fragrans* (female)	height: 11 m	
8	*Myristica argentea* (sex unknown)	height: 3 m	
9	*Myristica argentea* (female)	height: 13 m	
10	*Myristica fragrans* (male)	height: 14 m	
11	*Myristica fragrans* (female)	height: 14 m	
12	*Myristica fragrans* (sex unknown)	height: 4 m	
a	*Musa* L.	height: 7 m	
b/c	*Musa* L.	height: 1 m	
A	*Canarium indicum* (female)	height: 24 m	DBH: 0.6 m
alang-alang	*Imparata cylindrica*		
ferns	unidentified fern species		
cassava	*Manihot esculenta* (soil with a too limited effective depth for nutmeg)		
70	contour line (altitude [m])		
	boundary of measured plot		



Sources: Mapping, household interviews, and herbarium collection (Stubenvoll 1997).

Nutmeg is propagated in a similar way as described in Ch. 6.1.1, except that farmers more commonly transplant naturally established seedlings of about 50 cm height during the rainy season (December until February). Presently, a sufficient number of seedlings are available on either island. Until the 1970s, however, nutmeg trees were rare in Tioor, so that farmers took seedlings for free from Kasiui, where nutmeg groves have existed since at least 1900.

Husbandry and harvest of *Myristica fragrans* Houtt. is performed like in the colonial nutmeg plantations of Banda. The major difference is the harvest of the fruits *at one time*, including those not yet completely ripe. Twice per year, the man climbs up the tree and severs the fruits from the twigs with a *gai-gai*, which is a long pole of bamboo at which a sharpened piece of iron or a hook is attached. The work on the tree is risky, since falling could cause fractures or even death. His wife and children collect the fallen fruits, cut the half-ripe pericarps open and remove the kernels, which are then taken to the village for subsequent separation of the aril. Pericarps are left in the tree garden. Both arils and seeds (still within the seed-coats) are usually sun-dried. As the water content of half-ripe seeds is higher than of ripe seeds and thus require a longer drying, they have to be separated first from each other. After drying, seed-coats are cracked to free the dry nutmeg of commerce, which is sold together with the dried aril to an intermediary.[142] Dried products are bought at slightly better prices by the crew of the *Perintis* ship (cf. Ch. 5.2) on its way back to Ambon. The negative effects on yield and on quality of the products by this kind of harvest and processing are described in Ch. 6.1.1. Its

[142] Unlike copra and cloves, marketing of nutmeg/mace is a female task: *"It's better the women save the money from nutmeg sale; otherwise the men could use it for buying cigarettes or gambling*" (farmer in Tioor). In Tioor, *kernels* are also sold or bartered with goods from an intermediary, who takes on the handling after harvest, and delivers it to his associated merchant. In Rhun, children collect fallen kernels, and pay them to television set owners as the 'entrance fee' for watching the daily TV programme.

advantage is the time-saving procedure, because it saves the farmer's work to check trees for ripe fruits every day, and to collect fuelwood for drying the seeds.

In Banda, young pericarps of true nutmeg are used for the production of candied fruits (*manisan*), which are locally and regionally marketed. An edible mushroom (*kulat pala*) can be cultivated on decaying pericarps (Burkill 1935, 1528), although this was not observed in Rhun. In Tioor, small quantities of roasted and ground nutmeg are mixed with water and drunk as a medicine against stomach-ache. But in larger doses nutmeg is toxic due to its *myristicin* content.[143]

Fruits of the up to 15 m tall *Myristica argentea* Warb. can be harvested once per year. It is likely that this species was traded not long ago from the Bomberai peninsula in Irian Jaya, its region of origin (Warburg 1897, 349; Flach 1966, 4). Papuan immigrants came to Tioor in the nineteenth century and reports are lacking from *Myristica argentea* Warb. by the Dutch *hongi* expeditions of the seventeenth century. Although the quality of its products are inferior to those of *Myristica fragrans* Houtt. and result in slightly lower producer prices, farmers also plant this species – without protection trees – due to its greater robustness against long periods of drought. Farmers of the community of Kelvow, however, always integrate protection trees or leave tall primary forest trees, so that they exclusively cultivate true nutmeg.[144]

Clove tree gardens (*dusun cengkeh*)

Besides the products from *Myristica fragrans* Houtt., it was the spice of the clove tree (*Syzygium aromaticum* (L.) Merrill & Perry) of the *Myrtaceae* that so much attracted European traders and discoverers to look for Maluku, where this tree originates. Unlike nutmeg and mace, which have become persistently unimportant in Maluku, clove became a highly demanded product for a second time in the 1970s and 1980s. This so-called clove-boom resulted in substantial clove plantings all over Indonesia. Farmers in Tioor and Rhun participated in this development. New plantings are rarely established, however, and most farmers even regard the harvest as no longer worthwhile, since the clove agency BPPC was operating as a monopoly buyer and re-seller to cigarette factories between 1990 and 1998, causing a sharp decline in producer prices (cf. Ch. 5.5.2).

In Rhun, the *dusun cengkeh* is the only type of tree garden occupying a larger area, although single, mono-specific stands of an individual farmer seldom comprise more than 20 trees. Besides these groves, the clove tree is also an integral part of mixed gardens.[145] During the clove-boom, seedlings were introduced from Ambon and Seram, and transplanted in between old nutmeg plantations at a spacing of 6 m x 6 m. In Tioor, clove tree gardens are mainly covering the eastern slopes and the southern plateau of the island. Seedlings were introduced from Kasiui, where farmers had to buy or barter them with taro[146] in the times of the clove-boom. Clove seedlings were transplanted as a single perennial crop by means of *tumpangsari*, and have developed to mono-specific clove tree gardens. Compared to Rhun distances are more spacious at 8 m x 8 m, or 6 m x 8 m.

For successful propagation, the seedling should be transplanted into prepared holes as soon as possible, taking much care not to hurt its root system. Young trees need temporary shade, usually provided by inter-crops as cassava and banana, and extra water during dry spells. Husbandry is restricted to occasional and careful weeding once or twice per year.

143 Weil (1965, 200) furnished details on the dangerous doses. The consumption of two ground nuts (10 g) is said to cause death (Flach and Tjeenk Willink 1989, 193).

144 More information on *Myristica argentea* Warb. is provided by Warburg (1897, 347-365), and Flach (1966).

145 See for example Maps 4.1.1.

146 At that time one *kaleng* of taro (about 18 kg of root crops) was bartered with seven 50 cm tall clove seedlings.

The clove tree usually takes five to six years until the first harvest of clove buds, and yields increase until the tree reaches an age of 20 years. Thus, most clove trees in Tioor and Rhun are still approaching maximum yields. The harvest is labour-intensive and dangerous, being carried out by the men. Pickers equipped with a small basket, climb up the tree on ladders fixed at the trunk, and pull the branches towards them. Then the complete inflorescences are picked, *just before the first buds are about to open*, and put into the basket. As not all buds fulfil this important quality criterion at the same time, a tree is climbed several times in a harvest season. After picking, the harvested inflorescences are put into sacks and transported to the village, where all household members separate the buds from the flower stalks. In the following days, the green buds are sun-dried until the colour has changed from light green to dark brown. The dried cloves are then sold in sacks to a local co-operative (KUD) that is integrated in the domestic clove market. Cloves are also locally used as a medicine against toothaches.

Harvest is possible once per year, and the yield fluctuates remarkably: A heavy crop is only produced in intervals of three or four years, being followed by poor or mediocre crops in intervening years (Godoy and Bennett 1990, 67; Verheij and Snijders 1989, 259-60). Thus, it is impossible to provide reasonable average figures: For example, a single 20 year old tree could produce up to 10 kg of dried cloves in one year, and would not fruit at all in the following year. In fact, farmers in Tioor reported a complete crop failure in the two consecutive years of 1995 and 1996.

Besides the problems of fluctuating yields and of state monopoly-driven low producer prices, serious diseases threaten to kill clove trees. Most dangerous is the ‘Sumatra disease’, which is wide-spread in Indonesia. Bacteria that live in the root system of the tree spread upwards and cause the rapid death of the infected tree, which becomes obvious by desiccating leaves (Verheij and Snijders 1989, 261). The disease is still a minor problem in Rhun and Tioor, however, as young trees are relatively tolerant to it.

Sago tree gardens (*dusun sago*)

Unlike coconut, nutmeg and clove, which have been predominantly planted as a response to the increasing importance of a market-orientated economy in Tioor since the 1960s, the true sago palm (*Metroxylon sagu* Rottboell) of the *Palmae* merely serve the subsistence activities of the Tioorese. The palm cannot be cultivated in the uplifted coral island of Rhun due to its requirement of a superficial ground water table of not more than 50 cm deep during dry spells (Schuiling and Flach 1989, 184; Flach 1997, 52). Thus, any products from *Metroxylon sagu* have to be traded.

In Tioor, large, mono-specific sago tree gardens with clusters (*rumpun*) in distances of about 7 m, or 200 clusters per hectare, stretch behind the coastal banks along the east coast. On the contrary, sago groves with clusters in one or a few rows at spots of the western coastal plain and along streams *are substantially smaller* and show irregular, but wider spacing. This allows other tree species to naturally establish, or to be inter-planted by the farmers, e.g., fruit tree species like *Durio zibethinus* Murr., and *Artocarpus altilis* (Parkinson) Fosberg, and even true nutmeg (*Myristica fragrans* Houtt.).

In already existing sago tree gardens the palm propagates itself, both vegetatively by means of basal suckers, which form trunks themselves resulting in clusters, and sexually by seeds. However, the latter is less probable due to the common harvest of ‘premature’ trunks. As the sago palm is less popular than the coconut palm, and as its habitat is restricted to the coastal plains and along streams – the former with very few space available – new plantings are only occasionally established in the upper watershed by means of *tumpangsari* during a later stage of perennial integration, or directly through slash-without-burn and leaving over tall trees. Sago trees are also planted in primary forest to secure tenure rights, and along streams to visually mark boundaries. For planting, a rooted sucker about 1 year old is separated from a parent palm with a clean vertical cut through the runner, leaving about 15 cm of the runner on the sucker to serve as food reserves (Schuiling and Flach 1989, 183). The sucker is subsequently transplanted into a 30 cm deep burrowed hole near the banks of a stream. Since only a part of the transplanted suckers are viable – Schuiling and Flach (1989, 183) mention a success rate of approximately 50% – a farmer could propagate sago by seed, but this is not practised yet because seeds are difficult to obtain. During the youth stage of the palm shade is essential, and weeding must be regularly carried out. The sago palm flowers and fruits with the age of approximately 12 to 20 years – depending on the ecological conditions – and after which the up to 10 m high parent trunk dies.

The most important product of the sago palm is the starch, which is stored in the trunk. In Tioor, the labour-intensive harvest is traditionally carried out by the man at the felling site. Felling of the tree should be performed just before flower initiation, because then a maximum of starch yield can be expected. The crown and the leaf-bearing part of the trunk which has a low starch content are then cut off, and the upper half of the bark is removed. The soft fibrous pith is pulverised by pounding it loose with an adze-like wooden tool that is covered with a piece of iron at the end. Pulverised pits starts spontaneously fermenting, which will lead to an irreversible staining of the starch. Thus, only the amount is rasped that can be processed in the same day. Clean water, preferably from a running stream, is essential for the subsequent extraction of starch. During the dry season a hole is dug to obtain groundwater. For extraction, some of the rasped pith is mixed with water and thoroughly kneaded in a sago leaf sheath that is fixed onto a rack. The starch containing water is drained off through a sieve made from a piece of cloth, and collected in an old canoe, so that the fibre remains in the leaf sheath. The excess water runs over the edges of the canoe, whereas the starch settles on its bottom. As soon as all starch is virtually washed out, the fibre is replaced by some more rasped pith to repeat the procedure. At the end of the day, the starch is stored in baskets (*tumang*) made of young sago palm leaflets, with a capacity of about 15 kg of wet starch, and brought to the village. Storage of *tumang* under water slows down starch deterioration. As all remnants remain in the tree garden, few nutrients are lost from the soil.

Wet sago starch is traditionally prepared by the woman in various ways. Most common is boiling, resulting in a paste-like mass called *papeda*, or baking of wet starch in a *porna* (see footnote 120), but it can be also fried, roasted, or mixed with the seeds of *Canarium indicum* L. to the cookie-like *lutlubak,* which is called *bagea* in Ambon and surrounding islands. *Lutlubak* is a staple food in neighbouring Kur Island, where *Canarium indicum* L. is intensively cultivated. The baked form (*sagu lempeng*) is hard, rather durable and easy to transport. Before consumption it is dipped in water, coffee or other fluids and sauces. A part of the consumed *sagu lempeng* is imported from Seram and sold in the intermediaries' stores. Farmers from Mamur (community of Wermaf), who have large sago tree gardens, provide a part of the sago starch for their kin in the uplifted coral island of Kaimear.

Sago starch serves as important food reserve in times of prolonged drought, when other starch containing crops are vulnerable.[147] The only problem is then the scarcity of clean water for processing. With the exception of cassava, yields are considerably higher than from all other crops cultivated for starch production. A 7 to 8 m long bole may yield 15 *tumang* or an equivalent of 225 kg of wet starch, which can be processed in about one week by a single male.[148] This yield is enough for a two months diet of one household. Despite the high yield potential and the absence of serious pests and diseases, the *time- and labour-intensive* processing deters some farmers from sago cultivation.

[147] This is underlined by the following comment: "*If there were no sago trees in Tioor, we would starve during a long period of drought*" (key informant in Mamur community). After the drought in 1982, when the Tioor people experienced famine, many farmers planted sago trees on a large scale.

[148] Processing of 2 *tumang* per day is calculated by farmers in Tioor. If 50 trunks were annually harvested from 1 ha, the hectare yield of wet starch would be 11.25 t.

The sago palm provides secondary products for the households as well. The leaflets produce high quality roof thatch (*atap*), and the dried rachis of the leaves (*gaba-gaba*) are used for walls and ceilings in house and field hut construction.[149] Sago leaves are freely accessible, provided the palm owner agrees to the harvest. The men only take the oldest leaves of any palm. In the village, sago leaflets are folded over 2 m long pieces of unidentified *varfur*-bamboo lath, and sewn together with a string of unidentified *tali haluk* by a group of women. Thereafter, the product, which is called *bengkawan*, is sun-dried. At least 200 *bengkawan* are needed for covering the roof of a house. The labour-input for their production is calculated as 3 man-days (MD) for the collection of raw material, and 7 MD for sewing. *Bengkawan* are locally sold for Rp. 300 each. An *atap* roof may last for 5 to 12 years, depending on the cover density of *bengkawan* (Brouwer 1996) and the roof's angle of tilt.

Mixed tree gardens (*dusun campuran*)

Mixed tree gardens of simple structure

Strictly speaking, tree gardens with a single cash crop producing species *and* with protection trees are mixed tree gardens, like a part of the nutmeg tree gardens. The farmers, however, do not regard them as a *dusun campuran*. Accordingly, the land-use map of Tioor (Map 3) classifies these tree gardens as mono-specific, e.g. *dusun pala*. Although it is more common in Tioor to plant coconut, nutmeg, clove, and sago in mono-specific stands, various combinations of these species on a single land unit *do* exist. Eighteen combinations were identified, covering a total of 72.46 ha,[150] with three types dominating:

(1) *Coconut and clove* (16.2 ha): In this type the coconut palm serves as a shade tree for clove trees, which are integrated by means of *tumpangsari* at later stage of garden development. The combination is most often established by farmers of the community of Wermaf in the eastern slopes of the island. Coconut palms are planted at a spacing of 10 m x 10 m, clove trees occupy the space in between.

(2) *Coconut and nutmeg* (13.8 ha) (like in Fig. 6.11): Structure and development of this type is similar to (1). This is most often found in the coastal plain further inland at the transition to the slopes.

(3) *Clove and nutmeg* (10.4 ha): This type is almost exclusively planted by farmers of the community of Kelvow in the southern plateau of Tioor, and includes protection trees, such as *Canarium indicum* L., and *Durio zibethinus* Murr. Spacing is 7 m x 8 m.

Occasionally, sago palm clusters are integrated in mixed tree gardens at habitats along streams.

Mixed tree gardens of complex structure: Agroforests

In the case of a *multi-specific* arrangement – i.e. any combination of coconut, sago, nutmeg, coffee, and/or cloves *including* fruit trees, tall protection trees and eventually forest remnant trees – a tree garden can be classified as an *agroforest* due to its complex forest-like multi-strata structure and the natural regeneration of other useful plant species, which are not eliminated by the farmer (cf. also Fig. 6.9). Since the 1980s, farmers have begun to integrate a multitude of tree species into former dry fields of shifting cultivation by means of *tumpangsari* in the communities of Kerkar, Wermaf and Kelvow (Tioor). Thus, most agroforests are just emerging. In Rhun, this garden type has more progressed in its development, but it actually refers to a mixed garden, because annuals are always cultivated between trees. As innumerable combinations of tree species integrated into an agroforest exist, it is impossible

[149] In Kelvow, sago trees were planted in the 1980s due to a shortage of sago leaves (interview with key informant).

[150] Where only a few trees of a certain second species are planted, and thus the first species is by far dominating the scenery, the farmer still regards the tree garden as a *dusun* of the first species. Accordingly, the area of mixed tree gardens refers only to those where two or more species are almost equally important.

to provide a general description of its structure, practices and functions. Thus, case studies of peasant households (cf. 6.5) illustrate examples of this tree garden type. Various perennials are subject of the next section. They are often interspersed into agroforests and other tree and mixed gardens, in small numbers even in 'mono-specific' tree gardens.

Other common perennials integrated into gardens

It is intended to provide only the information on common perennials in the text and in Tab. 6.7, that is relevant and specific for the two island case studies.[151] Tree species not being included in this paragraph play a minor role, or are naturally established and not being removed by the farmer. They might be important for some households, however. Thus, they are separately described in Ch. 6.3.6 and Ch. 6.5, or are included in App. 1.1, App. 1.5 and App. 1.6.

Banana and plantain (*Musa* L.):[152] At least 11 cultivars of these tree-like perennial herbs (*Musaceae*) are recognised in Tioor and Rhun, cultivated in mixed gardens and tree gardens for their fruits, which are consumed raw, cooked or fried. In Tioor, bananas and plantains (cooking bananas) are staple food, and thus an important part of the daily diet. In Rhun, they are planted on a smaller scale. They serve as a supplementary diet, although a few farmers are marketing bananas to Banda Neira and Ambon. Farmers in Rhun reported that worsening natural conditions, such as prolonged droughts, and reduced soil moisture, caused numerous bananas to die (cf. Map 4.2.1). In Banda Besar, bananas are important crops for the markets in Banda Neira, Geser and Ambon, and are called 'the crop of the lazy people' (*tanaman orang malas*), because they need relatively little care.

Betel-nut palm (*Areca catechu* L.): This palm of the *Palmae* is restricted to Tioor, and is highly valued for its betel-nuts, which play an important role in cultural and ritual ceremonies. Betel-nuts are provided together with chalk and betel-leaves (*Piper betle* L.) to guests for the traditional betel chewing. The palm is most commonly found in coconut tree gardens, mixed tree gardens and mixed gardens. Local demand is greater than the local supply, so that fruits have to be traded from Seram, or Irian Jaya. Five fruits were sold at Rp. 500 (September 1997).[153]

Robusta coffee (*Coffea canephora* Pierre ex Froehn.) (see also van der Vossen and Soenaryo 1989): In both Tioor and Rhun, it is most common to grow Robusta coffee of the *Rubiceae* in mixed tree gardens and mixed gardens. This perennial shrub does well in the shade of medium-sized and taller trees and perennial crops, such as coconut, and fruit trees. Without shade trees, yield potential is higher, but the productive life of the shrub is shortened. It is more posed to adverse bio-environmental conditions and stress, such as heavy rain, diseases and pests, and extreme microclimatic fluctuations in humidity, temperature and soil moisture (cf. Beer 1987). Only in the Tioorese communities of Kelvow and Wermaf, the coffee is cultivated in pure stands at a spacing of 3 m x 3 m together with shade trees

[151] For more information the reader is again recommended to consult the relevant volumes of the PROSEA handbook (Westphal and Jansen 1989; Verheij and Coronel, R.E. 1991; Soerianegara and Lemmens 1993; Lemmens et al. 1995; Sosef et al. 1998), Clarke and Thaman (1993; 216-66), and Burkill 1935.

[152] The nomenclature for the genus *Musa* is confused. For a clarification see Clarke and Thaman (1993, 248).

[153] Betel-nut palms were often cut down to use the timber for house construction, so that supply of betel-nuts has substantially decreased. Hence, many households are widely replanting *Areca catechu* (see Ch. 6.5.2).

Table 6.7: Perennials in garden cultivation in Tioor and Rhun – a selection

Crop **Vernacular names*** ***Scientific name*** **Origin**	**Ecology: optimal conditions (tolerance) 1. soil; 2. water requirement; 3. mean temperature**	**Propagation and planting**	**Husbandry and harvesting (no application of commercial fertiliser, always hand-harvesting)**	**Post-harvest activities**	**Remarks**
Banana; Pisang; Muk *Musa spp.* Unknown; probably Malesia	1. deep, friable loam with good drainage and aeration, pH 4.5-7.5; 2. steady moisture supply, monthly rainfall at least 200 mm; 3. 27^{O}C (15-38^{O}C)	propagation by suckers or corms; planting by ♂, preferably in small holes at the onset of the rainy season	regular hand- or slash-weeding until crop shades out the weeds (by both ♀ and ♂); green manure application; harvest of mature fruits (self-consumption)	direct consumption as a staple food; or direct shipping and marketing of oversupply	sensitive to strong wind; harvest of premature fruits for marketing; pest and diseases a minor problem
Coffee; Kopi; Kof *Coffea canephora* Equatorial lowland forests of Guinea to Uganda	1. deep, at least 2 m, free draining loam soils, fertile and slightly acid, pH 5-6; 2. 2000 mm well distributed rainfall; 3. 22-26^{O}C	propagation by seed, but more often by transplanting of naturally established seedlings underneath shade trees (by ♂)	regular pruning, careful hand-weeding (by both ♀ and ♂); picking of ripe fruits by ♀, occasionally by ♂; first harvest some 3-4 years after planting	processing by ♀: pulping, soaking for 3 days, sun-drying, hulling, roasting, grinding; oversupply of sun-dried beans is sold or bartered	pest and diseases a minor problem
Breadfruit; Sukun; Hukun *Artocarpus altilis* Uncertain; native to the Pacific and tropical Asia	1. deep, well-drained, moist, alluvial soils rich in humus (shallow calcareous soils); 2. 2000-3000 mm; 3. 20-40^{O} C	propagation by seed, seedless types: e.g., by root cuttings (by ♂); shade for young trees better, but later full sun is required	regular weeding (by both ♀ and ♂); harvesting of mature fruits for self-consumption (by ♂, who is climbing the tree)	direct consumption after boiling, baking, roasting or frying; preservation by dehydration in the sun	cultivars differ greatly in their tolerance of adverse ecological conditions; pest/ diseases a minor problem
Jackfruit; Nangka; Kataferak vuly; *Artocarpus heterophyllus* Probably Western Ghats, India	1. deep, well-drained, alluvial, sandy or clay loam soils, pH 6.0-7.5 (various soil types); 2. 1500 mm or more; 3. warm, humid climate below 1000 m	propagation by large, fresh seeds of high yielding trees (by both ♀ and ♂)	bagging of premature fruits for protection against numerous pests; harvesting of mature fruit by cutting (by both ♀ and ♂)	direct consumption, either raw or after boiling, prepared e.g., with coconut milk as a vegetable	frequent cultivation; unpredictable yield; many pests; important for self-consumption due to nutritional value
Durian; Durian; Duran *Durio zibethinus* Native to Southeast Asia	1. deep, well-drained, light soils; 2. 1500 mm or more, well-distributed, but relatively dry spells stimulates flowering; 3. more than 22^{O}C	propagation by seeds (by ♂); sheltered site desirable, as branches laden with fruits may break in gusty winds	weeding; harvesting of fallen fruits; first harvest some 10-12 years after planting (by both ♀ and ♂)	direct consumption of flesh in fresh condition (is regarded as a delicacy); local marketing of fresh or fermented fruit flesh	low yields; perishable fruit; shade tree (heights of up to 40 m); fruits highly valued
Mango; Mangga; Mangga *Mangifera indica* Indo-Burma region	1. wide range of soils, deep but rather poor soil is preferred, pH 5-7; 2. 750-2500 mm, drought-tolerant; 3. 24-27^{O} C, at elevations below 600 m (tropics)	propagation most commonly by seeds, but also by grafts (by ♂, and occasionally ♀)	little weeding; harvesting of ripe fruits (by both ♀ and ♂), or premature, if fruits are to be marketed or consumed in salads	direct consumption of fruits, either ripe or unripe (in *rujak* fruit salad)	perishable fruit; many pests; fruits delicious and highly valued
Tamarind; Asam jawa; Asam jawa; *Tamarindus indica* Unknown; probably the drier savannas of tropical Africa	1. wide range of soils; 2. less than 4000 mm, wide range of climatic conditions, drought-tolerant; 3. up to 1000 m altitude	propagation most commonly by seeds (by ♂), possible is marcotting, grafting, and budding	little weeding; harvesting of ripe or half-ripe fruits for consumption, half-ripe for marketing (by both ♀ and ♂)	direct consumption of fruits, either fresh or mixed in sour soupy dishes; roasted seeds are a delicacy	many pests and irregular fruiting; provision of a multitude of products; high demand on regional market
Sugar palm; Aren; ? ** *Arenga pinnata* Southeast Asia, Western New Guinea, extending to Annam and to the Liu-Kiu Islands	1. fertile soils (wide range of soils that are not regularly inundated); 2. abundant water supply (seasonal climates); 3. up to 1400 m altitude (tropics)	propagation by seeds or transplanting of wild seedlings (by ♂); sheltered site desirable, as leaves may break in gusty winds	occasional weeding; ♂ taps the inflorescence stalk to get the juice that is collected in bamboo receptacles; product: *tuak*	direct consumption of *tuak*; or distillation to a brandy called *sopi*; or processing to dark-red palm sugar	provision of a multitude of useful products; pest and diseases do not occur, except mice damaging seedlings

Notes: * English; Indonesian; Tioorese; ** observed only in Rhun.

Sources: Articles in PROSEA handbook, several volumes; Burkill 1935; Interviews, mapping and observation (Stubenvoll 1996 and 1997).

(e.g., *Canarium indicum* L.). The total area of these coffee tree gardens is relatively small (16.47 ha), and most of the shrubs are senile and have lost a great part of their productivity. Farmers use the product, the coffee beans, for the subsistence of the household. Surplus is sold to the intermediaries or bartered with goods from their stores. In Tioor, a second, unidentified species of *Coffea* with bigger fruits is additionally cultivated.

Trees yielding edible fruits: As the list on plant species in Rhun and Tioor suggests (cf. App. 1.1), numerous tree species producing edible fruits are used, most of which are sporadically cultivated or have been recently introduced. Some of them have a great potential to be grown on a wider scale, and have been evaluated accordingly by the farmers as species of high priority in agroforestry extension. The following species are presently grown on a wider scale on at least one of the two islands:

(1) **Breadfruit (*Artocarpus altilis* (Parkinson) Fosberg):** In Rhun, breadfruit of the *Moraceae* has been recently introduced by some farmers, so that it still is a minor perennial there. In Tioor, however, it is commonly found in tree gardens and mixed tree gardens in the coastal plain and along streams. Breadfruit is mainly planted for its edible fruits that contain carbohydrates and proteins, and which are very nutritious, especially in calcium, phosphorus, iron and a variety of vitamins (cf. App. 1.7). Secondary products are the timber of old trees that is used to make canoes, as well as the latex and the leaves that are taken as traditional medicine (Rajendran 1991, 83-4; cf. App. 1.6). Like sago palm and jackfruit, the combination of the production of carbohydrates and the perennial character makes breadfruit a species of high priority in agroforestry extension.

(2) **Jackfruit (*Artocarpus heterophyllus* Lamk):** In both Tioor and Rhun, jackfruit of the *Moraceae* is the most common tree producing edible fruits which is planted in all kind of gardens and around field huts. Like breadfruit, the pulp of fruits contains carbohydrates, protein, calcium, phosphorus, iron, and a variety of vitamins, and additionally sodium and potassium (Soepadmo 1991, 87; cf. App. 1.7). Seeds contain mainly carbohydrates. The timber is a highly valued secondary product, used for furniture and construction. Various parts of the tree are taken as traditional medicine, such as the latex against abscesses, and the root against skin diseases, fever and diarrhoea.

(3) **Durian (*Durio zibethinus* Murray):** In Rhun, the Dutch planted durian trees of the *Bombacaceae* in a location appropriately called *kolam durian* (‘durian basin’) last century. With this exception, durian trees have been frequently planted in both islands since the 1980s, so that most trees just have come into fruit bearing, and local supply of fruits is still outweighed by local demand. Like breadfruit and jackfruit, the flesh (seed arils) of ripe durian fruits contains carbohydrate, protein, calcium, phosphorus, and a variety of vitamins (Verheij 1991a, 157-8; cf. App. 1.7). Secondary products are the seeds being boiled or roasted for consumption, and the less durable timber that is used for indoor construction.

(4) **Mango *(Mangifera* spp.)** (see e.g., Boer et al. 1995): On both islands, four species of *Mangifera* (*Anacardiaceae*) are cultivated (four in Tioor, two in Rhun), of which two could be identified.[154] *Mangifera indica* L., *Mangifera foetida* Lour (cf. Bompard 1991) and a third, unidentified *Mangifera* species (*mangga telur*) are grown for their edible fruits. *Mangga pauh* has a reddish-brown exudate drying black. It is cultivated as a shade tree. In Rhun it is also used as a windbreak in former nutmeg plantations. *Mangga pauh* provides timber, used in indoor construction, and small edible fruits. Extracts of unripe fruits and of bark, stems and leaves of *Mangifera indica* L. serve as a traditional medicine due to antibiotic activity (Verheij 1991b, 212). An advantage of *Mangifera* is their adaptability to grow on poor soils and to withstand prolonged droughts.

[154] Identification of *Mangifera* spp. is difficult, because most of them can be only distinguished by their flowers.

(5) **Tamarind (*Tamarindus indica* L.):** *T. indica* of the *Leguminosae* is presently grown on a wider scale in Rhun, whereas in Tioor only two single trees, planted as ornamentals, were found in the community of Kar (Map 6.3).[155] It is cultivated for its fruits, which are regionally marketed and mainly used as an ingredient for souring soupy dishes. It also has other, secondary uses, such as the roasted seeds, which are claimed to be superior to groundnuts in flavour, and the medicinal purposes of the bark and the leaves (cf. Coronel 1991, 298f). Like *Mangifera* spp., it grows on poor soils and withstands prolonged droughts.

Sugar palm (*Arenga pinnata* (Wurmb.) Merrill): Another very useful palm species is the sugar palm (*Palmae*), which is cultivated in Rhun, but absent in Tioor. It is grown for its juice that is tapped from the inflorescence stalks. The juice is either fermented to a palm wine of low alcoholic content (*tuak*), which is occasionally distilled to a brandy (*sopi*), or processed to dark-red palm sugar. The latter is marketed in Rhun and Banda Neira, whereas *tuak* and *sopi* are frequently consumed by the men after their fieldwork is done. A wide range of secondary uses is provided by the palm. Among others: high quality fibre from the roots, the pith of the trunk and leafstalks, and the trunk; leaflets for basketry, and leaflet stalks for brooms; and the attractive wood for flooring, furniture, and as a fuelwood (cf. Smits 1989, 50-1), can all be produced. It can grow on a wide range of soils, and its multitude of functions could make sugar palm a perennial of high potential in agroforestry extension. However, its main drawback is the prohibition of alcohol consumption, decreed by the local police in Banda Neira in the 1980s.[156]

Tree tenure

The issue of tree tenure, as an influential factor in the decision-making of a farmer with regard to tree planting, is most influentially regulated by *adat.* It is at least as complex as the arrangements of land tenure (see Ch. 5.4.3), also because both tenure systems are strongly interdependent. Furthermore, tree tenure depends on the kind of tree species and the way of tree establishment. *Adat* distinguishes several categories with regard to tree tenure:

(1) *The right to plant trees*, with three distinct possibilities:
   (a) Trees can be planted without restrictions only in those locations, which are already under control of the planter, i.e. where he has got secured, *individual* land tenure right.
   (b) In Tioor, primary forest land that is *still freely accessible* may be claimed through planting of productive trees, such as nutmeg and sago.
   (c) On *clan's land* (*tanah dati*) or *family's land* an individual member of the clan or family may also plant certain tree species, provided he has consulted the head (of the clan or family, respectively) arranging an agreement on tree's accessibility (see (3)).

(2) *The ownership of trees*: Principally, the planter of a tree has got the ownership of it. This category is not equivalent with the accessibility to trees, especially if the tree is planted on *tanah dati* or family's land. However, through the planted tree, the owner has secured traditional land tenure right on the plot – be it individually or commonly with the clan.

(3) *Accessibility, i.e. the right to use products of planted trees*: The planter of a tree and members of his family or clan have a certain, but not rigidly practised right of access. Depending on the category of land tenure distinct arrangements can be recognised:

[155] This does not necessarily mean that *Tamarindus indica* L. is not cultivated at all in the agricultural landscape of Tioor. However, it was neither quoted during the household interviews, nor observed during island excursions and mapping activities (except the two trees in Kar), indicating its insignificance for the Tioorese.

[156] Nevertheless, most men still consume remarkable amounts of sugar palm *tuak*, because control from the distant police station in Banda Neira is quite seldom.

(a) *Tanah dati* (Tioor): Tree tenure is acknowledged by other members of the clan, who use the products of any kind of tree species, by means of leaving a symbolic part of the yield to the planter. An example are semi-wild sago stands[157] at the east coast of Tioor, that were enriched by the farmer: The owner and his clan have the same right of access on *wild trees*, whereas a labour system of sago processing in Mamur (community of Wermaf) lays down, that the owner of a *propagated tree* first gets 1 or 2 *tumang* of the harvest, the remaining starch is then equally shared between him and his clan's assistants. Another example is the coconut tree gardens on *tanah dati* in the community of Rumoi: The yield is equally apportioned among the clan's households, which participated in the commonly performed harvest.

(b) *Family's land* (Tioor and Rhun): Tree tenure on individual land of a deceased farmer that has been inherited *without apportioning* among his offspring is differently regulated. In Tioor, *all trees* belong to the members of the family. Thus, they have an equal right of access, even if a tree was planted by a child before the father's death. For possible arrangements, see Ch. 5.4.3 on inheritance of land tenure. In Rhun, only those trees belong to the members of the family that were planted by the father. Tenure on trees planted by a descendant before the father's death is treated in the same way as on individual land (cf. Ch. 6.5.1; Map 4.3).

(c) *Individual land* (Tioor and Rhun): Theoretically, the planter has the exclusive right of access, but this is practically limited to tree species providing cash crops, e.g. coconut, nutmeg, and clove. To all other cultivated tree species, such as sago palms and fruit trees, clan's members have the possibility of access after a consultation with the owner.

    For *sago trees*, two possible sharing arrangements have been identified in Tioor. Firstly, in *larger sago tree gardens* at the east coast, *and pure sago groves* along streams, both of them completely propagated by the farmer, the planter and his family have right of access, although the owner gets a greater share of sago starch that is produced together with the other members of the family. For instance, in the community of Rumoi, the planter of a sago palm gets half of the yield, the other half being apportioned among his family's assistants. If the owner decides not to participate in processing, he will be given an amount of starch that is not exactly fixed. Secondly, to *sago trees, that are integrated into mixed tree gardens or mixed gardens*, the planter has the sole right of access and may leave his right to anyone who wants to process sago starch on his own. The tree-owner will then get half of the yield.

    Fruit trees that merely serve the subsistence activities of the people are accessible to all members of the clan, or – in Rhun – of the family. The tree-owner may demand later on subsistence products from the members of the clan or the family, respectively. This reciprocal system significantly contributes to the social and nutritional security of the households. Fallen fruits are *common property*, i.e. they can be taken by anyone. Hence, valuable fruits and seeds that are not harvested by picking them from the tree, such as *durian* fruits and *kenari* seeds, would have to be guarded by staying the night in field huts underneath the tree during the harvest season, if the tree owner intended to get a maximum harvest.

All these categories only refer to propagated trees. However, it must be stressed that these possible arrangements are not always rigidly practised. This is especially true, if a perennial was *naturally established* in, and has not been removed from an individually held tree garden, such as a timber tree, or a tree providing fuelwood or non-timber products (fruits, medicine, and the like). Another case is the use of *forest products*, such as from naturally established timber trees on communal or claimed

[157] It is practically impossible to distinguish between wild sago groves and stands propagated by ancestors decades or centuries ago.

primary forest land, which is theoretically laid down by *adat* in the category of *common property*: Each individual of the community has an equal right of access. However, the *de facto arrangements of actually acquiring* those tree products, especially with regard to timber, are again manifold, which will be examined in Ch. 6.3.6 on forestry, hunting and gathering.

Unlike the important *de jure* land tenure, the *official jurisdiction* plays a minor role with regard to tree tenure. There are three issues with a possible relevance to tree tenure because of the contradiction to *adat*, but only the first has practical importance – at least for the time being:

(1) *Taxes*: As pointed out in Ch. 5.4.3, for each state-owned nutmeg tree the households of Rhun are responsible to pay an annual tax to the Government at regency level via the *kepala desa*. All nutmeg trees on state land, even those planted by the farmers, refer to this category. The tax regulation for the *dusun kelapa* in Tioor was described in the paragraph on coconut tree gardens.

(2) *Compensations*: In the case of a new plantation enterprise operating in Rhun, land being presently used by the farmers would be 'expropriated' by the Government. Although farmer-owned trees would then be compensated with a small amount of money, this would not be equivalent to the lost tenure and the missed future harvests.

(3) *Protection forest*: The slash-and-burn based farming system in Tioor contradicts with the official jurisdiction, that theoretically would not allow the clearance of any forest tree, as Tioor is completely classified as 'Protection Forest' (see Ch. 5.4.3).

Resource inputs

Like dry field agriculture, the establishment and management of tree gardens is performed with an input of the means of production land, labour and capital. *Capital-input* is small, and eventually needed for tree seedlings. *Labour* is either carried out by a male adult, or paid – most commonly in form of apportioning of yield. Commercial fertilisers and pesticides are not used, except the governmental sponsored programme in Tioor against the coconut pest *Sexava* sp. *The input of land* depends on garden distribution, i.e. on the area of tree gardens.

Distribution of tree gardens

The complex issues of tree and land tenure set limits to a provision of data on tree garden distribution. In most interviews, farmers only specified detailed information on *owned* trees in terms of number and/or yield, and on *individual* land in terms of area. The calculation of tree garden areas drawn from a number of trees and yield is only reliable for the coconut tree gardens in Tioor, because a substantial number of trees from species like nutmeg, clove, and sago is interspersed into mixed gardens and mixed tree gardens. It is even more difficult to provide data on clan's land or on accessibility to trees of clan's members, because this information was, if at all, only qualitatively provided by the interviewees. For these reasons, the distribution of tree gardens is differently outlined – either the distribution in terms of area (coconut), or the distribution in terms of *the number of trees* (nutmeg, clove). As the category of accessibility is extremely important for the sago tree gardens in Tioor, it is only possible to make a distinction between cultivators and non-cultivators with right of access on the one hand, and non-cultivators without any right of access on the other hand. The tree gardens of Rhun are not considered here due to their limited total area.

(1) *Coconut tree gardens*: 361 households are sharing 380 ha of *dusun kelapa*. Thus, the average is roughly one hectare per household. However, like land resources in general, coconut tree gardens are unequally distributed among the farmers (Tab. 6.8). This is also reflected in income differences, as copra is the single most important income source in the village (see Fig. 5.5). 58.7% of the households hold coconut tree gardens of an area between 0.5 ha and 1.5 ha. 29.6% of

the households do not possess coconut groves, although a great part of these young families have access to their parents' garden or are establishing new plantings. Hence, one important factor in garden distribution is the age of the household head. Families with small areas of old coconut tree gardens did not have the opportunity to do regular planting activities in former years, if the man was for a longtime absent for income activities, such as forging in Seram, and turtle-hunting. In Uran Island, coconut tree gardens of an estimated 20 ha are distributed among five clans. Each clan commonly organises the management of these gardens (harvest, distribution of yields, rejuvenating), as households of the clan do not have individual tenure on any *dusun kelapa* there.

Table 6.8: Distribution of coconut tree gardens in Tioor

Area of tree garden	less than 0.5 ha		[0.5 ha; 1.5 ha]		more than 1.5 ha		others	
	A	B	A	B	A	B	A	B
No. of households	31	5	212	24	11	3	107	8
Percentage	8.6 %	12.5%	58.7%	60%	3.0%	7.5%	29.6%	20%

Notes: **A**: Data for all 361 household; **B**: Data for 40 interviewed households; **others**: none, and/or access to parents'/family's/clan's tree gardens, and/or beginning to plant/not yet productive.

Sources: Interviews with village leaders and households, mapping and observation (Stubenvoll 1997).

(2) In Tioor, mono-specific nutmeg and clove tree gardens cover a total of about 65 ha and 60 ha (if unmapped areas are included), respectively. Tab. 6.9 shows data on the number of mature trees for the interviewed households, including those trees integrated into other land-use types.

Table 6.9: Number of productive nutmeg and clove trees in Tioor [40 households]

Number of trees	no cultivation	less than 10	[10;50[	[50;100[	more than 100	others
Nutmeg (no. of households)	3	3	12	5	1	16
Clove (no. of households)	11	3	2	7	2	15

Notes: **others**: access to parents'/family's/clan's trees; beginning to plant/not yet productive; or data insufficient.

Sources: Household interviews and mapping (Stubenvoll 1997).

With regard to non-cultivators the difference between nutmeg (3 or 7.5%) and clove trees (11 or 27.5%) is most striking. It can be explained by the selection of interviewed households: 8 of the 21 interviewed household heads settling in the communities of Rumoi, Kerkar, and Rumalusi do not cultivate clove, whereas the remaining 3 non-cultivators live in the communities of Wermaf, and Kelvow (of a total of 19 interviews). Thus, clove is over-represented in the eastern and southern part of the island, which is also pointed out in App. 3.2: Nearly 90% of the clove tree gardens are situated within the combined community area of Wermaf, and Kelvow. The other important feature is the relatively small number of trees per household: Only two households possess more than 100 clove trees, and a single one more than 100 nutmeg trees.[158]

(3) *Sago tree gardens* cover a total of about 82 ha in Tioor. Tab. 6.10 provides figures about the number of sago cultivators and non-cultivators, including those sago trees that are interspersed into mixed gardens and mixed tree gardens.[159]

[158] If planted on a single land unit in mono-culture at a spacing of 7 m x 7 m, 100 clove/nutmeg trees would occupy 0.5 ha.

[159] In some interviews pure sago groves were not mentioned as a part of the household's available land resources. Again asking later on for clan's land, these groves were stated, although being established by the interviewee.

Most farmers (91.4%) in the community of Kelvow own or have rights of access to sago tree gardens, including some in the community area of Wermaf. This is historically determined, as some elder Kelvow farmers planted sago trees *before* immigrants from Kaimear and Gorom settled in the east coast of Tioor in the 1950s and 1960s. Compared to that high proportion, only 46.9% of the households in the community of Rumoi are sago-cultivators, indicating the minor importance of and the lower acceptability to sago planting due to the time- and labour-intensive processing. Furthermore, the historical economic activities – turtle-hunting and work migration to Seram – enabled farmers of Rumoi to easily get sago starch from there, so that it was formerly less compelling for them to plant sago palms.

Table 6.10: Sago cultivators and non-cultivators in Tioor's communities

Community	No. of households	Mapped area of sago tree gardens	No. of cultivating households[1]	No. of non-cultivating households	Percentage of cultivating households[1]
Rumoi	64	5.69 ha	30	34	46.9 %
Rumalusi	26	8.24 ha	17	9	65.4 %
Kerkar	69	14.8 ha	52	17	75,4 %
Kelvow[2]	93	8.97 ha	85	8	91.4 %
Wermaf	109	43.73 ha	78	31	71.6 %
TIOOR (Sum)	**361**	**81.43 ha**	**262**	**99**	**72.6 %**

Notes: **1** The figure includes: households without own plantings, but with rights of access to clan's sago trees; and households with sago trees integrated into mixed tree gardens and mixed gardens;
2 Some elder farmers of Kelvow own large sago tree gardens in the community area of Wermaf.

Sources: Interviews with village leaders, household heads, and key informants (Stubenvoll 1997).

In summary, tree garden distribution is not equal, but this is eased by the complex tree tenure arrangements, especially for sago trees. Most influential factors of the size of individual tree gardens are: the age of the household head, the frequency of former activities outside of the island, the land area of *tanah dati* and of the community, and the degree of *tumpangsari* activities. Access to tree gardens is possible for most households, which is extremely important, especially for those without any individual groves.

Labour arrangements

The cultivation of most perennials is a typical *male task* and usually performed by an individual farmer. Women and children younger than 12 years are engaged in planting of seeds of trees producing edible fruits, in harvesting coffee shrubs and fruit trees, and in processing of certain products, such as coconut oil for household consumption. Unlike in dry field agriculture, help of a group or individuals of other households is not deployed for tree garden management belonging to an individual household. Family's or clan's tree gardens are jointly managed (planting, husbandry, harvest, post harvest activities) by all households of the family or of the clan, with yields being equally apportioned, unless the garden is split among them into several plots.

A widespread characteristic is *hired labour* for the harvest of cash crop producing trees. An example is the coconut tree gardens of Tioor. Most management activities (including planting) are presently carried out by the man and his male offspring older than 12 years, whereas in the beginning of the copra-boom in the early 1970s immigrants from Flores came to Tioor for the harvest and the weeding, for which they got half of the copra yield. While most of these seasonal work immigrants returned to Flores after a couple of months, some of them married and settled down in Tioor, because of the large land reserves that were available at that time. If the farmer is not capable to carry out certain management activities, he can also look for hired labour with the following exemplary wages (1997): Rp. 10,000 for the collection and storage at a kiln of 1,000 nuts; Rp. 5,000 for the splitting of 1,000 nuts; Rp. 150,000 for the hand-weeding (*pamere*) of 1 ha of coconut tree garden. Yields will be equally shared, if the coconuts are harvested and processed to copra.

Another example is the clove harvest. The sharing of the yield is a common labour arrangement between the owner and the picker, especially if the former has too many trees, that could not be harvested solely by him in time. In Rhun, the share is 2:1 in favour of the owner, whereas in Tioor it is 1:1, but there the picker also has to take over the drying of the buds.

Labour input

In general, the amount of labour involved in garden management depends on a lot of different factors, so that it is extremely difficult to determine the labour input in man-days (MD). In fact, farmers provided quantitative data on labour input only for harvest and post-harvest activities. This is also represented by the fact, that propagation and husbandry of perennials is usually combined with other activities in the field. The age of the trees is another important factor of labour input, which is further contributing to the difficulties in specifying labour input: Trees of different ages are found in most tree gardens due to irregular enrichment planting. Nevertheless, it is attempted to sort out labour input in tree garden management with the following qualitative remarks:

(1) *Propagation*

(a) *Modes of propagation*: In many cases, farmers use naturally established seedlings being transplanted into the dry field or into an already existing garden (enrichment planting). Alternatively, but still rarely, seeds are raised in prepared nurseries in the field. Both modes require the labour-intensive digging of holes before transplantation. The former mode will be even more energy-intensive, if seedlings have to be carried to the field over long distances. Propagation from seed directly in the plot is less labour-intensive, although the period till the maturity of the tree is lengthened. Therefore, farmers prefer one of the two former propagation methods, especially with regard to nutmeg and clove trees. Vegetative propagation is not practised yet, although some farmers in Rhun have introduced clone material of mango (*Mangifera indica* L.) from Ambon and Seram into their gardens, making use of two advantages: The juvenile phase of a vegetatively propagated tree is greatly shortened, and its productivity is improved due to the selection of clone material from most fruitful trees.

(b) *Origin of propagation material*: Seedlings and seeds of introduced tree species have had to be taken from other islands to the planting site. For instance, farmers in Tioor bought clove seedlings from Kasiui Island in the 1970s and 1980s, which required at least two days for travelling with a canoe and the transaction in the villages of Kasiui. This time-consuming activity must no longer be carried out, because nowadays clove seedlings are locally available from the introduced parent trees. Presently, many fruit tree species, such as salak (*Salacca zalacca* (Gaertner) Voss), rambutan (*Nephelium lappaceum* L.), langsat (*Lansium domesticum* Correa), and avocado (*Persea americana* Miller), are established by using seeds from fruits that were bought in Seram, Irian Jaya, or Kasiui as a food for the trip back to Tioor, or as a little present. The formerly difficult inter-island diffusion of tree species is one reason of the late introduction of numerous popular fruit trees in Tioor. On the contrary, Rhunese farmers could easily obtain planting material from the central Banda Islands, where many species were introduced during the pre-colonial and colonial periods.[160]

(c) *Number of established trees*: In a dry field, the farmer obviously plants a greater number of tree seedlings and seeds of the first perennial crop in the *tumpangsari* farming system. The integration of a second perennial crop, and enrichment planting in existing tree gardens is irregularly performed and involves only a few seedlings at one time, so that labour input is comparably small.

(2) *Husbandry* includes most often weeding, and very seldom pruning, mulching and manuring. With the exception of coconut tree gardens, farmers do not consider these activities as a great burden, because they are irregularly and cursorily performed while checking the tree garden, or in combination with other field activities. Consequently, labour input can be only estimated for coconut tree gardens in Tioor. Complete burning of the cover vegetation requires less labour-input than hand-weeding (*pamere*) or controlled burning (i.e., cutting, and gathering of plant debris which is set on fire in a selected part of the grove): Thus, the range of labour-input varies from approximately 5 to 15 MD per hectare.

(3) Information on labour input for the *harvest* of tree garden products, and for the *handling after harvest*, is relatively reliable, because yields are almost steady, except during prolonged droughts. However, labour-input much depends on the number of fruits per tree to be harvested. Harvesting of coconut and nutmeg is regularly carried out thrice and twice per year, respectively. Harvesting of *coconuts* and processing the nuts at a kiln takes approximately 30 MD per hectare and year. A household – i.e. the couple and their children – can harvest three to five *nutmeg* trees per day including drying of nutmeg and mace. *Sago* is harvested in times of food shortage or just before a tall trunk is due to flower, requiring an average of 7 MD for a latter (see also the section on sago tree gardens). As the yield of *clove* greatly fluctuates from year to year, so does the labour input. An experienced picker needs an estimated three hours for the harvest of a ten-year old clove tree bearing a heavy crop. This is an equivalent of 1 to 2 kg of dried cloves (household interviews; cf. also Rehm 1989b, 504).

6.3.4 Mixed gardens

Rhun becomes the focus of this chapter, because mixed gardens (*kebun campuran*) are the major land-use type (40% of the island area, Tab. 6.3) apart from permanent dry fields. The mixed garden can be classified as an agroforestry system, because it is characterised both by a simultaneous cultivation of annuals and perennials in one land unit, and by economic and ecological interactions of its components. Additionally, many farmers in Rhun have integrated goat husbandry as a pastoral component into the mixed garden (see Ch. 6.3.5). The requirements of a continued cultivation of annuals are: a constant good soil fertility, adjusted and careful management to avoid soil degradation and erosion, and the right choice of species complementary to each other, such as deep-rooting trees and shallow-rooting annuals.

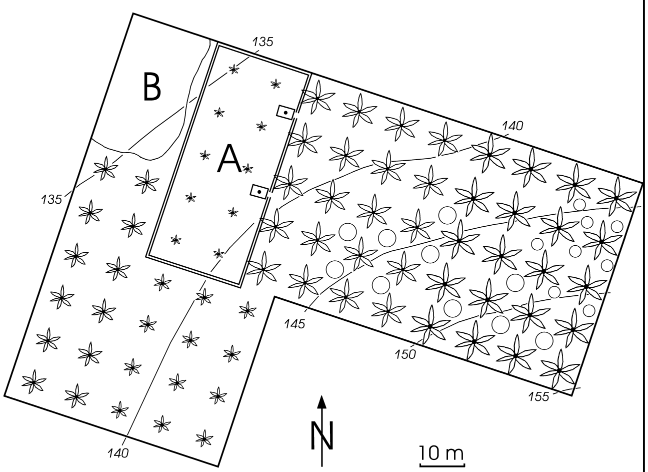
In Tioor, the evolution of mixed gardens is a new phenomena – although once this garden type was practised in historical land-use systems along the western and northeastern coastal plains, where nowadays coconut groves are dominating the scenery (see Ch. 6.1.2). Presently, mixed gardens have

[160] Some of them were only observed in Neira and Banda Besar, e.g. *Antidesma bunius* (L.) Sprengel (salamander tree, buni; *Euphorbiaceae*), *Artocarpus integer* (Thunb.) Merr. (chempedak; *Moraceae*), *Chrysophyllum cainito* L. (caimito, sawo; *Sapotaceae*), *Cynometra cauliflora* L. (namnam; *Leguminosae*), and *Flacourtia inermis* Roxb. (governor plum, tomi-tomi; *Flacourtiaceae*).

predominantly emerged on the ridges of the southern and western part of Tioor, and occasionally along the bottom of the eastern slopes. Their development follows the pathway of *tumpangsari*, but distances between integrated trees are spacious enough to allow a continued inter-cropping of annuals after the third year (Fig. 6.11).

A special type of a mixed garden is the home garden (*pekarangan*), which is occasionally arranged around a house. As the maps of settlements (Maps 6) suggest, the potential area of home gardens is very small, so that it is dominated by just a couple of trees. Most common are coconut palms (dwarf cultivars, to avoid damage of the house by falling nuts) and small fruit trees, such as *Annona squamosa* L. and *Psidium guajava* L. Taller trees, such as *Mangifera indica* L., are planted near a house only in Tioor, because in Rhun their roots could damage the water tanks of the households.

Figure 6.11: Horizontal structures of a mixed garden in Tioor – Kovnan Batbotan location



Legend

Coffea canephora, 5 years
Myristica fragrans, 5 years
Cocos nucifera, 1 year
Cocos nucifera, 2 years
Cocos nucifera, 5 years
Cocos nucifera, 7 years
Cocos nucifera, 9 years

Tree species, age of tree

Dry field with cassava, sweet potatoes, bananas, vegetables, and interspersed coconut palms (*tumpangsari*), enclosed by a fence constructed with timber (from nearby secondary forest) and bamboo (from nearby bamboo stands).
Dug holes ( ) behind two entrances to protect the crop from wild boars

B **Natural bamboo stand** (vernacular name of bamboo species: *Kovnan*)

Contour line and altitude [m]

Mixed garden of 0.8 ha surrounded by old secondary forest – Spacing of coconut palms: 10 m x 10 m – Interspersed nutmeg trees and coffee shrubs in the eastern part of the field, developing to a mixed tree garden without production of annuals – In the western part, annual crop rotation, presently in plot A – A bamboo stand is spared from clearing, to provide bamboo for fence construction.
The farmer holds two other fields: a dry field of 0.8 ha; and a nutmeg tree garden of 0.25 ha (see also footnote 113).

Sources: Mapping and household interviews (Stubenvoll 1997).

Emergence of mixed gardens through extension of dry fields and inter-planting of cloves

Since the 1970s, there have been two principal modes of mixed garden establishment in Rhun. The major factor in land-use change in Rhun is the underlying peasant strategy of (1) an *extension of dry field area* and of (2) *inter-planting of clove trees in nutmeg stands* (see Ch. 6.4.1). Subsequently, other perennials have been interspersed.

(1) The fall of the nutmeg plantations in Rhun is closely linked with a continuous decline of the number of nutmeg and protection trees, such as *kenari* (*Canarium vulgare* Leenh). In 1968, when the *Prajakarya* took over the plantations from the PPD, a part of the protection trees were cut out to increase the yield potential of the nutmeg plantations.[161] In the resulting empty space, the

[161] The management reduced the number of *kenari* trees from 20 to 15 per hectare. Three years later, in 1972/73, the annual output of nutmeg from Rhun was an average of 3.4 kg per tree, whereas the PNP XXVIII in Banda Besar reached only

farmers (at that time plantation workers) have illegally established dry fields: In a first step they planted bananas, and then subsequently taro and cassava. As soon as nearby nutmeg or protection trees died or were wilfully destroyed, the farmers could extend the small, illegal plots little by little with a cultivation of annuals and an integration of perennials other than nutmeg trees.[162] Thus, the existing dry fields, dating back to the Japanese occupation in WW II, have been supplemented by small plots. As a result, each peasant household uses several, dispersed fields.

(2) More elaborate was the planting of clove seedlings, and to a lesser extent bananas, by the farmers in between nutmeg stands in the late 1970s, when clove prices were high. This could be carried out either in the same plots of (1), or in separated areas. Again, the farmers have grown annuals in nearby spots of ageing, dying, or wilfully destroyed nutmeg and protection trees. As previously stated in Ch. 6.3.3 on tree garden development, clove trees are by far outnumbering nutmeg trees.

General characteristics of mixed gardens

With both modes of appropriation of state-owned nutmeg plantation areas, the farmers have been able to integrate more perennials, whether it be clove or any other species except nutmeg, into the illegal dry fields later on. Unlike *tumpangsari* with an early integration of tree seedlings in Tioor, there is no rigidly defined rule of mixed garden establishment in a permanent dry field in Rhun. Like in agroforests, the *choice of tree species* is greatly differing among peasant households. The *timing of integration* into permanent dry fields is irregular as well. Decision-making with regard to the choice of tree species and timing of their propagation can be understood as a permanent adjustment to changing market demands, to the needs and desires of a peasant household, and to declining soil fertility. The result is a dynamic mosaic of trees and annuals in a great variety (Tab. 6.11) on the same land unit. Some of the plants are more common, such as cassava, eggplant, capsicum pepper, sugar and coconut palm, kenari, and soursop.

As each farmer individually chooses the pattern and timing of planting and the tree species, it is not possible to derive generalisations of mixed gardens, except in terms of complexity of both species and structure (see Ch. 6.2.2). Hence, a case study of a peasant household in Ch. 6.5.1 provides an exemplary design of a mixed garden. Most commonly, a mixed garden primarily serves the subsistence activities of the households in Rhun. As shown in Tab. 6.11 and in App. 1.1, only a few species merely produce cash crops. Even the marketable products of *Cocos nucifera* L. are predominantly consumed by the households themselves.

some 0.7 kg per tree, without a reduction in protection trees. In 1976, Rhun's output decreased to about 1.6 kg per tree. However, this can be largely explained by the beginning of nutmeg smuggle (interviews with key informants).

[162] The most common method of the destruction of *kenari* trees was performed by small cuttings in their buttresses and the burning of the resin (*kensi*) coming out of the cutting. The burnt tree dies, loosing its foliage, and will later collapse during strong wind. Presently, an average of 2 to 3 *kenari* trees per hectare, or 10% to 15% of the pre-1968 level, has remained in Rhun (drawn from mapping, observation and excursions).

Table 6.11: Common plant species in mixed gardens in Rhun

Carbohydrate producing plants (9 species)	***Timber trees (9 species)***
Arenga pinnata (sugar palm) *Colocasia esculenta var. antiquorum* (taro) *Curcuma domestica* (curcuma *Dioscorea* spp. (yams) ***Manihot esculenta*** (cassava) *Maranta arundinacea* (arrrowroot) ***Musa* spp.** *(*banana) *Saccharum officinarum* (sugar cane) *Zea mays* (corn)	***Alstonia scholaris*** (pulai) ***Canarium vulgare*** (Java almond; *vernacular name*: kenari) *Dracontomelon dao* (New Guinea walnut) *Endospermum moluccanum* (cheesewood) ***Hibiscus tiliaceus*** (beach mallow) *Mangifera* sp. (mangowood) *Neonauclea glabra* (*vernacular name*: emeng) *Terminalia catappa* (Indian almond) *Toona ciliata* (Indian mahagony)
Vegetables and pulses (17 species)	**Trees yielding edible fruits and seeds (18 species)**
Amaranthus* spp.** (amaranth) *Apium graveolens* (celery) ***Arachis hypogaea (groundnut) *Brassica juncea* (Indian mustard) ***Capsicum* spp.** (capsicum pepper) *Citrullus lanatus* (watermelon) ***Cucumis sativus*** (cucumber) *Cucurbita* spp. (pumpkin) *Lagenaria siceraria* (bottle gourd) *Luffa acutangula* (loofah) *Lycopersicum esculentum* (tomato) *Momordica* spp. (bitter gourd) ***Phaseolus vulgaris*** (common bean) *Psophocarpus tetragonolobus* (winged bean) *Sauropus androgynus* (star gooseberry) ***Solanum melongena*** (eggplant) *Vigna unguiculata* (yard-long bean)	*Aleurites moluccana* (candlenut) *Anacardium occidentale* (cashewnut) ***Annona muricata*** (soursop) *Artocarpus altilis* (breadfruit) ***Artocarpus heterophyllus*** (jackfruit) ***Averrhoa bilimbi*** (bilimbi) *Bouea macrophylla* (gandaria) *Citrus* spp. (citrus) *Durio zibethinus* (durian) *Gnetum gnemon* (melinjo) *Inocarpus edulis* (Tahitian chestnut) *Lansium domesticum* (langsat) *Mangifera indica* (mango) *Psidium guajava* (guava) ***Syzygium aqueum*** (water apple) *Syzygium cumini* (jambolan) ***Syzygium malaccense*** (Malay apple) *Tamarindus indica* (tamarind)
Cash crop producing trees (4 species)	**Others (6 species)**
Myristica fragrans (nutmeg) ***Syzygium aromaticum*** (clove) *Theobroma cacao* (cocoa) ***Coffea canephora*** (robusta coffee)	***Ananas comosus*** (ananas) *fruit* *Ceiba pent*andra (kapok) *fibre* ***Cocos nucifera*** (coconut palm) *vegetable oil* ***Morinda citrifolia*** (Indian mulberry) *dye, medicine* ***Moringa oleifera*** (horseradish tree) *vegetable* ***Pandanus*** spp. (pandanus) *fibre*

Notes: Information on secondary uses, subsistence level and market range is given in App. 1.1.
Bold: Most common species.

Sources: Interviews, observation, mapping, and herbarium collection (Stubenvoll 1996); Functions of plants according to PROSEA handbook.

The common characteristics of mixed gardens in both Tioor and Rhun are:

(1) the permanence of perennials and most of the annuals, which are immediately replanted after harvesting, except during dry spells;

(2) the importance of their vertical structure – several layers are using the limited space and the resources water, light and soil in an efficient way, which is important due to limited land area;

(3) the integration of subsistence and market products into one land unit;

(4) the maintenance of soil productivity and regulation of water supply;

(5) the high level of internal agricultural inputs; and

(6) the reduction of risks (for instance pests and diseases) and dependencies by producing a lot of different products for the subsistence of the households.

6.3.5 Animal husbandry

Animal husbandry is restricted to small livestock – goats (*Capra hircus*), chickens (*Gallus gallus*), and perching ducks (*Cairina moschata*) – and common on either island. Dogs are kept by some households in the Christian communities in Tioor. They assist in hunting of wild boars which is occasionally carried out by a group of men (see Ch. 6.3.6). Husbandry of cattle, horses and buffaloes is not suitable under the environmental conditions (problems of water supply; limited land area), although in the seventeenth century the Dutch VOC attempted to establish cattle farming in then unpopulated Rhun, with a limited success, however (Loth 1996, 5 and 12).

Goat husbandry

During the period of the Dutch and Indonesian plantation enterprises, poultry was kept near the plantation buildings,[163] whereas goats were only allowed to graze in a corral (a fenced enclosure) in areas outside the nutmeg plantations, and an additional 'cut-and-carry' of forage. Thus, the number of goat livestock was very limited. Nowadays, three management systems of goat husbandry are practised in Rhun: free grazing; grazing plus more labour-intensive 'cut-and-carry' of forage, in own and adjacent gardens, where mature goats are tethered to trees; and, grazing in corrals in the own garden and additional 'cut-and-carry' of forage into the corral (Tab. 6.12). The former two practices cause emotional debates and conflicts within the community, because breeders do not restrict the grazing area to their own field. Goats are therefore often damaging or destroying plants of other farmers, even if they are tethered to trees. In some occasions, goats were brought to another place by the damaged party, so that the breeder had to look for them. In fact, the damage to vegetation, and the institutional weakness of absent regulations in case of destruction of plants by browsing goats, are obstacles in tree planting activities.[164]

Fencing seems to be less problematic, but it is most labour-intensive, and breeders have to cut forage from fields of other farmers as well. An advantage of the corral management system is the possibility to lease out goats to another farmer, who will manage the daily feeding and surveillance of the animals. The offspring of the goats is then equally shared between the owner and the breeder. Some of the farmers practising this system have additionally constructed small stables to shelter the animals from adverse weather conditions (rain, cool nights, wind), because goats are occasionally killed by trees or bananas being uprooted and knocked down by strong wind. Preferably male goats are sold on the local and regional markets, or to traders anchoring in Rhun, fetching up to Rp. 150,000 per animal (in 1996), or are domestically consumed, e.g., for wedding and funeral ceremonies, or at the end of Ramadhan (*Idul Fitri*). Female animals are not marketed in most cases, because breeders take more care of getting sufficient goat offspring than to produce goats for marketing purposes.

In Tioor, goats are kept in the village area, and are left to roam and browse alone in the coastal plains. Main reason for the farmers not to keep goats in upland gardens is the existence of big snakes (*Python* sp., *Boidae*) which would feed on small and medium-sized animals. Herds would also have to be regularly overseen, so that it saves the farmer from almost daily surveillance in distant gardens. Sometimes goats perish after consumption of residues from cassava preparation. As shown in Tab. 6.12, goat husbandry is a marginal economic activity in Tioor – 20% of the interviewed household keep a few goats. Main purpose is the domestic consumption of goats for socio-cultural and religious

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[163] Before WW II, the plantation workforce lived in a labour line (see Map 6.4).

[164] As one farmer (HH 25) put it: *"I would certainly plant more trees in my fields, but there are too many goats of other farmers around there, browsing on my tree seedlings and even on cassava leaves."*

activities, although grown-up male animals are occasionally sold to traders coming to Tioor. The producer price is up to Rp. 100,000 per animal (1997).

Table 6.12: Animal husbandry in Tioor and Rhun

No. of animals	Number of households[1]										No. of animals per household	
	20 and more		]20;10[		[10;5[		[5;1]		none			
Husbandry of ...	**Tioor**	**Rhun**	**Tioor**	**Rhun**	**Tioor**	**Rhun**	**Tioor**	**Rhun**	**Tioor**	**Rhun**	**Tioor**	**Rhun**
... goats	none	1	none	3	1	1	7	5	32	15	0.6	3
... poultry	2	1	4	none	8	5	8	5	18	13	5.6	3.4
... dogs	none	none	none	none	3	none	13	none	24	25	1.7	none

Management system of goat husbandry in Rhun	Free grazing	Corrals	Tethering
No. of goat breeders	1	3	6

Notes: **1** 65 interviewed households (40 in Tioor; 25 in Rhun).

Sources: Household interviews (Stubenvoll 1996 and 1997).

Poultry farming

Poultry usually stays around the house and scavenges for scraps, insects, forage plants and minerals, so that farmers need no extra input, except during prolonged droughts when availability of proteins becomes critical. Eggs are a steady source of protein, and especially sought after, when fishing cannot be performed during times of rough sea. The periodic outbreak of the Newcastle disease (*tetelo*) is a problem for the Rhunese chicken farmers, because almost all of the chickens in the village will then perish, with the exception of the sitting hens. Some farmers in Rhun tend to keep chickens in the field, where animals are spared *tetelo*, but there they are subject to theft.

Tetelo was not reported in Tioor, but there *pela* obligations include the provision of poultry to visitors from islands that have a *pela* relationship with Tioor (see Ch. 5.4.2). As one farmer (HH 38) put it: "*I have a lot of chicks, but most of my grown-up chickens were recently slaughtered by visitors from Kasiui. They come and simply slaughter chickens straight away, wherever they can get them, because they do not have to care about somebody's property. It is pela, isn't it?*" If not being claimed victim of Newcastle disease or *pela* obligations, a chicken is worth up to Rp. 7,500 (Tioor) or Rp. 10,000 (Rhun) in the village. Attractive tail feathers of cocks are a substitute of live bait in line fishing, and are therefore in great demand by fishermen, because the population of bait fish has steadily decreased.

6.3.6 Forestry, gathering and hunting

The forest in Tioor provides a multitude of useful products for the households, and thus is not only of value in terms of bio-diversity and its ecological functions. In Rhun, primary forest has largely disappeared in the last century when the nutmeg plantations were established on the island. Hence, people have to rely on non-domesticated forest products from their gardens or secondary forest, although pockets of original vegetation still exist. The following discussion puts focus on the use of three kinds of non-domesticated forest and garden resources: timber, non-timber products, and wild animals.

Tenure and access to non-domesticated timber trees and non-timber products

As previously outlined in Ch. 6.3.3, tenure on cultivated trees overwhelmingly underlies the categories of 'right to plant trees', 'ownership of trees', and 'accessibility to the products of trees'. These depend on: the tree species, the status of land tenure, and clan and family relations. Although tree tenure and access to non-domesticated, naturally established trees (*pohon yang tumbuh sendiri*) is partly in line with these categories, it is additionally much influenced by *communal* regulations and traditions on access to timber. In the future, the situation might become more complicated with an ever increasing curtailment of access to timber by governmental acts. Although the traditional understanding of tree tenure, with respect to non-domesticated trees, recognises the category of *common property*, which would allow any community member to cut down a tree or to use the timber of a fallen tree, there are specifications and restrictions on access to timber trees, especially on land that is held or claimed by an individual, a family or a clan, and in sacred places (*keramat*):

(1) *Timber trees in individually held land (Tioor and Rhun): Adat* allows anyone to use the products of a naturally established tree *on individual land* except from cutting it down or to use timber of a collapsed tree. Preferably the user should consult the owner, if a fallen tree would be used for timber production: In Rhun, a fallen protection tree of the former nutmeg plantations is owned by that farmer, on whose field the tree had actually collapsed. Whereas in Tioor, the former stand of a fallen tree determines ownership of it. A standing timber tree is always subject to negotiations between the potential user and the owner. It is up to the owner to refuse or to allow the cutting of the tree in question. In the latter, more common case, some form of compensation would be arranged – either an amount of money, a part of the cut poles, or most often – in the sense of reciprocity – the prospect to get access on products of the user's tree gardens later on.

(2) *Timber trees in clan's land or family's land except primary forest land (Tioor and Rhun):* This category is similarly dealt with that of timber trees in individual land-holdings. The only difference is concerning the decision-making of the tree owner, i.e. the family or the clan. Negotiations take place between the party requesting the use of a timber tree and the head of the clan (or the family), who in turn has to consult other clan (or family) members who might have claims on the tree. Hence, negotiations are more complicated, and the final agreement about compensations, or the refusal of the request, depends on the consultations of the clan (or family). A claim of a clan (or a family) member on a timber tree is usually not negotiated, i.e. it is freely accessible for all members and siblings of the clan and family, respectively, with the exception of family members from another island. However, after consultation a requested timber tree could be cut down in any case by the latter without any compensation. Timber trees in clan's, family's, or individual land are not subject to *pela* obligations.

(3) *Timber trees in primary forest land (Tioor)* are *common property*. This applies to both on land that is already claimed by a farmer and on land not being claimed yet by anyone, as long as there is no indication that a tree is demanded. Such an indication is made by a notch of a person's name put into the bark of the tree, or the planting of nutmeg tree seedlings around it. In primary forest land under claim of a family, the sign is most commonly put up by members of that family, because other persons usually respect land tenure claims. Access to signed timber trees is relatively easy for another person, however, as his request is seldom rejected. Compensations are not demanded (*dikasih cuma-cuma*), although reciprocal obligations are expected. Timber trees in primary forest may become subject to *pela* obligations if requested by one *pela* village in the realisation of a community project that requires timber for construction. However, there is no evidence that this had ever been the case in villages being in *pela* relations with Tioor.

(4) *Forest resources in sacred primary forest land (keramat) and cemeteries (Tioor and Rhun):* As previously outlined in Ch. 5.4.2, it is a strict taboo to make use of any natural resource in a *keramat*. Contrary to the suggestion of Hardin (1968), this taboo perfectly illustrates that *common property* will not necessarily cause the depletion of a natural resource, because *nobody* will

wilfully violate the ban in order to avoid the revenge and punishment by the ancestors and spirits living in the *keramat*. The same is true for trees in cemeteries.

(5) *Bamboos, rattans and non-domesticated trees producing fuelwood or non-timber products (Tioor and Rhun)* in primary forests are *common property*, and can be used by anyone. No claims can be made to these products, and no compensations can be demanded. In gardens, *adat* requires a request from the user that is usually not rejected by the garden-holder.

Labour arrangements

Once a tree is subject to be processed to timber or charcoal, the user has to arrange the necessary labour input. Cutting of beams, rafters and boards is carried out by an owner of a power chain saw after an order by the user. In Rhun, the processed timber is divided between the owner of the power chain saw and the tree user in a share of 2 : 1 in favour of the former. In Tioor, the owner of the power chain saw is paid a fixed amount of money for each piece of processed timber, depending on the size of the beam and on the timber tree species.[165] The transport of beams from the cutting site to the village requires at least two strong males, who get a fixed piece wage from the owner of the beams, again depending on the beams' size and the distance to the village. For instance, the cutting of a 2 m long and 9 cm strong beam of the hard Moluccan ironwood (*perai*; *Intsia bijuga*) is paid Rp. 2,500, that for *gubar* (*Calophyllum inopyllum* L.) Rp. 1,500 (1997). The transport of one *perai* beam over a distance of 2 km is receiving Rp. 1,500.

The cutting of timber for fencing is performed by a group in *kerja masohi* with manual tools, such as axes – axe handles are self-made from timber of *Streblus ilicifolius* (Vidal) Corner – and machetes. In Tioor, charcoal is produced with the same tools and the use of smouldering fire being controlled with water by a single forger, who plans to forge machetes with his group in one of the coming days (see Ch. 5.5.2). He is occasionally assisted by members of the forger group or other men who want to sell charcoal (Rp. 10,000 per sack). Obtained charcoal is then equally distributed among them.

External users

Unlike larger islands in Maluku such as Halmahera, Seram, Buru, and Taliabu, where logging companies are operating with concession licences – either for forest utilisation with selective cutting (HPH), clear cutting (IPK), or commercial forest plantations (HTI) – issued by the Indonesian Government (see, e.g., Monk et al. 1997, 607-35), small islands like Tioor and Rhun are spared these capital-intensive operations. Herein lies one of the advantages of small tropical islands.[166] Likewise, illegal cutting and poaching of timber hardly occurs due to difficult transportation and easy control of the small forest area by the islanders. Hence, external users have to negotiate with the traditional leaders and the village administration about processing of communal forest resources, including compensations in form of money for the village budget. Commercial users are definitively in a worse bargain position than family members from other islands, or *pela* villages requesting timber for larger community projects. They can improve their bargain position, however, by negotiating with an individual farmer about his timber trees in individually held land, particularly if the latter urgently needs money. In Tioor, external trade of timber has begun in the 1980s, when timber on most of the surrounding islands had become depleted. The only small islands in the region between Seram and Kei with primary forest left are Manawoka (Gorom Islands), Tioor, and uninhabited Utir (Kei Islands),

165 In Tioor, only two households are equipped with a power chain saw, both bought with IDT money. When the IDT groups had failed, they claimed the saws as private property. In addition, two workers from Kasiui are operating in Tioor, each with a power chain saw of an ethnic Chinese settling in Kasiui.

166 As described in Ch. 5.5.2, marine resources were exploited by an external private company in Tioor.

where the traditional leaders of nearby Ur and Kei Tanimbar (see Fig. 5.1b) have imposed a strictly controlled ban on timber extraction by external users (interview in Tioor with a visitor from Ur; personal communication with R. Topatimasang). Rhun has never been a source of timber resources for external users, although a part of *kenari* wood is traded by Rhunese as fuelwood to Banda Neira.

Major timber trees

As the list of plant species in App. 1.1 suggests, there are about 80 identified and some more unidentified tree species producing timber. This is either as a primary use (29 identified species in Tioor; 8 in Rhun) or as a secondary use (30 identified species in Tioor; 27 in Rhun). It is beyond the scope of this study to provide details on all of these tree species, for these are furnished for instance by Burkill (1935), and the volumes of the PROSEA handbook, so that in the following important characteristics of only the major timber trees are described.[167]

***Anthocephalus chinensis* (Lamk) A. Rich. Ex Walp.** (cf. also Smits et al. 1993): This fast growing tree of the *Rubiceae* is found on a variety of soils in secondary forest in Tioor, called *telia*, and grows up to a height of 40 m. Its lightweight timber is mainly used for canoe-making, as it is inferior to other timbers in indoor construction. In contact with the ground, the wood is highly perishable. As the area of secondary forest has steadily increased, and the demand of timber of *A. chinensis* is still limited, there is still no indication of its depletion.

***Calophyllum* L.** (cf. also Lim and Lemmens 1993): *C. inophyllum* L. (called *bintanggur* in Rhun, *gubar* in Tioor) of the *Guttiferae* is found most commonly on sandy beaches on the seashore, and as an ornamental in cemeteries. However, it is so much in demand for its durable timber, that almost all of the tall trees have been cut down. The timber is used in house construction (boards), and ship construction (boards, beams for the ribs, masts, and canoe hulls). The seeds contain oil which is sometimes used as an illuminant. The latex from the bark serves as an adhesive, e.g. for diving goggles, and as a traditional medicine. According to the farmers, *C. inophyllum* L. is a top priority tree species for use in reforestation for coastal protection, and further inland in agroforestry extension on sandy soils. Another unidentified *Calophyllum* species (called *gubarfat*) with large leaves of a length of up to 40 cm is restricted to Tioor's secondary forests, but there a widespread species.[168] It grows up to a height of 40 m. The timber is less durable than that of *C. inophyllum*. It is used in ship (masts, boards) and house construction (rafters, boards), and for canoe hulls.

***Intsia bijuga* (Colebr.) O. Kuntze** (cf. also Johns et al. 1993): This tree of the *Leguminosae* occurs on both islands, although in Rhun, where it is called *kayu besi* (ironwood), it has become very rare and is insignificant in the village economy. In Tioor, *I. bijuga* (called *perai*) grows in primary forest and is sometimes found in tree gardens, because it is usually spared of being cut down in shifting cultivation. The heavy, hard, and very durable timber is used in ship and house construction (windows, rafters), and as the main raw material for charcoal production. *Perai* is therefore in high demand, and stands may soon be depleted.

[167] Most of the species not being described in the text are too much depleted, such as the high quality timber producing species *Gmelina moluccana* (Blume) Backer ex K. Heyne (*kayu titi*) and *Nothaphoebe calista* (*kai kuning*); have become almost locally extinct, such as *Cordia subcordata* Lamk (*kanawa*); or are less sought after for their timber. Nevertheless, some of these species have a great potential for use in agroforestry extension, such as *Casuarina equisetifolia* L. (*cemara, kasuari*). Information on maximum heights, uses of timber, frequency, and state of depletion of timber trees is summarised in App. 1.5.

[168] The collected specimen of this species was identified by the staff of Pusat Penelitian dan Pengembangan Biologi, LIPI, as *C. inophyllum* L. either, although the tree is restricted to secondary forest, does not occur along beaches and has much larger leaves than true *C. inophyllum* L. It is therefore regarded here as a separate species, also taking into account the indigenous different names used for both species.

***Neonauclea glabra* (Roxb.) Bakh. F. & Ridsd.** (cf. also Aggarwal 1998): *N. glabra* (called *emeng* in Rhun; *weman* in Tioor) of the *Rubiaceae* occurs in primary and secondary forest in both islands. In Rhun, *emeng* is highly valued for its very durable timber, that is in use for ship construction (ribs, boards), so that it has been considerably depleted. Accordingly, it was included by the farmers as a species of high priority in agroforestry extension. It grows on a wide range of soils, and even on rocky limestone with a thin solum, although it then does not reach maximum heights.

***Pometia pinnata* J.R. Forster & J.G. Forster** (cf. also de Graaf et al. 1993): In Tioor, *P. pinnata* (called *ton*) of the *Sapindaceae* is found in scattered stands in primary and secondary forest on a wide variety of soils, but is absent in Rhun. Like *perai*, it is usually spared from removal in shifting cultivation. The timber of *ton* is used for interior house construction (rafters, beams), for canoe hulls and as a fuelwood. It has the potential to produce a good charcoal. The sweet-tasting fruits and the seeds of *P. pinnata* are edible.

***Pterocarpus indicus* Willd.** (cf. also Rojo and Alonzo 1993): This nitrogen-fixing tree of the *Leguminosae* occurs in both Tioor (called *but*) and Rhun (called *lenggua*), although it has been considerably depleted, as the timber is in high demand for use in joinery, because *but/lenggua* yields a very attractive wood for furniture and doors. It is also used for heavy construction, rafters and beams. A decoction of the bark, which exudes an astringent, is taken against diarrhoea and fever. The bark also has tanning and dyeing properties. Presently, *P. indicus* is one timber species (besides *Canarium* L.; teak, *Tectona grandis* L.f.) being occasionally propagated by some farmers, e.g. in coconut tree gardens, but also in hilly terrain with less preferable soils. Hence, it was assessed by the farmers as a perennial of great potential in agroforestry extension.

***Toona ciliata* M.J. Roemer** (cf. also Gintings et al. 1995): *T. ciliata* is a fast growing tree of the *Meliaceae*, and occurs in Rhun, where it is called *kasturi*, but is absent in Tioor. *Kasturi* was planted as a shade tree in nutmeg plantations by the Dutch *perkeniers* (although *Canarium vulgare* Leenh. being more common), and is still frequently found in gardens of the peasants, although tall trees are rare due to overexploitation. The comparatively soft, valuable timber is used in light construction work, such as house and ship (masts) construction, but more often in joinery for furniture because it is easy to work. Bark and leaves are taken as traditional medicine. It is easy to propagate, and was included by the farmers as a tree of high priority in agroforestry extension.

Minor timber trees

The timber of the tree species mentioned so far serves as a primary use. Most of them have therefore come under immense pressure through overexploitation. The following tree species yield timber, although non-timber products and other functions are more important for the farmers.

***Alstonia scholaris* (L.) R.Br.** (cf. also Rudjiman et al. 1993): This tree of the *Apocynaceae* is commonly found in primary and secondary forest, and in gardens on a wide variety of soils in both Tioor, where it is called *yagar*, and Rhun, called *kayu susu* ('milk wood') due to its sticky white latex, which contains alkaloids. It is the main product of *A. scholaris*, being tapped for use in traditional medicine against eye troubles. A decoction of the bark is taken against roundworms, malaria, fever, diarrhoea and dysentery. The weak timber is suitable for interior trim, drawing boards, and furniture. The up to 40 m tall *A. scholaris* is occasionally planted as a shade tree in a *dusun pala*.

***Canarium* L.** (cf. also Kochummen et al. 1995): Two *Canarium* species of the *Burseraceae* are found in Rhun, namely *C. vulgare* Leenh. (called *kenari*), and to lesser extent *C. indicum* L. (called *kenari Ambon*). In Tioor, only the latter is frequently planted by farmers, where it is called *kier*. *Kenari* was cultivated by the Dutch as a protection tree in the nutmeg plantations of Rhun. The seeds of both species are the main product, with bigger seeds of *C. indicum* than those of *C. vulgare*. Seeds contain a vegetable oil of high quality, serve self-consumption in cakes and cookies (*lutlubuk*; see section on sago tree gardens) or are marketed in the region for Rp. 8,000 per kg. Farmers in Rhun, who formerly destroyed trees, are therefore rejuvenating *kenari*, and assessed it as an important tree species in agroforestry extension. Presently, children and women are rivalling for the collection of fallen fruits in Rhun. On the nearby island of Kur, seeds of *C. indicum* are a major factor in the local economy. The non-durable timber of both species is used in indoor construction, for furniture, canoe hulls, and as fuelwood. Old trees produce a reasonable amount of resin (cf. footnote 162), which is locally mixed with the papery bark of *kayu putih* (*Melaleuca leucadendra* (L.) L.; imported from Buru and Seram) or the bark of *Hibiscus tiliaceus* L. for caulking boats.

***Dracontomelon dao* (Blanco) Merr. & Rolfe** (cf. also Louman et al. 1995): This tree of the *Anacardiaceae* occurs in Rhun (called *cerpati*), whereas it is absent in Tioor. It was planted by the Dutch as a protection tree in nutmeg plantations. Its fruits and seeds are edible, and young leaves are cooked to serve as a vegetable. The timber of *cerpati* is valued for use: in joinery, for furniture, in light construction, as a fuelwood, and in boat-building.

***Hibiscus tiliaceus* L.** (cf. also Wiselius 1998): The fast growing *H. tiliaceus* of the *Malvaceae* is a common tree along sandy shores and tidal creeks, and is also found further inland in coastal plains and along streams. It occurs in both Tioor, where it is called *var*, and in Rhun (called *warok*). As previously pointed out in Ch. 6.1.1, it serves as a shade tree for young nutmeg trees. It is easily to propagate by stem cutting, and in Rhun, many farmers integrate *warok* into their mixed gardens, because of the robustness of its timber in water, making it a valued resource for traditional boat construction. The timber also makes a good fuelwood, and is used in house construction. The leaves are used as a traditional medicine against fever and cough. The bark yields a fibre for the production of good quality ropes and for the caulking of boats.

***Paraserianthes falcataria* (L.) Nielsen** (cf. also Rojo et al. 1993): The nitrogen-fixing *P. falcataria* of the *Leguminosae* is a common species in secondary forest in Tioor (called *wepa*), and occasionally found in Rhun (called *sika*). According to the Guinness Book of Records, it is the fastest growing tree in the world. For farmers in Tioor, flowering of *wepa* indicates the end of the dry season. The timber is used for canoe hulls and as a fuelwood, although other species are preferred for the latter purpose. In Rhun, leaves are collected to feed goats. In Tioor, *wepa* has the main functions of being a pioneer species in fallow land and a shade tree in a *dusun pala.* The trees tend to be easily damaged by wind.

***Terminalia catappa* L.** (cf. also Sosef et al. 1995): *T. catappa* of the *Combretaceae* most commonly appears along sandy and rocky beaches, but also further inland in the coastal plain, in both Tioor (called *tapia*) and Rhun (called *ketapang*). It is an ornamental tree in the village area. Main products are the edible seeds, and various plant parts, which are used in traditional medicine. A decoction of the leaves is taken against cough, sore throat, and is diuretic. The fluid of squeezed leaves is used against eye troubles. A decoction of the bark can be used as a gargle which alleviates toothache. The timber is used for light construction, in boat building including masts and canoes from large stems, for furniture, and as fuelwood. The bark, leaves, and young fruit produce a tannin and a dye.

Gathering of non-timber products (NTPs)

Besides the timber used for construction and fuelwood, people in Tioor and Rhun also depend on the gathering of non-timber products (NTPs) of non-domesticated plants and trees. This includes such products as bamboos, rattan (one unidentified species in Tioor), medicinal plants and plant parts, fruits, nuts, fibres, resins, oils, dyes, and the like.[169] Particularly, indigenous knowledge of the plants'

[169] It is not intended to provide a more detailed account on species producing NTPs, despite their importance for the people, because it would need too much space. Hence, the reader is recommended to consult App. 1.1 and App. 1.6.

medicinal properties is of significant importance for the islanders, as it is difficult to obtain modern and relatively expensive drugs far away from the urban centres. As women are usually collecting traditional medicines, PRA on medicinal plants was carried out with women, which resulted in a list of about 60 species locally used in Tioor against several illnesses and pains (see App. 1.6). Fibres and rattan are used in the production of household utensils, in handicraft, and in the construction of field huts and roofs.

Six unidentified species of bamboo (*Graminae*) occur in both Tioor and Rhun (cf. App. 1.2 and App. 1.3).[170] They are fast growing in clumps in forests, and also in gardens, where they are not removed due to their important role as a building material in local construction, handicraft, production of fish traps, and for household utensils. Young shoots of certain bamboos are collected as a vegetable and regarded as a delicacy. Two bamboo species in Tioor (called *varfur*, and *kofat*) have medicinal properties. The major threat to bamboo stands in Tioor is the practice of shifting cultivation and the 'struggle for land'.[171]

Hunting

Hunting is virtually only performed in Tioor, because wild animals of economic importance do not occur in Rhun.[172] Wild boars (*Sus scrofa*), the common spotted cuscus (*Spilocuscus maculatus chrysorrhous*) and freshwater crustaceans are the main objects of the hunters. A common, but rather destructive and labour-intensive method of cuscus hunting is to simply cut down the tree, where a night-active cuscus is supposed to stay. Alternatively, traps are used. Freshwater crustaceans, mainly shrimps, are caught with small traps made of bamboo, or by hand in remaining puddles of dried up streams during the dry season. The battue of wild boars is regularly carried out by a group of six or seven Christian men together with their dogs. Some farmers dig deep holes being covered with branches and cut herbs behind the only narrow entrance into a fenced dry field (cf. Fig. 6.11). Although the meat of boars is appreciated as a source of protein by the Christian communities, the primary intention of wild boar hunting is to protect dry fields and young coconut planting from destruction.

Depletion of forest resources

Many forest resources have come under immense pressure due to overexploitation, and probably more important, by anthropogenic change and loss of habitats through the conversion of forests by agricultural practices, such as slash-and-burn agriculture and tree garden extension. In the following, indications of forest resources' depletion are outlined before turning to the question, how the communities are dealing with this problem.

(1) *Inter-island timber trade*: People in Rhun already have to import almost all timber for boat and house construction from Seram, as local timber trees have become scarce. Prices of sawn timber have steadily increased in recent years, so that timber for a *perahu* is now more expensive than a diesel engine. The high price of timber is also reflecting the risks and bribes involved in illegal logging operations and illegal inter-island timber trade. In Tioor, an ethnic Chinese constructed a

[170] The identification of bamboos poses considerable difficulties, because it is not sufficient to restrict specimen collection to leafy or flowering branches (cf. Dransfield and Widjaja 1995, 32).

[171] An example is the location of *Kovnan Batbotan* (literally 'bamboo forest') in the north of Tioor, where presently most of the bamboo stands have been replaced by dry fields (including secondary forest) and mixed gardens (see also Fig. 6.11).

[172] Other wild animals, such as snakes, rats and mice, are killed as well, although they do not serve as an economic product. In Tioor, there are ten unidentified species of terrestrial snakes, of which three are poisonous (PRA with villagers).

huge ship (250 t) in 1997/1998. He bought large poles for the keel from Misool Island (Irian Jaya), since governmental control of illegal logging is supposed to be less effective than in Seram.

(2) *Increasing distances to find timber for charcoal production*: Forgers in Tioor reported, that *perai* for charcoal production could be easily found near the village until the 1980s. Presently, they have to look for *perai* in a distance of at least 1.5 km. Until the 1950s, *kei papua* (*Pemphis acidula* J.R. Forster & J.G. Forster) was preferred for charcoal production. This tree species is almost extinct in Tioor. Remaining stands, not worthwhile for extraction, are found in Baam Island.

(3) *Increasing prices for local timber*: Especially in Rhun, prices of local timber have increased. In Tioor, the increase is less dramatic, although the price of charcoal has doubled in the 1990s (see Ch. 5.5.2).

(4) *Depletion of certain timber species*: As App. 1.5 on the state of depletion of timber trees suggests, most of these species have become depleted. The only exceptions are those tree species which are pioneer species of secondary forest.

The traditional understanding of *common property*, as outlined above, knows a partial restriction on forest resource-use. This seems to be insufficient in safeguarding the future availability of forest resources, because tree garden extension and shifting cultivation as major factors in resource depletion are still dominant. On the *individual land-holding* a new development might have potential for conservation of forest resources. In anticipation of the depletion of timber trees and bamboos, some farmers find an excuse of rejecting the request of a potential user of trees/bamboos in their gardens without endangering their social respect and reputation in the community, by stating the important ecological function of the tree or the bamboo in question.

Despite the importance of forest resources for the islanders, most non-domesticated species are not propagated by the farmers so far. Hence, natural propagation of tree species in gardens, and the care of non-domesticated plants by the farmer, will play a crucial role in sustainable resource management. To guarantee a sufficient self-propagation of trees, the role of the small sacred forest areas (*keramat*) and remaining primary forest as a conservation area of the local gene pool is of utmost importance. Thus, the conservation of primary forest was put into the community-based resource management plans.

Yet, one issue has to be brought into the discussion concerning sustainable management of forest resources in the following chapters. The dwindling forest area has not only the effect of a depletion of economically important resources such as timber, it is also environmentally deleterious. This leads to increased soil erosion and to destabilisation of water resources.

6.3.7 Functional diversity and economic results

The discussion in the previous paragraphs of Ch. 6 included a description of the *functions of* cultivated and non-domesticated *plant resources*. The purpose of this paragraph is to put together this information to an analysis of the *farming systems' functions*, which can be divided into the interwoven realms of (1) socio-economic and ecological services, and of (2) production (Sardjono 1990, 110ff; von Maydell 1986, 175ff). Finally, examples of economic results are examined.

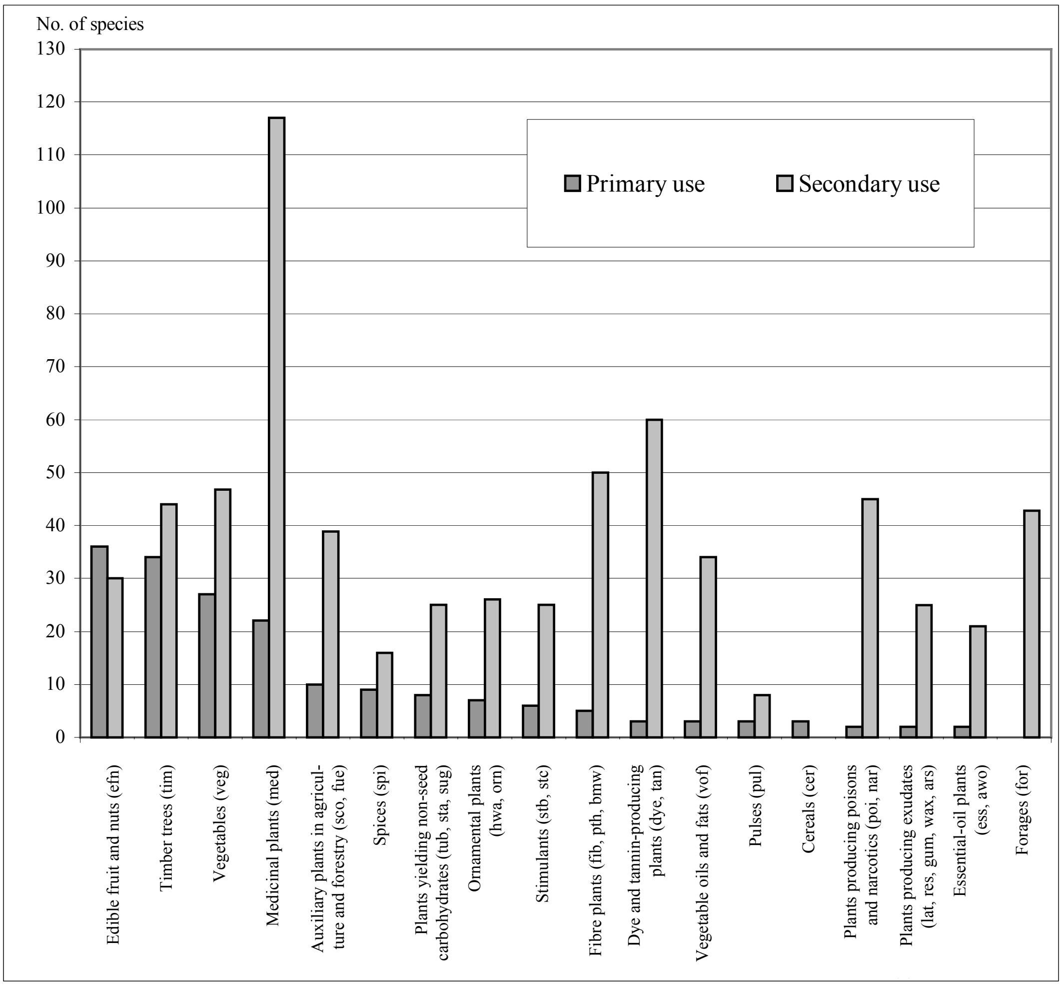
Socio-economic and ecological services

App. 1.1, App. 1.2, and App. 1.3 provide details on the market range of the main products of 182 identified (in Tioor: 160; in Rhun: 100), and several unidentified (39; 24) plant species being cultivated, or used as non-domesticated plants. In Tioor (Rhun), primary products of only 9 (8) plant species predominantly serve marketing purposes, whereas primary products of 160 (67) plant species are merely used for the subsistence activities of the people. Primary products of another 21 (36) plant species are available to the households in Tioor (Rhun) for their subsistence, although surpluses are sold or bartered in local and regional markets. The market-range of secondary products and products of most unidentified plant species is not included in the appendices. Hence, in *terms of the number of plant species*, agriculture, agroforestry, and forestry are *subsistence-oriented* on either island. *In terms of income generation from the agricultural sector*, however, Tioor's coconut, nutmeg and clove tree gardens are market-oriented, whereas in Rhun these trees provide only a small part of the household's income. Thus, the agricultural activities of the Tioorese can be interpreted as an interlocked mixture of both subsistence- and market-orientation being almost equally important. In Rhun, subsistence activities are by far dominant.

With this subsistence-orientation of agriculture and agroforestry, peasant households are less dependent on and approaching to an autarkic supply of staple food, except in times of yield-diminishing droughts. In combination with a sufficient supply of proteins by fishing, nutrition is most of the time well guaranteed. In 1998, however, the livelihood was threatened due to the prolonged drought of 1997, and an unusual drought period occurring in January 1998, destroying most of the newly established cassava. The majority of families had to live off rice and sago imports, at least for the first six months of 1998, until the first annuals were due to be harvested. In combination with the economic crisis and rising food prices in 1998, nutrition became seriously endangered. This example emphasises the importance of subsistence-orientation and self-sufficiency. Absolute priority is given to staple food production, supplemented by sago cultivation in Tioor. Usually trees are integrated into the landscape, if there is sufficient land available. They are placed where the terrain is inclined, or where soil is less fertile for the cultivation of annuals. The farmers of Rhun have thus replaced a mono-cultural, export-orientated land-use system (nutmeg plantations), from which they could neither profit nor stabilise their livelihood, with a highly diversified, subsistence-orientated agriculture and agroforestry, that can be regarded as socio-economically successful, because income is generated from non-agricultural activities. In Tioor, tree gardens fulfil this function of income creation, as land reserves have still been sufficient for their enlargement after abandonment of cropping of annuals, but at the expense of large areas of primary forest being lost through shifting cultivation in the upland.

Social services of farming systems refer in most cases to the social security arrangements of the households. Reciprocity is an important feature in almost all life situations and decision-making processes. Examples include the flexible access to tree products, timber trees, and vegetables, and the labour arrangements of *kerja masohi* or *gotong royong*. In terms of ecological services, the crucial role of trees in both forests and agroforestry systems for, e.g., the protection of soil and water resources is just stated here, because all services are further discussed in Ch. 7 on the evaluation of agroforestry.

Figure 6.12: Primary and secondary uses of 182 identified plant species



Notes: Bamboos (at least six species) and one rattan species (in Tioor) have not been identified by their scientific names. Information on lower plants (algae, mosses, ferns, lichens, fungi) was not collected. Abbreviations according to App. 1.1.

Sources: Interviews, PRA, and herbarium (Stubenvoll 1996 and 1997); Grouping according to PROSEA commodity groups (exception: medicinal plants are separated from plants producing poisons and narcotics).

Production and yields

App. 1.1, App. 1.2, and App. 1.3 also show details on the primary and secondary uses of plant species occurring and being cultivated in Tioor and Rhun. Fig. 6.12 summarises these uses by quantifying the number of species in each commodity group. The most significant feature is the *functional diversity* of the products yielded by these plant species. The multifunctional production of food resources (both staples and supplementary foods), timber, fuelwood, handicraft materials, traditional medicines, stimulants, dyes, tannins, fibres, and many more is important for the livelihood and the nutritional diversity of the peasant families.[173] Most of these plant species are found and cultivated in the arboreal landscape, i.e. in agroforestry systems and in forests (see App. 1.1).

The determination of *yields* commonly poses difficulties, because (cf. Sardjono 1990, 122):

(1) farmers do not record yields, especially of subsistence products, so provided data on yields from interviews represents a subjective estimation by the household head. Nevertheless, yield trends of annuals and major perennials, i.e. comparisons of former and present soil productivity, can be at least qualitatively derived from these data;

(2) yields of certain products, especially fruits and other tree products, may show great fluctuations from year to year. This can be caused by pests and diseases, environmental stress (e.g., prolonged droughts)[174], or the tree's individual characteristics, such as the yield cycle of clove trees, or female nutmeg trees differing in productivity (see Ch. 6.1.1, and Ch. 6.3.3; Tab. 6.13);

(3) yields depend on management activities and local differences in soil fertility. Hence, provided data on yields varies from farmer to farmer; and

(4) the overall yield of tree products serving the subsistence activities of the households is hardly determinable, because other family members may pick fruits as well, so that the tree owner does not exactly know the yield potential of the tree.

Table 6.13: Approximate annual yields of selected agricultural products

Crop	Unit	Yield (min.)	Yield (max.)	Average yield	Product	Yield-equivalent (average)	Yield (literature)
Cassava (Tioor)	1 klg.[1]	from 10 plants	from 5 plants	from 8 plants	fresh storage root[2]	22.5 t/ha	9 t/ha [90 t/ha][3]
Cassava (Rhun)	1 gepe[1]	from 12 plants	from 8 plants	from 10 plants	wet starch[2] (squeezed storage root)	13 t/ha	4.5 t/ha [45 t/ha][3]
Taro	1 klg.[1]	from 20 plants	from 4 plants	from 10 plants	fresh corm	18 t/ha	15 t/ha [2 – 75 t/ha][4]
Rainfed rice (Tioor)	0.3 ha	0.3 t	0.8 t	0.5 t	cereal	1.5 t/ha	2 t/ha [0.5 – 4 t/ha][5]
Sago (near maturity)	1 tree	200 kg	250 kg	225 kg	wet starch	11.25 t/ha (if 50 trees are cut)	10 t/ha [5 – 25 t/ha][6]
Coconut (mature tree)	1 tree	3 kg	30 kg	10 kg	dried copra	1.5 t/ha (150 trees/ha)	0.5 – 1 t/ha [0.5 – 6 t/ha][7]
Nutmeg (♀) (mature tree)	1 tree	1 kg	15 kg	3 – 5 kg	dried seed	375 – 625 kg/ha (125 female trees/ha)	1,250 kg/ha[8]
Clove (mature tree)	1 tree	0 kg	10 kg	2 kg	dried buds	300 kg/ha (150 tree/ha)	185 kg/ha [750 kg/ha][9]

Notes: **1** klg. = kaleng (about 18 kg of root crops) and gepe (about 12 kg of wet starch); **2** the storage roots of cassava contain 65% of water; the weight ratio of fresh storage root : wet starch : dry matter is about 6:3:2 (drawn from measurements); **3** de Bruijn and Veltkamp 1989, 179; **4** Wilson 1989, 105; **5** Vergara and de Datta 1989, 212; **6** Schuiling and Flach 1989, 184; **7** Ohler 1989, 94; **8** Flach and Tjeenk Willink 1989, 195; **9** Verheij and Snijders 1989, 262; **3-9:** average figures [variations; or maximum figures].

Sources: Interviews and yield measurements (Stubenvoll 1996 and 1997); Articles in PROSEA - A selection (1989).

173 This result coincides with Thaman and Clarke (1993, 19), who furnished ecological and cultural functions, and uses of trees in agroforestry systems on other Pacific Islands.

174 Yield measurements of selected agricultural crops were carried out during field work, although this procedure has had two main drawbacks. On the one hand, the results cannot be regarded as representative, as only few households were involved. Hence, the results can only serve as an *indication*, whether data provided from household interviews is reliable, or not. On the other hand, the prolonged drought in 1997 resulted in untypical low yields, so that from this point of view the results are not representative either. The latter still has the advantage of being capable to understand the logic of a peasant who must take into account the possibility of crop failure.

For these reasons, it is attempted to provide figures on yields of those agricultural products of which sufficient or fairly reliable data was obtained (Tab. 6.13). Yields of major perennials were outlined in Ch. 6.3.3 on tree gardens, but are included in Tab. 6.13. The main result is a high coincidence of yields from the island case studies with average yields given by the consulted literature. The main exception is the lower yield of nutmeg in Tioor and Rhun, which is due to (1) the existence of shade trees, (2) a picking of half-ripe fruits, and – most important – (3) a lesser spacing (150 trees/ha) by the small-scale farmers than given by Flach and Tjeenk Willink (1989, 195: 250 trees/ha).

Economic results

Tab. 6.14 provides information about the market-range of selected agricultural products in Tioor, and local producer prices and price developments if marketed. For a comparison: In October 1997, 1 kg of medium quality rice costs Rp. 1,500, 1 kg of sugar Rp. 2,000, and 40 kg of cement Rp. 20,000 in an intermediary's shop.

Generally, producer prices of agricultural products have been extremely low in recent years, especially for cloves (see Ch. 5.5.2, and Ch. 6.3.3), and until 1997 nutmeg and mace. For example, nutmeg producer prices had dropped from a previous height of Rp. 8,000 per kg (1987; then US$ 5) to Rp. 750 per kg (then US$ 0.3) in 1993 (Stubenvoll 1994, 60). This was caused by global oversupply, inelastic demand, corruption in the Indonesian trade and export cartel ASPIN (*Asosiasi Pala Indonesia*) (CMR 1986, 48; Schwarz 1992), and ASPIN's abolishment of the agreement on limited exports between Indonesia and Grenada (CMR 1990, 28), which together count for 95% of the world's nutmeg production (Smith 1986, 31).

In the second half of 1997, however, the situation has completely turned around. As Tab. 6.14 suggests, nutmeg and mace experienced rocketing producer prices between August 1997 and February 1998. Three reasons can be stated:

(1) The financial turmoil in Southeast Asia has led to a rapid decline of the value of the Rupiah (from Rp. 2.500 per US$ to Rp. 15.000 per US$; later stabilising at about Rp. 9.000 per US$). Accordingly, producer prices in Rupiah have increased, as nutmeg/mace is exported on US$ basis.

(2) Previous low producer prices, and the drought in Indonesia during 1997, as well as in Grenada, have caused an unusual decline in supply, and thus an increase in world market prices.

(3) High competition among buyers of these speculative crops also contributed to the price increase.

Clove farmers have not been able to participate in this development, as cloves are traded within the domestic economy on Rupiah basis, so that its downfall has not had any effect on producer prices.[175] The producer price of copra, a product both for domestic and international markets, has also increased, although not as much as of nutmeg/mace. This can be partly explained by the local cartel of the three ethnic Chinese entrepreneurs (see Ch. 6.3.3, and Ch. 6.4.1), and consequently, a lacking competition among buyers and a bad bargain position of dependent copra farmers. Coffee prices have risen either, predominantly due to the drought of 1997, after which local demand exceeded limited local supply.

The combination of Tab. 6.8, Tab. 6.9, Tab. 6.13, and Tab. 6.14 allows calculations on potential annual income from cash crop farming in Tioor. In Rhun, nutmeg and copra insignificantly contribute to households' income generation, and can therefore be ignored for a calculation. Only cloves provide some additional income. A typical Tioorese farmer, who has a *dusun kelapa* of 1 hectare (average annual yield: 1.3 t copra), 50 female nutmeg trees (150 kg dried nutmeg; 22.5 kg mace) and another 50 clove trees (100 kg dried buds), could generate an annual income of about 1.4 million Rupiah

[175] The slight increase in price in January 1998 was mainly caused by the Indonesian Government's announcement of the abolishment of the state clove monopoly, which was one condition to get IMF-credits.

(producer prices in August 1997), or about 5.8 million Rupiah (producer prices in January 1998). Hence, the economic crisis in Indonesia will not hit cash crop farmers in Tioor as much as most people in other parts in Indonesia, including Rhun (cf. Bänzinger 1999, 23). It has to be repeatedly stressed, that Fig. 5.5 and Fig. 5.6 on annual income takes the producer prices as a basis, *before* the Indonesian economy crisis (see Ch. 3.3).

Table 6.14: Market-range and prices of selected agricultural products in Tioor

Product	Unit	Marketing	Price (Rp.)[1]	Remarks
Jackfruit	---	subsistence product	---	Vegetable, fruit.
Chilli	1 cupa[2]	surplus bartered	1,000	4 varieties, spice. Local market.
Cassava	1 kaleng[2]	surplus marketed	3,500	2 varieties, staple food. Local/regional market.
Taro	1 kaleng[2]	surplus marketed	4,000	2 varieties, staple food. Local/regional market.
Coffee	1 kg (dried)	surplus marketed	5,000 (Aug. '97) 7,500 (Dec. '97) 9,000 (Feb. '98)	Local market. Price depends on supply, which was very limited in February 1998 due to the long drought in previous months
Sago (processed)	1 tumang[2]	surplus marketed	5,000	2 varieties, supplementary and emergency food.
Clove	1 kg (dried)	market product	2,500 (Aug. '97) 3,500 (Feb. '98)	Domestic market. Abolishment of state monopoly (June 1998; announced in January 1998).
Nutmeg[3]	1 kg (dried)	market product	3,000 (Aug. '97) 9,000 (Dec. '97) 20,000 (Feb. '98)	Export product. Price depends on US$ rate, world market price, and competition among buyers.
Mace[3]	1 kg (dried)	market product	10,000 (Aug. '97) 25,000 (Dec. '97) 50,000 (Feb. '98)	Export product. Price depends on US$ rate, world market price, and competition among buyers.
Copra	1 kg (dried)	market product	400 (Aug. '97) 700 (Dec. '97) 1,000 (Feb. '98)	Export product. Price depends on local monopoly situation (buyer cartel), and partly on US$ rate.

Notes: **1** Variability is only shown for products with a great price fluctuation.
2 Measure of capacity: *cupa*: about 0.25 l; *kaleng*: equivalent to about 18 kg of root crops; *tumang*: equivalent to about 15 kg of wet sago starch.
3 Nutmeg/mace from *Myristica fragrans*. From *M. argentea* prices are slightly cheaper. Yield of mace is about 15% of nutmeg yield.

Sources: Interviews with households and key informants (Stubenvoll 1997).

6.4 Factors and effects of land-use change

The central task of this chapter is to *synthesise* explanatory factors – most of which were stated in previous chapters – that are influencing peasant decision-making with regard to land use and resource management *to an integrative approach*, by referring to Fig. 6.5. An understanding of the underlying peasant strategies, logic and perceptions (Ch. 6.4.1), helps to assess the relative significance of influencing factors of land-use change on either island after WW II (Ch. 6.4.2). The *effects* of land-use change (Ch. 6.4.3), especially on the islands' resource-base and the environment, will ultimately have consequences for the future potentials of land use and resource management, and will in turn become crucial factors of peasant decision-making.

The discussion of peasant strategies, factors and effects of land-use change not only provides a basis for an evaluation of traditional agroforestry as a potential resource-caring land-use system in Ch. 7.1, but also forms a starting point to approach possible scenarios of future agroforestry (Ch. 7.2). Moreover, the evaluation of traditional agroforestry gives reasons for its inclusion in community-based resource management plans (Ch. 8) – which again has to take into consideration peasant strategies, logic, and perceptions.

6.4.1 Peasant strategies

Peasant decision-making and strategies are derived from the principal household goals (Fig. 6.5), and influenced by characteristics, knowledge, beliefs, attitudes, perceptions, and behaviour of the household (cf. Shaner et al. 1982, 65). Furthermore, two issues must be stressed when dealing with peasant strategies. Firstly, it is important to understand the *time-horizon* of a peasant, who also aims at minimising risks and dependencies. For instance, a strategy could be risky in the short term, but it may contribute to the security of the household in the long run (and vice versa), such as *experiments* in tree planting or other innovations. And secondly, the household's decisions do not necessarily reflect a common interest or perception of all household members. For instance, the husband may have other, eventually contradictory opinions about his choice of strategies than his wife (see Ch. 6.5.2).

Although several influencing factors with regard to land use and resource management are differing in Tioor and Rhun – both in kind and significance – the deployed peasant strategies show many common characteristics, which in the following are summarised along manifested differences.

(1) *The 'struggle for land'* is a significant strategy of most households, i.e. they have competed for the appropriation of land falling under the categories of common property (primary forest in Tioor) and state property (nutmeg plantations in Rhun). It can be interpreted as an overwhelmingly long-term oriented strategy, as land resources have been appropriated not only for present household needs, but also to secure limited land (which is one important production factor) for the children (i.e. for the future), especially in Tioor, where much of the land has been acquired even if it is not immediately cultivated.

(2) *The cultivation of perennials* is closely linked to strategy (1) and long-term oriented either, because a farmer not only expects production of cash crops or non-timber products, but also claims and later secures tenure on the plot where the tree in question is planted. Examples include the integration of nutmeg trees and sago palms in primary forest in Tioor, and the interspersing of clove seedlings in nutmeg plantations in Rhun.

(3) The *diversification of income-generating activities* is widely consistent with the household's goal to secure the livelihood through minimisation of risks and dependencies. Off-farm activities may be more successful in terms of income generation, especially when producer prices of most agricultural cash crops are low. Moreover, an efficient use of scarce labour may require the household to opt for such a flexible strategy: Sexual division of labour allows one partner to be also engaged in off-farm activities, as it is not necessary for all members of the household to fully commit themselves to farming throughout the year (Fig. 6.8). For instance, machete-forging or seasonal regional fishing of male household members can be easily performed during a dry spell. The time-horizon of this strategy is both short-term oriented (through a possible immediate, flexible choice of the most profitable activities) and long-term oriented (to gain experience and acquire knowledge).

(4) The *diversification of agricultural production* is correlated to the same household goals as strategy (3) (see Ch. 6.3.7, socio-economic services). The focus is predominantly concentrated on short-term oriented, self-reliant subsistence production by risk-reducing cultivation of a wide range of foods and secondary products in dry fields and gardens. This is the case because a successful, exclusive production of cash crops, such as copra, nutmeg, and clove, depends too much on volatile producer prices. However, cash crops will be produced if: (a) economic returns are perceived to be profitable in the long run, (b) available land resources allow their extension, and (c) soil fertility falls below a critical level which would make continuous production of annuals unfeasible and in turn risky.

Strategies (1) to (4) are similar on both islands, although some have a *different priority or characteristic*. For instance, farmers in Rhun deploy strategy (4) with a priority of subsistence production in permanent fields and mixed gardens, whereas in Tioor cash crop production is increasingly important. And, income creation requires high mobility of Rhunese fishermen and sailors, whereas the Tioorese are mainly engaged on island-based off-farm activities.[176] The following strategies are *different in kind*, however:

(5) *Marketing and trade* considerably differs in both communities. *In Tioor*, it is dominated by ethnic minorities, i.e. ethnic Chinese entrepreneurs and immigrated intermediaries from Flores. Main characteristic is a tight patronage-client relationship between entrepreneurs, who can secure profits by acting like a cartel without any competition of newcomers, and farmers, who are interested in long-term guaranteed marketing of their products (predominantly copra). Moreover, farmers can rely on capital assistance of their patron, should they immediately need cash. Entrepreneurs are the only potential creditors, who in turn will get cheaper access on the farmer's future products, and even on tree gardens as a security, as long as the credit is not being paid off (see Ch. 5.4.3). Small-scale trade of indigenous Tioorese is not practised, because it could quickly run into ruin, due to social obligations within the clan. For instance, clan members could take goods from the store on credit, and later successfully refuse payment with the disarming argument, "We all are a family".[177] *In Rhun*, all traders are members of the society, which is possible, as the majority of people are descendants of immigrating Butonese, an ethnic group of successful traders and ship constructors in Indonesia. Moreover, a fleet of 40 motorships and capital of the wealthier Rhunese allow the society to be independent from ethnic Chinese and Arab traders living in Banda Neira.

(6) One of the most striking results of the previous analysis is related to the somewhat contradictory development of (long-term oriented) nutmeg cultivation, which has been continuously enlarged as *farmer-owned* plantings in Tioor, but has dramatically declined in *state-controlled* plantations in Rhun. This result demonstrates that factors such as tree and land tenure, and full siphoning off of profits from tree products, are crucial for small-scale farmers and their decision-making. The world market itself obviously has had the same economic influence on producer prices of nutmeg and mace in *both islands*, and therefore is *not* the single reason for the collapse of the nutmeg culture in Rhun. This result has wide-ranging consequences for the discussion in Ch. 8.

6.4.2 Explanatory factors

In the foregoing discussion it was argued that the *emergence of traditional agroforestry* besides dry field agriculture is a common feature of land use in both islands, although to a different degree of subsistence activities and commercialisation of the farming system. For this reason, and due to the different historical developments, an integrative approach to explanatory factors of land-use change (Fig. 6.13) is possible only by a separate, summarised reflection on each island.

Tioor: From subsistence-based farming to increasingly important commercialisation

Three *main factors* of deforestation, i.e. driving back natural forest, and land-use change since the 1960s (shift from subsistence-based, permanent farming to perennial cash crop production in the coastal plains, and emergence of shifting cultivation and *tumpangsari* in the upland), can be stated:

176 As intermediaries in Tioor buy forgery products at low prices, forgers would have to travel to regional markets as far as Tanimbar or the Onin peninsula in Irian Jaya for a more profitable marketing (see Ch. 5.5.2). The reverse situation existed until the 1960s, as the Tioorese were very mobile, whereas the Rhunese worked in local nutmeg plantations.

177 Two households of indigenous Tioorese are shop keepers, and demand an immediate paying of their goods. However, they cannot fully depend on the social security arrangement (reciprocity) of the other households.

(1) *Annual population growth* of 2.5% since 1922 has been caused both by natural population growth (excess of births over deaths) and immigration. Immigrants founded new settlements at the east coast and in the southwest of Tioor, presently populated by about 800 inhabitants (Tab. 5.1), which is equivalent to 50% of Tioor's total population. Consequently, agriculture has had to be extended from the narrow coastal strip to upland to meet peasants' crop needs.

(2) Since the 1960s, *marketing facilities* have been established first by Butonese traders, and later improved by ethnic Chinese entrepreneurs. Thus, cash crops and surpluses of tubers (taro, cassava) can be steadily marketed, giving an incentive to enlarge both tree gardens and dry fields. Improved transportation – since the Perintis ship is regularly stopping in Tioor (1994) – has intensified this trend, making it easier for farmers to experiment with newly introduced tree species (candlenut, cashew, cocoa), and may lead to an extension of mixed gardens.

(3) *Traditional land tenure* has contributed to a rapid extension of dry fields and tree gardens, as clearing of primary forest and tree planting secures permanent land tenure for farmers, who – in combination with population growth and immigration – have been increasingly competing for acquisition of as much land as possible *(merebut tanah).*

Other factors of deforestation include: (4) decreasing soil fertility, especially on slopes and under slash-and-burn; (5) increasing demand of charcoal and timber, since the 1980s also for the regional market; and (6) forest fires during the dry season, caused by uncontrolled burning and careless charcoal production.

Rhun: From nutmeg plantation enterprises to peasant subsistence-based farming

Main factors of agro-deforestation, i.e. driving back of man-made, forest-like nutmeg plantations including protection trees, and land-use change to peasant subsistence-based farming since WW II, have been the *unfavourable world market situation* for nutmeg, and the *lacking tenure rights on land and nutmeg trees* for the peasants. Other factors include *mismanagement of the Government's plantation enterprises; corruption; smuggling of a great part of the nutmeg harvest*; *population growth; the limited island area of 465 ha; and a drop in the number of protection trees*.

(1) *Unfavourable world market for nutmeg*: As stated in previous chapters, the first dramatic collapse of world market price of nutmeg occurred during the global recession in the 1930s. In WW II trade was interrupted, leading to the first clearance of nutmeg and protection trees. Thereafter, the world market price stayed at a low level until 1986, when a nutmeg cartel (Indonesia, Grenada) was formed. At that time, however, the nutmeg tree population in Rhun amounted to only 10% of its pre-WW II level. Due to overproduction, inelastic demand of nutmeg, and corruption, the cartel failed in 1990, causing another price depression. With a volatile and low world market price the plantation enterprises could not properly manage the plantations, wages for the labour force remained low, and the originally Dutch system of free food rations (*rangsum*) for the workers had to be suspended. The recent development of rocketing local producer prices is irrelevant for Rhunese with only few nutmeg trees remaining.

(2) *Lacking tenure on land and nutmeg trees*: The historically determined lacking *de jure* tenure on land and nutmeg trees led to disapproval, a lack of care, or deliberate destruction of nutmeg and other state-owned trees by the farmers. This would not have been possible, if the peasants had owned the nutmeg trees, even with the unfavourable world market situation for nutmeg as indicated by enlarged nutmeg plantings in Tioor. By replacing nutmeg trees with other tree species and annuals, farmers have got access to the land of Rhun. Nowadays, they semi-legally (*hak pakai*) manage the land, because the Government had to tolerate their appropriation (see Ch. 5.4.3). The farmers have thus developed an indigenous understanding of land and tree tenure,

which is contradictory to the *de jure* tenure system. As it will be discussed in Ch. 8.3.3, new developments could lead to an re-expropriation of the peasants' fields. In 1997, the Ministry of Agriculture issued a decree, that the nutmeg plantations would have to be rehabilitated on the Banda Islands including Rhun, with an area of 3,700 ha (or 65% of the total islands' area).

(3) *Mismanagement, corruption and smuggle*: Corruption in the Government plantation enterprise and mismanagement further contributed to the decline of the nutmeg plantation. For instance, capital for rejuvenation was used only to a limited extent and the tree population got senile, whereas the major part of capital flowed into the pockets of the directors and managers. Moreover, salaries for the workers were irregular and paid late, because – according to the managers' explanation – the harvest had not been sold for the expected price yet. The extension of open fields and the planting of clove trees were just two strategies of the workers (cf. Ch. 6.3.3). Another one was the smuggling of a large part of the nutmeg harvest, which was brought on local ships (*prahu*) as far as Singapore (see Ch. 5.5.2). The peak of smuggle – 90% (!) of the harvest – was reached between 1987 and 1990, when *PT Perkebunan Pala Banda* ran the plantations.[178]

(4) *Population growth, limited land area, and a drop in the number of protection trees*: Population growth of 1.7% between 1950 and 1996 has led to an increasing demand for land, timber, and fuelwood, being secured by the destruction of protection and nutmeg trees, and the simultaneous enlargement of fields. Without protection, nutmeg trees have become vulnerable to insolation, so their number has further dropped. Because land area is very limited, each peasant tried to get access to as much land as possible, before another family would have acquired it. The only way to do this was to drive back nutmeg plantations.

6.4.3 Effects and problems

Although land-use change has been a successful strategy of the farmers in terms of socio-economy, related deforestation in Tioor, respectively agro-deforestation[179] in Rhun, may increasingly have serious impacts on the environment and the natural resource-base, on which both communities depend. This trend may set limits to any future socio-economic development. Most effects and problems are already evident to a different degree in either island. Only most crucial implications, and locally specific features of deforestation and land-use change are outlined in the following (and summarised in Fig. 6.13), as a voluminous literature deals in general with these processes in the tropics.

(1) *Soil degradation and soil erosion*

In most of the tropics, *soil degradation and soil erosion* are two major, interdependent threats to maintaining soil fertility of land cleared for agriculture (Prinz 1986, 117-28; Young 1989, 81-4). *Soil degradation*, i.e. the lowering of soil fertility, is a problem predominantly associated with soils of low natural fertility (e.g., problems of acidity, low nutrient content, nutrient deficiencies in N and P, adverse physical properties) such as ferralsols, acrisols, and vertisols. The soil is likely to be rapidly degraded, for instance if fallow periods are shortened, resulting in the lowering of nutrient content and an emergence of *lahan kritis* ('critical land').

Previously fertile soils may also suffer degradation through 'over-cultivation' (Young 1989, 81), but this may take longer than for inherently less fertile soils. In the case of Tioor and Rhun, the dystric variants of cambisols and fluvisols, and lithosols can be regarded as soils of naturally medium fertility.

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[178] Only 20 to 25 tons were annually harvested by the enterprise on all Banda Islands, although 220 tons would have been realistic (PTPBB, 1987 to 1990). Thus, smuggling has contributed to ever increasing losses of the plantation enterprises.

[179] For simplicity's sake, and if not otherwise stated in the coming discussion, the term 'deforestation' includes both deforestation and agro-deforestation.

Whereas the eutric variants of cambisols and fluvisols, and rendzinas overlain by volcanic ash and humus, posses a naturally high fertility. Thus, *chemical* soil degradation may increasingly become a relevant problem in Tioor, if fallow periods will be shortened. Until now it is restricted to a few places, such as Ampera and Gunung Ra (cf. Map 3). Degraded soil is locally called *tentena piakar*. In Rhun, with its fertile soils and permanent agriculture, it may be much easier to be managed. For instance by the inclusion of short fallow periods (cf. Maps 4). Moreover, pressure to chemical soil degradation is relieved by periodical addition of nutrients by volcanic activity.

Physical soil degradation is significant in both islands, however. For instance, increased heating up and hardening of the soil during dry spells as a consequence of vegetation loss decreases root development and plant growth.

Soil erosion, i.e. loss of the upper solum and thus of soil fertility, ultimately leads to soil degradation, too, *regardless* of the natural soil fertility. In Tioor and Rhun, soil erosion is overwhelmingly caused by high amounts and intensities of rainfall (water erosion; cf. App. 2.4), whereas wind erosion plays a minor role. The extent of water erosion depends on several factors (Morgan 1986, 40-62; Prinz 1986, 118-9, Young 1989, 25-31):

- erosivity of rainfall (length, distribution, intensity);
- erodibility of soils (e.g., infiltration capacity, texture, aggregate stability);
- topography (gradient angle, length of slopes);
- plant cover; and
- erosion control measures (e.g., mulching, hedgerows cropping).

Erosion level is highest in dry fields with a young crop only partially covering the soil and without erosion control measures, in steep and sloping terrain. There is evidence, that in several places soil has been already heavily eroded, such as Gunung Tanah Merah and Batu Lawa-Lawa (both in Rhun), and Koly (in Tioor).[180]

Although loss of fertility and degradation is the most significant impact of soil erosion, other effects have to be stated as well:

- most of the eroded material is carried into the sea instead of being deposited in land, and thus adversely affecting littoral ecosystems and their productivity as a consequence of sedimentation (see (7) below; and Ch. 2.3.2);
- surface water from streams in Tioor cannot be consumed by the community without filtering of sediments in times of rainfall; and
- landslides (*tanah longsor*) may change the local landscape.

(2) *Hydrological disturbances*

As argued in Ch. 2.3.2, fresh water is a scarce and probably the most vulnerable resource on small tropical islands. Disturbances of the water balance are closely related with deforestation due to the loss of the tropical forests' principal hydrological functions (Prinz 1986, 126-7). Amount and energy of high and intensive precipitation is buffered by forests through *interception* (i.e. direct evaporation of water being held in the canopy), high *transpiration* rates, and *water storage* in the soil. Thus, surface runoff is generally low and relatively evenly distributed, thereby reducing erosion hazards. Accordingly, driving back forests has created hydrological disturbances in both Tioor and Rhun.

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180 Mapping, observation, PRA and interviews.

Irregular surface runoff: On the one hand, an event of intensive and long rainfall causes peak flooding of streams in Tioor (observed in December 1997), eventually destroying infrastructure such as bridges (information of key informants). On the other hand, prolonged droughts have serious implications both for the supply of fresh water for the communities, and the water resources in the soil. For instance, a rapid drying up of streams in Tioor, except Werlarat (and partly Wervurun and Wergus), of which the headwaters are largely surrounded by primary forest, in 1997, was perceived by all communities as a threat to their livelihood.[181] Completely depending on rainfall (which is collected in water tanks) for drinking water supply, prolonged droughts are even more precarious in Rhun without any ground water reservoir to draw from.

Soil water balance: Low water storage in the soil, and accelerated surface runoff lead to: decreased infiltration (especially in steep terrain), drop of the water table, and rapid decline of soil moisture in the A horizon during dry spells (cf. App. 2.3). Adverse effects of hardened and dried up soil for plant growth then contribute to decreasing crop yields.

(3) *Pests in fields and mono-specific tree gardens*

As agriculture and tree gardens have been enlarged, some pests could gain a foothold in somewhat less diversified or mono-specific land-use types, decreasing crop yields (e.g. wild boars, mice), or having the potential to destroy tree gardens (e.g., wild boars, and *Sexava* sp. feeding on coconut palm leaves).

(4) *Depletion of timber and fuelwood*

Increasing demand for *timber and fuelwood*, and deforestation through land-use change, have caused a depletion of both resources in Rhun, and of timber in Tioor. The existence of kerosene stoves in 13 of 25 interviewed households in Rhun is an indication of fuelwood shortage, whereas all interviewed households in Tioor exclusively use fuelwood for cooking.

(5) *Destruction of forests and gardens by anthropogenic fire*

Slash-and-burn agriculture and charcoal production in Tioor frequently cause fire to spread at the end of the dry season, destroying nearby secondary and primary forests,[182] and also gardens of other farmers. In Rhun, the spread of fire less frequently occurs, as permanent cultivation without extensive burning is dominating.

(6) *Coastal abrasion*

As stated in Ch. 5.5.2, removal of coral boulders for lime production has been a major cause of coastal abrasion, predominantly at the east coast of Tioor. Land-use change has contributed to this development, because not only mangroves have been almost entirely destroyed, but also most parts of sand-binding, protective beach vegetation has been removed to make place for coconut tree gardens. As a consequence, coastal strips of coconut tree gardens and several houses have been lost to the sea.

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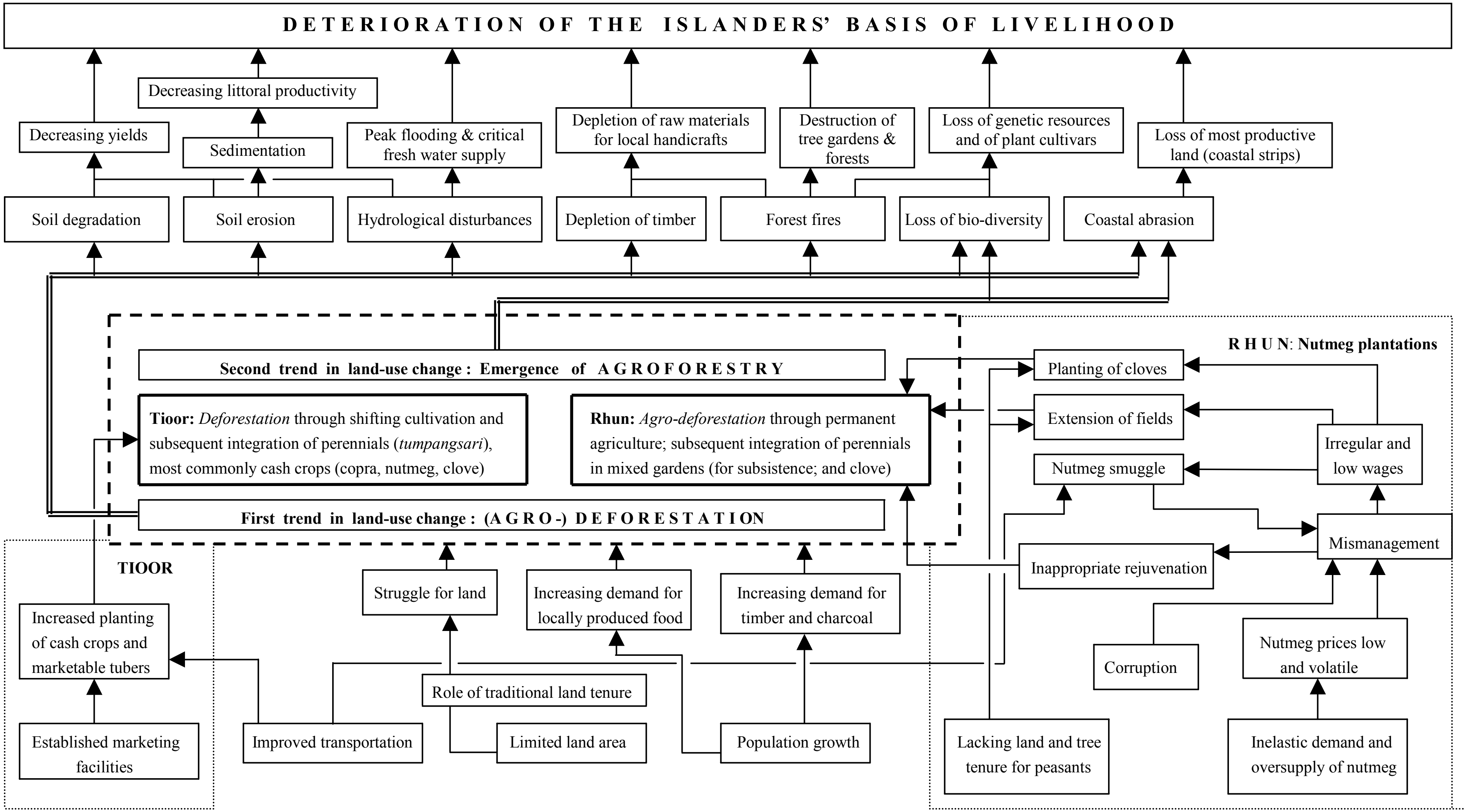
[181] Two examples are given: (1) An outbreak of diarrhoea killed several people in January 1998, and was caused by consumption of *contaminated* water. This underlines the urgency of drinking water development. (2) Forgers in Rumoi appreciate to take a refreshing bath after work in nearby Werlarat, the only stream which had not dried up until the beginning of the rainy season in late December 1997. This indicates the importance of primary forest in its headwaters.

[182] Sacred forest is occasionally affected by spreading fire, so that secondary forest will develop (e.g., Gunung Ra; Map 3).

Figure 6.13: An integrative approach to factors and effects of land-use change



Note: factor (independent variable) ⟶ effect (dependent variable)

Source: Interviews, mapping and observation (Stubenvoll 1996 and 1997).

(7) *Declining stocks of fish and other marine resources*

As discussed in Ch. 5.5.2, pressure on fish stocks and commercialised marine species has increased. Destructive fishing methods performed by outsiders (reef blasting, use of potassium cyanide), overexploitation of species, and a lowering of the littoral ecosystems' productivity (by removal of coral boulders and mangroves, and sedimentation of eroded soil) are the main causes.

(8) *Decline of bio-diversity*

Decline of bio-diversity at species and subspecies level is a result of both deforestation, agro-deforestation, and overexploitation of terrestrial and marine resources.

- Several marine species occurring in the waters of Tioor and Rhun have been included in the CITES list of endangered species and are protected under Indonesian law (cf. Tab. 5.6).
- Overexploitation and deforestation has brought some timber tree species on the verge of local extinction, such as *Gmelina moluccana*, *Cordia subcordata*, and *Calophyllum inophyllum*.
- At *sub-species levels*, the example of the nutmeg tree is very striking: The gene pool of *Myristica fragrans* Houtt. has been definitely depleted due to its domestication and restricted production for centuries. Nevertheless, it may be regarded as relatively diverse, compared to other production centres which exclusively used planting material from Banda in the nineteenth century. Thus, a drive back of nutmeg in Banda may substantially reduce the world-wide gene pool of this species.

6.4.4 The islanders' perception of problems

A comparison of the problems stated above with the farmers' *perception* of problems related to land use (Fig. 6.14) suggests, that to a certain extent both communities are aware of adverse implications of deforestation. However, problems are perceived in a different proportion on either island. In Rhun, the *most frequently stated problems* are associated with: a low number of protection trees, low producer prices, declining soil fertility, and strong wind and rain. Crop pests and prolonged droughts are regarded as problems by most of the interviewed households in Tioor. In the following, it is attempted to sort out interpretations of the farmers' perception of problems.

As farmers usually 'measure' soil fertility in terms of crop yield relative to *labour input*, the statement of the problem of *declining soil fertility* (Rhun: 52%; Tioor: 13% of the interviewed households) can be interpreted to some extent as a problem of limited labour availability, although this was not explicitly specified as a bottleneck. In fact, labour input is partly removed from agriculture as many male Rhunese are frequently absent. In Tioor, off-farm activities are most commonly performed on the island, so that labour can be more flexibly divided between agriculture and off-farm activities. This interpretation needs to be qualified, however, as other reasons for a perceived declining soil fertility may be valid as well. This is firstly indicated by the problem of 'weeds', which was stated by only three farmers. Apparently, weeds can be suppressed by sufficiently available labour. Hence, farmers take great care to perform weeding, as this significantly improves crop yield. And secondly, the frequently stated problem of a *limited number of protection trees* (72% of the interviewed households in Rhun) indicates that declining soil fertility may be also perceived as a result of agro-deforestation in Rhun.

In Tioor, declining soil fertility may be still of minor relevance for most of the farmers,[183] because most dry fields have been cleared for the first time, secondary forest occupies a relatively large area,

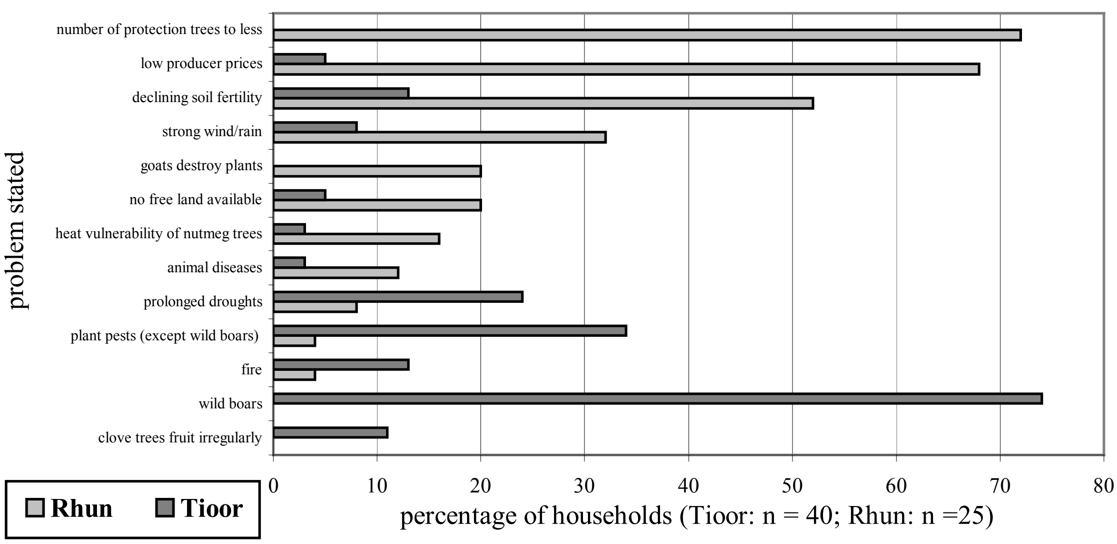
[183] At the end of each interview, the farmer had the opportunity to bring on any issues (cf. manual in App. 5.1). Interestingly, several farmers asked why '*tanah merah*' ('red soil') is less fertile than '*tanah hitam*' ('black soil'), and how to improve soil fertility. Thus, (declining) soil fertility is an important and manifested issue for the farmer, although it was not stated as a problem in the first place when being asked.

or *land pressure* is less apparent than in Rhun (5% of the interviewed households in Tioor, 20% in Rhun). A decline in crop yields is rather perceived in relation to pests (wild boars 74% of the interviewed households in Tioor; other pests 34%, in Rhun 4%), than to declining soil fertility. For example, much labour, energy, and patience is required to protect gardens from predating wild boars.

The difference of perceptions with regard to the extreme climatic conditions – *strong wind and rain* (32% of the interviewed households in Rhun; 8% in Tioor) and *prolonged droughts* (8%; 24%) – can be partly understood as related to the timing of the interviews. In 1996, when farmers in Rhun were interviewed, rainfall was high and intensive (cf. App. 2.4). Moreover, a violent wind damaged gardens and houses in December 1996. In 1997, when field studies were carried out in Tioor, a prolonged drought hit Southeast Asia. Nonetheless, the adverse impacts of climatic extremes which are increased by deforestation ('number of protection trees to less') are commonly regarded as a problem.

Cash-cropping in Rhun is dominated by cloves, whereas coconuts are used for the subsistence activities of the households, and nutmeg has been driven back. Consequently, farmers in Rhun (68%) perceive *low producer prices for cash crops* (i.e. cloves) as a major problem, so that off-farm income generation is deployed as a common strategy. On the other hand, cash-cropping farmers in Tioor reported slowly rising prices of copra, which is their main income source, so that a minority of interviewed households (5%) put forward low producer prices as a problem.

Figure 6.14: **Farmers' perception of problems related to land use**



Notes: Rounded fractions.
Following problems were stated by *less than 10%* of the farmers in either island: weeds, birds of prey, poisonous snakes, dioecy of nutmeg trees, difficulties in getting certain tree seedlings, great distance of trees for charcoal production, scarcity of timber, marketing (no demand), and unsecured land tenure.

Sources: Household interviews by use of a manual (Stubenvoll 1996 and 1997).

Frequently stated problems are as informative as are those *specified by just a few households*. For instance, *depletion of natural resources* was quoted by a total of just four households in Tioor and Rhun (6%), although e.g. forgers and joiners much depend on charcoal and good quality timber, respectively. As the import of timber to Rhun suggests, a depletion of these resources may be perceived to be relatively easily handled by substitution and imports. Another example is the problem of *insecure land tenure* in Rhun, which was stated by only three interviewed households, despite its important role concerning land-use change. One can approach to an interpretation by considering the fact, that insecure land tenure is a *politically* sensitive issue, which therefore was in most cases consciously withheld during the interviews with households of the first selection step. A similar explanation may be valid for *socially* sensitive issues, such as institutional problems and land-use conflicts among the islanders [e.g., *browsing goats* (20% in Rhun), and *fire* (4% in Rhun; 13% in Tioor)]. As will be discussed in Ch. 7.1.3, institutional problems are manifold on both islands.

These sensitive issues are good examples of the value of semi-structured and narrative interviews in collecting deeper information from households (cf. Ch. 3.2). In fact, interviews at these levels resulted in information strongly indicating that farmers perceive environmental problems (soil erosion, hydrological disturbances) and resource depletion as consequences of deforestation and overexploitation of natural resources.[184] Obviously, the perception of problems is not sufficient, but it is necessary to react: in some form of an adaptation of local land use and resource management to changing environmental conditions, or by other means, such as seasonal off-farm activities or even emigration.

In this sense, the emergence of traditional agroforestry may be interpreted as one kind of strategy towards sustainable land use (cf. Ch. 7.). As this might not be sufficient for all households in the future due to limited land resources, various off-farm activities may become more important. Moreover, most families attach great importance to another strategy – namely investments into the education of their children – as crucial for securing the families' livelihood through migration of their children, improved chances of employment in urban centres, and remittances onto the island (see Ch. 6.5.1).

6.5 Case studies of peasant households

The foregoing discussion examined historical and present land use, farming systems and various land-use types, related structures, practices, functions, and land-use change. Before turning to an evaluation of traditional agroforestry with regard to sustainability, case studies of two peasant households provide a deeper insight into the peasant decision-making processes, as well as on mixed gardens and agroforests, which so far have been generally examined.

In a first step, the discussion comes back to Tab. 6.3, which shows the area of each identified land-use type *on an island-base* in Tioor and Rhun. The farming system of *each peasant family consists of several, if not all of these land-use types*, being simultaneously practised, most commonly in dispersed fields and gardens. This result is underlined by App. 3.1, which evaluates areas of land-use types concerning 22 households of the second step of the selection process.

6.5.1 Rhun: Mixed garden dominated land use

The first farmer case study, household head **Laida**[185] (HH 1; living in Rhun; Religion: Islam), is described by Stubenvoll (1994, 85-95), so that it is possible to analyse recent developments in land use by a time-and-motion study between 1992 and 1997.

[184] Two quotations are provided:
(1) "*Our livelihood cannot be secured with solely cropping of nutmegs or cloves, but without trees it is even more difficult to perform agriculture. Even bananas are difficult to be cultivated*" (farmer in Rhun);
(2) "*This morning, the forgers of Rumoi had to look for charcoal providing perai trees as far as Kar community* [some 2 km]. *Less and less perai trees are growing in Tioor, because the forest has been so rapidly driven back. In the long run we will have serious problems"* (farmer in Tioor).

[185] Names of household members are fictitious in the text as some information may be politically sensitive.

Family structure and income-generating activities

Laida was born in Banda Besar in 1959, and married **Waine** in 1979. The couple has two sons and two daughters. The eldest son lives in Banda Neira to attend upper secondary school, the second in Ay for lower secondary school, whereas both younger daughters are still in elementary school in Rhun. **Waine** is the eldest daughter of the already deceased *Laeba*, who married twice: Five sons are *Laeba's* offspring of his first marriage. After the death of his first wife *Waira*, he founded a family with *Wamahi*, of whom he had two daughters and two sons. Before his death in 1990, *Laeba* allowed **Laida** to settle down in Rhun and to live off the family's fields. Unlike most other households in Rhun, *Laeba* decided not to apportion his fields among his offspring, so that *several households are now jointly managing* these larger land-holdings. A larger field area may make it easier for a family to integrate highly diversified agroforestry systems into the landscape, but might involve conflicts of land utilisation, if several households hold tenure rights on it.

Sailing (including occasional regional fishing) is the main income source for the household, so that **Laida** is often absent from Rhun, all together three or four months per year. During his absence, **Waine** has to take on her husband's tasks and responsibilities in the village and fields. Goat husbandry and agriculture provide supplementary cash. **Laida** emphasised during the interviews, that it is his main aim to enable his children to get upper secondary school (*SMA*) qualifications, for they would later have better chances to find an employment in urban centres, or in the military.

Land and tree tenure

Different access to and the use of fields is expressed by land tenure, area of fields and residence of *Laeba's* offspring and his widow *Wamahi* (Tab. 6.15). **Laida** holds two small fields (Tanjung Walo-Walo 2, Parigi)[186] which his household exclusively uses. He has access to a field of **Waine's** half-brother who lives in Ambon (TWW 3) and whose fields **Laida** may cultivate during his absence. And he has access to three common fields of *Laeba* (TWW 1, BP, BLL). If *Laeba* had decided to apportion his fields among his offspring according to Butonese *adat*, **Waine** would have obtained just a small portion (1/24) of her father's land (see Ch. 5.4.3).

Tenure on farmer-owned, state-owned and non-domesticated trees is shown in Map 4.3. It is regulated as examined in Ch. 5.4.3, Ch. 6.3.3 and Ch. 6.3.6, although with flexible, traditional arrangements, and has the following consequences for **Laida**:

(1) *Right to plant trees*: In his two small fields, **Laida** has unrestricted traditional rights to plant trees and annuals. In TWW 3, he has to consult **Waine's** half-brother (*Lamusi*) as the garden-holder first, including a negotiation concerning access on tree products. In the three common fields (TWW 1; BP; BLL) both annuals and perennials can be planted by **Laida** in any place after consultation with *Wamahi* and the second son of *Laeba*, who is the head of the family, since the eldest son lives in Ambon. For practical reasons and to avoid conflicts, the households, which are managing the largest common field (TWW 1), have mutually agreed to predominantly, but not exclusively, use a defined part of it (plots α, β, γ; see Tab. 6.15, Map 4.1.1, and Map 4.3).[187] This

[186] In the following, all fields (1.81 ha except Lobang Angin) are abbreviated: TWW = Tanjung Walo-Walo; BP = Belakang Perek; BLL = Batu Lawa-Lawa; P = Parigi; LA = Lobang Angin (0.1 ha).

[187] In 1993, *Lamusi*, the third son of *Laeba,* and settling in Ambon, demanded the apportioning of all common fields according to Butonese *adat*, because two of his children wanted to establish households in Rhun. Finally, he had to give in, because all other parties rejected his demand, including his stepmother *Wamahi*. *Lamusi*, and his children then returned to Ambon.

allows also a flexible field utilisation and labour arrangement, should one household forego cropping procedures on 'his' designated plot.[188]

(2) *Ownership of trees*: With the approval of *Laeba*, **Laida** planted fifteen clove trees, several fruit trees, and coconut palms in the γ-plot of TWW 1 in the 1980s. Laida holds exclusive property rights to these trees. Moreover, by planting them, **Laida** has improved both his land tenure rights on the land in question, and his negotiation position in case of land tenure conflicts within the family of *Laeba*. This fact is particularly important for his household, as **Laida** is an immigrant holding just two small fields.

(3) *Accessibility to tree products*: Trees serving subsistence activities (coconut palms, coffee shrubs, fruit trees, except the durian tree of **Laida** for marketing purposes), and trees of *Wamahi*, i.e. all trees not being inherited to *Laebas* children, are accessible to all households of the family without any restriction. Trees providing cash crops (clove, nutmeg) are usually accessible to the tree owner. However, clove trees in BP, TWW 3 and in the β-plot of TWW 1, being owned by *Lamusi*, are presently managed by **Laida**, unless the former returns to Rhun for the harvest. In this case he would leave a part of the yield to **Laida** as a compensation for **Laida's** previous labour input (e.g., husbandry).

Table 6.15: Land tenure of the family of *Laeba*

Children of Laeba	**Extended family property**			**Nuclear family property[1] (access to field)**
	Tanjung Walo-Walo 1	Belakang Perek	Batu Lawa- Lawa	
1st son (M; 3)[2]	lives in Ambon, no land use			none
2nd son (W; 3)[2]	use of field (α)[3]	no land use	no land use	0.9 ha
3rd son (D; 5)[2] (*Lamusi*)	use of field (β)[3]	lives in Ambon, comes occasionally to Rhun		Tanjung Walo-Walo 3
4th son (M; 4)[2]	own fields are large enough, no land use			1.8 ha
5th son (M; 3)[2/4]	use of field (α)[3]	use of field	fallow	none
1st daughter (**Waine & Laida**; M; 4)[2]	use of field (γ)[3]	use of field	fallow	Tanjung Walo-Walo 2, Parigi; (access to Tanjung Walo-Walo 3)
2nd daughter (M; 3)[2]	use of field (γ)[3]	use of field	fallow	0.3 ha
6th son (M; 0)[2] (*Lacabo*)	use of field (taro) (γ)[3]	lives in Banda Neira, comes occasionally to Rhun		none
7th son (M; 1)[2/5]	use of field (γ)[3]	use of field	fallow	Lobang Angin (0.1 ha)
Widow *Wamahi* (mother of the four latter children)	is supported by her children, and holds tree tenure of many trees in Tanjung Walo-Walo 1 (see Map 4.3)			none

Notes:
1 Data provided by household head in question;
2 M = married; W = widower; D = divorced; number of children;
3 Greek letters specify the part of the field where the household most commonly cultivates annuals;
4 Married in 1997 for a second time and moved from Ambon to Rhun;
5 Moved from Ambon to Rhun in 1996.

Sources: Stubenvoll 1994, 88; Household interviews and mapping (Stubenvoll 1996).

(4) *State-owned nutmeg trees*: In 1987, each household in Rhun has got the right to manage ten[189] nutmeg trees (preferably within their respective land-holdings), and the duty to share yields with the plantation enterprise PTPPB. Since its bankruptcy in 1990, nutmeg trees are still managed by the farmers under the conditions of paying taxes to Government at regency level and of

188 For instance, *Laeba's* second son can no longer cultivate 'his' α-plots, since his wife died in 1996. This circumstance allowed *Laeba's* fifth son to return to Rhun after a second marriage, and to cultivate these plots.

189 Each widow and widower has got the right to manage *five* nutmeg trees.

rejuvenating dead trees. **Laida's** designated nutmeg trees are situated in TWW 1, but only two of them remaining productive in 1996. The other trees have been already rejuvenated by **Laida**.[190]

More complex is the relationship between tree and land tenure in the case of nutmeg trees in **Waine's** family land-holdings being allocated to other households, like four trees of *Lakara* within the field BP (Map 4.1.2g). According to agreement, *Lakara* should rejuvenate them, with the result that this portion in BP would be obviously governmental land. Only the clove trees in this plot of *Lamusi* would be peasant property. Thus, the latter successfully pushed *Lakara* not to rejuvenate, in order to get *usufruct right* on this tiny plot.

(5) *Non-domesticated timber trees* are governmental property, although being treated by the peasants according to *adat* (cf. Ch. 6.3.6). A good example of this issue is the cerpati tree [*Dracontomelon dao* (Blanco) Merrill & Rolfe] in TWW 1 at the southern field boundary, which collapsed into **Laida's** nutmeg plot in 1993, destroying one nutmeg tree. Three ship constructors wanted to buy the utilisation right of the timber. However, **Laida** decided to submit it to a friend who had given him the small field TWW 2 as a present in 1988. Thus, products of fields fulfil social functions.

Structures, practices, and functions of the farming system

The land-use maps show (1) spatial arrangement of plants and other components (field huts, paths, field and plot boundaries) in 1992 (Maps 4.1); (2) major changes in land use until 1997 in TWW 1 and BP (Maps 4.2); and (3) land and tree tenure in TWW 1 (Map 4.3). These maps allow a calculation of the area being reserved for the production of subsistence products and cash crops in each land-use type (Tab. 6.16).[191]

TWW 1 and BP are the most important fields, where approximately 90% of the annuals are produced (in 1992, 45.52 of 50.02 ares; in 1997, 42.94 of 47.92 ares). Nevertheless, TWW 1 is a mixed garden being dominated by a wide range of tree species,[192] making a more efficient use of limited natural resources through a vertical arrangement of plant components. The layout of TWW 1 resembles an *agroforest* – a complex association of perennials in various layers, but including interspersed annuals. In BP, the production of annuals is by far predominant, indicating that the households prefer short distances to the village for almost daily harvest of crops for subsistence, e.g. cassava and vegetables. The home garden in Tab. 6.16 refers to the clove and fruit trees around the two houses of **Laida's** relatives, which were constructed in 1995 and 1996, respectively. **Laida's** tiny home garden with cultivation of vegetables, five coconut palms and a bamboo clump is not included in Tab. 6.16.

The other fields are either comparably small in area and dominated by cassava, although with some clove trees and coconut palms planted at the field boundaries, or they are in the fallow stage, such as BLL which is heavily eroded due to extensive cropping of onions in the 1970s. In BLL, fallow

190 Most of the interviewed households have not rejuvenated yet, as *even rejuvenated* nutmeg trees belong to the Government. Moreover, land still occupied with nutmeg trees is regarded *by the farmers* as governmental land, whereas land being cultivated with farmers' crops as land under usufruct right (*hak paka*i). Of course, almost all land in Rhun is *de jure* governmental land. For instance, all of *Laeba's* and **Laida's** fields are falling in this category. According to the widow *Wamahi*, the history of *Laeba's* land-use has begun in the late 1950s, when he cleared plots of 20 m x 10 m in TWW 1 and BP each. In the 1970s, *Laeba* then extended these plots, and began cultivating onions and raising chickens in BLL. Consequently, *Laeba* had not cleared any plots during the Japanese occupation, so that all family's land has a weaker status of *hak pakai* (see Ch. 5.4.3).

191 The peasant classification of land-use types is used here: For instance, TWW 3 and BP are regarded by **Laida** as dry fields, despite the existence of a couple of clove trees and other domesticated perennials. Most fields (LA; TWW 2 and 3; P) and field parts are flat (TWW 1; BP) or gently undulating (less than 8% inclination in TWW 1, BLL and BP), except parts of BLL and TWW 1 (hilly slopes of some 8% – 30% inclination).

192 Among others: 60 clove trees, 65 coffee shrubs, about 90 bananas (parent plants), 33 coconut palms, 5 kenari trees (in or near the field), and 1 durian tree (all figures only include productive trees in 1992).

vegetation is dominated by the naturally established, nitrogen-fixing shrub *Leucaena leucocephala* var. *leucocephala* (Lam.) de Wit, of which the cut slender stems are used as fuelwood, and as stakes for vines (e.g., yard-long bean, *Vigna unguiculata* (L.) Walp.; common bean, *Phaseolus vulgaris* L.; winged bean, *Psophocarpus tetragonolobus* (L.) DC.), grown in BP and in the home garden of **Laida**. The serious pest *Heterophylla cubana*, a psyllid, which caused much damage to *Leucaena leucocephala* in the Pacific Islands and in Southeast Asia (cf. Monk et al. 1997, 730-1) in the 1980s and 1990s, was not observed on Rhun Island. Other useful plants in BLL are bamboos, pineapple (*Ananas comosus* (L.) Merr.), *Pandanus* sp. (for home-made *tikar* mats), and medicinal plants (e.g., the unidentified *akar olah-olah*). Another mapped plot – a coconut grove of 0.1 ha in LA (situated above TWW 1) – was used by **Laida**, until the land-holder, *Laeba's* seventh son, returned from Ambon to Rhun in 1996. Hence, the plot is not included in Tab. 6.16, although **Laida's** household may consume coconuts from it.

Practices of the subsistence-oriented land use and functions of **Laida's** fields (*kebun*) are similar to those analysed in previous sections. Thus, is it sufficient to restrict the description to specific and most significant results. The most important crop, cassava, is cultivated as described in Ch. 6.3.2: slash-without-burn. Occasional burning of cut and gathered plant debris, ash and green manuring on formed mounds, and propagation is most commonly carried out with Pattern 4 (Fig. 6.7). The 'piece-meal' harvested crop is immediately replanted except during dry spells, resulting in cassava plots of different age (see cassava-plot indices in Maps 4.1). **Laida** and occasionally his wife are involved in the labour-intensive harvest of clove and nutmeg trees. They do not demand any paid labour for it. In general, *labour* is the only means of production being sufficiently available, although setbacks occur especially when **Laida** is absent for sailing and regional fishing. *Capital* is scarce, and sometimes used for tree seedlings (formerly cloves; presently certain fruit trees). Commercial fertilisers and pesticides are not applied. As *land* is the scarcest resource on Rhun Island, vertical extension in a multi-layered layout of the garden is one possibility to increase production of supplementary food resources.

Table 6.16: Land area of agroforestry components in fields of Laida (1992 and 1997)

Field	TWW 1	TWW 2	TWW 3	BP	BLL	Parigi	Total	%
Land-use type	Mixed garden	Dry field	Dry field	Dry field/fallow/ home garden	Fallow	Dry field		
Components	a r e a s i n a r e (rounded fractions)							
Annuals 1992	35.82	1.27	2.82	9.70	0	0.41	50.02	30.74%
Annuals 1997	*25.97*	*1.75*	*2.82*	*16.97*	*0*	*0.41*	*47.92*	*26.46%*
Clove/(nutmeg) 1992	31.40	0.38	1.43	2.11	0	0	35.32	21.70%
Clove/(nutmeg) 1997	*31.40*	*0.38*	*1.43*	*2.11*	*0*	*0*	*35.32*	*19.50%*
Other perennials 1992[1]	27.21	0	0	0	0	0.95	28.16	17.31%
Other perennials 1997[1]	*27.21*	*0.11*	0	*1.19*	*0*	*0.95*	*29.46*	*16.26%*
Fallow 1992	8.29	0.59	0.53	7.62	29.38	2.81	49.22	30.25%
Fallow 1997	*29.63*	*0*	*0.53*	*2.61*	*29.38*	*2.81*	*64.96*	*35.86%*
House/home garden	0	0	0	0	0	0	0	0%
House/home garden	*0*	*0*	*0*	*3.46*	*0*	*0*	*3.46*	*0.02%*
SUM 1992	102.72	2.24	4.78	19.43	29.38	4.17	162.72	100%
SUM 1997	*114.15*	*2.24*	*4.78*	*26.41*	*29.38*	*4.17*	*181.12*	*100%*

Notes: **1** Excluding secondary vegetation;
For abbreviations of fields see footnote 186.

Sources: Stubenvoll (1994); Mapping (Stubenvoll 1996).

According to **Laida**, the most important *function* of gardening (*berkebun*) is the production of staple and supplementary food for the subsistence activities of his household. As the fertile *kebun* BP guarantees a sufficient, stable amount of cassava, **Laida** and the relatives of his wife have been able to integrate more and more trees in TWW 1 for diversifying food and cash crops, thereby reducing risks of crop failure and malnutrition, and dependencies on food imports. Apparently yields have not substantially decreased, also through fitting in short fallow periods. Only during pronounced droughts, there may be a lack of vitamins and minerals for nutrition. Moreover, surpluses of certain subsistence products (vegetable, fruits) are sold in the village, cash crops and goats in Ambon and Banda Neira, so that the *kebun* is contributing to the household's income.[193] Although it is almost impossible to provide an exact figure of the annual income from horticulture and animal husbandry (see Ch. 6.3.7), **Laida** estimated it as to 150,000 to 250,000 Rupiah. Production of fuelwood, construction material (timber, bamboo), forages for goats, medicinal plants, resins, and the like are further functional values of **Laida's** gardens. Important *ecological functions*, such as soil protection and improvement, regulation of water supply, and provision of shade through integration of trees are most significant in the mixed garden TWW 1 (see Ch. 7.1.1 for an account on ecological sustainability).

Changes in land use between 1992 and 1997

The time-and-motion study between 1992 and 1997 reveals very marginal changes in land use in smaller plots (TWW 2 and 3; P; LA), as well as in BLL which is still in the fallow stage. Thus, it is sufficient to outline the *few* major changes in land use in the fields TWW and BP (see Maps 4.2):

(1) *Field extension*: In the eastern part of TWW 1, **Laida** has claimed a freely available plot dominated by secondary and original vegetation by integration of a few perennials (coffee, breadfruit). Likewise, *Lamusi* encroached taro and cassava plantings in the western part of the field. In BP, *Laeba's* sixth son (*Lacabo*) cleared most parts of the fallow vegetation (mostly the spiny, straggling and scrambling *gonggai*; probably the nitrogen-fixing *Mimosa diplotricha* C. Wright ex Sauvalle) and – together with **Laida** – subsequently extended cassava and vegetable production. Several fruit trees (e.g., *Bouea macrophylla* Griffith) were integrated as well. However, along the western edge of BP, several houses were recently constructed, among others by the households of *Laeba's* second daughter and fifth son.

(2) *Dying of most senile, state-owned nutmeg trees and of several bananas*: **Laida** has transplanted naturally established nutmeg and *Canarium* seedlings in TWW 1, whereas other farmers (e.g., *Wamahi, Lakara*) have decided not to perform any replanting. Bananas are susceptible to prolonged droughts and strong winds, and have considerably suffered in recent years. Replanting has been carried out by **Laida,** however.

(3) *Less intensive cropping of annuals in TWW 1*: This is indicated by both a decreasing area of annuals, and the field huts which went to ruin. Reasons include:

- an encroachment of annual production in BP, which is in immediate neighbourhood to the village, whereas the walking distance to TWW 1 is approximately 30 minutes;
- a progressive shift to rice consumption due to an improved income situation, as **Laida's** expenditures for house construction have been almost completed;[194] and

[193] The market range of agricultural products is shown in the legend of Map 4.1, and App. 1.1.

[194] In 1995, Laida even bought a television set, and a satellite disk. Electricity is provided by a diesel engine of his neighbour, who in turn has connected his television set to Laida's satellite disk. Watching the daily television programme, for which each participant has to pay a small amount of money (Rp. 100), is a very popular phenomena, especially of the children. An increasing number of households therefore carry out the investment in TV sets, diesel engines, and satellite disks.

- an increasingly important seasonal work migration (regional fishing, trading) for **Laida** and male relatives of **Waine**, so that male labour input for agriculture is substantially decreasing.

(4) *Goat husbandry has been moved to field BP* after the death of one female animal caused by a collapsing banana tree in TWW 1. Moreover, **Laida** and his wife save the daily walk to TWW 1 for looking after the animals.

Problems related to land use, and household strategies

Problems in connection with land use and agroforestry are manifold, and can be grouped according to (1) the level of social organisation, (2) issues related to socio-economy, and (3) biophysical factors.

(1) *Within the household*, scarce capital is a problem, although rising rice consumption and recent investments indicate a better economic position than in 1992. The issue of traditional land tenure may still be effectively regulated *within the family, but* inherent conflicts of interests and eventual disputes about regulations on inheritance after *Laeba's* death could prevail, as soon as more children of the parties will marry and establish new households in Rhun. As an apportioning of fields for *each* household, recently demanded by *Lamusi*, is not in the interest of *Wamahi* and most other households, a compromise could become necessary in the future. For instance, all common fields could be split in two equal parts: one part being commonly managed by the households of *Laeba's* first five children (with *Waira*), the other part by the households of the offspring of his second marriage (with *Wamahi*). Furthermore, the reciprocal character of gardening is hampered, as **Laida** puts it, "*by the laziness of my brother-in-law* [who is married with Laeba's second daughter]*, whose household also lives off my cassava plantings. That's the reason why I plant more cassava than we actually consume!*"

(2) **Laida** regards the low producer price of nutmeg and clove, and the lacking tenure to state-owned nutmeg and protection trees as the major obstacles with regard to agriculture: *"Although I care for naturally established nutmeg and kenari trees, I actually do not want to increase production as long as it is unclear to whom the trees later belong. In the end, everybody could say 'this tree has been naturally established' [tumbuh sendiri] and claim access on its products."* Moreover, theft of tree products (fruits, coconuts, palm wine *tuak*) and even of cassava are widespread in the community. Encroachment planting of other farmers into the fields of **Laida**, as for example in Parigi, is partially hindered by him with the strategy of planting hedges and trees along field boundaries. Anthropogenic fire occasionally spreads into the fields and gardens.

(3) Fertility erosion of the thin solum in most parts of BLL has forced the household to leave the field continuously fallow. The major biophysical obstacle, for all households, is the *variability of rainfall*. As pointed out in Ch. 4.2.2, prolonged droughts frequently hit Banda in recent years. Hence, diversification of agricultural production is also a strategy to reduce risks of complete crop failure. Pests and diseases are commonly a minor threat to cultivated plants, with the exception of mice occasionally feeding on pulses.

6.5.2 Tioor: *Tumpangsari* dominated land use

Unlike *Laida*, whose decisions in land use – on a *limited land area* in Rhun Island – are strongly influenced by family relationship and land tenure arrangements among several households of the extended family, **Paulus** (HH 27; Religion: Protestant) holds *a large land area* in Tioor Island without any tenure rights of his relatives. Only remaining primary forest land may be converted to dry fields by members of his extended family.

Family structure and income-generating activities

Paulus was born in Flores (Regency of Sikka, Province of East Nusa Tenggara) in 1950, and immigrated to Tioor in 1972 for working in the coconut groves of the Tioorese. After his marriage with **Helena**, he has settled down in Kerker settlement. The couple has seven children (three sons and four daughters), of whom two are attending secondary school in Masohi (Seram) and two younger children are in elementary school in Tioor. The two eldest sons are contributing a little bit to the household's income. One is working as an assistant of an ethnic Chinese merchant in Tioor, the other in Masohi. The eldest daughter assists **Paulus** in gardening. Income of the household is almost entirely generated by agricultural activities. Copra, nutmeg, and surpluses of taro and bananas are the main cash crops, being cultivated in four dispersed fields.

Land tenure and the 'struggle for land'

Two *dusun kelapa*, in the locations of Vanoa Lenlus (VL) and Varun (V), were acquired as an inheritance of **Helena's** father, who began to clear there in the 1950s, and subsequently integrated coconut palms by means of *tumpangsari*. The other two fields, in the locations of Kabtukun Wony (KW) and Urit Aliminy (UA), have been acquired by **Paulus** with the mode of gradual clearing of primary forest land since 1978. The history of land use (Map 5.2) illustrates this strategy of claiming large areas of primary forest by first clearing small plots along the area's edges, also making use of natural boundaries such as streams, ridges, and steep terrain. In subsequent years, the extension of cultivated land has moved further inland. The household of **Paulus** holds individual tenure rights on all land that was inherited to, or ever cleared by him (see Ch. 5.4.3).

On remaining primary forest land in KW and UA, however, **Helena's** relatives still have a right to clear land for their own purposes. As long as family members hesitated to clear primary forest in these locations, **Paulus** could afford to convert just that primary forest land to dry fields that was actually needed for his subsistence activities.

However, in 1997, 0.8 ha in the northern part of UA (Map 5.1.1, 'disputed area'), originally claimed by **Paulus**, was cleared by his brother-in-law – in accordance with *adat* – for cropping of annuals in a new *ladang* plot. Therefore, swift clearing of remaining primary forest, even if it is not due to be cultivated straightaway (*merebut tanah*), could become crucial for **Paulus** if he wanted to secure his remaining claimed land. The expression *merebut tanah*, literally meaning 'struggle for land', is used in *contemporary* Tioor to refer to two different things. In its original meaning, it refers to land still freely accessible, i.e. primary forest land not being claimed yet by anyone (or common property; see Ch. 5.4.3). Arguing like Hardin (1968), the peasant logic would be in this case: "I clear and secure *any* land before *somebody else* would do it." According to **Paulus**, who *already* holds claimed land in accordance with *adat*, he *would not* interpret such an action as *merebut tanah*: "I clear and secure *my* land before somebody else of *my family* would do it." However, in the eyes of the family's members, it would definitively constitute *merebut tanah*. Obviously, the result of both understandings is similar: the dwindling primary forest area.

Structures, practices, and functions of land use

As the fields in VL and V are completely cultivated with coconut tree gardens, the land-use maps of **Paulus'** fields are restricted to UA and KW (Maps 5.1), including the disputed area cleared by **Paulus'** brother-in-law. Spatial arrangement of plants are shown in an exemplary part of the field UA. The calculated area of secondary and primary forest, and the area being reserved for the production of subsistence products and cash crops in each field is given in Tab. 6.17.

Labour input in the coconut tree gardens in VL and V is limited, as the locations are only sporadically visited by **Paulus**, for checking, husbandry and harvesting of mature fruits. Thus, garden activities are usually confined to the other fields in UA and KW. **Paulus**, his wife and their eldest daughter are working daily in UA, which is more fertile than KW, and where a wide range of annuals are grown. The newly cleared plots are grown with maize, upland rice, vegetables (e.g., tomato, eggplant, chilli) and mung bean, whereas the older *ladang* plots are occupied with cassava, vegetables, and interspersed fruit tree seedlings. **Paulus** recently constructed a new field hut for staying the night in the field. Most of the taro, and additional vegetables are grown in the mixed garden in the southern part of UA, beneath cloves, nutmeg, coffee, bananas, sago (along the stream Werlok), young fruit trees (durian, jackfruit, salak), and betel-nut palms (Map 5.1.1). Sago groves are situated along the stream Werkivkiv at the northern boundary of UA, and along Werlok in KW. Primary forest (with valuable timber species, such as *Nothaphoebe calista* Kosterm., *Diospyros* sp., and *Pometia pinnata* J.R. & G. Forster) has been enriched with nutmeg trees to strengthen **Paulus**' claim to this area. A large natural stand of the unidentified bamboo species *kovnan* has not been cleared by **Paulus**, because it is the only remaining source of this economically important bamboo in the upper watersheds of Werlok and Werkivkiv. Other farmers also draw supply from it.

Table 6.17: Land use in fields of Paulus (1997)

Field	Kabtukun Wony	Urit Aliminy	Vanoa Lenlus	Varun	Sum	%
Walking distance from Kerker[1]	60 min.	90 min.	30 min.	30 min.	---	---
Soil fertility[1]	low	high	medium (lithic)	low (lithosol)	---	---
Inclination[1] and altitude	steep to very steep 80 – 220 m	nearly level to steep 240 – 310 m	undulated 100 m	steep 30 m	---	---
History of land use	First clearing in 1977; in each plot cultivation of rice (1x), taro (1x), cassava (4x), then integration of sago, nutmeg, coconut, etc.	First clearing in 1978; in each plot continued cultivation of sweet potato, taro, and integration of perennials; cassava since 1980	Cleared by father-in-law in the 1950s; cultivation of annuals and subsequent integration of coconuts by means of *tumpangsari*; inherited to Paulus and Helena in 1976		---	---
Land-use types	Tree gardens, dry field, secondary forest	Tree gardens, mixed garden, dry field, primary & secondary forest	Coconut tree garden		---	---
Dry field	0.80 ha	2.44 ha	---	---	3.24 ha	21%
Tree garden	1.83 ha	0.46 ha	0.50 ha	0.10 ha	2.89 ha	19%
Mixed garden	---	2.30 ha			2.30 ha	15%
Secondary forest	0.39 ha	0.68 ha	---	---	1.07 ha	7%
Primary forest	1.13 ha	4.68 ha	---	---	5.81 ha	38%
Sum	**4.15 ha**	**10.56 ha**	**0.50 ha**	**0.10 ha**	**15.31 ha**	**100%**

Notes: **1** Classification according to Paulus.

Sources: Household interviews and mapping (Stubenvoll 1997).

KW is extensively used with cassava, as **Paulus** wants to fully commit himself to the establishment of tree gardens and mixed gardens in the more distant location of UA: *"When I'm old, I shall not be strong enough for climbing the mountain as far as Urit Aliminy everyday. Hence, my children will work there in the future, and I shall restrict gardening to the lower parts of Kabtukun Wony."*

Moreover, his efforts to establish coconut groves in KW failed several times, as wild boars destroyed the new plantings. **Paulus** could save the fifth planting from destruction in the end, but only by regularly guarding of the plots. So he has become somewhat disappointed about the previous failures. First clove plantings of 1982 died in 1993 during a pronounced dry spell. Other perennials, such as coffee, kapok, fruit trees, and meanwhile the fifth planting of coconut palms have reached maturity.

Garden activities are performed as described in previous chapters: slash-and-burn for new *ladang* plots, i.e. an initial planting of a wide range of annuals with several cultivation patterns (Fig. 6.7), and a subsequent integration of perennials (*tumpangsari* farming system). **Paulus** is one of the innovative farmers in Tioor, who is introducing various edible fruit- and seed-yielding trees by seedlings and seeds taken from other islands, such as salak [*Salacca zalacca* (J. Gaertner) Voss ex Vilmorin], avocado (*Persea americana* Miller), rambutan (*Nephelium lappaceum* L.), cashew (*Anacardium occidentale* L.), and candlenut (*Aleurites moluccana* (L.) Willd.). It is striking that the area proportion of secondary forest in Paulus' fields is relatively small compared to the island's figure (cf. App. 3.2).

Paulus' gardens fulfil the major *function* of producing subsistence products for the household, including diversification, reduction of risks and dependencies, and provision of secondary timber and non-timber products. A difference to *Laida*, however, is the stronger focus on cash-cropping, which is practically the only source of the household's income. As the coconut tree gardens yield about 0.9 t of copra per year, which is equivalent to a producer price of 560,000 Rupiah (December 1997), and other crops (nutmeg, mace, taro, bananas) provide additional cash, **Paulus'** annual income can be accordingly estimated to Rp. 750,000. *Ecological functions* of tree gardens and mixed gardens play an increasingly important role (see Ch. 7.1.1), because most of the primary forest has been converted to arable land, or cleared for the purpose of claiming land tenure.

Problems related to land use and household strategies

(1) *Level of social relationship*: Diverging opinions between Paulus and his wife about usefulness and handicaps of certain naturally established timber trees and protection trees are one problem *within the household.* **Helena** regards those trees as not being necessary, and even dangerous within a garden, because the collapse of a tree could kill a person; and bigger branches falling off a protection tree could hurt someone while harvesting clove and nutmeg trees. **Paulus**, on the other hand, appreciates the positive ecological and protective functions of shade trees for his nutmeg groves, if **Helena** could stop killing those trees by ringbarking. Moreover, **Helena** regards annuals like taro as a more reliable income source than perennial cash crops.[195]

    As previously mentioned, the struggle for already claimed land is a central issue for **Paulus** *within the family*. Besides a swift clearing of the forest on his own, other potential solutions could be an internal negotiation with his relatives, or an adaptation of *adat* to this major cause of deforestation. The latter could be reached by its inclusion in a community-based resource management plan (see Ch. 8.2), in such a way that claimed primary forest cannot be cleared by family members without a consent of the land holder.

[195] These facts are underlined by two statements: *"A timber tree at the garden's edge is okay, but within the dusun it is not necessary. In 1982, a woman was killed in Mamur by a collapsing tree. ... If I see an empty space in the dusun, just a few meters are sufficient, I immediately will plant taro there. So, timber trees would hinder my taro plantings. Just compare: 25 kaleng of taro, which I can sell for 100,000 Rupiah in the village, is the same amount of money like selling 250 kg of copra, for which we would need an extra dusun kelapa and more labour input! So, betel-nut palms are the only trees that I frequently plant, because they have become scarce in Tioor."* (**Helena**); and: *"Now, the prolonged drought may threaten my coconut palms, and much more my heat-vulnerable nutmeg trees in Kabtukun Wony, of which many have already died. When I see my wife destroying protection trees there, I could get really mad. Trees are necessary in the upland!"* (**Paulus**).

(2) *Socio-economy*: Like in Rhun, theft of tree products (fruits, coconuts, coconut palm wine *tuak*) are widespread in the village. Uncontrolled burning and subsequent spread of fire are even more common, destroying parts of tree gardens. Moreover, other villagers often ask **Paulus** for fruits and vegetables without any compensation, sometimes with the false excuse, that they do not have any plantings in their respective fields. For him, as an immigrant from Flores, reciprocity does not play the role that it usually does for the Tioorese. He also does not call for *kerja masohi* activities. Thus, **Paulus** tries to keep his vegetable and fruit plantings a secret. A lack of seeds for certain vegetables was also stated by **Paulus** and his wife, as a difficulty in farming. In terms of *economy,* marketing (transport, demand) has improved in recent years. However, **Paulus** assesses low producer prices for cloves as the main drawback of cash crop production, although he only possesses a few productive clove trees. Producer prices of copra and nutmeg/mace are considered by **Paulus** as acceptable.

(3) *Biophysical factors* are the most negative influences for **Paulus'** gardens. Pests and diseases (wild boars, *Sexava* sp., mice), strong wind, prolonged droughts, decreasing soil fertility in KW, deforestation and a related lack of fresh water during prolonged droughts were mentioned by **Paulus** as the most significant examples. Deployed strategies include: staying the night in the field hut (against wild boars), and drop irrigation of trees by use of a bamboo culm, into which a tiny hole is cut in the bottom partition of an internode part.

6.6 Conclusion

The foregoing discussion in Ch. 6 showed that a complex land-use system has emerged on both islands, which has been based on deforestation in the first place, and where traditional agroforestry has been partly integrated in successional stages. The peasant strategy can be regarded as socio-economically successful, as the households put the focus on diversifying both their farming system (which is based on self-sufficiency), and their income-generating activities (which are also performed off-farm). An important difference in land use is related to cash-cropping. In Tioor, it plays a significant role in the village economy, whereas in Rhun the decline of the nutmeg plantations and the low floor prices for clove have led to only a marginal income from agriculture.

The effects of land-use change underline, however, that the farming system on either island may reach its ecological limits. Worsening environmental conditions, such as soil degradation and hydrological disturbances, have become manifested and are widely perceived by the farmers. This may pose a threat to their livelihood in the foreseeable future. In the Tioorese communities with some land reserves, the length of fallow periods may be still regarded as sufficient for soil fertility regeneration, although more and more land is put out of shifting cultivation by establishing tree gardens. Thus, fallow periods may be shortened. A serious erosion hazard, however, is the practice of shifting cultivation in steep and sloping terrain in most of Tioor Island. Thus, soil erosion may lead to soil degradation even in areas, which have been cleared for the first time, or which have been left fallow for a long period of time. In Rhun, soil erosion is the main factor in soil degradation as well. Many farmers have to leave fallow a part of their permanent dry fields due to heavy erosion, except in level terrain and in basins.

Strategies to overcome environmental degradation and resource depletion may aim at two directions. To keep the landscape in good health, *one strategy* could be an integration of a sufficient number of trees with traditional agroforestry techniques into the fields, as already demonstrated by a number of farmers. The case studies of peasant households were mainly chosen to show:

(1) that an analysis of agroforestry has to focus on the household level, before being able to draw conclusions for a wider level – such as a community, or a watershed;

(2) that farmers are confronted with all of the adverse impacts of deforestation;

(3) that farmers perceive these impacts and look for solutions by practising diversified traditional agroforestry, which could serve as a blueprint for enlarging such a system at a wider scale; and

(4) that traditional agroforestry also has flaws, mainly in the realm of the socio-economy of the household, which have to be seriously taken into consideration before agroforestry could go beyond the blueprint stage (e.g., in agroforestry extension projects).

The last issue makes clear, that the enhancement of traditional agroforestry may not be sufficient to tackle environmental problems. Therefore, *a second strategy* could aim at an improvement of agricultural practices and modification of traditional agroforestry, or an additional introduction of new practices and tree species.

The main criteria of any strategy are: environmental sustainability, economic productivity, and social acceptability, i.e. all measures and innovations must be acceptable and practicable by the farmers. The next chapter will therefore put the focus on an integrative evaluation of traditional agroforestry, which is believed to widely fulfil these criteria, because it is already in practice. Thus, it has to be shown, that the stimulation of a more widespread use of traditional agroforestry on both Tioor and Rhun could be an adaptable strategy – at least under certain circumstances which must be also identified. Measures to modify agroforestry, and possibilities to improve agricultural management are discussed in Ch. 8.

7. CRITERIA FOR TRADITIONAL AGROFORESTRY

In this chapter, emphasis is placed on clarifying the question as to whether or not traditional agroforestry is ecologically sustainable, economically productive, and socially acceptable within the existing local frame-work (Ch. 7.1). In conclusion, the future prospects of traditional agroforestry are examined (Ch. 7.2). The discussion underlines the necessity to find strategies, which can deal with the identified restrictions of traditional agroforestry. Such interventions for an enlargement of traditional agroforestry and the scope of its improvement are part of the strategy discussion in Ch. 8.

7.1. Potentials and limits of traditional agroforestry

It is important to recapitulate some features, which have to be taken into account when evaluating traditional agroforestry and its potential contribution to sustainable land use in Tioor and Rhun:

(1) Existing traditional agroforestry is characterised by various practices and types. In almost all cases the farming system of the household consists of most of these types. The diversity of traditional agroforestry is even more pronounced in terms of tree species, which have to be included accordingly in an evaluation. The type of agroforestry, the spatial approach (integration or segregation of annuals and perennials into one land unit), the extent of tree planting, and the tree species to which priority is given, depends on the individual perception and decision-making of the peasant household, and thus, on socio-economic, cultural, demographic, and biophysical factors.

(2) Traditional agroforestry as a part of the farming system is spatially, ecologically, and socio-economically interdependent on other land-use types. Thus, an evaluation of agroforestry has to consider the whole farming system, as well as demographic and socio-economic variables.

(3) Traditional agroforestry has been partly identified as an indirect, latent force in driving back primary forest in Tioor, i.e. it may also contribute to human disturbances of the environment. Thus, it is important to preserve remaining primary forest as much as possible.

The general remarks on agroforestry on small tropical islands in Ch. 2.4 form the starting point for an *evaluation of traditional agroforestry* on both islands. A qualitative approach is chosen for five reasons:

(1) The basic methodology of this study is a *qualitative* (see Ch. 3.2), so that collected quantitative data may be insufficient for quantifiable criteria.

(2) Some of the developed criteria are difficult, if not impossible to be quantified, or cannot be easily compared to each other in a quantitative way.

(3) As Nair (1993, 435) points out, there is generally a lack of quantitative methods to compare and evaluate agroforestry systems.

(4) Climatic events during the period of field research resulted in exceptionally low yields, so that quantitative figures may be regarded as not being representative.

(5) Recent political and economic transformations in Indonesia may have almost unpredictable implications for the local framework, especially with regard to the political scene and to producer prices (see 3.3).

The main attributes of agroforestry are *sustainability, productivity, and adaptability* (see Ch. 2.4). It then follows that the *criteria* for evaluating agroforestry should be based on these attributes (Nair 1993, 429). It must be stressed, that *attributes and criteria are correlated in reality*, despite an analytical separation in the following, and in Tab. 7.3.

7.1.1 Ecological sustainability

Considering the fragile environment, the limited land area, the vulnerability to natural disasters, and the scarce natural resources on which small tropical island communities depend, *conservation and sustainable use of resources* such as soil, land, fresh water, littoral ecosystems, and biota, are of top priority to maintain agricultural and littoral productivity. The criteria used are therefore: (1) soil conservation and soil improvement; (2) protection of fresh water resources and minimisation of hydrological disturbances; (3) coastal protection; (4) minimisation of adverse externalities to tropical littoral ecosystems; and (5) conservation of bio-diversity.

Soil conservation and soil improvement

Loss of organic matter and plant nutrients, and as a secondary problem loss of solum, by *soil erosion* were identified as the most serious factors in soil degradation on Tioor and Rhun (see Ch. 6.4.3). *Deterioration of chemical properties* through shortening fallow periods and 'over-cultivation' is evident in some places, too. The capacity of agroforestry for soil conservation, i.e. control of erosion, the maintenance of soil chemical, biological and physical properties, and the avoidance of toxicities, is discussed in detail by Young 1989, and Nair 1993. *Soil erosion* is controlled by agroforestry through the tree cover in combination with dead and living soil cover: *Rainfall erosivity* is reduced, unless the soil is only covered with high trees and lacks soil cover, such as litter or cover plants. Thus, a mixed garden with several tree layers and ground cover vegetation decreases rainfall energy and erosion. As agroforestry maintains and improves the *physical properties of the soil* (e.g., increase of stability and of water retention capacity), *soil erodibility* is also lowered. Moreover, soil moisture is positively regulated. Other beneficial effects of trees on soil include: bio-mass production (litter, root decay), nitrogen fixation (by certain *Leguminosae*, and *Casuarina* L.), nutrient addition through atmospheric input (rain, dust), nutrient uptake by *deep* roots (see Ch. 2.4), reduced leaching of nutrients into the lower soil, and a moderating effect on acidity, salinity and alkalinity (Nair 1993, 270), all of which contribute to the maintenance and improvement of *soil chemical properties*.

This review of soil conservation and improvement has to be qualified according to the different agroforestry systems being practised on either island.

(1) *Shifting cultivation*: Most crucial for maintaining productivity are sufficiently long fallow periods, and gradients of the *ladang* field. The length of fallow periods is supposed to become shorter in the future due to population growth. For instance, in communities with limited land reserves for shifting cultivation (e.g., Wermaf), primary forest and old secondary forests occupy a comparatively small area, whereas gardens are more dominant (cf. App. 3.2). Fallow periods are here significantly shorter than in other communities.

(2) *Tree gardens and mixed gardens*: *The one extreme* is the burning of cover vegetation in many coconut tree gardens in Tioor, so that some of the general advantages cannot be fully valid. In sloping terrain there is only a low reduction of rainfall erosivity, as the soil is insufficiently covered with vegetation and litter at the beginning of the rainy season. Burning adversely affects *soil micro-organisms* in the upper soil layer as well. Their quantity is identified as critical in Tioor (Liang 1998). Moreover, removal of coconut husks from the tree garden contributes to a loss of organic matter.[196] In nutmeg, sago and clove tree gardens little organic matter is lost in harvest. Goat husbandry in Rhun also has the potential to destroy cover vegetation, if herds become too large.

[196] Contrariwise, in a coconut tree garden *without burning* the highest amounts of organic C and of available P of all analysed samples were measured (cf. App. 2.1, sample No. VI).

The other extremes are mixed tree gardens and mixed gardens, both of multi-storey structure, and slash-without-burn establishment of nutmeg tree gardens including forest remnant trees in Kelvow (Tioor), which all resemble the natural forest, and largely fulfil the above mentioned functions. For instance, after four months (August till November 1997) with a total of 25 mm precipitation (see App. 2.4), soil moisture in the A horizon was preserved in primary forest, mixed gardens and nutmeg tree gardens with protection trees, whereas in dry fields, and tree gardens without protection trees the upper soil layer had dried up (see App. 2.3). Farmers in Kelvow stated erosion hazards in sloping terrain as a main reason to forego slash-and-burn, and instead to establish taro by *slash-without-burn*, and to integrate nutmeg beneath forest remnant trees.

Other criteria

Complex agroforests, and mixed gardens dominated by perennials, may *protect freshwater resources* and minimise *hydrological disturbances*, especially when being established in the headwaters and along the course of Tioor's streams. This is not specifically demonstrated yet, however, as shifting cultivation and the loss of primary forest by far outweighs the establishment of complex agroforestry systems in the headwaters. Agroforests are emerging only in the upper watersheds of Werkilwer (Kelvow community) and partly in Werkar (Kerkar community). The positive effect on soil moisture has been stated above.[197]

The *shore could be protected* from winds, waves, and abrasion by a complex association of suitable trees and herbaceous plants, e.g. sand-binding, deep-rooting, and wind-resistant species, resembling the natural beach vegetation. However, coconut tree gardens have been established in almost all parts of Tioor's coastal plain. Combined with the removal of coral boulders and mangrove vegetation, this has caused severe coastal abrasion at the east coast, also destroying coconut plantings. In Rhun, coastal protection is of minor relevance, as few beaches surround the island. The settlement is protected from high wave action by a dam.

As traditional agroforestry in most cases reduces soil erosion, lower amounts of erosion material are carried into the sea. Hence, *adverse externalities to riverain, estuarine and littoral ecosystems by sedimentation* are minimised, and their productivity may be maintained, also with a positive effect on local fishery. Of course, other methods which lead to a depletion and destruction of coral reefs, mangroves, and seagrass beds – such as blast fishing, coral mining, use of poisons and cyanides, and removal of mangrove trees – would have to be stopped, too.

Conservation of bio-diversity, both at species and sub-species level, by traditional agroforestry is – on the one hand – indirectly related to decreased sedimentation of erosion material, and the protection of littoral ecosystems. On the other hand, traditional agroforestry itself may provide habitats for endangered species, both of flora and fauna, and for animals (insects, birds, snakes) that prey on crop pests. The preservation of a diverse gene pool by propagation of various cultivars is regarded as another tool against plant pests and diseases, and against natural calamities (e.g., droughts). Thus, the potential for implementing integrated pest-management programmes without dependence on (dangerous and expensive) commercial herbicides and pesticides may increase (cf. Bottrell 1978, cited from Thaman and Clarke 1993, 21).

To conclude, most traditional agroforestry systems in Tioor and Rhun have (or could have, if adaptively managed or enlarged) a positive effect on the environment and the natural resource base.

[197] In Rhun, where streams are absent, the preservation of soil moisture by trees is of major concern. Furthermore, remaining primary forest in Tioor should be preserved for freshwater conservation, at least as long as complex agroforestry plays a minor role in the headwaters of streams. In terms of bio-diversity, however, primary forest should be absolutely protected.

As the next section will show, these fundamentals are important to maintain *productivity of land*, which depends largely on soil conservation, soil moisture preservation, and on protection of freshwater resources.

7.1.2 Economic productivity and stability

Economic considerations play an important role in decision-making processes of the peasant household, although other factors may be equally crucial. As economic evaluation of agroforestry is already well reviewed (e.g., Arnold 1987; Hoekstra 1987 and 1990; Stocking et al. 1990; Nair 1993), basic ideas of its economic features are summarised in Tab. 7.1. These features are then evaluated within the local framework in an analogous approach as in the article of Arnold 1987.

Table 7.1: Principal economic benefits and costs of agroforestry

Benefits (B) and opportunities	Costs (C) and constraints
B1: Maintains or increases site productivity through nutrient recycling and soil protection, at low capital and labour costs	**C1:** Reduces output of staple food crops where trees compete for use of arable land and/or depress crop yields through shade, root competition or allelopathic interactions
B2: Increases the value of output on a given area of land through spatial or intertemporal inter-cropping of tree and other species	**C2:** Incompatibility of trees with agricultural practices such as free grazing, burning, common fields, etc., which make it difficult to protect trees
B3: Diversifies the range of outputs from a given area, in order to (a) increase self-sufficiency, or/and (b) reduce the risk to income from adverse climatic, biological or market impacts on particular crops	**C3:** Trees can impede cultivation of mono-crops and introduction of mechanisation, and so (a) increase labour costs in situations where the latter is appropriate and/or (b) inhibit advances in farming practices (less relevant in Tioor and Rhun)
B4: Spreads the need for labour inputs more evenly seasonally so reducing the effects of sharp peaks and troughs in activity characteristic of tropical agriculture	**C4:** Where the planting season is very restricted, e.g., in arid and semi-arid conditions, demands on available labour for crop establishment may prevent tree planting (less relevant in Tioor and Rhun)
B5: Provides productive applications for underutilised land, labour or capital	**C5:** The relatively long production period of trees delays returns beyond what may be tenable for poor farmers, and increase the risks to them associated with the insecurity of tenure
B6: Creates capital stocks available to meet intermittent costs of unforeseen contingencies	

Source: Adapted from Arnold 1987, 175.

As already stated in Ch. 2.4, the main reason of agroforestry being economically beneficial for a farmer is that the – per definition – sequentially or spatially combined production of perennials with annuals and/or animals in one land unit is more profitable than growing these components separately (cf. benefit B2 in Tab. 7.1). This is the case if biologically and economically complementary interactions prevail over competition among these components. Interactions may be felt immediately or after some time (Hoekstra 1990, 310): *The long-term* complementarity supports maintaining land productivity due to conservation of natural resources, and is thus of great importance (cf. benefit B1 in Tab. 7.1). A summarised consideration of the benefits outlined in Tab. 7.1 allows the conclusion, that tree planting may be both an efficient way of meeting peasants' production goals using the resources of land, labour and capital available to them, and an appropriate measure for reducing production risks. This may be also true in situations where some costs (cf. costs C1 – C5 in Tab. 7.1) of agroforestry are manifested.

Economic productivity of traditional agroforestry can be interpreted in terms of *yields*; however, it includes *economic profitability* and *nutritional diversification* as well. Crop yields depend on input factors, such as labour and capital goods, and natural resources like soil, light and water, and may therefore vary extremely. Additionally, yields are affected by natural disturbances, and the outbreak of pests and diseases. Economic profitability of cash crops, and related income generation may also fluctuate, depending much on markets and marketing (e.g., transport, supply and demand, fluctuations). Besides cash crops, products for the subsistence activities of the households are substitutes for food imports, and may be of greater nutritional value than the latter. Thus, the criteria used are as follows: (1) an efficient use of resources to achieve an output (yield) that corresponds with farmers' production goals; (2) producer prices of cash crops; (3) nutritional diversity of subsistence products. These criteria are based additionally on another attribute, derived from the reflections on fluctuations, plant pests and the like: (4) the *stability* of a system to produce a relatively constant output even with disturbances (cf. Tabora 1991, 42).

Availability and use of resources

Land

Traditional agroforestry is not only used to claim and strengthen land tenure, and thus to secure land for the children. It may also be a labour- and capital-efficient strategy to intensify and diversify production *in small land-holdings*, e.g. in a *mixed garden* with a layered vertical arrangement of a multitude of annuals and perennials. On small tropical islands like Tioor and Rhun, an intensification in staple food production for self-sufficiency, which is one of the peasant goals, is principally only possible by means of an *increase in output per area*, as new land cannot be claimed for additional production. Thus, labour or capital input (e.g., in form of commercial fertilisers) would have to be increased. As the example of Laida's mixed garden (case study in Ch. 6.5.1) suggests, however, labour-intensive cropping is less appropriate in situations where off-farm income generation is dominant. Capital is limited, too. If available, it is preferred to be used in realms related to other peasant goals: for instance, in house construction and improvement to strengthen status and respect of the household in the community, and in off-farm investments to diversify income generation. As an increase in labour and capital input is difficult, *permanent dry field agriculture* in Rhun could lose its dominance. It will remain productive on level land and in hollows due to insignificant erosion hazards, eventually with short fallow periods.

The case of *shifting cultivation* in Tioor seems to contradict the observed scarcity of land, as this practice needs large land-holdings for long fallow periods, in order to allow soil fertility to regenerate for another production cycle. "Where there is sufficient land to support fallow, no other farming practise will produce a higher return to labour without inputs of capital" (Arnold 1987, 180). However, land *is* scarce in Tioor. Most of the existing fields (*ladang*) have been established from primary forest for the first time, and are thus still sufficiently productive. Moreover, in most cases the fields are subsequently inter-planted with trees (*tumpangsari*) instead of being left fallow. Thus, the area of shifting cultivation will steadily decrease, as well as the length of fallow periods. Population growth will also contribute to decreasing land productivity under shifting cultivation with short rotational cycles.

Already established *tree gardens* are then a consequence of *tumpangsari*. So far, most farmers in Tioor have preferred to segregate the cultivation of annuals (in *ladang* fields) and perennials (in tree gardens). This is particularly due to the possibility of focusing on farming activities in *one ladang* location at a given period of time, whereas mature tree gardens are frequently visited only during harvest (cf. Ch. 6.5.2). As the farmer does not work simultaneously in several locations, he saves time and energy in the daily walk to just one *ladang* and its protection from wild boars. As soon as shifting cultivation reaches its ecological, spatial and demographic limits, however, the integrative approach of annual/perennial production in mixed gardens will become more efficient. An integration of trees may maintain or increase soil fertility with relatively low labour and capital input, and diversifies production for subsistence needs and for marketing. This development is emerging mainly in the eastern and southern parts of Tioor (cf. Map 3), and demonstrated by interviewed farmers (cf. Fig. 6.11) with land-holdings being too small for shifting cultivation.

Labour

Traditional agroforestry and labour availability are most obviously related in the form of moderating labour peaks and troughs (benefit B4 in Tab. 7.1): Labour input may be spread more evenly throughout the season due to different harvest seasons of tree products. Most of the labour input in mature tree groves is needed for the harvest, which for instance occurs three times per year in coconut tree gardens. The growing of annuals is more labour-intensive due to repeatedly growing, weeding, and harvesting, and protecting fields from wild boars. Moreover, a combination of annuals and perennials may be better adapted to the observed sexual division of agricultural activities. As already stated, sexual division of labour and decreasing labour input in farming allow male members of a household to increasingly perform off-farm activities, at least seasonally. However, in the early period of tree plantings, labour peaks and high labour input may still occur: The *establishment* of tree seedlings is usually carried out in the busiest time of the year, i.e. the rainy season, when annuals are preferably planted. And *husbandry* in young tree plantings may require labour-intensive and careful weeding.

Besides sexual division of labour, the age structure is of relevance. Trees are somewhat better adapted to the circumstances of an elderly farmer than is agriculture, because he cannot perform labour requiring great energy and strength such as clearing of trees and fence construction. Furthermore, the options for off-farm activities are limited, so that tree crops may significantly contribute to the income of an old farmer.

Hired labour is most commonly available through social relations, and requires little cash. The more labour-intensive growing of annuals in shifting cultivation is carried out in agricultural groups with reciprocal obligations (*kerja masohi*); cash is needed for certain food stuffs and tobacco for the group. Hired pickers of tree products commonly receive a share of the yield, so that no cash is required. The same is true in the case of leasing out goats with the arrangement of sharing the goats' offspring.

Capital

Capital is not necessary for locally available tree seedlings. Propagation material is either obtained from naturally established trees, or from seeds of propagated trees. Accessibility to seeds from trees of other households is possible free of cost through social relations and reciprocal obligations. Newly introduced tree species, however, require capital, both for propagation material and transaction costs of travelling. As the example of clove trees suggests, farmers do not necessarily regard this disadvantage as decisive to forego tree establishment. They reduce cash needs by paying tree seedlings in kind, e.g. with staple food crops.

Another advantage is the potential to *use internal inputs* that are obtained from species being cultivated in traditional agroforestry, thereby decreasing dependence on capital goods, and supporting off-farm activities and value-adding. Examples include: leaves of *Pandanus* spp. for *tikar* mats, forages for goat husbandry, sago leaves and bamboos for house and field hut construction, and timber for fuelwood, joinery, canoes and ship construction. Charcoal for forging is so far produced from timber in Tioor's primary forest. As these stocks may soon be depleted, it could be increasingly important to integrate trees producing good quality charcoal into gardens.

The *creation of capital stocks* can be interpreted as a form of saving asset, which could serve to meet greater investments and unforeseen contingencies (cf. benefit B6 in Tab. 7.1). Examples include: goat husbandry, timber trees (e.g., forest remnant trees spared from cutting in shifting cultivation, timber trees in *tumpangsari* and mixed gardens, and old protection trees in nutmeg tree gardens), and whole tree gardens as a security for credits.

A serious drawback of tree planting, however, is the *long waiting period* until maturity of most tree species. With the exception of the early period after propagation of trees, when annuals can still be inter-cropped, land is unproductive until there is no return from tree products.

Production goals

Although *staple food production for self-sufficiency* is an important objective of the household, it is not however, the exclusive rationale, as all households are integrating trees into their fields, to varying degrees. In Rhun, self-sufficiency is more pronounced than in Tioor, as income can be largely created through off-farm activities, and as the more fertile soils allow an almost continual cultivation of annuals in level areas, eventually by fitting in short fallow periods. The reverse situation, i.e. *income generation with tree cash crops* as an exclusive goal without production of annuals, is also not evident. In Tioor, where copra, nutmeg and clove are important factors in the village economy, households depend on staple food as well. This is partly produced in sago tree gardens, which produce relatively stable amounts of starch to draw from in times (e.g., during pronounced dry periods) if annuals should fail.

Thus, the distinction between the two production goals of self-sufficiency through cultivation of annuals on the one hand, and of income creation through tree-planting on the other, is not an appropriate one and should not be exaggerated. Rather, farmers on both islands set priorities for the production goals of (1) *diversification of products*, including production of annuals for marketing as well as food and secondary products from trees (e.g., sago, fruits) for self-sufficiency, and of (2) *reduction of risks and dependencies*. In this way, the efficient use of resources by tree cultivation may contribute to these production aims.

Markets and marketing

As most households produce perennial cash crops, producer prices are crucial for the profitability of their farming system. Producer prices (i.e. the price which a farmer actually receives for his products) depend on several factors. Markets and the type of marketing are most important. Market information and bargaining position of farmers also greatly influence the degree of imbalance between producer and market price. An understanding of these factors is essential in sorting out strategies to improve producer prices and the profitability of crops (see Ch. 8.3.2).

Low producer prices are often a result of *supply topping demand.* For instance, *high* producer prices of a tree product for international and domestic markets give an incentive to extensively plant this tree species. If many farmers in a region (and concerning products for international markets in several countries) follow this strategy, prices will plummet as soon as new plantings come into bearing, as demand in most cases is inelastic. Then, farmers may disregard further tree harvest and marketing, or eventually replace the trees with other crops, resulting in rising prices as soon as supplies again becomes limited. Producer prices for world market products are also influenced by the exchange rate of Rupiah/US$ (see Ch. 6.3.7).

For small and isolated islands like Tioor, irregularity and high costs of transportation, seasonally rough sea, a perishable nature and a concurrent harvest season of certain tree products (mainly fruits), and distant markets are further complicating the issue of low producer prices. Rhun is in a better position due to the nearby local market of Banda Neira, and regular communication by local vessels between Rhun, Banda Neira and Ambon. Moreover, *market information* is obtained easier and faster by regular communication than in Tioor, so that the *bargaining position of farmers* can be strengthened. As outlined in previous chapters, copra farmers in Tioor are in a bad bargaining situation in relation to the ethnic Chinese entrepreneurs.

Nutritional diversity

As stressed in Ch. 6.3.7 and by other sources as well (e.g., Thaman and Clarke 1993, 21; Marten 1990), an characteristic of traditional agroforestry is its important contribution to local food supply. The intake of various vitamins, minerals, proteins and fibres from fruits, seeds and leaves is an important step towards a balanced and healthy nutrition. This is particularly important in times of drought when the supply of herbaceous vegetables is very limited. Several tree species also provide starch products such as *Artocarpus* spp., sago palm, bananas and sugar palm. More information on nutritional value and nutritional diversity of tree products in traditional agroforestry is provided in App. 1.7.

Risks and stability

As reduction or avoidance of *risks* was identified as one of the two prior farmer goals, other economic considerations are often modified or overridden, even if the latter seem to be more promising in the event that they are successful in the long term. It is usually argued that a poor farmer, who is close to the margins of existence, is concerned to avoid risks in the short term (cf. also Arnold 1987, 187; and Ch. 6.4.1). However, *time-horizons* of individual farmers may differ along with differences in availability of resources, and experience. Potential risks are manifold, for instance: climatic disturbances, such as drought, strong wind and heavy rain; soil degradation; plant pests and diseases; crop failures; fluctuations of producer prices; and insecure land tenure. The relevance of these risks is differently perceived and assessed by a given farmer. Another factor in examining the question, if tree planting may either increase, or reduce and even avoid one or several risks, is the *stability* of the farming system.

Tree planting may contribute to risk reduction as output of the farming system is diversified and produced over the different seasons. Should one crop fail, other crops may still produce reasonable yields, so that the system may be regarded as stable. For instance, the risk of plant pests and diseases is much greater in mono-cropping than in a diversified farming system including various tree species, also because trees serve as a habitat for animals preying on crop pests (see above). The impact of *Sexava* sp. illustrates the threat by pest infestation in coconut tree gardens in Tioor. However, the less likely spread of plant pests and diseases – except of wind-spread pests and diseases – from other areas is an advantage of tree-growing on isolated small islands. For instance, *Citrus* spp. are vulnerable to various diseases, so that healthy propagation material could be planted under strict quarantine, following eradication of all infected trees on these islands (cf. Samson 1991, 141). The positive effect of trees on soil moisture and fertility, and their potential to reduce the effects of wind and heavy rain was outlined in previous sections, as well as the insurance function of trees and capital assets of other agroforestry components (e.g., goats). Thus, risks may be reduced by tree cultivation, at least in the medium term when trees have reached maturity.

An increase of risks by tree planting is also possible. If a farmer must set priority towards a short-term orientated risk avoidance, he will focus on crops which can produce food and income faster than tree species can do. In small land-holdings in level land without significant erosion hazards, for instance, farmers will tend to prefer the cultivation of annuals for self-sufficiency of staple food, particularly if the small farm is the main source of support of the household. “On the other hand, where income from the land has become only a minor or supplementary component of the overall income, tree crops can again contribute positively to risk reduction” (Arnold 1987, 187). Volatile producer prices of tree cash crops and insecure land tenure may also be detrimental to tree planting. However, where the existence of trees somewhat strengthens insecure land tenure or secures claimed land, the latter drawback could turn out to be a potential advantage of tree establishment (cf. Tab. 7.2).

7.1.3 Social acceptability and adaptability

Another crucial question is, whether or not *farmers are both willing and able to practise more extensive tree planting*. It can be argued that traditional agroforestry is socially acceptable and adaptable for the islanders, as existing examples of these systems have been locally developed and have stood the test of time. However, two issues require an evaluation of social acceptability and adaptability. *The first issue* is related to dry field agriculture, which dominates the landscape – fallow areas have to be included – and which may conflict with an enlargement of traditional agroforestry. Thus, an evaluation should deal with social factors that could explain some peasants' ambivalent or negligent attitude towards more extensive tree planting. Social acceptability of agroforestry is also closely related to the economic profitability of the system. Economic reasons for a negligent attitude towards agroforestry were discussed in Ch. 7.1.2.

The second issue is concerned with the future prospects of traditional agroforestry. Generally, the long-term continuance of a land-use system will depend on its superiority to other land-use systems with regard to both its potential to satisfy the needs of the local people and its adaptation to the natural environment (cf. Sardjono 1990, 134-5). Thus, presently superior traditional agroforestry may not be suitable in the future.

The criteria used for social acceptability and adaptability are related to the realms of institutions, tenure, economy (see Ch. 7.1.2), culture, knowledge, and perceptions.

Institutions

As highlighted previously, institutional issues have a strong influence on peasant decision-making related to tree planting. Agroforestry could be beneficial for an individual farmer. However, this does not necessarily mean that the community or other households will obtain these benefits as well. Vice versa, if each farmer rationally neglects tree planting to avoid risks and costs of agroforestry, the community may be worse off in the end, as a result of externalities such as soil erosion and sedimentation in the littoral ecosystems. Functioning institutional arrangements could help to deal with differing interests, conflicts, and disputes between land-users and social organisations at different levels. Therefore, examples of institutional problems and (functioning or failing) arrangements are summarised in the following.

Young trees planted along or near field boundaries are frequently removed by a field neighbour who is worried about possibly declining yields of his annuals, because he regards trees as competitors for light and nutrients for his annual crops. Other reasons for tree removal may be envy at trees of another farmer, or disputes about the exact field boundary. Institutional arrangements allow farmers to plant only certain tree species on field boundaries, of which products are accessible to the field neighbour as well, such as *Moringa oleifera* Lamk, *Cocos nucifera* L., and shrubs like *Ananas comosus* (L.) Merr.

Destruction of trees and annuals by *spreading fire* or falling trees in the wake of slash-and-burn activities are very common in Tioor, and occasionally occur in Rhun. Although usually regulated by a traditional *adat* hearing, the responsible party sometimes refuses to pay compensation.

Theft of tree products is a widespread phenomena in both communities. Concerning cash crops, such as coconut, individual *sasi* in Tioor has been a response to this problem. However, its effectiveness as a deterrent against theft is not guaranteed. Most farmers interviewed complained about a loss of coconuts and nutmegs by theft. Moreover, up to now products serving the subsistence activities of the household cannot be included in *sasi* regulations.

In Rhun, because farmers do not restrict animals to their own fields, *browsing goats* frequently damage or destroy trees and annuals of other farmers. Until now, institutional arrangements for the payment of compensation by the responsible party do not exist.

Table 7.2: Beneficial and obstructive factors of tenure in traditional agroforestry

	Beneficial factors	Obstructive factors
Land and tree tenure	Tree planting strengthens claims on land, e.g. in primary forests in Tioor or in remaining nutmeg plantings in Rhun. **Rhun**: Tree planting has driven back nutmeg plantation, contributing to an appropriation of governmental land. **Tioor**: Tree garden areas are peasants' property.	**Rhun**: Most of the island is *de jure* governmental land; potential re-establishment of a nutmeg plantation would expropriate farmers' tree plantings. **Rhun**: Migrating households still hold tenure on fields, so that relatives cannot plant trees without approval of the former. **Rhun**: Farmer-established nutmeg trees are state property and subject to tax payments. **Tioor**: Coconut tree gardens are subject to tax payments. **Tioor**: Tree planting cannot be performed on commonly held land (e.g., agricultural groups, clans) being reserved for shifting cultivation.
Accessibility to tree products and trees	Accessibility to tree products of another farmer (e.g., sago starch in Tioor; coconuts for subsistence activities in Rhun) is part of the social security arrangements of the households.	Certain tree species (e.g., timber trees) are regarded as naturally established, so that access to tree products is free or relatively easy; a planter of such species cannot easily refuse requests of other parties without endangering his respect in the community. Theft of tree products is widespread. Products of trees planted in family's or clan's land are accessible to other household of the family or clan, respectively. **Rhun**: Protection trees (e.g., *Canarium vulgare*) are common property, so that their non-timber products are freely accessible.

Note: Factors are relevant on both islands, if not otherwise specified.

Source: Interviews, observation, PRA, and workshop sessions (Stubenvoll 1996 and 1997).

Tenure and accessibility to tree products

The complex issues of land and tree tenure, and accessibility to tree products in both communities were explored in detail in previous chapters. Beneficial and obstructive factors of tenure concerning tree planting in Tioor and Rhun are summarised in Tab. 7.2.

The most significant *beneficial* factor is a secured or strengthened tenure on land where trees are planted. However, in the case of Rhun, one *obstructive* factor is essential for many farmers in neglecting extensive tree planting. The high production potential of nutmeg could be an incentive for private investors to (re-) establish a nutmeg plantation on governmental land (see Ch. 8.3.3). Farmer-owned trees on that land would then be expropriated with a low compensation. *Accessibility* to tree products also has an ambivalent character with regard to tree planting. On the one hand, farmers may neglect planting of trees, the products of which are freely accessible (such as *Canarium vulgare* Leenh.). On the other hand, certain tree products such as sago starch and sago palm leaves serve as a means of reciprocity in social security arrangements.

Knowledge, cultural factors, and farmers' perceptions

Traditional agroforestry has not only included trees yielding cash crops into the system. Rather, it depends on a multitude of indigenous tree species, of which a wide range of non-timber items are locally used for self-sufficiency. An example are medicinal plants which are either deliberately integrated by the farmers – most commonly by the women – in tree gardens and mixed gardens, or which are naturally established. In Tioor, some 60 woody and non-woody plant species producing traditional medicines were identified (App. 1.6). Local knowledge with regard to useful functions of plant parts (leaf, bark, etc.) gained from generations of indigenous experiments is a precondition for trees to be cultivated or to be spared from removal. This fact also underlines potential difficulties in introducing non-indigenous tree species, because farmers may lack knowledge, or may neglect an introduction due to perceived undesirable tree characteristics. Examples include: tall fruit trees in Rhun, which are not planted near the house as their root system may otherwise destroy the water tank; trees with an abundant fall of leaves, which are not planted in the village as women save the daily sweeping around the house; tall trees with heavy fruits which are not grown near the house as falling fruits otherwise may damage the roof; and trees susceptible to strong wind which may not be integrated in tree gardens in order to protect smaller trees from damage by falling branches, or to avoid the risk of injuries or death by collapsing trees when picking the harvest.

Another socio-cultural factor is a gender-specific perception and opinion of tree planting. This may be due to distinct tasks of men and women or due to special needs of tree products. The sugar palm (*Arenga pinnata* (Wurmb) Merrill), for instance, is highly appreciated by men in Rhun for its alcoholic beverage, whereas *Pandanus* species are commonly planted by women who are engaged in *tikar* mat production.

7.1.4 Relevance of constraints for tree planting

Traditional agroforestry has the potential to maintain agricultural productivity and to minimise ecological problems, while being a sound land-use system in socio-cultural and economic respects. Tab. 7.3 summarises the evaluation of agroforestry by using five ranks; it is not further annotated. To extend the area under agroforestry, farmers on both islands are facing various difficulties, however, which are assessed in order of declining importance.

Weakening or failing institutional regulations

Although institutional regulations exist in the community (e.g., understanding of land and tree tenure), they have become weaker. In the worst case problems, externalities, and disputes are not regulated at all. Examples include: spread of fire to gardens or damage/destruction of trees by goats without compensation; disputes over field boundaries; and theft of farm products.

Insecure tenure rights (in Rhun)

Rhunese farmers may tend to prefer annuals, because investments in trees seem to be risky due to the insecure land tenure. If the Government reclaimed land for the re-establishment of a nutmeg plantation, peasants would lose access to their trees. Paid compensation would not be equivalent with lost future income, and costs of locking up land for production of annuals. Nonetheless, and somewhat contradictory to this conclusion, farmers have planted trees to drive back nutmeg plantations.

Food security versus agroforestry

Farmers *with small land-holdings* tend to give priority to annuals due to the importance of both food security and of independence from food imports, although tree planting may become more efficient in terms of labour and capital input. Trees provide additional products, including for the market economy, but so far they are usually planted only if there is land remaining, if land is too infertile for annuals, or if erosion problems become evident.

Lack of tree seedlings

Farmers reported the lack of tree seedlings as a major problem. This statement by the farmers indicates their perception of ecological problems and decreasing soil productivity, and their understanding of the importance of integrating trees into dry fields. However, some farmers are successfully organising various species of tree seedlings, most of which are locally available. Thus, the stated problem might be reduced to ‘a lack of *certain species* of tree seedlings’.

Table 7.3: Summary of qualitative evaluation of traditional agroforestry

Type, practice	Sustainability	Productivity	Stability	Adaptability	Acceptability
Shifting cultivation, long fallow	high	low	medium	**very high**	**very high**
Shifting cultivation, short fallow, and/or steep terrain	*very low*	*very low*	*very low*	high	medium
Permanent dry fields[1]	medium	medium	medium	**very high**	high
Mono-specific coconut tree garden	medium	medium	medium	**very high**	**very high**
Mono-specific clove tree garden	medium	low	low	high	low[2]
Mono-specific nutmeg tree garden without protection trees	medium	medium	low	high	high/*very low*[3]
Mono-specific sago tree garden	high	medium	high	high	medium
Mixed tree garden; simple structure	high	**high**	medium	high	high
Nutmeg tree garden with **forest remnant trees**/protection trees	high	medium	high	high	medium/*very low*[3]
Agroforest	**very high**	medium	**very high**	high	medium
Mixed garden; simple structure	high	**high**	high	high	high
Mixed garden; complex structure	high	**high**	**very high**	high	high
Goat husbandry (small herds)	medium	**high**	medium	*medium*	medium

Notes: Some practices are present in only one island: **bold** in Tioor; *italic* in Rhun.
1 Not a traditional agroforestry practice;
2 Until state monopoly in 1990 a *high* acceptability;
3 Acceptability in Tioor/*in Rhun*.

Sources: Interviews, observation, PRA, and workshop sessions (Stubenvoll 1996 and 1997); Sitaniapessy 1994, 5. Rank classes adapted from Tabora 1991, 45 (five ranks).

Marketing constraints

The *problem of transportation* of agroforestry products to markets outside of Rhun has lost most of its relevance, because communication is nowadays possible almost daily, either to Banda Neira or to Ambon. In Tioor, transportation is still less frequent, and has to be regarded as a drawback. The *demand for tree products* on the market in Banda Neira, especially for fruits, is expected to grow if tourism becomes more important. Even now demand is not satisfied during seasons with low fruit supply. Markets for Tioor could be the urban centres in Southeast Maluku (e.g., Tual). On the other hand, a widespread integration of trees could lead to oversupply and a *drop in prices*, especially for fruits, which have to be quickly marketed due to their perishable nature. The consumer would benefit from such a situation, in terms of falling prices and of health by increasing nutritional diversity.

Vulnerability of tree seedlings

Droughts are a serious threat to newly established tree plantings, so that farmers may be discouraged to repeat planting in the event of previous failures. Additionally, a lack of protection trees makes certain mature tree crops more vulnerable to severe droughts (e.g., nutmeg). Another risk is the occurrence of wild boars which may destroy newly established coconut plantings in Tioor.

Long waiting period till first harvesting of tree products

This constraint is linked with the importance of self-sufficiency. As long as a peasant is dependent on staple food, he cannot easily expand agroforestry. The long waiting period till harvesting of tree products will only be bridged, if sufficient income, for purchase of imported food, is obtained by off-farm activities.

Long absence of men (Rhun)

In Rhun, the long absence of men for fishing has the consequence, that the main actors in agricultural decision-making are women, who are traditionally responsible for sufficient food supply for the family. Thus, the influence of women in land use has become greater, and consequently the importance of annuals has increased. Men are usually the main actors in propagation, planting, husbandry of trees and in harvesting of tree products. As their influence in agriculture has decreased, men first have to help planting staple food, and only then they can use the remaining time to plant trees. Later on, necessary husbandry is likely to be insufficiently performed, limiting the prospects of newly established tree plantings.

Considering the potentials and flaws of traditional agroforestry, strategies towards an enhancement of such systems should be focused on (1) interventions to decrease the influence of constraints on tree planting, and on (2) acceptable modifications to improve agricultural practices in the existing local framework (see Ch. 8). The next chapter will conclude with future prospects of traditional agroforestry, on the condition of a development without strategic interventions.

7.2 Conclusion: Future prospects of traditional agroforestry

As von Maydell (1986, 172) points out, the scarcer arable land becomes, the more the trend towards agroforestry is under way. Many existing examples of agroforestry in densely populated areas underline that this hypothesis holds true (cf. Ch. 2.4). As land *is* a very limited resource on both small islands of Tioor and Rhun, and as annual population growth is some 2.5% and 1.7% respectively, the future prospects of traditional agroforestry seem to be bright, according to von Maydell's hypothesis.

However, agroforestry depends on other developments as well. Several risks were earlier discussed, such as volatile producer prices and insecure land tenure (the latter only in Rhun). Moreover, it has to be asked up to which population density traditional agroforestry may be a feasible land-use system. As the case study in Ch. 6.5.1 suggests, disputes about land use in the family's fields may be intensified when the children marry and found their own households. Migration could be a possible scenario, but it holds the problem that most commonly younger households with the greatest labour potential would migrate.

The future prospects of traditional agroforestry will depend much on the concurrence with other land-use types and systems as well (cf. Sardjono 1990, 134-5). The production of annuals in *dry fields* is obviously the major land-use practice concurrent to tree planting.[198] In Tioor, the production of annuals in shifting cultivation and a subsequent cultivation of perennials developing to tree gardens (*tumpangsari*) may soon reach its limits as the system depends on continued clearing of remaining primary forest land (in 1997: 16% of the island's area). The rapid driving back of primary forest since the 1970s has demonstrated the increasing difficulty of segregating shifting cultivation from tree garden areas. Yet, a part of secondary forest land will be sufficiently productive when being reclaimed for cultivation, as most of it is either of old age or a result of methods to struggle for land without previous cultivation. However, this situation is only true for the communities of Rumoi, Rumalusi, and Kerkar. In Kelvow and Wermaf, not only old secondary forest land is already limited, but also primary forest land has almost disappeared. Thus, the long term continuation of *tumpangsari* is questioned by the islanders: it may disappear, i.e. shifting cultivation will be practised *without* an integration of perennials such as coconut palms and nutmeg trees; or the land-use system may be modified in a way

[198] Nutmeg plantation is another land-use system concurrent to traditional agroforestry. A plan of the Government and influential figures in Banda Neira to re-establish a nutmeg plantation in the Banda Islands is in existence (see Ch. 8.3.3).

like some farmers in Kelvow, Wermaf, and Kerkar do: they have already begun to develop mixed garden systems, i.e. an *integrative approach* of cultivation of annuals and perennials on the same land unit. In Rhun, mixed gardens already occupy a significant part of the island's area.

A further enlargement of traditional agroforestry also depends on the question of how the households on both islands will be able to meet their staple food needs. Until today, cassava from dry fields and mixed gardens are the major source of carbohydrates in Rhun and Tioor. In Tioor, taro, sweet potato, upland rice and sago starch supplement the diet. The cultivation of a multitude of tree species, which provide both products for self-sufficiency, marketable surpluses of subsistence products and pure cash crops, could be an adaptable way *of securing the subsistence needs and the basic monetary income of the islanders*. An intensification of tree gardens and mixed gardens including a better and more stable producer price of cash crops is a possibility to decrease the dependency on locally produced staple food crops. Thus, it is crucial to identify (1) tree species which can fulfil these criteria, and (2) ways of valorising agroforestry products.

Concerning an adaptation of traditional agroforestry to the natural environment, the islanders' perception of environmental problems and hazards, and their knowledge of the causes is a precondition, although not necessarily in itself sufficient, to take measures against these problems in the form of more extensive tree planting. Traditional agroforestry could therefore gain importance in the future. In this context, opinion leaders – like Laida in Rhun, and Tioorese farmers in Kelvow, Wermaf, and Kerkar – could take on a leading role in enhancing agroforestry, if other farmers valued the advantages of such existing systems. As other examples in Rhun and Tioor demonstrate, the role of opinion leaders in adaptation of new and successful economic strategies could prove to be relevant for agroforestry extension as well.[199]

Finally, it has to be emphasised, that it is not the issue to *entirely* replace dry fields with tree gardens or mixed gardens, but to cope with the degradation of resources and of the landscape. Or, as Clarke and Thaman (1993, 193) stress: "To maintain the landscape in good health it is not necessary that every land-holding, every stretch of land, contain trees, just as every farmer need not to be an agroforester – but it is necessary that there be sufficient trees in the right places, at least on sloping land and along streams."

[199] As a farmer in Rhun put it: "*We are a society of imitators and followers. Once someone is successful, all others will do the same (ikut-ikutan). Consider fishing activities in other islands: Nowadays almost every household tries to get his own ship!*"

8. AGROFORESTRY FOR COMMUNITY-BASED DEVELOPMENT

The purpose of this chapter is to examine strategies for achieving sustainable production while at the same time conserving limited and fragile natural resources. Moreover, these strategies must be socially acceptable, so they require taking into account the *diverse* needs, priorities, capacities, aspirations and perceptions of the islanders in Tioor and Rhun. As will be discussed in the following sections, the approach is one of community-based development built on participatory land-use planning (Ch. 8.1). This strategy is linked with the construction of a community-based resource management plan (Ch. 8.2). Options for furthering traditional agroforestry and modifying agricultural management, as well as other preconditions for implementing and supporting a community-based resource management plan for community-based sustainable development must be also considered (Ch. 8.3).

8.1 Participatory land-use planning

Land-use planning is a basic component of a strategy towards balancing conservation and local economic development goals. It aims to match land types and land uses in the most rational way possible, and "... to make the best use of limited resources by:

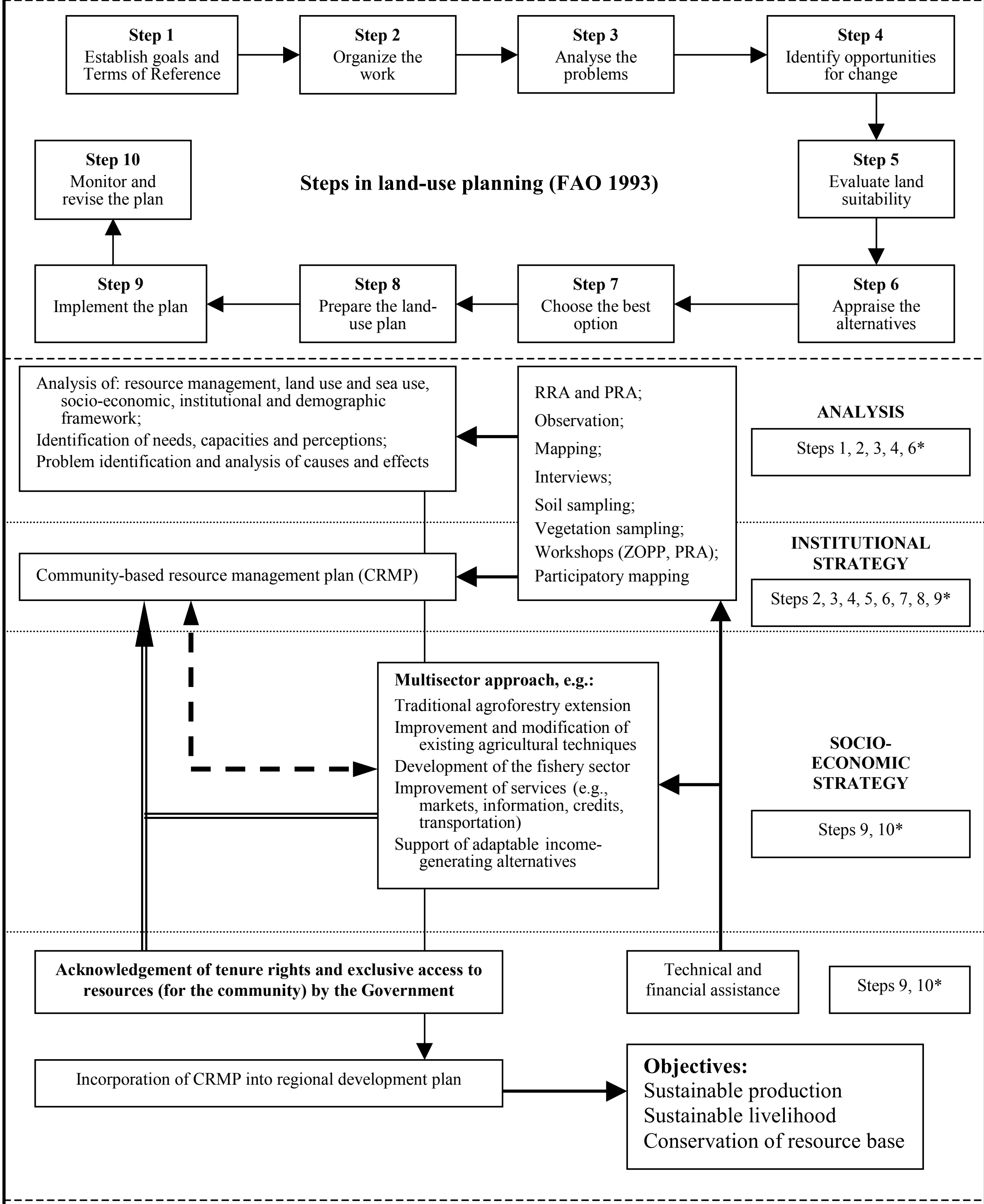
- assessing present and future needs and systematically evaluating the land's ability to supply them;
- identifying and resolving conflicts between competing uses, between the needs of individuals and those of the community, and between the needs of the present generation and those of future generations;
- seeking sustainable options and choosing those that best meet identified needs;
- planning to bring about desired changes; [and]
- learning from experience." (FAO 1993, 3).

FAO (1993) developed a sequence of ten steps of the planning process (see Fig. 8.1), which may have to be adapted to local circumstances. "In the still broader view, the steps can be grouped into the following logical sequence:

- Identify the problems. *Steps 1-3*.
- Determine what alternative solutions exist. *Steps 4-6*.
- Decide which is the best alternative and prepare the plan. *Steps 7-8*.
- Put the plan into action, see how it works and learn from experience. *Steps 9-10.*" (FAO 1993, 11f).

Land-use planning requires *community participation*, because land users in the involved communities must put the plan into effect (FAO 1993, 9; Amler and Betke 1993, viii). Locals' acceptability of new regulations, creation of local responsibility for sustainable resource management, and identification of people's diverse needs and perceptions, are also more likely to be achieved by local participation in the planning process. Moreover, this bottom-up planning goes hand-in-hand with the recent recognition of the conservation value and management potential of *indigenous knowledge* (cf. e.g., Momberg 1993). Its value is also acknowledged for participatory research, and project design/management (e.g., Khon Kaen University 1988; Chambers et al. 1989; Momberg 1993; Grimble and Chan 1995). This shift to participatory, demand-driven planning and community-based development emerged in response to the perceived deficiency of supply-driven, top-down approaches for assessing and designing projects, as well as of central command-and-control policies and resource management regimes, administered by governments or development agencies (cf. Narayan 1995, 5; Pannell 1997, 290).

Figure 8.1: Steps in land-use planning and approach for sustainable development on the islands of Tioor and Rhun



Notes:
- process of planning & implementation
- interdependent strategic elements
- preconditions for implementation
- methods and inputs to achieve results

* corresponding to FAO's steps in land-use planning

Source: Adapted from FAO 1993, 12; Stubenvoll 2000.

Concerning small tropical island communities, which depend heavily on marine resources for their livelihood, it is fundamental not to restrict the planning procedure to land use and management of terrestrial resources, but rather to include the management of marine, in particular littoral ecosystems as well. Accordingly, in the discussion on community-based development and resource management, the approach has to be extended to *land-use and sea-use planning*.

Fig. 8.1 shows the approach to address the objectives of sustainable production, sustainable livelihood, and conservation of the resource base. In a first step, present resource management, land use, and the like are analysed, and related problems are identified. For Tioor and Rhun, methodology and results of the analysis were subject of the Chapters 3 to 7. Such an analysis is a precondition to continue with the construction of a *community-based resource management plan* (Ch. 8.2). Additionally, local organisations have to be identified, and if necessary strengthened or created, for its implementation.

Other components of the approach are concerned with the *socio-economic* conditions of the islanders (Ch. 8.3.1 and Ch. 8.3.2). This has two main reasons:

(1) A community-based resource management plan is an innovation, which ultimately changes the co-ordinates of resource management potentials. Certain groups, especially resource-poor farmers and fishermen, may economically depend on natural resources, which will be subject to regulations likely restricting their utilisation. For these groups to be capable and willing to accept the plan, adaptable *alternatives of income generation* must be identified, developed and supported with technical and financial assistance. Principally, this identification requires a multisector approach, as problems are manifold, and as these problems are also caused by factors beyond a sector's limits. For instance, traditional agroforestry extension is part of the agricultural sector activities, but it also positively affects fishery by reducing soil erosion and sedimentation in the littoral.

(2) Sustainable resource management is more likely to be successful, if products of existing income-generating activities are valorised, e.g. by improving infrastructure, marketing and services.

Finally, implementation of a resource management plan and of socio-economic measures depends on an acknowledgement of tenure rights and exclusive access to resources for the communities by the Government. An approval of the plan is a first precondition, its inclusion in the regional development plan a necessary subsequent step. These facts underline, that bottom-up planning should be consistent with national guidelines and linked with regional top-down planning (cf. Ch. 8.3.3).

8.2 Community-based resource management plans (CRMPs)

These general reflections on participatory land- and sea-use planning are deployed for an investigation of community-based development in the context of Tioor and Rhun. Both communities worked out a community-based resource management plan (CRMP) as a basis to tackle environmental, institutional, and socio-economic problems (Masyarakat Pulau Rhun 1996; Masyarakat Pulau Tioor 1997), facilitated by my research activities. In the following, goals and principles of these CRMPs are discussed (Ch. 8.2.1), before turning to steps and methods of the planning process (Ch. 8.2.2) as well as to their contents (Ch. 8.2.3). An evaluation of both CRMPs is subject of Ch. 8.2.4.

8.2.1 Goals and principles

Goals of the CRMPs can be derived from the main objectives of development stated above – sustainable production, sustainable livelihood, conservation, and acceptability. Additionally, *specific goals* include:

(1) *Strengthening of traditional land and tree tenure*: This is due to the contradiction of the (insecure) traditional versus *de jure* land and tree tenure systems, which is a major constraint for an enhancement of tree planting (cf. Ch. 5.4.3, Ch. 6.3.3, Ch. 6.3.6, and Ch. 7.1.4);

(2) *Provision of a local institutional framework* ('regulations') *for encouraging traditional agroforestry*: Institutional problems at the local level also have so far prevented many farmers from enlarging the area under traditional agroforestry (cf. Ch. 7.1.4). Furthermore, improvement of existing agricultural techniques and encouragement of traditional agroforestry require an institutional framework to deal with *local* contradictions of *de facto* versus traditional land tenure.

(3) *Recognition of rights for the communities to responsibly control and manage local marine resources*: Exclusive access to commercialised marine species in and near the littoral of the villages' sea territory, especially in the distant coral islands of Uran and Baam, is directed at empowering the islanders, and at legitimating and supporting local capacity to curb overexploitation of marine resources and destructive fishing methods by external user groups (cf. Ch. 5.5.2).

These specific goals are interdependent, and crucial for achieving the main objectives of sustainable production and livelihood, conservation and acceptability. Underlined by the previous analysis, the prioritisation of these goals is site-specific. For instance, the goal of 'strengthening of traditional land tenure' is more relevant in Rhun, whereas 'rights to control and manage marine resources' (or 'strengthening of traditional sea tenure') is of high priority in Tioor.

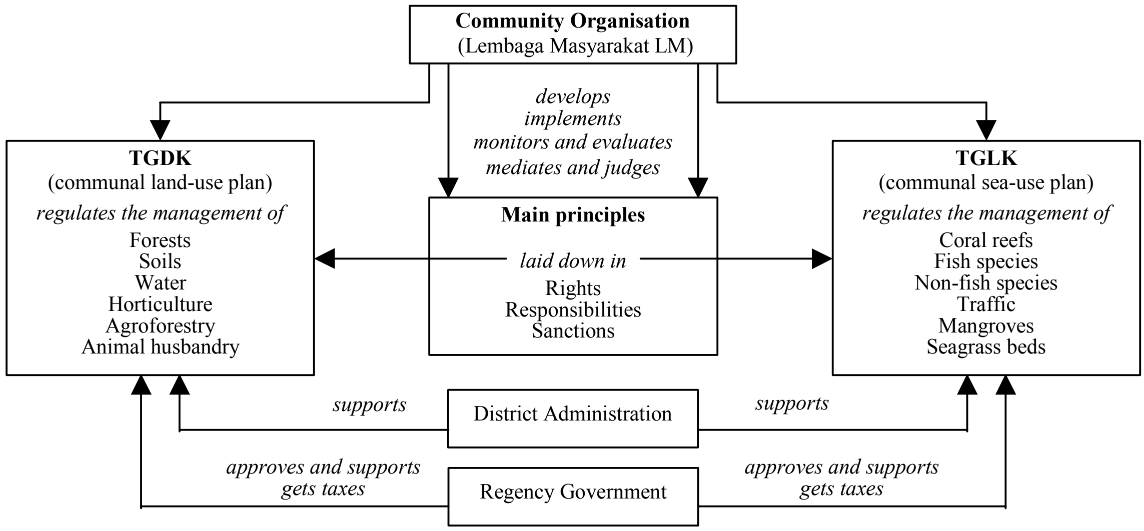
Fig. 8.2 illustrates the common *principles* of a CRMP. A Community Organisation (*Lembaga Masyarakat*, LM) develops,[200] implements, monitors, and evaluates the communal regulation about land use (TGDK) and sea use (TGLK).[201] At later stages, LM may have to improve the plan by

[200] As the discussion in Ch. 8.2.2 will show, the *construction* of a CRMP solely by the LM is less appropriate where participation of villagers would then be limited, or where a LM still has to be created.

[201] The Indonesian terms Tata Guna Darat Kesepakatan (TGDK) and Tata Guna Laut Kesepakatan (TGLK) may be translated with 'agreement reached on land use' and 'agreement reached on sea use', respectively. A combined term of both plans is then TGDLK (Tata Guna Darat dan Laut Kesepakatan). In App. 4, both CRMPs are provided in English, translated from the original documents.

A similar term, TGHK (Tata Guna Hutan Kesepakatan; the 1982 agreement reached on forest land use), is deployed by the Ministry of Forestry (MoF) for a classification of state forests into five categories, as well as related purposes and permitted exploitation: (1) nature reserve for nature and genetic conservation (no exploitation), (2) protection forest for water and soil protection (no exploitation), (3) restricted production forest for erosion protection and timber production (selective felling), (4) normal production forest for timber production (selective or clear-felling), and (5) conversion adapting or adding regulations, in order to take account of new developments or experiences with CRMP's implementation. This indicates that the planning process is iterative and continuous.

Figure 8.2: Principles of a community-based resource management plan



Source: Stubenvoll 2000.

LM consists of four co-operating groups:

(1) The *village administration* (*kepala desa*, LKMD, LMD, etc.) co-operates additionally with the district administration, and is the contact body for the Government at regency level.

(2) The *representatives of the farming community* (*tokoh masyarakat*) who are elected in the two villages.[202] The common purpose of the creation of *tokoh masyarakat* is to more directly involve land and sea users, in order to enhance their readiness to accept and to implement the CRMP.

(3) The *religious leaders* (*tokoh agama*), who represent the religions (Islam, Catholicism, and Protestantism), and who are included in LM as influential figures in both communities.

(4) *Adat leaders* (*tokoh adat*) are only present in Tioor (see Ch. 5.4.2), so in Rhun religious leaders take on their duties.

LM's rights and duties are explicitly formulated in App. 4. LM is only responsible for matters concerning the CRMP, and does not have any other rights and responsibilities. The district administrations in Geser (for Tioor) and Banda Neira (for Rhun) support the respective CRMP. The Government at regency level (in Masohi) approves and supports, and subsequently integrates CRMP into its regional development plan. A part of the expected community's profits from CRMP will be paid later in form of taxes to the Government at regency level, to ensure its necessary assistance in the long term. It is stressed that co-operation between the communities (via LM) and the administration is starting after the formulation of CRMP.

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forest for conversion to agriculture or other uses (clear-felling). However, the 'agreement' TGHK only expresses the views of the Government and timber concessionaires as it has not considered customary land tenure or traditional village boundaries. The RePPProT maps (1988-89) also show these forest categories, although disparities between the MoF's maps may lead to confusion in the field (cf. Monk et al. 1997, 603).

[202] Rhun Island is divided into ten sub-units, each comprising several traditionally named locations (cf. Map 7.2.1). All peasant households farming on a certain sub-unit are organised in one farmer group and then elect two representatives – a man and a woman. Only farmer group No. 1 is represented by two chairmen and one chairwomen, due to its high number of farmers. In Tioor Island, each of the five communities (*dusun*) is represented by one man and one woman. The election is organised by the respective community leader (*kepala dusun*). See also Ch. 8.2.3.

The *main principles* – rights, responsibilities and sanctions – are laid down both in TGDK and TGLK which regulate most aspects of land use and sea use, respectively. *Agroforestry* is a key element of TGDK, directly influencing agriculture and animal husbandry, and indirectly affecting soil, forestry, water, coral reef, fish and non-fish stocks.

Despite these common principles, both CRMPs show significant differences which are expressed by the obvious, but important fact, that local conditions and resource management differ on both islands. On Rhun, for instance, CRMP only covers land use (TGDK), because the villagers perceive environmental problems as more severe in the terrestrial ecosystems. Nevertheless, they decided to work out a sea-use plan later on, if TGDK proves to be effective. Tioor's resource management plan covers both land use and sea use, and is accordingly titled as 'TGDLK Pulau Tioor' (cf. footnote 201). The village stressed the necessity of an immediate integration of marine resource management in the form of *sasi* into its CRMP. For the time being, this integration has proved to be the only effective tool for successfully rejecting a fishing enterprise which tried to gain access to the coral reefs of Tioor and surrounding islands in November 1997 (cf. Ch. 8.2.4). These differences not only find expression in the contents of the CRMPs, but also in the procedure of steps deployed to formulate a CRMP.

8.2.2 Steps and methods

Overall and specific goals, and principles of a CRMP were the basis for the planning process (Fig. 8.1) and the construction of a CRMP in both communities. Actually, the first six steps of FAO's guidelines for land-use planning, grouped into 'identification of problems' and 'determination of alternative solutions' (cf. Ch. 8.1), were also part of the field survey before carrying out the first activities of CRMP construction.[203] Thus, field research and construction of a CRMP were interdependent activities in the whole planning process. This interdependence is expressed in terms of *knowledge* of the local framework. As the methodology of research activities was based on qualitative social research, PRA and RRA (cf. Ch. 3.2), much information on traditional knowledge, on needs and perceptions of the farmers, and on problems and locally developed strategies could be collected. On the one hand, this information and an understanding of problems were a justification to proceed in land- and sea-use planning, and a precondition to looking for alternative solutions. In the subsequent development phase of a CRMP, on the other hand, more information was acquired, contributing to a deeper knowledge of the existing local framework. Such an approach may support the choice of a 'best' alternative, i.e. steps 7 and 8 of the planning process as proposed by FAO's (1993) guidelines for land-use planning.

The information collected during the field survey was not only crucial for the contents of each CRMP, but also important for choosing the appropriate approach and required methods of its own construction. The construction and formulation of a CMRP was a complex effort, which required a well thought-out sequence of steps and a combination of methods used in workshop sessions, informal group discussions, and mapping activities. Methods include *Zielorientierte Projektplanung* (ZOPP, target-oriented project planning; cf. GTZ 1987), stakeholder analysis (cf. Grimble and Chan 1995), participatory rural appraisal (PRA; cf. Chambers 1983; Mosse 1994), and participatory mapping. Based on experience and preliminary results of the field survey, and on consultation with village head (*kepala desa*), community heads (*kepala dusun, kepala RT*) and other influential villagers (e.g., religious leaders, opinion leaders), a procedure for the construction of a CRMP was developed. Steps and differences between the two villages are outlined in the following.[204]

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[203] Rhun's CRMP was developed and formulated in September 1996, Tioor's CRMP in November 1997.

[204] The *ideal* character of the sequence of steps must be stressed again. Practically, the procedure is iterative and continuous, and may have to be adapted to information obtained during the construction phase of a CRMP.

Step 1: Introduction of CRMP's principles to the heads of the village and the district administration

Before performing any activities for the construction of a CRMP, the approach has to be introduced to influential village representatives. In Indonesia, it is a question of respect and of recognition of his local authority to *first* involve the village head (*kepala desa*). Moreover, he formally has to approve the construction of a community organisation (LM) that includes representatives of the farming community, and religious and customary leaders in addition to the village administration. Usually, only the latter would be the formal body to decide about local development options like a CRMP, and to propose actions via the district administration to the Government at regency level. Hence, the inclusion of other representatives into the LM is a measure that will cut the influence of the village administration concerning a CRMP.

The introduction of CRMP's goals and principles to the village head therefore requires including the justification of the LM's construction, and the clarification of LM's competence. As discussed earlier (Ch. 5.4.2), the *kepala desa* and the members of the village administration, in both villages, are confronted with a principal dilemma. On the one hand, they are members of the society, represent the village, and have to serve local interests and development goals. On the other hand, they are accountable to the Government, which actually approves the election of the *kepala desa* and directly supervises him and the village administration in the person of a military official (*babinsa*). Passing and implementation of a CMRP solely by the village administration then could be interpreted by the villagers as a tool of the Government to regulate local resource management in a typical top-down situation. As a consequence a CRMP could be rejected by the islanders, so successful implementation of a CRMP would be unlikely. In fact, the village heads of both Tioor and Rhun strongly supported the additional inclusion of village representatives beyond the formal village administration in the LM. After the approval of the CRMP's principles by the *kepala desa*, the head of the district administration (*camat*) is informed about the plan, as the district administration later has to support its implementation.[205]

Step 2: Introduction of CRMP's principles to influential village representatives and opinion leaders

Influential village representatives and opinion leaders are partly identified by stakeholder analysis during the field survey.[206] In addition, during Step 1, the village head provides more information on this group. The introduction of CRMP's goals and principles, and the planning procedure, to village representatives and opinion leaders has two main purposes. Firstly, at the end of the meeting the members of this group decide on an approval of continuing the procedure. Obviously, in case of a rejection, the construction and formulation of a CRMP is not possible, unless acceptable alternatives can be discussed and compromises agreed on at this stage. Secondly, during the meeting, the understanding of interests and perceptions of village and opinion leaders can be improved, to more easily find common ground. This will result in a categorisation and involvement of those members of the group potentially supporting the plan, and those potentially challenging, opposing or rejecting it at later steps of the procedure. Thus, the introduction of CRMP's principles to village and opinion leaders will contribute to give "early considerations to ways of building on commonalities and

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[205] Actually, this was only carried out in Banda Neira (for Rhun), because it was practically impossible to travel to the distant district town of Geser (for *isolated* Tioor). The *camat* in Banda Neira approved the plan, although he was sceptical about the chances of its implementation. Nonetheless, he stressed not to mention that the plan could have originated from himself or from other Government authorities, to avoid villagers' distrust and to increase their acceptance.

[206] Stakeholder analysis is an approach for "gaining an understanding of a system by means of identifying key actors or stakeholders in the system, and assessing their respective interest in that system. By 'stakeholder' is meant all those who affect, and/or are affected by the policies, decisions and actions of the system; they can be individuals, communities, social groups or institutions of any size, aggregation or level in society" (Grimble and Chan 1995, 114).

complementarities of interest and possibilities for cooperation and compromise" (Grimble and Chan 1995, 114).

In Rhun, one meeting was held, whereas in Tioor one meeting in each of the five communities was necessary to ensure the participation of all influential village representatives and opinion leaders. In all meetings, principal approval of proceeding with the construction of a CRMP was given. However, representatives of one community in Tioor (Rumoi) stressed their ambivalent attitude towards a part of the proposed principles, especially concerning regulations on marine resource management. Details on the background of this attitude are provided in Ch. 8.2.4.

Step 3: Construction of a preliminary CRMP (first workshop stage)

During workshop sessions a preliminary CRMP is constructed by the villagers, with methods of ZOPP and PRA. A first basis for constructing a CRMP is – in theory – the participation of all members of the village, although this is practically not feasible as not all villagers are able or willing to participate. Moreover, with an increasing number of participants workshop activities and discussion could get more and more chaotic. Thus, an appropriate way of organising workshops needs to be found (see below). A second basis is that all potential regulations on resource management, land and sea use are proposed, discussed, evaluated, and agreed on by the participants. This requires a discussion of problems and opportunities. And finally, a third basis is the presence of a panel chairman or facilitator, whose task is to guide the workshop by raising issues, problems and opportunities, summarising alternative solutions discussed in the forum, mediating between diverging interests, and helping to find compromises.

The approach to ensure participation of the villagers differed significantly between Rhun and Tioor. The reason is logistical: The dispersed settlements in Tioor made it unfeasible to hold all workshop sessions in a certain location, such as the village head's office in Rumoi, because villagers settling in the east coast and in Kelvow would have had to travel long distances, likely preventing their participation. Contrariwise, it was impossible to organise workshops on the east coast while staying in Rumoi due to difficult communication, and to transport material needed during the sessions. Therefore, it was decided to construct a preliminary CRMP in a two-day workshop in Rumoi by twenty village representatives (village leaders, as well as influential women, such as the chairwoman of the family welfare promotion PKK). This resulted in limited participation of villagers at this stage.

In Rhun with only one settlement, villagers' participation was much easier to be organised. The island's area was divided into ten, appropriate sub-units (cf. Map 7.2.1), in accordance with results of the field study and in consultation with the village head during Step 1. Farmer groups were created in a way that each group consists of all households farming in the respective sub-unit (see footnote 202). In addition, a youth group was formed. Workshop activities were then carried out by each group separately. For this purpose, all farming households of a group got a letter of invitation to participate in the workshop the next day.[207] During each workshop the following procedure was implemented:

(1) introduction of CRMP's goals and principles, and villagers' approval;

(2) problem formulation and discussion, and identification of opportunities (only by Group 1);

(3) problem discussion and identification of opportunities, and eventually formulation of further problems (only by Groups 2 to 10);

(4) participatory mapping and land evaluation of the respective sub-unit's locations (see below);

[207] Most households hold fields in more than one sub-unit. Accordingly those household heads and their wives were invited twice or more. About 60% of the invited household heads participated at least once in the workshops.

(5) discussion and formulation of proposed regulations concerning two types of opportunities;[208]

(6) evaluation of selected plant species (each group evaluated other annuals and perennials); and

(7) election of a chairman and a chairwoman as representatives of the farming community.

In Tioor, the approach was similar with two exceptions: Firstly, participatory mapping and land evaluation were performed in discussions with key informants before and during the workshop stage (see below). And secondly, representatives of the farming community were only elected after Step 6.

Step 4: Villagers' discussion about preliminary CRMP and second workshop stage

The results of the workshop activities are then formulated into a preliminary version of the CRMP, forming the basis of villagers' discussions. To avoid misinterpretations, it is important to explicitly stress in the preface of the document its provisional nature.[209] Copies of the typewritten document were then disseminated for informal discussion organised by the community heads, and continued by the villagers spontaneously. This decision-making process by the islanders, whether to approve, reject, or adapt proposed regulations, aims at widening community participation. Especially in Tioor, where parti-cipation of villagers during Step 3 was limited, internal discussion on the preliminary CRMP was regarded as essential to achieve locals' acceptance of the plan in its final version.

Thereafter, discussion proceeds in workshops in which all villagers have the opportunity to present the results of their internal consultations. In Rhun, just one workshop was held at this stage, attended by chairmen and chairwomen of the farmer groups and other interested villagers. Most of the regulations proposed by the respective farmer groups were approved, whereas only a few had to be adapted or were rejected, also due to the high level of participation during Step 3. Thus, based on the results of this workshop, a final CRMP could be formulated, but without further workshop activities in Step 5.

In Tioor, one-day workshops were carried out in each of the five communities. It turned out that results of the internal consultations widely differed between the communities, which complicated the discussions in the workshops. Regulations accepted (or rejected) by all communities were adopted (or left out) later in the final CRMP. Other regulations were accepted by only a part of the communities, so that compromises had to be found which could be accepted by the other communities, too. If a regulation was rejected by one or more communities without any acceptable and possible adapted formulation, it finally had to be left out in the final CRMP (for more details see Ch. 8.2.4).

Step 5: Formulation of a final CRMP (third workshop stage)

On the basis of the workshops' results after Step 4, the final CRMP is then formulated in a third workshop stage. As pointed out above, this step was only carried out in Tioor due to the diverging opinions of the islanders. The same village representatives as in Step 3 attended the workshop, and tried to find compromises for still controversial issues. In Rhun, it was sufficient to consult village representatives who adopted the approved parts of CRMP's preliminary version for formulating the final CRMP.

[208] Discussion on all of the identified topics (agriculture; agroforestry; nutmeg planting; forestry; goat husbandry; field boundaries; village boundary; rights, responsibilities and sanctions; organisations; and households without land tenure) by each group had proved to be too time-consuming, so only two or three topics were chosen for the discussion.

[209] Despite this preface, the religious leader in Mamur (east coast of Tioor) misunderstood the document as already valid, because it was typewritten (!), and accordingly ordered the strict compliance with the regulations in his community.

Step 6: Villagers' approval of final CRMP in a formal village assembly

The formulated final CRMP is then ready to be approved by the villagers in a formal village assembly, or, like in the case of Tioor, in community assemblies. At this stage, discussion about details is not possible, as the attending participants are too numerous. After the approval by the village assembly, the final version of the CRMP is typewritten. Copies of the CRMP are then submitted to village representatives and members of the LM. Additional copies for later submission to the district administration and the Government at regency level are prepared, too.

Participatory and transect mapping

As noted above and in Ch. 3.2, participatory mapping was carried out in Rhun during Step 3, whereas in Tioor a sketched map was developed in several meetings with key informants before the first workshop stage. These mental maps of the participating villagers had three purposes. Firstly, topography, location of streams, mangroves and settlements, land use, tree cover, soil fertility, area of coral reefs, coastal erosion, resource management problems, and the like, were documented by means of enlarged base maps drawn on posters (see Ch. 3.2), in order to provide a visual communication tool for stimulating discussion during workshops and for identifying solutions to problems of sustainable resource management. Secondly, this information was used for a participatory, qualitative land evaluation, based on indigenous knowledge and experience, and supported by results of the field study. And thirdly, the process of creating maps should help the islanders "to articulate their concept of resources and how they are used ... [as well as] to prove that they are indeed already managing [the land]" (Thorburn 1995, 38).

As villagers do not share the same knowledge, the development of these sketched maps is a *process* in which additional features may be supplemented, and already collected information may be revised. Especially during subsequent field excursions with villagers, the sketched map can be improved. In Rhun, this cross-checking by observation revealed a relatively accurate result of the mental map developed by the participants of workshops during Step 3. However, as land use and topography in Tioor Island is highly complex, and as most commonly villagers from Tioor's west coast participated in the discussions, the results of participatory mapping were not entirely satisfactory. Thus, a transect map of Tioor Island (Map 3) was additionally produced (see Ch. 3.2). This procedure had proven to be very time-consuming, so that it was carried out mainly in January and February 1998, after the villagers' final approval of the CRMP. Despite the drawback of a certain degree of inaccuracy (e.g., contour lines; see App. 5.3), several advantages of this method are stressed:

(1) *Relatively low costs of data collection*: Aerial photographs, satellite images, survey with Global Positioning System (GPS) (cf. Sirait et al. 1994), and measurements with a theodolit could provide more accurate results than maps solely produced by participatory and transect mapping can do. However, they all require technology far beyond a village budget, and in certain cases – especially for aerial photographs – beyond a project budget.[210] Low-cost to medium-cost instruments like tape measure, compass, altimeter, and clinometer are sufficient to perform transect mapping. Moreover, villagers are highly motivated and quickly get accustomed to handle these instruments for collecting data on their own. In Tioor, members of the measuring teams were keen on data collection also for the purpose of improving their local knowledge. As one member put it: "*By participating here I come to parts of my island, where I have never been before*." Thus, this method is adapted to local capacities, and could be easily performed at regular intervals (e.g., every ten years), for instance to document change in land use, state of resource depletion, or evaluation of conservation measures.

[210] For instance, projects implemented by undermanned or insufficiently subsidised local non-governmental organisations.

(2) *Purpose-oriented, acceptable accuracy by drawing on local knowledge*: Although not highly accurate in terms of topography and coral reef area, information on certain issues can be obtained and observed more detailed by participatory and transect mapping than by aerial photographs or satellite images. Especially with regard to forest resources (such as determination of economically important tree species and of exact age of secondary forest) and to cultivation history, local knowledge may prove to be adapted to the purposes of participatory mapping outlined above. The accuracy of other features may still be acceptable, although aerial photographs and other expensive methods will provide better results, such as the course of streams and tree cover.

(3) *Practicable data collection during cloudy conditions*: In the humid tropics, weather conditions most often set limits on aerial photographs and satellite images, as these images are at least partly covered by clouds. Exceptional events may complicate this situation. For instance, in the wake of the forest fire crisis in Indonesia (see Ch. 3.3), Tioor Island was permanently covered by 'haze' from beginning of October until mid-November 1997. On the contrary, transect mapping can be carried out without any restrictions during cloudy conditions. However, during the rainy season activities are hindered by heavy rainfall.[211]

Informal discussions

Accompanying the construction of the CRMP, informal discussions with village representatives, key informants and opinion leaders are useful to monitor the ongoing process. This could eventually lead to a revision of the chosen approach and the required methods of the CRMP's development. In these discussions it is possible to address obstacles to smooth planning, which may arise in various realms.

(1) *Logistical problems*: Dates, sequence and place(s) of workshops, and methods need to be fixed site-specifically. For instance, it is less appropriate to hold workshops at Fridays or Sundays when villagers go to mosque or church, respectively. Social rivalry among communities could require holding the first of the workshops in the oldest community. In Tioor, the villagers of Rumoi insisted on being the first community involved in the planning process, as most other communities were founded in the twentieth century. Accordingly, their inhabitants are regarded as newcomers who would have to submit to the interests of the "prime community" (*dusun induk*) Rumoi. Finally, the creation and use of maps and posters may be less adequate if the majority of the villagers are illiterate persons.

(2) *Insufficient information*: During the workshop phase it may turn out that additional information is necessary to proceed with activities, or to be able to develop certain regulations for rational resource management. In this case, group meetings may be organised or key informants may be interviewed to collect this information with PRA.

(3) *Diverging interests*: Informal discussions may strongly contribute to finding common ground between individuals and groups with diverging interests, perceptions and opinions. This will increase the likelihood of achieving compromises concerning regulations and institutional arrangements.

[211] This is the reason why data collection for Map 3 could not be completed.

8.2.3 Results

Regulations of the CRMPs are obviously site-specific, but in both cases they are purpose-oriented and share the objective of tackling socio-economic, environmental, and institutional problems at the local level. It is not the intention of this section to repeat a seamless analysis of land-use problems, factors and effects of land-use change, and problems associated with the degradation of marine resources and ecosystems, although these problems formed the starting point for the construction of each regulation of the CRMPs. It must also be stressed that the task of this thesis is to derive more general conclusions, rather than providing a detailed account on the contents of the CRMPs. Therefore, the regulations are briefly summarised by focusing on the background to their inclusion into the CRMP.

Rhun

The document (Masyarakat Pulau Rhun 1996) begins with a formulation of land-use problems, from which strategies are derived. These strategies serve as a basis for the regulations in the main part of the report, which is provided in a translated version in App. 4.1. The next step is a clarification of the framework of the proposed plan, which is based on social forestry on state land. A *stewardship contract* between the village and the Government at regency level is the precondition for a possible implementation of CMRP. With this contract, the Government leases the state land to the village for a period of 40 years. The established community organisation LM then has to organise the implementation of the proposed plan. Each farming household will get usufruct right on that land that is presently cultivated by the household, including allocated state-owned nutmeg tree gardens, and state land being illegally occupied with peasant's crops, but so far tolerated by the Government (see Ch. 5.4.3). The household's responsibility is to comply with the CRMP (see below). After 40 years the contract will be extended by the Government on condition of a successful implementation of the CRMP. The idea of this institutional framework is to give incentives for farmers to enlarge the area under agroforestry by guaranteeing them secured land tenure on state land.

LM has clearly defined responsibilities and rights (cf. App. 4.1). LM will get a not yet specified part of the taxes, paid by the farmers, to ensure the functioning and operations of this organisation. Additionally, fines and rates on common property used by community members (e.g., timber from village forest) are income sources for LM. It is the body that can deny (or withdraw) land tenure rights to (or from) peasants, who do not acknowledge (or who repeatedly violate) the regulations.

The regulations are subdivided into the sectors of (1) horticulture (annuals), (2) agroforestry (perennials yielding cash crops), (3) (agro-)forestry (other perennials), (4) animal husbandry, and the topic of (5) field and village boundaries. The land-use plan combines the first three sectors by allocating commonly agreed field area proportions, which were derived from a participatory land evaluation. These proportions were then matched to each traditionally named location, according to the criteria inclination of slopes, soil fertility, and tree cover (see Maps 7.2). Every farmer is obliged to cultivate his land area according to these proportions, but is almost free to choose the cultivated plant species. An appendix in the document provides information on the suitability of location units for the cultivation of plant species.

(1) Horticulture (annuals)

Maximum area proportion for plants yielding non-seed carbohydrates varies between 50% and 0%, the latter in protected locations, steep terrain and along the coast. If a household faced difficulties in achieving self-sufficiency, LM could allow a maximal enlargement of the area proportion by an additional 10%. This flexible regulation was necessary to ensure acceptance by farmers who are provided with small land-holdings. Slash-and-burn agriculture with fallow periods can no longer be practised to avoid uncontrolled spread of fire; instead, perennials have to be integrated into these locations.

(2) Agroforestry (perennials yielding cash crops)

The regulation about agroforestry (*perkebunan*) distinguishes between the cultivation of nutmeg on the one hand, and all other perennials yielding cash crops as the main product on the other hand. Maximum area proportion is laid down without this distinction, however, and varies between 50% and 0%, the latter in protected areas. A farmer can decrease the area for annuals, and instead integrate perennials yielding cash crops to more than this maximal area proportion.

Nutmeg cultivation combined with an integration of protection trees (e.g., *Canarium vulgare* L.) has to be carried out by almost all farmers. The minimum number of trees depends on the size of fields.[212] Taxes are paid to the Government at regency level from revenues of later nutmeg and mace harvests from this minimum number of nutmeg trees. Nutmeg trees additionally planted are free of taxes. Ten nutmeg trees belong to the Government, all others to the farmer. As a consequence, a minimum number of 6,000 trees (or 20% of pre-WW II level) will be established in Rhun Island, resulting in annual tax revenues for the Government of a price equivalent to an expected 4.1 t of nutmeg and 0.7 t of mace. A not yet fixed part of these revenues is retained by the village for LM funds.

These regulations take into account the interest and commitment of the Government to maintain nutmeg cultivation in the 'Nutmeg Islands' at a reasonable scale, a preservation of the worldwide most important *in-situ* gene pool of *Myristica fragrans* Houtt., an additional income source for farmers in form of NTPs from nutmeg, mace, and seeds of *Canarium vulgare* L., and the protective function of perennials in the agricultural landscape. With the replanting of ten state-owned nutmeg trees, the farmers fulfil their duty of the 1987 contract when this number of trees were allocated to them by the last plantation enterprise PTPBB (see Ch. 5.4.3 and Ch. 6.5.1).

In the remaining field area up to the maximum area proportion, farmers can integrate other perennials yielding cash crops, for which the farmers do not have to pay taxes, such as clove, coconut, and coffee. These trees exclusively belong to the farmer. These regulations address the farmers' goal to diversifying cash crop production, and consider the present situation of clove farming in Rhun (see Ch. 6.3.3).

(3) Agroforestry (perennials for protection purposes)

The main function of these tree species is the protection of natural resources (e.g. soil, fresh water, other crops). Moreover, their products are economically important. Minimum area proportion varies between 25% and 100%. Sacred places (*keramat*) are protected communal areas. From village forests outside *keramat* areas, products can be collected by every farmer free of charge, except timber from collapsed trees that is used for construction purposes; standing trees may not be cut down. On farm plots, each farmer gets tree tenure on these perennials, but is obliged not to cut them down below a defined size and to replace trees removed for their timber. LM has to permit any removal of these tree species.

(4) Animal husbandry (goats)

The main goal of regulations on goat husbandry is to avoid damage to plant species by browsing goats, above all to newly established perennials. Each goat breeder therefore has to mark his goats with a

[212] It varies between 40 trees (combined size of fields larger than one hectare) and no trees at all (combined size of fields smaller than 0.2 ha).

collar and to keep them in stables or behind living fences planted along field boundaries. In a transitional period he can keep his goats tied to trees or staked within his field, taking into account the widespread perception of goat breeders, who argued with the high costs of constructing stables and the long time-span of establishing living fences. Sanctions for disregarding these responsibilities include the ex-propriation of goats by LM. Goat breeders insisted on including a regulation addressing theft of goats.

(5) Field and village boundaries

Field boundaries are identical with the present traditional understanding of land tenure. LM registers field boundaries and judges in cases of dispute about the field boundary. Two farmers can agree on a change of their common field boundaries, for instance by straightening these. Each field boundary is marked by specified tree species, which are planted by both farmers. It is also possible for two farmers to exchange fields, which has to be registered by LM. The village boundary will be defined by LM at a later time. Houses can only be constructed within this boundary.

Rights, responsibilities and general sanctions are separately summarised. Farmers will have the exclusive tenure on their fields, if they manage them according to the regulations. They can collect non-timber forest products and, by paying a fee, use timber from the village forest. Other rights include the use of IDT funds (see Ch. 5.2) for investment in agriculture and agroforestry, and assistance by the Government services (*Dinas*) at regency level. Responsibilities are laid down both for the peasants (e.g., rehabilitation of land by afforestation in compliance with the CRMP, tax payments) and for the Government (e.g., provision of services and seedlings, guarantees of exclusive land tenure rights for the farmers). Sanctions are formulated in a general way and will be specified later on. Maximum penalty will be the withdrawal of tenure rights for the village by the Government, if LM cannot implement the CRMP. Thus, a realisation of the CRMP is in the interest of the village and of each individual farmer.

Maps, lists and evaluation of plant species, the specification of land units and area proportion figures, and an example of an agroforestry design are provided by the appendices, and support the CRMP.

Tioor

Although the principles of Tioor's CRMP (TGDLK Pulau Tioor; Masyarakat Pulau Tioor 1997) are equal to Rhun's CRMP (TGDK Pulau Rhun), both plans differ in several respects. This section gives special priority to these differences.

Unlike Rhun, the implementation of the CRMP in Tioor does not directly depend on the approval of the Government at regency level. However, Government's recognition of the CRMP would strengthen *adat*, as local organisations, such as LM that includes traditional and religious leaders, and traditional institutions, such as *sasi* and *pela*, could then support local autonomy and local control of resources.[213]

Rights, responsibilities, and sanctions for members of LM are stated in greater detail than in TGDK Pulau Rhun. The share of the revenues for LM is fixed to 40% (of the total income) to meet LM's administration, meeting and enforcement costs. The remaining 60% will be used for investments at the local level or to improve the enforcement of regulations on threatened coral reefs. Income sources consist of fees for opening and closing marine *sasi lelang* (see Ch. 5.4.2), of fees for products traded out from Tioor (copra, nutmeg), and of fines.

The inclusion of marine resource management into Tioor's CRMP is a major difference to Rhun's CRMP, and results in a more comprehensive plan. The sea-use plan (TGLK) of Tioor is largely based

[213] For a detailed discussion see Ch. 8.2.4 and Ch. 8.3.3.

on the reconstruction of communal *sasi laut* which had failed in the late 1980s (see Ch. 5.4.2). *Sasi laut* on several, mainly commercialised marine species, aims at preventing external users from fishing and poaching these resources in Tioor's territorial waters (Fig. 5.1a), and at conserving endangered species and juveniles. Another fundamental of TGLK is the protection of the coral reef through the strict ban of destructive fishing methods and coral mining, in order to both maintain (or even increase) its pro-ductivity and to slow down coastal abrasion. LM is supported by a *secret* foreman (*kewang*) in con-trolling territorial waters. This enables the chairman of LM to create a fictitious *kewang* in secrecy.

The CRMP clearly distinguishes between local users and outsiders. Not only fees and fines are different. The villagers also prevent most outsiders from claiming and poaching marine resources. For instance, only people from neighbouring villages in a *pela* relationship with Tioor (cf. Ch. 5.4.2) are allowed to fish in Tioor's customary territorial waters (see Map 7.1.3) for self-sufficiency. They may also participate in collecting commercialised marine species at the first day of lifted communal *sasi*. Sanctions can be imposed on local violators of the CRMP in form of a fine or of community labour. It is also possible that a violator will be humiliated, if he/she has to announce publicly his/her violation.

A shortcoming of the Tioor's land-use plan (TGDK) is yet the lack of a land evaluation, and thus it is not possible, at least for the time being, to match land units to a specified land use. The inclusion of marine resource management into the CRMP had contributed to this concession, because workshop activities could not cover a land evaluation as detailed and time-consuming as in Rhun Island. Moreover, the transect map (Map 3), which could have been an important tool for such an effort, was drawn *after* the islanders' approval of the final version of the CRMP. So far, land use is regulated in the upper watersheds of streams, along streams, in primary forests, along the shore and along field boundaries. Furthermore, registration and transaction of land property, the use of timber and the theft of fruits and cash crops are included in TGDK. Main objectives of TGDK are the protection of remaining primary forest, a reduction of the area under slash-and-burn agriculture by a simultaneous extension of mixed gardens and agroforests, the protection of fresh water and soil, and the reduction of institutional deficiencies such as unclear field boundaries and the struggle for land.

8.2.4 Discussion

In this chapter the attempt is made to draw general conclusions with regard to both CRMPs. For this, both obstructive and stimulating factors of their construction and future implementation are discussed and illustrated by examples in the local context. The discussion in Ch. 8.3 on preconditions for a successful implementation, which are not directly touched by a CRMP itself, will provide additional input for an integrative discourse on community-based development on small tropical island communities (Ch. 9).

(1) Traditional institutions

If institutions are "the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction" (North 1990, 3), then organisations must be distinguished from institutions. "Like institutions, organizations provide a structure to human interaction. Indeed when we examine the costs that arise as a consequence of the institutional framework we see they are a result not only of that framework, but also of the organizations that have developed in consequence of that framework. Conceptually, what must be clearly differentiated are the rules from the players" (North 1990, 4).

The fact that *traditional institutions* such as *sasi*, *pela*, and *keramat* play a decisive part in the CRMPs raises the question under which conditions and with which arrangements such institutions may be successfully (re-)constructed. For instance, as stated in Ch. 5.4.2, communal *sasi* (*sasi umum*) disappeared in both communities. On the other hand, types of individualised *sasi* have persisted in Tioor, indicating the need for institutional arrangements to secure some kind of certainty in resource (in this case: tree garden) management. Thus, before being able to appropriately reconstruct an effective *sasi umum*, reasons for its previous failure must be understood first.

(a) Population growth

The perception of islanders in both Tioor and Rhun why *sasi umum* failed during the 1980s is predominantly related to population growth. This *mono-causal* explanation was brought forward by them during household interviews: "*It is impossible for the village head and the kewang to enforce and police sasi umum, because of our overpopulated island. All of us have depended on the uncontrolled extraction of resources, such as lola [Trochus niloticus], formerly regulated by sasi umum*." Certainly, this perception holds truth, as the break-down of communal *sasi* in many Central Maluku societies coincides with an increasing commercialisation of *lola* (cf. Zerner 1994, 1108ff) and other valuable marine species, while at almost the same time floor prices of cloves have plummeted. Seeing it in this way, it then follows that any reconstruction of *sasi umum* would no longer be possible, since population density and economic dependency on the resource have irreversibly passed critical levels. In fact, the proposal to construct *sasi umum* for coconut tree gardens was widely rejected by Tioor's communities, as this resource is a major factor in the village economy.[214]

On the other hand, the break-down of *sasi umum* may be explained by other factors as well. The negative influence of these factors on *sasi umum* has greatly increased when local resources have been commercialised – resources which were formerly restricted to subsistence purposes (Zerner 1994, ibid.):

(b) Equitable resource distribution: One of the purposes of *sasi* is an equal distribution of resources and profits (Ch. 5.4.2). Thus, *sasi umum* may fail if certain groups and stakeholders gain advantage to utilise resources, especially commercialised species. It is therefore crucial not to restrict considerations on *sasi umum* to *endowments* (i.e., the rights and resources that people have), but rather to extend the view to *entitlements* (i.e., legitimate command over alternative commodity bundles) and *capabilities* (i.e., what can people do or be with their entitlements) (Leach et al. 1997).

Example 1.1: The use of new and more sophisticated technologies, like diving equipment and the use of outboard motors to access more remote parts of coral reefs, would put women and poor fishermen at a disadvantage (cf. Pannell 1997, 296-7).

Example 1.2: After a ban on climbing *kenari* trees (*Canarium vulgare* Leenh.) was imposed to strengthen the rights of elderly and women (cf. footnote 73), kerosene lamps have been widely deployed by men in Rhun and other Banda Islands to collect fallen fruits during the night.

(c) Breach of contract and corruption

Example 1.3: *Sasi umum* on *lola* was practised as a sold *sasi* in Tioor (*sasi bablian*, see Ch. 5.4.2). Before *sasi* was opened, the village head and the village administration of Tioor determined a fixed per kilogram price at which each the harvest of *lola* had to be sold to the buyer of *sasi bablian*. This included a determination of the percentage of the overall proceeds which the trader was required to pay to the village as well as to the village head (cf. also Pannell 1997, 297). Then, a middleman for the buyer arrived in Tioor for the transaction. The collected specimen were weighed and recorded by

[214] A communal *sasi* on coconuts could minimise theft, could improve yields and product quality, could provide a strengthened bargaining position for farmers when selling copra to traders, and could contribute to establishing a village co-operative.

village representatives for villagers to be individually paid for their harvest. However, according to the village administration, the middleman paid only half of the determined per kilogram price. Villagers were obviously disappointed with this breach of contract by the middleman. Other islanders, however, believed that the village head and members of the village administration lined their own pockets with the other half of the fixed per kilogram price (see also Example 5).

Astonishingly, despite these factors, *sasi umum* was finally reconstructed, as the institutional framework has attempted to address these issues and experiences. Moreover, it is more likely to establish *sasi* regulations on species which apparently have become so scarce that they are insignificantly contributing to household's income, especially if *sasi umum* can be strongly instrumental in reaching other, for the islanders more fundamental goals besides conservation, namely the *strengthening of land tenure* (in the case of Rhun), and *the recognition of exclusive access to resources in traditional communal sea territories* (in the case of Tioor).

In conclusion, the (re-)construction of *sasi umum* at local level is more likely, or can only be achieved if:

- knowledge and information about the biological fundamentals of the resource in question can be tapped, be it knowledge traditionally anchored in the society and/or provided by scientific research (see Examples 6);
- alternative income can be generated (see Ch. 8.3.2);
- profits for all groups and individuals are expected to be greater than the costs;
- profits and costs are equitably distributed in the community (cf. also Borrini-Feyerabend 1997, 14);
- *sasi* can be instrumental in excluding external user groups from the exploitation of resources in communal territory (for small island communities especially the sea territory);
- *sasi* is acknowledged by the Government (see Ch. 8.3.3);
- all groups and stakeholders have the opportunity to be involved in the construction process of *sasi umum* ('participation'), as well as a right and possibility to influence regulations; and
- a local organisation is existing or established which is able to formulate and enforce regulations, as well as to secure equitable distribution of profits (see (8) below).

The case of *sasi umum* is the most important, but also the most disputed issue concerning conservation and sustainable livelihood. The other two traditional institutions – *pela* (in Tioor only), and *keramat* (or, as interpreted in Ch. 5.4.2, 'an eternal *sasi* in sacred forests') – have persisted in the two communities while at the same time *sasi umum* failed – as argued, mainly for economic, institutional and demographic reasons. This fact sheds light on the important ritual, social, and cultural dimensions of traditional institutions. These dimensions are also found in still practised types of individualised *sasi* (e.g., *sasi matakau*; cf. Ch. 5.4.2). Thus, besides economic and ecological benefits, the implementation of CRMPs could translate regulations into ritual and socio-cultural benefits for the islanders as well. For example, *pela* – although *in theory an inviolable* blood-brotherhood among *pela* villages which contributes to counteracting social fragmentation (cf. Ch. 5.4.2) – could be strengthened through a differentiation between *pela* villagers with rights of access to resources and other external users without these rights.[215]

[215] Another example of the potential of *pela* for socio-cultural, economic and environmental benefits is reported from the village of Ihamahu on Saparua Island. In 1997, Ihamahu's village leaders contacted the Raja of Amahai, a village on Seram Island in a *pela* relationship with Ihamahu, to propose a joint community project. The project's basic component would be the re-afforestation of *Imparata* grasslands on an estimated 600 ha of Amahai's customary land, carried out by

Finally, the examples of *pela* and *keramat* show a valuable characteristic that traditional institutions may have: *flexibility*. These institutions have evolved over decades and centuries, and have persisted in periods of transformation, disruption and war. This flexibility to cope with such developments indicates another potential of traditional institutions: *efficiency*. As it is with *sasi*, the functioning of an institution depends on its costliness, e.g., the costs of enforcing regulations, or the costs of excluding external users. Costs are manifold and – from an economic viewpoint – may be grouped into transactions costs and transformation (production) costs (cf. North 1990, 6). More precisely, the *relation* of benefits and costs that result from institutions for a society are decisive for the functioning of its institutions. For example, as Leach et al. (1997) point out, "in highly valuable grazing sites, institutional forms with relatively high transaction costs may persist, whilst for low value, highly variable grazing resources the opposite is most likely". With these general reflections on traditional institutions in mind, the discussion turns to more specific problems and opportunities.

(2) Diverging interests

As stated earlier in Ch. 8.1, a CRMP represents an innovation. This does not only influence economic, social and political interests of various groups and individuals *at a local level*, but may extend to *regional* and *provincial levels*. Groups and individuals that may lose (gain) influence and power could form an alliance to prevent (or support) a CRMP's construction.

Example 2: Rumoi community in Tioor tried to prevent the construction and implementation of the plan. The reason given was their disapproval of the proposed *sasi* regulations on marine resources, especially fish species targeted by an ethnic Chinese enterprise. This resulted in a rejection of the whole plan during the community workshop in Step 4 of the construction phase, although Rumoi opinion leaders stressed the rationality of most regulations in informal discussions.

More profound is the explanation of an alliance between this community, their Protestant clergyman and the district military commander in Geser, whose wife acted as a front woman for the enterprise trying to get access to Tioor's customary territorial waters (cf. Ch. 5.5.2). The enterprise obtained permission from the regency's fishery service (*Dinas Perikanan*) in Masohi and the district administration in Geser to fish in the customary waters of Seram Timur's villages. However, the enterprise was prohibited from using destructive fishing methods such as blast and cyanide fishing, from collecting/fishing commercialised species such as top-shell, bêche-de-mers, and sharks, and from operating in villages where communal *sasi laut* was imposed. These conditions for the enterprise show that the Government is committed to taking measures against the destruction of coral reefs, and to support local control of marine resources, also by acknowledging an institution such as *sasi*.

Thus, with an integration of *sasi laut* into the CRMP, the enterprise would not have been able to operate in Tioor's waters. The district military commander and the subordinate *babinsa* of the Watubela Islands urged therefore the clergyman of Rumoi to instruct his community not to accept the plan. The clergyman, maybe also profiting financially, would have gained power from this deal, if the village mayor – who even turned to Islam – would not have been able to formally instruct the development of the CRMP. And the community was promised renovation of the church building, financed by the enterprise. Additionally, this community did not accept the village head, although he is a member of the Kolatlena clan of Rumoi. One month before this event, the village head decided (in accordance with governmental instructions) to locate the new Government elementary school in the location of Wersetan, situated 500 m from their settlement (see Map 3). As a community member put

Ihamahu villagers. Thus, Amahai village would provide its uncultivated land reserves, while overpopulated Ihamahu village would provide labour. Benefits, especially tree tenure and accessibility to timber and non-timber products, would be shared by both villages (personal communication with villagers from Ihamahu).

it: "*The village head does not take care about our needs, because we want our school to be located in our settlement"*. This rivalry had its original roots in the IDT programme (see Example 5). Moreover, this example underlines the difficult role of the village head trying to serve the interests of various groups in the village, while at the same time being accountable to his clan and to the Government.

Practically, the resistance of the Rumoi community – urged on by the economic interest of the district military commander and the *babinsa*, and the political interest of the local clergyman – posed a most serious obstacle to the construction of Tioor's CRMP, as acceptability of regulations by the islanders is a most important criterion of CRMP's implementation. Moreover, in the local framework, village administration and the village head are less powerful than the district military commander and the *babinsa*, and usually have to submit to their instructions. It therefore raises the question how to deal with such a complicated situation. The strategic approach deployed for finally achieving a successful construction of the CRMP aimed at weakening this alliance.

The first, decisive step was to weaken the position of the district military commander and the *babinsa*, by taking advantage of their abuse of political power for their own economic interests. When the *babinsa* arrived in Tioor to urge the village administration to formally allow the operation of the enterprise, his demand was successfully rejected with the indirect threat of reporting his abuse of power to military superiors in Ambon.[216] After he had returned to Geser to report the rejection to his superior, the village administration passed a communal *sasi laut* during Step 3, so that the enterprise was hindered in beginning its activities in Tioor's waters. Meanwhile, the enterprise had illegally deployed potassium cyanide for fishing Napoleon wrasse (cf. Ch. 5.5.2) in Kasiui and nearby islands including Baam, causing an immense fish kill. This event was then reported by the village head to the district administration in Geser. Probably fearing disciplinary actions by his superiors, the district military commander withdrew his instructions and discontinued his support for the Chinese entrepreneur. As soon as the power basis of the local military persons was removed, the enterprise was unable to go ahead with its operation plan in Tioor's waters.[217] Therefore, the clergyman and the villagers in Rumoi finally had to relent, and the construction of the CRMP could be continued. Perceptions and opinions about proposed preliminary regulations were obtained in informal group discussions with Rumoi villagers after the workshop meeting in Step 4, and formed the basis for the final version of Tioor's CRMP in which most of the proposed fish species were no longer subject to *sasi laut*.

(3) User groups versus non-user groups

Users of a specific resource tend to hold on to the status quo ('as less regulation as possible'), whereas non-users tend to press for strict management limitations ('as much regulation as possible'). These variations and division of labour goes hand in hand with gender- and age-specific resource utilisation, indicating a differentiated community. Sound argumentation, based on information and knowledge, mediation and diplomacy (by an opinion leader of the community, or by a facilitator) can be helpful or even decisive in finding a compromise, eventually by dropping one proposed, disputed regulation to achieve agreement on another, more important one.

Example 3.1: TGLK Pulau Tioor prohibits the removal of living corals and coral boulders from the sea. One community, Wermaftengah, did not want to accept this regulation and insisted on free access

[216] My presence at the meeting proved to be crucial in this situation, as the *babinsa* could not threaten the members of the village administration with physical violence or with summons to the military commander in Geser. It therefore demonstrates, that the power of the village administration is usually too limited to reject the instructions of the military.

[217] One month later, in January 1998, the regency fishery department withdrew permission for the enterprise (interview with the Head of the Fishery Service, *Dinas Perikanan*). The district military commander and the *babinsa* were posted to another district.

to living corals, although one of its settlements, Mamur, is severely threatened by coastal erosion. Except for this community, all others can afford to buy cement or can use coral rocks *from the shore* for house construction. Their interest is therefore focused on an intact coral reef, ensuring the reef's productivity and protecting the coast from erosion. In the end, the resisting community relented. The possibility to get credits for house construction by a special LM fund had to be brought forward. Additionally, the village mayor promised to ask for Government funds for the construction of a protection dike in front of the threatened settlement.

Example 3.2: Goat husbandry in Rhun proved to be an issue emotionally discussed during the workshop sessions. In the beginning, views were heard from two extreme poles. On the one hand, many goat breeders did not accept any regulations concerning goat husbandry by arguing that present management systems are sufficient to protect vegetation and afforestation efforts. On the other hand, most non-breeders wanted to entirely ban goat husbandry in Rhun, as this group perceived goats as an obstacle to tree planting. Through mediation and discussion of possible solutions, emotions finally cooled down, and the extreme positions approached a common grounds for the regulations on goat husbandry.

(4) Poverty and food security

Poverty, linked with food security, is a serious constraint when dealing with community-based resource management plans. Even with the knowledge of the deterioration of their means of livelihood, a (part of the) community can be forced to continue less adapted or even destructive land use and sea use, in order to ensure the minimum livelihood for the present.

Example 4.1: The acceptance of the regulation about living corals and coral boulders (see Example 3.1) would have been easier achieved, if the resisting community could have afforded to buy cement. This was the reason to include the LM credit programme for cement purchase.

Example 4.2: As shown in the previous chapters, cassava-based agriculture in Rhun is a socio-economically successful peasant strategy of guaranteeing self-sufficiency in terms of staple food. Nonetheless, a part of the farmers perceive the ecological disturbances of this strategy, such as degradation of soil and destabilisation of water resources, and agreed therefore to the necessity of performing afforestation as long as the institutional framework of the CRMP would guarantee the participation of all households. However, other farmers raised the problem of insufficient provision of staple food-crops, and thus a threat to food security, if trees were to dominate the landscape. To avoid a situation in which dry field agriculture would be the winner in the competition with agroforestry, the concept of field area proportions for the production of annuals was developed and accepted by the community, as it provides flexibility for peasants to produce enough staple food-crops (see Example 7.2). Additionally, measures to increase yields were discussed (cf. Ch. 8.3.1).

(5) Corruption

Embezzlement of LM funds by LM members can endanger the implementation of a CRMP. Individuals can use this potential risk as an argument during the construction phase of the plan, in order to prevent LM from exercising the right to collect fees and fines. However, LM would be incapable of organising the implementation of the plan without this right.

Example 5: Experience of corruption concerning the IDT programme in Tioor (cf. Ch. 5.4.2) was the main reason for the rivalry between Rumoi community, and the village head and his deputy, who were accused of embezzling parts of IDT funds for private interests and of claiming IDT equipment as their own private property.[218] The resulting distrust did not only complicate the construction of Tioor's CRMP (see Example 2), but also led to emotional informal discussions about *expense allowances* for LM members and surveyors. Rumoi villagers did not accept any fund money for LM members, whereas other villagers proposed a figure as high as 75% of the LM's fund as expense allowance for LM members. Finally, this figure was fixed at 40%, while the remaining fund would be used for village development projects and the local credit programme for cement purchase (see Example 3.1).

(6) Knowledge

Information and knowledge of the biological fundamentals of resources (e.g., reproduction cycle of fish; ecological requirements of tree species) are a precondition for rational resource management. Moreover, groups and individuals possessing this information and knowledge can more likely influence (or get others to agree to) regulations concerning the resource in question.

Example 6.1: Among other marine species, Tioor's sea-use plan (TGLK) bans the collection of top-shell (*lola*, *Trochus niloticus*) for three years by communal *sasi laut*. During the subsequent collection period, specimens of a diameter smaller than eight centimetres at the bottom side may not be collected. A previous proposal, to shorten the *sasi* period to one year and to allow the collection of specimens of a diameter bigger than *five* centimetres at the bottom side as soon as *sasi* is lifted, was rejected and withdrawn by its initiators, due to information input of a scientific study on *Trochus niloticus* by Arifin (1993),[219] which decided the issue with regard to *sasi lola*.

Example 6.2: The planting of living fences, mainly consisting of shrubby Leguminosae [e.g., *Leucaena leucocephala* (Lam.) de Wit *var. leucocephala*], along field boundaries to control browsing goats was widely accepted for Rhun's land-use plan, including by goat breeders, as these species grow on a variety of soils, may increase soil fertility by nitrogen fixation, and also provide secondary uses, such as fuelwood and forages for goats.

(7) Technical or logistical constraints may complicate implementation and enforcement of a CRMP.

Example 7.1: Enforcement in territorial waters is a tricky task, which needs an effective information system (e.g. walkie-talkies), fast transportation for and courage by the surveyors, because external users are often fishing during the night, are predominantly equipped with powerful motors and may carry weapons (e.g., bombs), which they could eventually use against surveyors.

Example 7.2: The concept of field area proportions in Rhun (see Map 7.2.6 to Map 7.2.8) is a technical, mathematical approach. Its feasibility for peasants can be questioned. However, without a concept like this, there would be no quantitative indicator, which is needed to evaluate afforestation activities. Thus, TGDK Pulau Rhun clearly states that a farmer does not necessarily need to realise the exact proportion, but that he can achieve it in an approximate way.

(8) Organisations and enforcement problems

Besides enforcement problems concerning external users of marine resources (see Example 7.1), it is particularly difficult for small island communities to sanction members of the community, because most people know each other well or even stand in familial relationship to each other. Regulations will be ignored, if LM is unable to sanction violations. Moreover, if the LM is unable to discipline external

[218] Since this is a highly sensitive political issue, reliable information concerning the truth of this accusation could not be obtained. However, as most IDT groups had failed in Tioor, it likely holds *some* truth. To the contrary, other informants stated that funds were equally apportioned among IDT group members for consumptive purposes.

[219] The juvenile phase of *lola* lasts three years, when specimens reach a size of six centimetres. Communal *sasi laut* on other marine species could not draw on information input from scientific studies. The regulations concerning these species were derived from *traditional knowledge* instead, underlining its value for community-based resource management.

users without long-term interests in the community, the local population will likely no longer have an incentive to be bound by management restrictions such as *sasi umum*. Accordingly, once a CRMP is developed, its implementation is not yet guaranteed. The weaker local organisations are, the more difficult it will be for LM to deal with this matter. On the other hand, the creation of this organisation, that involves all groups of the community, can possibly strengthen local capacities in dealing with institutional problems. In Tioor, for instance, the payment of a fine was perceived as less serious (and therefore probably less effective) than the possible sanction of public humiliation in the village. As one villager put it: "*We could easily pay a fine, but we would feel ashamed if we had to announce publicly our mistake. Hence, we shall not violate a regulation.*" It could be argued that the village administ-ration is the right body for CRMP's enforcement, rather than the constructed LM. As the previous analysis showed, however, the village administration has not been able to solve institutional deficiencies.

8.3 Requirements of implementing CRMPs

The CRMPs of both communities must be regarded as a *necessary* institutional framework for streng-thening local capacities and traditional land tenure to tackle environmental degradation and socio-economic problems through an extension of tree cultivation. Nonetheless, the existence of a CRMP may *not be sufficient* for sustainable development and conservation goals unless several socio-economic and political-institutional preconditions are met. As shown in Fig. 8.1, most of the socio-economic, technical strategies require technical and financial assistance, e.g. from a (locally not yet existing) development project. Similarly, the acceptance of the CRMPs by the Government and decision-makers is a requirement still pending. Thus, this thesis cannot provide a detailed account on these locally specific preconditions. Rather, general reflections as well as recommendations are provided in this chapter.

8.3.1 Furtherance of agroforestry and improvement of agricultural practices

A first requirement is to choose the right trees, and adaptable management systems and technologies for a furtherance of traditional agroforestry. As concluded earlier in Ch. 6.6, strategies may aim in three directions: firstly, a stimulation of a more widespread integration of indigenous trees into the agricultural landscape; secondly, an introduction of non-indigenous tree species; and thirdly, an improvement or modification of existing agricultural practices, e.g., to increase yields per area.

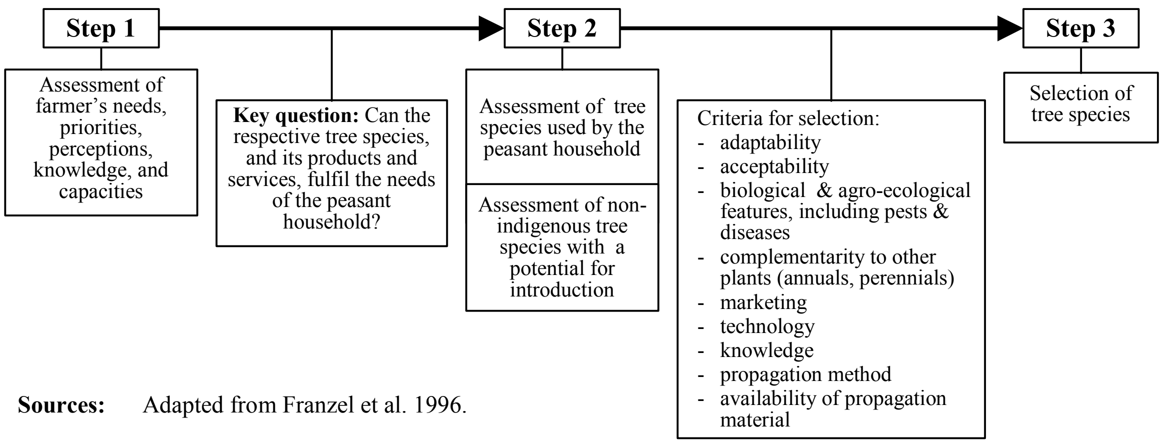
Choosing the right tree species

Farmers in both villages gave early considerations about the question, how to adapt their farming system to the constructed CRMP.[220] The central issue in these discussions revolved around the possible tree species to be chosen in traditional agroforestry extension. Fig. 8.3 shows the procedure of deter-mining priorities in the selection of tree species. Franzel et al. (1996), and the D & D methodology for agroforestry extension (Raintree 1987; cf. Ch. 2.4), consider the assessment of farmer's needs a key issue regarding the selection of both already used and non-indigenous tree species.

[220] In Tioor, for instance, the questions are: How can the area under shifting cultivation be decreased by a careful shift to mixed garden establishment? How can remaining primary forest be preserved? And, how can the productivity of existing tree gardens be improved?

Several tree species used, which are beneficial for farmers in both villages, were discussed and evaluated in previous chapters (Ch. 6.3.3, Ch. 6.3.6, and Ch. 6.5).[221] The variety of their products and services fulfil the multiple needs of the peasant households (cf. Ch. 6.3.7). Accordingly, a highly diversified number of tree species, yielding products (foods, building materials, medicines, etc.) both for subsistence activities, and for marketing purposes (cash crops for regional, domestic and international markets, as well as marketable surpluses of subsistence products) should be selected. This has positive effects of risk reduction (e.g., pest, diseases, droughts, low producer prices), and will contribute to an autocentric development by locally integrated economic circuits.[222] Moreover, farmers' adaptability and acceptability of already used trees are likely and therefore advantageous, as well as existing knowledge about tree characteristics, and a ready availability of propagation material.

Figure 8.3: Procedure of determining priorities in the selection of tree species



Sources: Adapted from Franzel et al. 1996.

About 50 tree species, summarised in footnote 221 and Tab. 8.1, have been determined for potential use in agroforestry extension. Each farmer will select only those tree species from this pool which serve his individual needs and priorities, and which are adapted to the agro-ecological conditions in his fields. A strategy could be a simultaneous planting of several cash crops to avoid dependencies, and to buffer a plummeting producer price of one cultivated crop by the others. Species yielding crops for regional outlets should dominate these plantings, as these are independent from world market prices, and as continental regions have a competitive advantage of scale for most export crops. A more evenly seasonal distribution of income generation is another advantage due to different harvest seasons. As demonstrated by key farmers, existing mixed gardens and agroforests provide appropriate layouts of fields for agroforestry extension by other farmers of the communities.

[221] In alphabetic order: *Aleurites moluccana*, *Alstonia scholaris*, *Areca catechu* (only in Tioor), *Arenga pinnata* (only in Rhun), *Artocarpus altilis*, *Artocarpus heterophyllus*, *Calophyllum inophyllum*, *Canarium* spp., *Cocos nucifera*, *Coffea canephora*, *Diospyros* sp. (only in Tioor), *Dracontomelon dao* (only in Rhun), *Durio zibethinus*, *Hibiscus tiliaceus*, *Intsia bijuga*, *Leucaena leucocephala* (only in Rhun), *Mangifera* spp., *Metroxylon sagu* (only in Tioor), *Musa* L., *Myristica fragrans*, *Neonauclea glabra*, *Nothaphoebe calista* (only in Tioor), *Pandanus* spp., *Paraserianthes falcataria*, *Pometia pinnata* (only in Tioor), *Pterocarpus indicus*, *Tamarindus indica* (only in Rhun), *Terminalia catappa*, and *Toona ciliata*.

[222] Autocentric development is a bottom-up development approach with the objective of comprehensively utilising local resources for direct satisfaction of local basic needs. The primary focus of locally integrated economic circuits is oriented to a marketing of raw materials and processed products in local, regional, and domestic outlets. This does not mean, however, to completely forego marketing of products for international markets, such as nutmeg. For a detailed discussion on locally integrated economic circuits for autocentric development in peripheral, remote and resource-poor rural regions see Rauch and Redder 1987a and 1987b.

The selection of non-indigenous tree species is principally also possible, although certain advantages of already used species cannot be fully matched. Introduction of non-indigenous trees will very likely require propagation material from nurseries, information by agricultural services and media (e.g., radio), and – for cash crops – the establishment of functioning marketing networks. However, several farmers in Tioor and Rhun have introduced non-indigenous trees by carrying seeds from other islands, indicating that these farmers are keen to experiments which could improve their farming system. Therefore, non-indigenous tree species could be successfully promoted, if their products and services fulfilled farmers' needs. Indigenous tree species, which have become locally extinct or scarce, fall into this category as well, because propagation material is hardly available at the local level. Some of these species are so sought after, that farmers would appreciate their re-introduction, e.g. *Cordia subcordata* Lamk.

Tab. 8.1 provides a list of already used and non-indigenous tree species with a high potential in agroforestry extension, which were neither discussed nor evaluated in previous chapters. Trees yielding edible fruits and nuts are of highest priority, as well as trees providing valuable timber for construction and production purposes (e.g., joinery). Multipurpose trees (MPTs) for production, soil protection and improvement, as well as for marking boundaries are also regarded by farmers as relevant species.

Table 8.1: Minor tree species with potential in agroforestry extension

Species	**Category**		**Products and services – Remarks**
	Tioor	Rhun	
Artocarpus integer	**U**	**N?**	Nutritious edible fruit; vegetable; timber – needs steady water supply and shade
Bouea macrophylla	**N!**	**U**	Popular edible fruit; vegetable; shade tree – no serious pests
Casuarina equisetifolia	**U**	**N**	Beach-stabilising; fuelwood; nitrogen-fixing; for coastal protection; charcoal for forging
Cinnamomun burmani	**U**	**U**	Fuelwood; marketable spice
Cordia subcordata	**E!**	**E!**	Highly valued timber for ship construction; beach-stabilising; medicine; for coastal
Eugenia linneata	**U**	**N?**	Timber – grows wild in primary and secondary forest
Garcinia mangostana	**N!?**	**E!?**	Popular edible fruit; dye; timber – very long development phase; needs shade
Gmelina moluccana	**E!**	**E!**	Highly valued timber (excellent for canoe hulls)
Gnetum gnemon	**N!**	**U**	Edible seed; vegetable; fibre – nutritious; marketable; risky picking
Inocarpus fagiferus	**U**	**U**	Ornamental; edible seed; beach-stabilising; forage; timber; for coastal protection
Lansium domesticum	**U**	**U**	Popular edible fruit; timber; medicine – needs shade; several pests and diseases; marketable
Morinda citrifolia	**U**	**U**	Dye (e.g., for *tikar* mat production); medicine; edible fruit; fruit-pulp for cleansing steel
Moringa oleifera	**U**	**U**	Vegetable; marking field boundaries; fibre – fast-growing; easily propagated
Myristica argentea	**U**	**N?**	Spice; combination with *Canarium* L. – inferior to *M. fragrans*, but less susceptible to
Nauclea purpurascens	**U**	**N?**	Timber – grows wild in primary and secondary forest
Nephelium lappaceum	**N!**	**U**	Popular edible fruit; medicine; dye; timber – fruits eaten by bats; needs sheltered location
Psidium guajava	**U**	**U**	Nutritious edible fruit; medicine; timber – adapts to a wide range of growing conditions
Sesbania grandiflora	**N!**	**U**	Fuelwood; forage; nitrogen-fixing; for supplementation of *Leucaena leucocephala*
Syzygium cumini	**N!**	**U**	Edible fruit; forage; dye; windbreak; fuelwood – drought-tolerant; no serious pests
Tectona grandis	**N!**	**U**	Highly valued timber (e.g., for joinery); dye; medicine

Notes: **U** used; **N** non-indigenous; **E** (almost) extinct; **!/!?/?** high/medium/low potential for *introduction*.

Source: Interviews, PRA and workshops (Stubenvoll 1996 and 1997); PROSEA, several volumes.

Increasing yields per area

As argued previously, in the face of population growth it is particularly important to increase yields per area on small tropical islands. Vertical extension of production in multi-storey mixed gardens and agroforests is one possible response. Another possibility is the improvement of agricultural techniques.

Increasing *staple food-crop* yields per area may contribute to the readiness of farmers to extend tree cultivation in agroforestry systems. For instance, the *mukibat* technique (see Ch. 6.3.2) for increasing cassava production seems to be promising, especially in Rhun, where the Ceara rubber-tree *Manihot glaziovii* is already cultivated, and where farmers are experienced with *mukibat*. Advantageous is also the possibility of inter-cropping sub-annuals in the *mukibat* plot. Its drawback is certainly the labour-intensive cultivation procedure. An increased cultivation of trees yielding starch, such as the sago palm (in Tioor only), the sugar palm (in Rhun only), breadfruit, and jackfruit is another recommendation. These tree species are already very popular on both islands. It has the advantage of integrating trees into the agricultural landscape, while at the same time diversifying food production for self-sufficiency.

General recommendations for improving agricultural management concerning crops yielding carbohydrates include (see also FAO and IIRR 1995, 34-7):

- practise crop rotation with nitrogen-fixing pulses (*Leguminosae*, such as groundnut and mung bean), as already demonstrated by a number of farmers;
- practise inter-cropping, as already performed in certain cultivation patterns (e.g., cassava and maize; cf. Fig. 6.7);
- diversify production to reduce the risk of crop failure;
- add organic material (instead of burning and spreading of ash);
- select nitrogen-fixing, fast-growing and deep-rooted trees to protect and improve soils;
- plant along contours, in combination with hedgerows of *Leguminosae* (e.g., *Sesbania grandiflora* and *Leucaena leucocephala*) and other trees, to control soil erosion;
- use mulch; and
- develop and protect forests and agroforests in slopes and upper watersheds.

With regard to *cash crop production*, particularly copra farming, integrated pest management is of utmost importance. The bushcricket *Sexava* sp. (*Phaneropterinae*) caused considerable damage to Tioor's coconut tree gardens in the 1970s (see Ch. 6.3.3), and has so far been successfully controlled by use of pesticides. However, noticeable signs of a renewed outbreak of the pest were observed during fieldwork. This example demonstrates a shortcoming of mono-specific tree gardens. The usual practice of burning cover vegetation in coconut tree gardens has been a questionable response by farmers in controlling *Sexava* sp., as this substantially reduces yields and destroys useful medicinal plants. It may have negative effects on natural hosts as well, limiting the potential of biological control. For instance, the parasitic wasp *Leefmansia bicolor* (*Encyrtidae*) infests the eggs of the pest. It is indigenous to the region (Monk et al. 1997, 752). Thus, burning of cover vegetation should be abandoned, and accompanied by integrated pest management. Traditional hand-weeding (*pamere*) is more labour-intensive, however. Additionally, mono-specific coconut tree gardens should be diversified (cf. Fig. 6.9). Where a multitude of other tree species is integrated into these gardens, outbreak of pests is less likely due to provision of habitats for natural hosts. Other reasons for decreasing copra yields, such as overcrowded spacing, ageing, and removing husks from gardens, should be adequately addressed by replanting activities at spacious distances, and kiln-drying.

8.3.2 Alternative income generation and valorisation of commercialised products

Where poverty is an overwhelming problem, and where food security plays an important role in the village economy, the *creation of alternative income* is a second precondition for a successful implementation of a CRMP. Additionally, *valorisation* of cash crops and marine resources – by value-adding and improved marketing – would support the acceptance of regulations restricting the use of resources. Improved marketing could include inter-village co-operation by taking advantage of *pela* relationships, as a response to common dependency on ethnic Chinese traders. Thus, on the one hand, a CRMP is only part of the solution. On the other hand, alternative income-generating projects and programmes (for instance the IDT programme) and valorisation of products will likely fail without a CRMP. Tab. 8.2 shows products with a potential concerning one or more of these strategies to enlarge the basis for sustainable development. Recommendations for most promising opportunities are discussed in the following. Generally, a need for integrated approaches is stressed to ensure potentials being translated into substantial benefits for the communities.

Table 8.2: Income generation and valorisation of commercialised products – a selection

Product	Strategy Present condition	Value-adding	Marketing improvement	Inter-village co-operation	Income generation
Copra (Tioor)	Sold to ethnic Chinese via intermediaries	Coconut oil	Co-operative; communal *sasi*	Network of co-operatives	—
Sugar palm juice (Rhun)	Palm wine, locally used	Palm sugar	—	—	Palm sugar (local market)
Sugar palm wood (Rhun)	Locally used for flooring	—	—	—	Flooring; furniture (local, and regional market)
Canarium seeds	Sold to local traders (Rhun); for subsistence (Tioor)	Cookies; edible oil	—	Inter-island trade to producers of cookies	Cookies (local market); edible oil (international market)
Nutmeg and mace	Sold to ethnic Chinese via intermediaries	—	Co-operative; communal *sasi*	Network of co-operatives	—
Timber	Sawn by villagers from Kasiui (Tioor); bought by ethnic Chinese	Co-operative chain saws; local joinery	Co-operative; communal *sasi*	—	Furniture; house construction (local and regional market)
Vegetables and pulses	Sold and bartered in the village; for subsistence	—	—	—	Marketing in regional markets
Edible fruits	Sold and bartered in the village; for subsistence	—	—	—	Marketing in regional markets
Regional fishing (Rhun)	Salted, dried fish (*ikan asin*), sold in Ambon	Fresh fish, sold in Banda	—	—	—
Traditional fishery	Subsistence-oriented, marketing of *ikan asin*	—	Co-operative; communal *sasi*	Network of co-operatives	See text, Tab. 8.3 and Tab. 8.4
Mariculture	Collection of *Trochus niloticus*, bêche-de-mers, etc.	—	Co-operative; communal *sasi*	Network of co-operatives	

Sources: Interviews, PRA and workshops (Stubenvoll 1996 and 1997).

Copra

Since copra is a major factor in the village economy of Tioor, its valorising is regarded a primary strategy to increase household's income. Value-adding may be achieved by processing a part of the copra to cooking oil for regional markets (Geser, Tual) instead of selling all copra to ethnic Chinese traders for domestic and international markets.[223] Actually, coconut oil is presently produced and

[223] In the early days of Indonesia's economic crisis (1997), prices for industrially produced cooking oil have rocketed, because a great percentage is exported on US$ basis. This development underlines the great potential of locally produced cooking oil for regional markets as a product for locally integrated economic circuits.

marketed in the Gorom Islands by a number of households, although to a limited extent. A problematic effect of this would be an increased use of fuelwood, unless producers were to operate with kerosene stoves or alternative energy resources.[224] Marketing of copra, and coconut oil as well, can be improved by: establishing a *co-operative*; introducing communal *sasi* on coconuts (to strengthen the bargaining position of copra farmers; see footnote 214), and operating with co-operative *transport facilities* (e.g., vessels constructed with local timber) for transport of products to regional markets. Such a vessel could also take products from other islands, e.g. in villages in *pela* relationship with Tioor. For instance, a co-operative could receive a double floor price for copra in Tual, Kei Islands, compared to selling it to intermediaries in Tioor. However, the tight patron-client relationship between ethnic Chinese entre-preneurs and copra farmers could be obstructive to establish a functioning co-operative.

Vegetables, pulses, and edible fruits and seeds

Alternative income-generating activity for Rhunese farmers may include the production of edible fruits, vegetables and pulses for Banda Neira as the main outlet, and eventually for Ambon. As communication to these markets has improved since the mid-1990s, transport of these perishable products is no longer a hindrance. Present great demand by consumers in Banda Neira is expected to increase, also because tourism may gain importance in the famous diving sites of the Banda Islands.[225] As recommended above, leguminous vegetables and pulses should be used in crop-rotation. In Tioor, irregular transpor-tation is detrimental for marketing of such products, although less perishable fruits, such as mangos, and processed edible fruits and seeds, such as durian flesh for *dodol* and *Canarium* seeds for *lutlubak* (cf. Ch. 6.3.3),[226] may offer opportunities for marketing in urban centres. The problem of a concurrent harvest season in the region (and resulting oversupply) was stated in Ch. 7.

Development of the fishery sector

As shown in Ch. 5.5.2, traditional fishery is performed mainly in the coastal waters. It is subsistence-oriented, although marketing of commercialised species (e.g., molluscs, bêche-de-mers, sharks) and *ikan asin* contributes to local household income. For the development of the local fishery sector, a multitude of measures in an integrated approach are recommended. Principally, suggestions of Dolman (1990), on how to use marine resources to promote sustainable development in small-island developing countries, can be adopted along qualifications concerning the local setting.

(1) *Promoting traditional fishery*, instead of investments in cost-intensive and environmentally problematic industrial fishery and processing facilities, “will be cheaper, create more employment, contribute to the attainment of nutritional objectives, and serve to promote a more equitable income distribution” (Dolman 1990, 89). However, various issues presently hindering local fishermen to increase household’s income must be considered. Tab. 8.3 summarises potential measures to address most serious problems. A special case of development of the fishery sector is regional fishing of Rhunese fishermen. Integration of cold storage facilities within their motorised ships may be a value-adding measure. Fish caught in the region, for instance tuna, could then be transported in fresh condition to cold storage ships in Banda Neira presently buying fresh fish from local fishermen. These ships could also provide fishermen with ice supplies. In general, fresh

224 For possibilities for the development of alternative energy systems, such as wind, photovoltaics, ocean thermal energy conversion (OTEC), bio-gas, geothermal energy, and hydropower, see Takahashi and Woodruff 1990, and Dolman (1990, 94-6). In Tioor and Rhun, the use of solar power is regarded to be the most promising of these alternatives.

225 Tourism for alternative income creation may have potential in Rhun as well. However, tourists will not come to Banda, as long as sectarian violence in Maluku persists. This example indicates the great dependency of certain economic activities on the overall political situation in Maluku and Indonesia.

226 *Dodol* is a kind of toffee made of palm sugar, coconut milk, durian flesh and sticky rice. An effort to commercialise seeds from *Canarium* spp. is currently being undertaken by a Government project in the Solomon Islands (cf. Pelomo 1994).

fish fetch higher prices, due to heavy weight loss of salted, dried fish (*ikan asin*). Another advantage would be a shortened absence from the village, widening the scope for agricultural activities and agroforestry extension.

Table 8.3: Promotion of traditional fishery

Problem	Potential measures and remarks
Seasonal fluctuations of activities due to adverse weather conditions during monsoon periods	Not possible to be addressed directly; however, as agriculture is most labour-intensive during monsoon periods, agricultural income sources can, at least partly, compensate income losses in the fishery sector
Operation risks in times of haze as a consequence of regularly occurring forest fires in other parts of Indonesia	Improving navigation, e.g. with a simple compass in each vessel and boat
Depletion of baitfish stocks for line fishing	CRMP*; mariculture; conservation of littoral ecosystems; see (2) & (3) below
Lack of equipment and processing facilities	Incorporating the purchase of adaptable equipment (fishing nets, boats, etc.) into IDT programme or other projects and credit programmes
Disturbance of littoral ecosystems (e.g., coral reefs)	Conservation measures, CRMP*; see (3) below
External fishermen and enterprises deploying destructive fishing methods in Tioor's coastal waters	CRMP*; strengthening traditional rights over communal sea-territory; strengthening local capacity and providing equipment for enforcement

Notes: * Incorporation of measure into CRMP, or its consideration by CRMP.

Sources: Dolman 1990; Interviews, PRA and workshop sessions (Stubenvoll 1996 and 1997).

(2) *Promoting mariculture* (or sea farming), i.e. promoting "the cultivation in salty or brackish water of living organisms for human use and consumption" (Dolman 1990, 90): Mariculture can be managed in closed cycle and open cycle systems. Open cycle systems, in which the cultivated organisms are returned to a less controlled and more natural environment, are more recommendable for the communities of Tioor and Rhun, because these systems require less capital, energy, skill, and management demands than closed cycle systems (cf. Dolman 1990, 91). Highly migratory species in open cycle systems can be confined by nets or home-made bamboo cages.

Tab. 8.4 shows potentials for mariculture of most promising marine organisms. All recommended measures are interdependent in relation to the implementation of a CRMP. Moreover, licences to legalise trade are crucial for mariculture of protected species, such as *Trochus niloticus* and turtles.

Table 8.4: Promotion of mariculture

Species	Outlet	Potential measures
Trochus niloticus *Turbo marmoratus*	International market	Communal *sasi* integrated into CRMP; provision of juveniles *; open cycle system; harvest during opened sasi; eventually communal marketing with licences to legalise trading
Turtles	Domestic & international market	Communal *sasi* integrated into CRMP; fry caught in the wild (beach) and confined in open cycle system with cages or nets; part of grown-up turtles released; licences to legalise trading
Bêche-de-mers	International market	Communal *sasi* integrated into CRMP; open cycle system; harvest during opened sasi; eventually communal marketing
Baitfish	For traditional fishery	Communal *sasi* integrated into CRMP; fry caught in the wild and confined in open cycle with cages or nets
Seaweed	International market	Communal *sasi* integrated into CRMP; open cycle system; eventually operation by a co-operative or group

Notes: * In a research project carried out in Rhun, LIPI released *Trochus* juveniles, which were bred in LIPI's research laboratory in Ambon.

Sources: Dolman 1990; Interviews, PRA and workshop sessions (Stubenvoll 1996 and 1997).

Ecological conditions have to be taken into account as well, when promoting mariculture. For instance, mariculture of *seeweeds* is relatively simple and suited for Tioor's large eastern island shelf, being more or less protected from strong wave action during monsoon periods. Rhun Island's shelf is comparatively small in area, so that the basic requirements for sea-weed cultivation, namely a suitable substratum in shallow water from which the seaweed can grow towards the sunlit surface of the sea, can only be partially fulfilled. Seaweed may be cultivated for food, as an export product,[227] for mulch, as an energy resource, or for fertiliser (cf. Dolman 1990, 92-3).

(3) Conserving areas of high marine productivity, especially coral reefs, seagrass beds and mangroves, is the ultimate precondition for development of the fishery sector. Consequently, this issue has been included in Tioor's CRMP, whereas coral reefs in Rhun are presently not threatened by coral mining, blast and cyanide fishing. Rather, soil erosion and sedimentation pose a threat to the productivity of the coral reef, so that these factors have been addressed by Rhun's CRMP.

8.3.3 Acceptance by the Government and decision-makers

Acceptance by the Government and decision-makers is a third requirement of implementing a CRMP. Traditional land tenure in Tioor is acknowledged by the Government so far, because expropriation of customary land in favour of governmental projects or commercial extraction operations is extremely unlikely in the resource-poor island of Tioor.[228] Another argument for possible governmental support concerning Tioor's *land-use plan* is the assistance by the agricultural services during the outbreak of the bushcricket *Sexava* sp. in Tioor's coconut tree gardens in the 1970s. However, governmental acknowledgement of Tioor's *sea-use plan*, particularly with regard to *traditional sea territory,* is required to strengthen local rights, as well as to provide the legal basis for curbing exploitation of marine resources by outsiders. As outlined with Example 2 in Ch. 8.2.4, the other fundamental of Tioor's sea-use plan, communal *sasi laut*, has been acknowledged by the district administration.

The rehabilitation plan for the nutmeg plantations in Banda

Contrary to Tioor, Rhun's land-use plan requires approval by the Government at regency level, in order to realise the proposed stewardship contract for social forestry on state land. However, as discussed in the following, influential figures in Banda Neira were planning to re-establish a nutmeg plantation in the Banda Islands including Rhun. This plan was supported by the recent, sharp increase of nutmeg prices.

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[227] For instance, agar-agar from *Gelidiella acerosa* (Forsskal) Feldman et Hamel. World market demand for agar-agar is presently higher than available seaweed supplies (Prud'homme van Reine and Hatta 1989, 136).

[228] Similar to the seizing of traditional nutmeg production in Banda by the VOC (cf. Ch. 5.1), there are numerous examples of expropriation of customary land, as well as of disdain for traditional resource management practices (Thorburn 1995, 15), in *contemporary* Indonesia. In East Kalimantan, the Indonesian Government seized the bird nest caves of the local Punan, who owned and managed bird's nests sustainably for centuries, to the profit of the economic elite in Jakarta (Michon and de Foresta 1996b, 6; for more information on the greedy economic elite see Schwarz 1994). Topatimasang (1997, 7-8) provides several examples from Maluku, where whole islands were depopulated for mining purposes by state-owned companies, such as in 1982 in favour of the nickel producer PT. Aneka Tambang in Gebe Island in the Halmahera Sea. The populations of Teon, Nila, and Serua in the Banda Sea were moved to Seram in the 1970s, officially because of the danger of volcanic activity (Monk et al. 1997, 672), but probably also for securing open access for companies to the sulphur deposits on these islands. In 1988, a logging company belonging to Indonesia's then largest conglomerate, the Salim Group, started operating in ancestral forests of eighteen villages on Yamdena Island. And in 1996, a copper and gold mining exploration by a joint venture of PT. Aneka Tambang and the Canadian Ingold Company occupied traditional land of the people on Haruku Island.

The CRMP document was submitted to the Government at regency level in November 1996. The proposal about social forestry stated clearly the deadline for an approval: one year after the passing of the final version of the CRMP by the community on the 9th of October, 1996. As the deadline was exceeded, the community understood this as a disapproval of the plan by the Government, so the community annulled all regulations. The slowness of bureaucratic procedures cannot be explained with the administration's arrogance or sloppiness only. The reason for the missing feedback must rather be located in the differing interests of the real decision-maker, namely the Bandanese Des Alwi, whose ties were directly linked with the Presidential Palace in Jakarta.[229] Des Alwi planned a nutmeg plantation project on the Banda Islands.

A 1997 decree of the Ministry of Agriculture brought 3,700 ha (or 67% of the area of the Banda Islands) directly under the control of Des Alwi's foundation. The project was due to be supported by governmental funds of seven billion Rupiah (US $ 2.8 million at pre-crisis rate), which would be shared between the foundation (45%), the Government (45%) and the local co-operative (KUD, 10%). Since the Government had not reacted to the CRMP proposal, it can be supposed that the nutmeg plantations were to be rehabilitated without any tenure rights for the peasants. The Government would play the part of implementing the afforestation of nutmeg trees, while the foundation and the local co-operative would organise harvesting, processing and marketing. The University of Pattimura in Ambon would play a key part in the project. According to an order of the Governor of Maluku in 1996, it had to carry out research for producing identical, high yielding nutmeg clones via genetic engineering.[230]

Although the present status of the project is unknown (see footnote 229), it is briefly evaluated. The risks of the intended project outweigh by far its chances.

(1) *Ecological risks:* The loss of bio-diversity by reducing the gene-pool to an absolute minimum by use of tissue culture has to be regarded as the most significant risk. It would irreversibly wipe out the world's largest in-situ gene pool of *Myristica fragrans* (see also Ch. 6.4.3). A spread of diseases and pests, until now a relatively minor risk for nutmeg cultivators compared to other cash crops, would be the immediate risk in a plantation with one clone. If not controlled by pest management, including the use of pesticides and fungicides with negative effects on soil, water and coral reefs, it would lead to a destruction of any plantation. Thus, capital input will be necessary, which would make the economic feasibility of the project doubtful.

(2) *Economic risks:* Besides inputs of imported pesticides and fungicides, costs would also arise from research and development of high yielding propagation material, from food subsidies for the communities during the first five years without production, from transmigration of families who would not accept expropriation of farmer-owned trees, and from control of nutmeg smuggling out of the established plantation. Furthermore, the academic community would focus its future activities on this very modern branch of agricultural research, therefore neglecting its research efforts in technologies being more adjusted to the needs of small-scale farmers ('academic brain drain').

[229] It is stressed that the discussion focuses on the state of affairs during my field research activities, i.e. *before* the Indonesian economy crisis and the step-down of President Soeharto in May 1998. As emphasised in Ch. 3.3, the reformed political landscape in Indonesia, as well as the persistent sectarian violence in Maluku, including Banda, since January 1999, has altered the political co-ordinates at a local level as well. This means that cronies of the Soeharto clan, such as Des Alwi, have lost influence in realising their interests.

[230] Vegetative propagation of nutmeg trees by approach-grafting and air-layering shows limited success-rates of 60% to 70% (see Ch. 6.1.1). Trials of tissue culture, carried out by the National Research and Development Centre for Industrial Crops, has been successful with other crops (e.g., clove), but has so far failed for nutmeg (Mariska 1992).

(3) *Socio-economic risks:* These risks are manifold, as shown by the history of the Bandanese nutmeg plantations: smuggling; disapproval, intended destruction and removal of nutmeg trees; low wages; dependence on food imports and world market; marketing monopoly. About 99% of the world's nutmeg production is presently produced by small-scale farmers. Grenada has established a farmer co-operative association, resulting in good quality products at acceptable floor prices.

The only *potential benefits* of this project are also tainted with shortcomings:

(4) Products of good and stable quality would be harvested, because processing would be centralised (into drying facilities possibly operating with solar power) and marketing would be channelled through the foundation and the local co-operative. Precondition would be the control of smuggling. But this practice would be equivalent to a monopoly, or in other words a remainder of the VOC era.

(5) Re-afforestation would balance the environmental conditions. It is impossible to imagine, however, that the overall ecological effects would be more positive by re-afforestation using one clone of one tree species than by re-afforestation using a variety of tree species, as the latter was proposed by the people of Rhun.

(6) A nutmeg plantation could contribute to promoting eco-tourism. On the other hand, a community-based social forestry project could likely attract more tourists, if all types of nutmeg production would be established: the pre-colonial system, represented by the community-based approach of Rhun's TGDK; the colonial system, using seedlings for propagation; the modern system, using vegetative propagation, and if successful also tissue culture; and a nature reserve, to preserve the still existing gene-pool. This idea would require thorough land-use planning, which has not yet been carried out under the Government's project.

Towards linking bottom-up with top-down planning

This example of a top-down development approach underlines two important points that should be emphasised in conclusion. The first one is related to the question of the future outlook of traditional agroforestry, which was already discussed in Ch. 7.2. The example of a planned nutmeg plantation in Banda highlights the limits of agroforestry in areas with a high production potential of a specific product. This limit is particularly manifested in situations where local control of land and local power is weak, and where powerful decision-makers ignore traditional resource management practices.

The second one refers to community-based development approaches in general. Bottom-up planning and community mapping (as a tool to document and to strengthen local control of customary land and sea territories) are of limited value, as long as they are disdained by decision-makers and by Government's central command-and-control policies.[231] Therefore, there is a need for community-based development to be consistent with national guidelines and linked with regional (top-down) planning. This should not be interpreted as a 'one-way' link in the sense of central command-and-control policies. Rather, national and regional levels of planning should be aware of the following: locally perceived needs, local problems and opportunities, and the value of local knowledge. In other words, the task is to bringing communities closer to governments, as well as vice versa. Thus,

[231] With regard to community mapping, Topatimasang (1997) concludes: "... a map produced by a community will only be effective as a tool [for community-based development] until a certain level. Once this level is passed and the power centres start to use their real forces, a map itself is not enough anymore. It is the time of legal instruments and political processes to come into the arena. Without a significant legal assistance and a clear political agenda after a community mapping process, a map itself will be merely a map. This is mainly true in an over-centralised political system like Indonesia."

community-based development approaches could be included in the recent decentralisation effort in Indonesia.[232]

The improvement of interaction between the three broad levels of planning (national, regional, and local; cf. FAO 1993, 5-8) would also better address two other potential disadvantages of bottom-up planing – the specific characteristics of local plans and the limited technical knowledge at local level:

- *Transferability and broader effectiveness*: Incorporating local plans into a wider framework, such as a regional development plan, would increase the potential for local solutions to work at regional levels. This transfer of local solutions is especially important if a region is characterised by a relatively high homogeneity in terms of biophysical conditions, culture and economics. Moreover, where a regional population has developed strong ties of socio-economic co-operation, economic strategies could make use of and more directly support (economic) *linkage effects*. As previously argued (cf. e.g., footnote 215), the traditional *pela* alliances in Maluku may serve this purpose. Therefore, local plans could contribute to a more effective regional development.
- *Knowledge and technology*: As Tisdell (1993; cf. Ch. 2.3.3) puts it, local knowledge might be insufficient to realise the impact of imported technologies. This would mean that "... technical agencies need to make a big investment of time and labour in widely scattered places" (FAO 1993, 7). By tapping local knowledge through demand-driven bottom-up planning and greater interaction, higher levels of planning would receive better information with regard to which technologies are most appropriate for local land-users and fishermen.

[232] For more details on decentralisation in Indonesia see e.g., Beier and Dürr 1998. For a more general discourse on decentralisation see e.g., Prud'homme 1995, Smoke 1999, and Fuhr 1999/2000.

9. IMPLICATIONS FOR SMALL TROPICAL ISLAND COMMUNITIES

The monographic discussion on the two very small islands of Tioor and Rhun focused on land use, particularly on traditional agroforestry in its genesis and its importance for the islanders, as well as on resource management in the broader sense. As stated in Ch. 3.2, the purpose of the problem-oriented, quasi-inductive approach and the qualitative methodology is to *generate* hypotheses which support the central hypothesis of this study (cf. Ch. 1):

Traditional agroforestry systems are a suitable or even superior basis for sustainable land use, and therefore have the potential to be included in the construction and implementation of community-based resource management plans for sustainable development in small tropical island communities.

The central task of this final chapter is therefore to examine the relevance of the – locally specific – results for small tropical islands, especially very small tropical islands, in general, also by drawing on the overview of their typical characteristics and common problems in Ch. 2. Finally, reflections on the consequences for political action, as well as for research and extension, are given as a conclusion.

Traditional agroforestry for community-based sustainable development

With regard to the potential of traditional agroforestry for community-based development in small tropical island communities, the following *hypotheses* are derived from the foregoing discussion:

(1) *Traditional agroforestry is adapted to the socio-economic conditions of resource-poor islanders, as well as to the fragile environment and smallness of small tropical islands*.

Considering the frequently described problems associated with smallness of small tropical islands – such as increasing population pressure, land fragmentation, and high competition among different land uses in a very limited land area – traditional agroforestry seems to be the only starting point of increasing and diversifying production through vertical extension, instead of an enlargement of cultivated land. At the same time, traditional agroforestry is contributing to the conservation of fragile natural resources – in particular fresh water, soil and littoral ecosystems. Coastal agroforestry, based on indigenous, salt- and wind-resistant trees and plants, may tackle coastal abrasion by stabilising the shore. Agroforestry along streams, based for instance on the sago palm, and other trees yielding starch (e.g., *Artocarpus* spp.) is important for reducing peak flooding, silt load and soil erosion in high islands which are characterised by numerous streams with small-sized catchments and steep slopes. Moreover, these tree species provide supplementary and emergency food.

In terms of *socio-economy*, the diversification of products, i.e. the combined production of products for self-sufficiency and for marketing purposes in agroforestry systems makes societies less vulnerable to both economic and natural dependencies. Furthermore, the use of internal inputs corresponds with the capacities of resource-poor farmers. However, islands with a comparative advantage for a special product – like nutmeg in Banda – should make use of it (see (3) below), but within a system that considers the socio-economic and cultural needs and capacities of the communities. For instance, such tree species can be easily integrated into agroforests. In this way, *mono-cultural plantations* are less suited for small tropical islands, because they require higher management skills, more capital, and a larger land area than are commonly available in very small tropical island communities. The existence of farmer-established coconut and sago tree gardens in Tioor is not contradictory to this consideration, because other perennials are frequently interspersed into these land-use types. Like mono-cultural plantations, *dry field agriculture* is of limited potential for increasing production on small tropical islands. It is certainly less adapted in sloping terrain of *high islands* due to soil erosion and degradation hazards as well as trade-offs, such as peak-flooding and sedimentation in riverain and littoral ecosystems. Moreover, increasing production in level terrain would require capital input in the form of fertiliser (to counteract loss of soil fertility as a result of ‘over-cultivation’; see Ch. 7.1), pesticides, and mechanisation. As the study showed, however, small-scale farmers generally lack capital. The use of pesticides and fertilisers will eventually lead to long-lasting, if not irreparable, damage to freshwater resources, particularly in the Gijben-Hertzberg lenses of *atolls* and *low-lying coral islands*.

(2) Diversification is important in terms of income generation which largely depends on an intact resource base. Traditional agroforestry may provide raw materials for income-generating activities, thereby reducing pressure on natural resources by substitution.

Likewise, with a diversified agricultural production system, risks and dependencies are reduced by a broad range of economic activities of islanders. This is especially important in those small tropical island communities, where seasonal climatic fluctuations do not allow for a particular, highly specialised income-creating activity. For example, island fishery depends on a relatively calm sea, whereas agricultural events most commonly take place during the rainy season and a rough sea. Handicraft, such as forging in Tioor, also fits for this seasonal diversification of economic activities.

However, very small tropical island communities may have a limited range of economic opportunities. Some of these opportunities require a population to be mobile, be it for fishing migratory fish species or seasonal work migration. Thus, transportation, especially provided by traditional boats, is a key factor for widening the scope of income generation. Moreover, most economic activities depend on the natural resource base. For instance, forging in Tioor depends largely on local timber for charcoal production. Thus, in anticipation of dwindling natural forests, agroforestry for charcoal production or the substitution of natural resources through products from existing agroforests (e.g. coconut shells from *dusun kelapa*; cf. also Beller et al. 1990, 382) will become an increasingly important management option. The incorporation of cultivated, highly valued timber trees into agroforestry systems will contribute to ensuring a steady provision of raw material for other handicrafts as well, such as boat construction and joinery. These examples illustrate perfectly the potential *linkage effects* of agroforestry with other economic sectors.

Agroforestry also affects the fishery sector through decreased sedimentation and increased littoral productivity. Restoration of mangroves and beach vegetation, as well as afforestation along streams is particularly important with regard to fishery. Since ancient times, small tropical island communities depend on inshore fishery for their subsistence. Increasingly, fishery is a source of income generation. At the same time, however, commercialised marine species have been overexploited and littoral ecosystems degraded through destructive fishing techniques, sedimentation, and pollution. Any development of the fishery sector therefore does not only depend on rational resource management of marine ecosystems, but also – and at least equally important – on sustainable management of landscapes.

(3) Despite priority of diversification, specialisation of economic activities, and related division of labour, may be a rationale on small tropical islands with specialised resources and comparative advantages. This includes agroforestry, when a leading crop for marketing purposes is cultivated, but at the same time integrated into a diversified agriculture for self-sufficiency.

The comparative advantage of nutmeg cultivation on the Banda Islands was frequently stated as an example. On the farm level, a farmer who has established a diversified subsistence-oriented farming system, could simultaneously integrate nutmeg trees into his system. Similarly, tree species which are highly vulnerable to non-wind borne diseases and pests, such as *Citrus* spp., could be cultivated on small tropical islands, provided that healthy propagation material would be used and that natural and socio-economic conditions would allow their introduction. Specialisation with regard to crops for marketing purposes then does not mean to establish mono-cultural plantations. According to the approach of locally integrated economic circuits, the basis is rather *specialisation within diversification*, i.e. the support of few leading commodities for international and national outlets by a broad range of products for self-sufficiency, and local and regional markets. In very small islands far from continental areas, high-value, low-bulk and non-perishable crops should be preferred as leading export commodities.

(4) Secured land and tree tenure are preconditions for the establishment and the enlargement of traditional agroforestry systems, such as the dusun. Farmers may even plant farmer-owned trees to gain access to and control of state land, or to secure claimed customary land.

The example of nutmeg cultivation is again used to demonstrate the importance of farmer control of land and tree resources (see also Ch. 6.4.1). Despite unfavourable world market prices, farmers in Tioor have enlarged nutmeg production in farmer-owned tree gardens, whereas governmental nutmeg plantations in Rhun have been steadily driven back by farmer-owned clove trees in mixed gardens and by permanent dry fields. Any development of agroforestry therefore depends on clearly defined and secured access to tree products, i.e. full siphoning off of profits/benefits from tree products, as well as secured land tenure.

Traditional law, customs, and a code of ethics which allows accessibility to tree products of other farmers, i.e. in societies with high levels of reciprocity, could be interpreted as a hindrance to enlarging the area under traditional agroforestry. However, such social security arrangements serve social equity, widening the scope of acceptance of diversified traditional agroforestry. Moreover, where virtually all farmers participate in community forestry or where a periodic ban on the use of specific cultivated resources is imposed (*sasi*), theft of tree products not falling under the category of 'free accessibility' is less likely.

Exclusion of external users of land resources (e.g., timber) is relatively easy in very small island communities due to their isolation. Moreover, local control and safeguard against poaching of land resources is more effective on the limited land area of small islands than in continental regions and larger islands. However, as shown by the case study of Tioor, customary waters, especially relatively distant coral reefs, are not immune from external poachers and enterprises.

(5) On the one hand, the emergence of traditional agroforestry is a response to the ecological disturbances caused by dry field agriculture and related deforestation and agro-deforestation. On the other hand, traditional agroforestry may contribute to driving back natural forests.

The implication of this hypothesis for small tropical island communities is toward planting enough trees at least on sloping land, along streams and along the coast, while at the same time preserving remaining natural forests – on islands where they still exist. Therefore, a *tumpangsari* based farming system should focus on the development of mixed gardens, where staple food crops can still be produced, i.e. an integration of perennials and annuals. A continued separated production of annuals would otherwise maintain pressure for converting natural forests to dry fields.

As pointed out in Ch. 2.3.2, the conservation of remaining forest stands on small tropical islands contributes to: control of soil erosion and degradation, protecting land from natural calamities, regulation of microclimate and water supply, providing food and habitats for animals (including endemic species), and providing timber and non-timber products for humans. Moreover, bio-diversity of plant species, both at species and sub-species levels, is conserved. This increases the potential to draw from propagation material of valuable tree species found in natural forests, which could be integrated into agroforestry systems elsewhere on the island. Especially man-made agroforests, which structurally resemble natural forests by incorporating forest trees into the system, could be of value for upland and watershed management.

(6) *Although traditional knowledge and traditional institutions may be ignored or lost in the face of commercialisation and by imported technologies, they are of great value for community-based approaches to tackling environmental degradation and socio-economic marginalisation by creating a more sustainable agriculture including agroforestry. The key is to synthesise external knowledge with traditional knowledge systems.*

As pointed out in Ch. 2.3.3, traditional knowledge is sufficient as long as local technologies are deployed. When a new technology is introduced, however, this knowledge may not be sufficient to assess its impact, especially on the environment and on the society. Therefore, external knowledge must be made available to island communities, simultaneous to the introduction of a new technology. Most important is a combination of traditional and external knowledge, because the latter is often of continental origin and therefore of limited value for island communities as long as the local framework, including local knowledge, is disregarded.

Traditional institutions could provide a regulatory framework for effectively organising community forestry or co-operative farm forestry. This is necessary, because land management problems need to be tackled at a scale larger than the individual household, e.g. at the watershed level, co-operatively at the community level, or – on very small tropical islands – at island level. In anticipation of commercialisation or of new technologies brought to islanders, the challenge for island communities is then to pragmatically adapt traditional institutions to these developments. Of major concern is thereby, that benefits are perceived to be greater than the costs, and that these benefits are equitably shared in the community. In terms of traditional agroforestry, where benefits are only obtained in the medium-term or even long-term, external knowledge (or 'rationality') about the chances of community forestry must support traditional knowledge. The latter often draws from the forebearers' experiences of *how* to use the land sustainably, but may lack *rational* explanations of *why* this particular land use is sustainable.

(7) *Any land-use strategy (including agroforestry) must take into consideration the wide range of agricultural and wild lands found on small tropical islands. Therefore, tree species in agroforestry systems must be selected site-specifically.*

For each of these lands – primary or secondary forest stands, sacred forests, beach vegetation, home gardens, mixed gardens, agroforests, dry fields of shifting cultivation, mono-specific stands of coconut, and many more – agroforestry systems with particular, preferably indigenous tree species should be considered. Nonetheless, this could include new species of fruit and timber trees to diversify the farm enterprise. Decisive for a successful introduction of new species is their agro-ecological adaptation, and the capacity and acceptance by the farmers. As discussed in the island case studies, opinion leaders and innovative key farmers with leadership skills could play a crucial role in demonstrating of how to enlarge agroforestry at the community level through the strongly developed informal contacts and social relations on small islands.

(8) *Community-based development built on traditional agroforestry is an appropriate approach for small tropical island communities.*

A significant feature of small, and particularly very small tropical islands is that locally caused environmental disturbances take effect on the spot rather than being transferred into other regions. This has two important consequences for man-environment relationships and sustainable resource management. Firstly, as small tropical islands are home to a complex network of various interacting, fragile ecosystems, any disturbance of one ecosystem will ultimately affect others as well. The *rate* of natural degradation is therefore multiplied. This multiplication effect means in extreme cases, that causes and effects of disturbances are temporarily closely related. And secondly, as a consequence of the close spatial and temporal interaction of causes and effects of disturbances, islanders will more likely perceive environmental degradation as a direct result of their own activities. With this perception, combined with the fact that negative influences are not externalised into other regions, local counter-reactions and changes in behaviour are to be expected. This may be increased on those small tropical islands where the islanders have developed a strong cultural identity or where worship of the land, i.e. their island, and to the ancestors are pronounced.

Therefore, demand-driven community-based approaches to rational resource management, including an institutional framework and related organisations, may evolve, in which resource users actively participate in overcoming their problems. In this approach, organisations that have developed as a consequence of the local institutional framework may be a means to mobilise traditional knowledge to solve these problems by improved management. For instance, in the case of land-use problems, traditional agroforestry and improved agricultural management can be deployed and implemented by farmer groups. As discussed in (6) above, external support will facilitate the identification of practicable solutions and be helpful for finding common ground, especially if rivalry in the community would hinder the acceptance even of beneficial changes. However, the impetus for organisation and implementation should come from the community to avoid external paternalism, which will most likely be rejected by islanders.

Although initial external support to catalyse community-based sustainable development may be costly and time-consuming, implementation of farmer-driven solutions shows promise to be more efficient, less expensive, and more acceptable in the long run than top-down oriented transfer of technology. For example, in the southern Philippines, farmer organisations became the basis for a successful grassroots approach to finding new land care solutions, partnering with local government, pulling in outside technical and financial resources, and diffusing new information throughout the community (Garrity 1999).

(9) Traditional inter-island co-operation is a basis for the extension of community-based development approaches, especially where agro-ecological, cultural and economic factors in the region are similar.

Like other traditional institutions, traditional inter-island relations may be of great value for community-based development. Through inter-island relation:

- economic linkage effects are to be realised;
- mutual support can take into account different island resource opportunities (e.g., land on one island, and labour on the other island, cf. footnote 215);
- knowledge, information, tree seedlings and adaptable technologies can be efficiently exchanged and quickly spread through regular informal contacts;
- disadvantages of diseconomies of scale are eased, particularly relating to transportation and co-ordinated marketing;
- inter-island co-operative arrangements could be expanded and formalised with support of governmental and non-governmental organisations (e.g., to co-operatively patrol, and to physically prevent external fishermen from poaching or from using destructive fishing techniques in *common* territorial waters);
- a spread of local solutions by networks may contribute to the long-term success of local organisations and institutions; and
- reciprocal obligations will counteract social fragmentation.

Conclusion: Consequences for political action, extension and research

Being the world's largest archipelago nation with hundreds of small and very small inhabited islands,[233] and housing one of the richest coral reef ecosystems, Indonesia currently concentrates on development of its larger islands. Thus, the results of this study should attract more attention to the needs of small island communities in this huge archipelago.

Generally, this study showed that top-down and bottom-up planning should be seen as two approaches to be integrated for achieving sustainable development. This result is not restricted to small tropical islands. An integration would require decentralisation of power and fiscal responsibility, eventually by establishing a fourth level below regency level in the Indonesian planning hierarchy. It would be the easiest for the village to play this part as the lowest level of any bottom-up planning organisation. Indigenous knowledge could then be made more easily available for sustainable resource management. Its value for development programmes is shown in this study, and documented and scientifically verified by other studies as well (e.g., Momberg 1993).

Decentralisation of power must also include divestiture of state control over land and sea territories as well, because local control of traditional sea territory and secured land tenure for farmers are the basis for acceptable solutions relating to rational resource management, such as social forestry and fishery development. Enforcement of regulations in communal sea territories should be supported by the Govern-ment and the navy, because islanders may lack equipment, such as information systems and motorised boats. However, governmental services at provincial and regency level are presently undermanned and insufficiently equipped with vessels as well.

To enhance the extension of agroforestry, negative impacts have to be recognised and analysed first. Since an enhancement of agroforestry systems would cause the reduction in a given area of one or more other land-use systems, the whole land-use system must be included in this process. The next step consists of finding ways to decrease the negative influence of identified constraints. This involves a planning process, preferably carried out by the community as the main actor in land-use decisions. A community-based resource management plan (CRMP) has the advantage of dealing directly with institutional shortcomings at the local level, which were identified as important factors of ecological and economic problems in the two island case studies. Its main disadvantage is the dependence on three preconditions. Without (1) approval by the government, (2) alternative income generation and (3) choice of the right trees, and of adaptable management systems and technologies for a furtherance of agroforestry, the chances of CRMPs seem to be limited. But without a CRMP, investments in human resources or income generation cannot be sustainable, as the failure of most IDT funds in the two island communities of Tioor and Rhun showed. Alternative income generation, and the strong interaction between different island ecosystems require an integrated approach of island sustainable development. Therefore, sectoral solutions must be combined in a holistic framework, if trade-offs of a particular sectoral strategy are to be avoided.

Besides direct support of governmental services and extension workers, education and dissemination of information concerning improved agricultural management and the importance of wildlands and coastal ecosystems are crucial to promote a broad integration of production and protection in small island communities. For instance, television and broadcast programmes are not restricted to national multimedia organisations. Since short-wave radios and parabola television sets exist on even the remotest islands, it could be extended also to international programmes, provided it is broadcasted in

[233] Besides Maluku, other Indonesian provinces – particularly Riau, Nusa Tenggara Barat, Nusa Tenggara Timur and the four provinces of Sulawesi – consist of many small islands as well.

the vernacular language. Elementary schools could introduce traditional agroforestry in their curricula, stressing its value, as well as its nutritional and protective function.

Nurseries should be incorporated in a decentralised manner, i.e. preferably on every island, because diffusion from central nurseries on main islands to more remote islands most commonly takes place at farmer level. Extension work could more strongly focus on this branch of agricultural development by supporting farmer organisations to establish community nurseries, especially for valuable and popular trees yielding edible fruit and seeds, and trees adapted to coastal areas including mangroves.

Finally, it has to be emphasised, that problems and potentials of development are *local and site-specific*. This is especially true on small islands which are highly diverse in terms of biophysical, historical and cultural factors. Therefore, extensive empirical research is necessary to document and understand the local framework. Since community-based development depends on local knowledge, participatory research approaches are highly recommended to successfully combine external and local knowledge for developing locally adapted solutions against environmental disturbances and marginalisation.

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PROSEA handbook

The PROSEA handbook is available in blue cover (hardbound), distributed by Backhuys Publishers, Leiden (formerly by Pudoc, Wageningen) for developed countries, and in green cover, distributed by the Prosea Network South-East Asia, Bogor, as a low-price paperback for all developing countries. For a complete citation of the blue cover version see the first of the editors' names in the references. Following volumes of the PROSEA handbook, published until 1999, were used by the author:

Basic list of species and commodity grouping		edited by Jansen et al. 1991
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No. 2	Edible fruits and nuts	edited by Verheij and Coronel 1991
No. 3	Dye and tannin-producing plants	edited by Lemmens and Wulijarni-Soetjipto 1991
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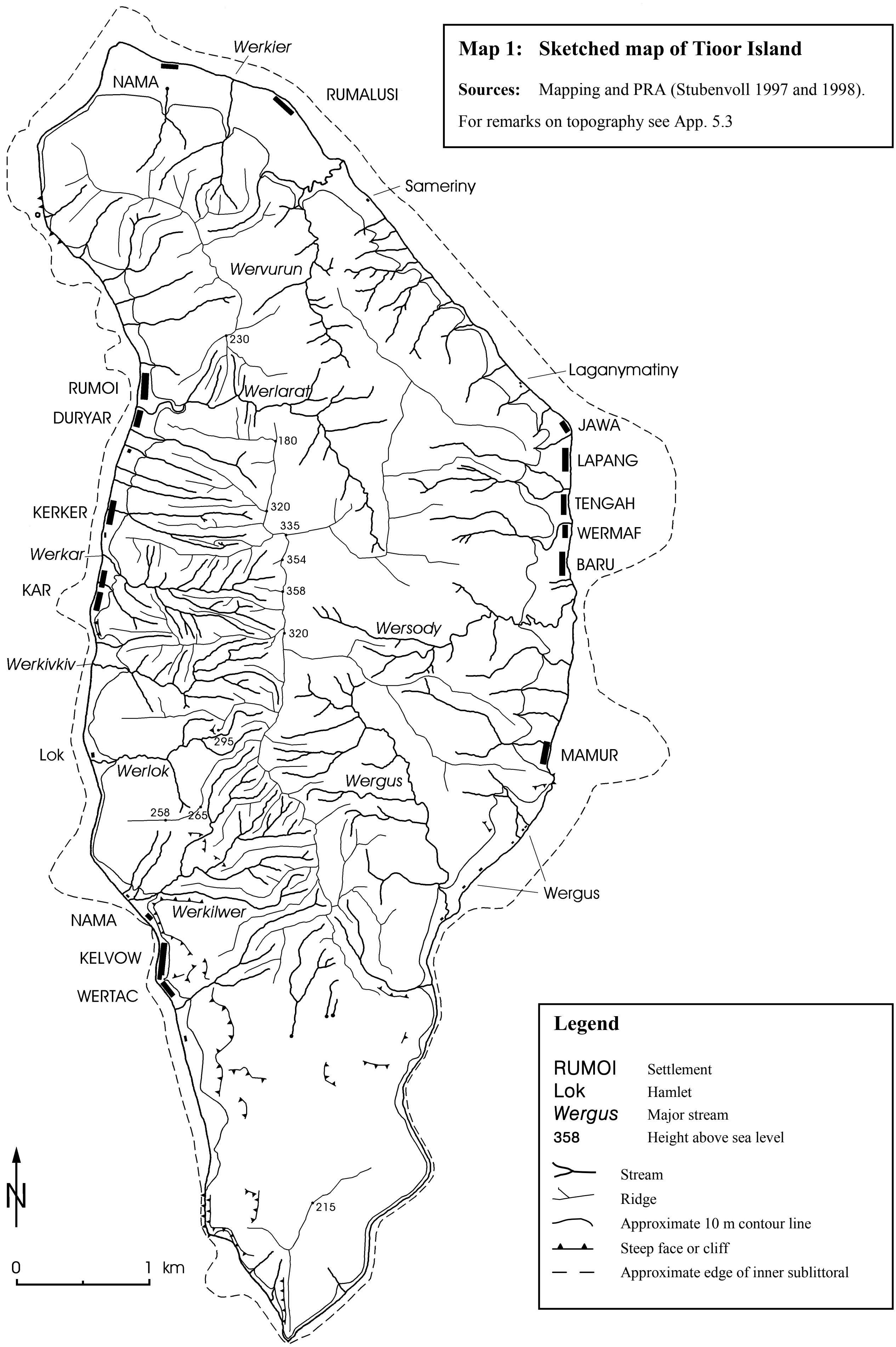


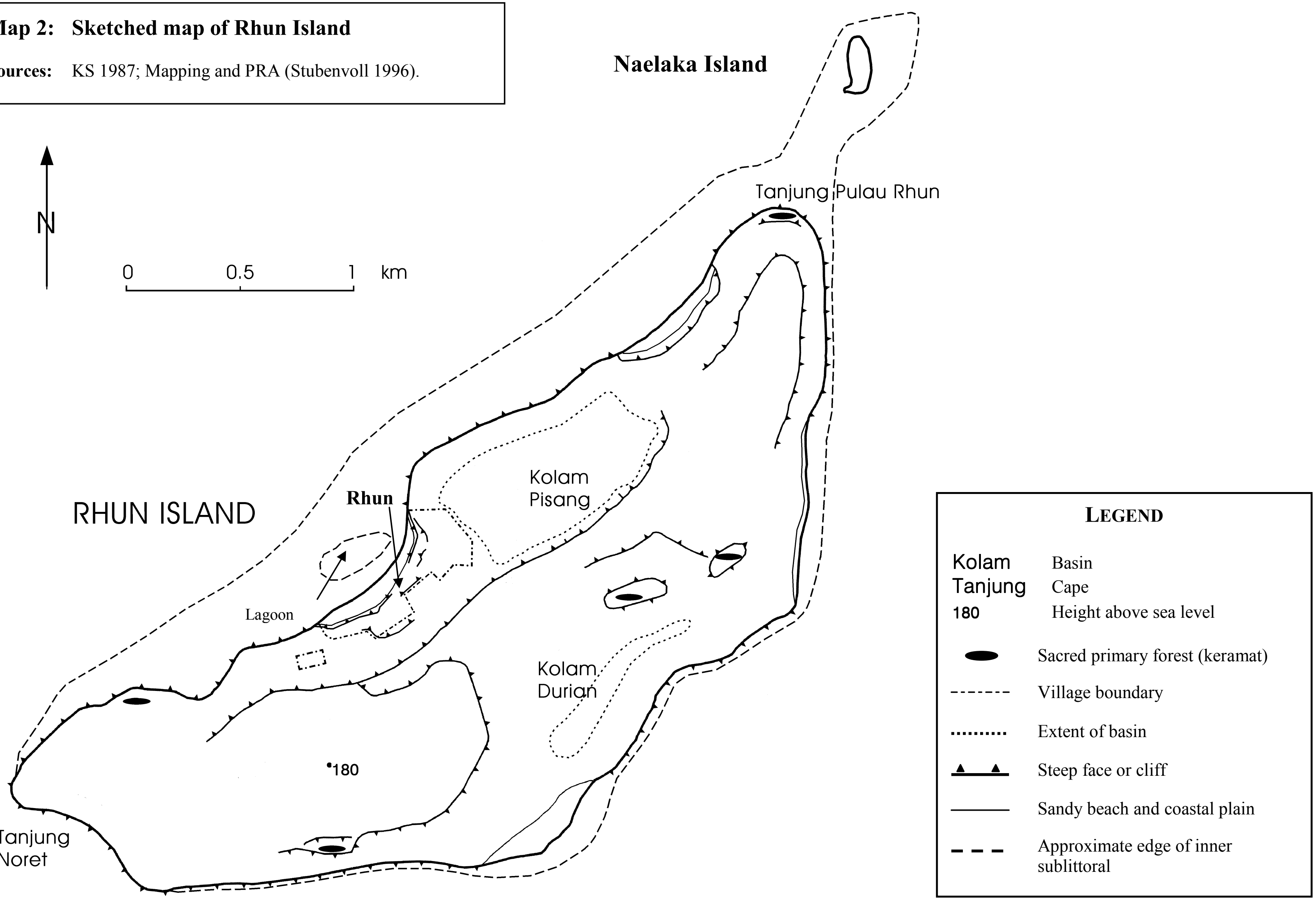
Map 1: Sketched map of Tioor Island

Sources: Mapping and PRA (Stubenvoll 1997 and 1998).

For remarks on topography see App. 5.3

Map 2: Sketched map of Rhun Island

Sources: KS 1987; Mapping and PRA (Stubenvoll 1996).



RHUN ISLAND – SAMPLE SURVEY OF HOUSEHOLD LAIDA (HH 1)

Legend of Maps 4.1, and of Parts of Maps 4.2 and Map 4.3

Trees and shrubs

(English – vernacular – scientific names)

	Trees and shrubs	Market range of primary product*
A	Ambarella – Kedongdong – *Spondias cytherea*	1
As	White cheesewood – Kayu susu – *Alstonia scholaris*	1
B	Beach mallow – Warok – *Hibiscus tiliaceus*	1
Bm	Bamboo sp. – Bambu – (*Graminae*)	1
Br	Breadfruit – Sukun – *Artocarpus altilis*	1
C	Clove – Cengkeh – *Syzygium aromaticum*	5
Cv	Java almond – Kenari – *Canarium vulgare*	4
Cw	Cashewnut – Jambu mete – *Anacardium occidentale*	5
D	Durian – Durian – *Durio zibethinus*	2
Dd	New Guinea walnut – Cerpati – *Dracontomelon dao*	2
Em	Cheesewood – Anoa – *Endospermum moluccanum*	1
G	Gandaria – Gandaria – *Bouea macrophylla*	2
H	Horseradish tree – Kelor – *Moringa oleifera*	1
I	Indian mulberry – Bengkudu – *Morinda citrifolia*	1
J	Jackfruit – Nangka – *Artocarpus heterophyllus*	1
K	Coconut palm – Kelapa – *Cocos nucifera*	1
Kp	Kapok – Kapok – *Ceiba pentandra*	1
L	Lime – Jeruk nipis – *Citrus aurantifolia*	1
Lg	Langsat – Langsat – *Lansium domesticum*	2
M	Malay apple – Jambu merah – *Syzygium malaccense*	2
N	Nutmeg – Pala – *Myristica fragrans*	4
R	Robusta coffee – Kopi – *Coffea canephora*	3
Rb	Rambutan – Rambutan – *Nephelium lappaceum*	2
S	Sugar palm – Aren – *Arenga pinnata*	2
T	Tamarind – Asam jawa – *Tamarindus indica*	4
N_o	State-owned nutmeg trees managed by a household not in relationship to extended family	
Note:	Small letters for young trees not yet productive	
○	Papaya – Pepaya – *Carica papaya*	1
∘	Ananas – Nenas – *Ananas comosus*	1
[2]	Banana – Pisang – *Musa sp.* (number indicates the number of suckers per parent plant)	3
(3)	Nutmeg – Pala – *Myristica fragrans* (number of naturally established seedlings, ready to be transplanted)	4

Sub-annuals, annuals, bi-annuals, and perennials cultivated as annuals

CA	Cassava – Singkong – *Manihot esculenta*
T	Taro – Keladi – *Colocasia esculenta* (eddoe type)
V	Vegetables – Sayur-sayuran
Y	Yams – Ubi – *Dioscorea* spp.

Cassava plots – Indices

a	propagated in:	January 1991
b	propagated in:	August 1991
c	propagated in:	November 1991
d	propagated in:	December 1991
e	propagated in:	January 1992
f	propagated in:	February 1992
g	propagated in:	March 1992
h	propagated in:	April 1992
i	propagated in:	July 1992
j	propagated in:	August 1992

Taro plots: taro propagated in May 1992

Most common vegetables (alphabetic order)

Amaranth – Bayam – *Amaranthus tricolor*
Angled loofah – Gambas – *Luffa acutulanga*
Bottle gourd – Labu putih – *Lagenaria siceraria*
Chilli – Cabe – *Capsicum* spp.
Eggplant – Terong – *Solanum melongena*
Star gooseberry – Katok – *Sauropus androgynus*
Tomato – Tomat – *Lycopersicum esculentum*
Winged bean – Kecipir – *Psophocarpus tetragonolobus*
Yard-long bean – Kacang panjang – *Vigna unguiculata*

Yams plots – Indices

35	35 mounds a 3 propagated tubers
100	100 mounds a 3 propagated tubers

All tubers propagated in July 1992

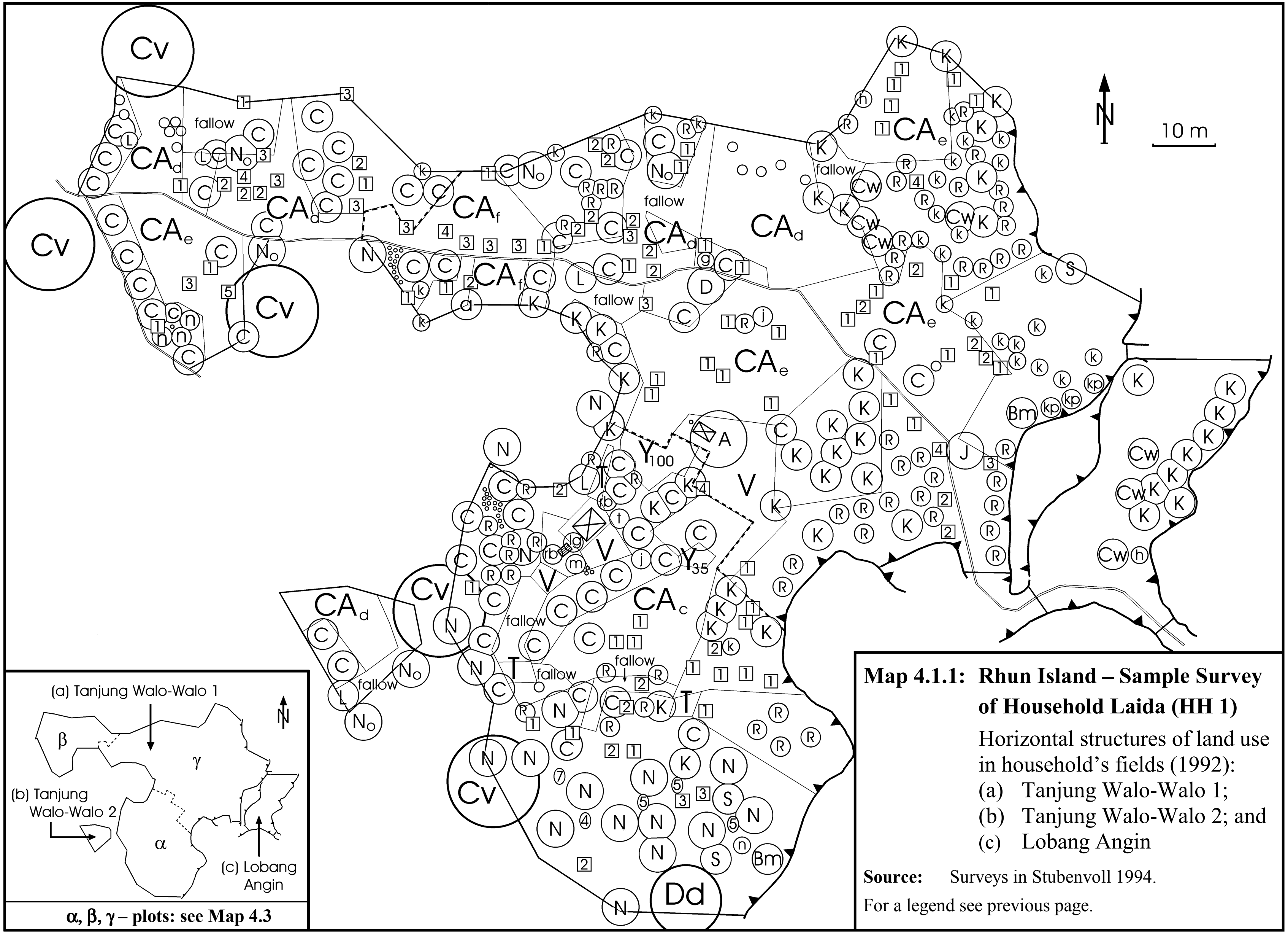
OTHER FEATURES

Path
Steep face (cliff in field Batu Lawa-Lawa)
Field boundary
Plot boundary
Boundary of α, β, γ -plots
Field hut
Bench
Foundation
fallow — Plot in fallow stage
Stump of dead tree
Encroachment planting by field neighbour

* **Market range of primary product**

1 mere subsistence product
2 subsistence product, surpluses marketed only in Rhun
3 subsistence product, surpluses marketed also outside of Rhun
4 market product, but also for self consumption
5 mere market product.

Note: Field survey in September 1992 by Stubenvoll (1994).



Map 4.1.1: Rhun Island – Sample Survey of Household Laida (HH 1)

Horizontal structures of land use in household's fields (1992):
(a) Tanjung Walo-Walo 1;
(b) Tanjung Walo-Walo 2; and
(c) Lobang Angin

Source: Surveys in Stubenvoll 1994.

For a legend see previous page.

Map 4.1.2: Rhun Island – Sample Survey of Household Laida (HH 1)

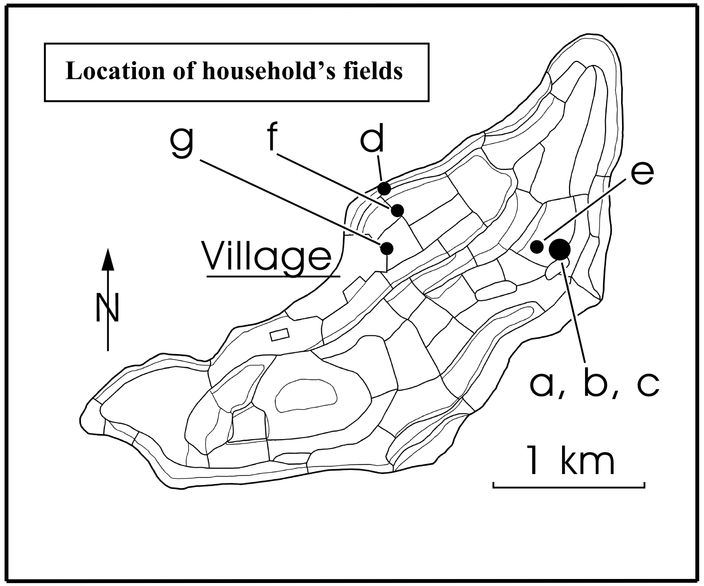
Horizontal structures of land use in household's fields (1992):

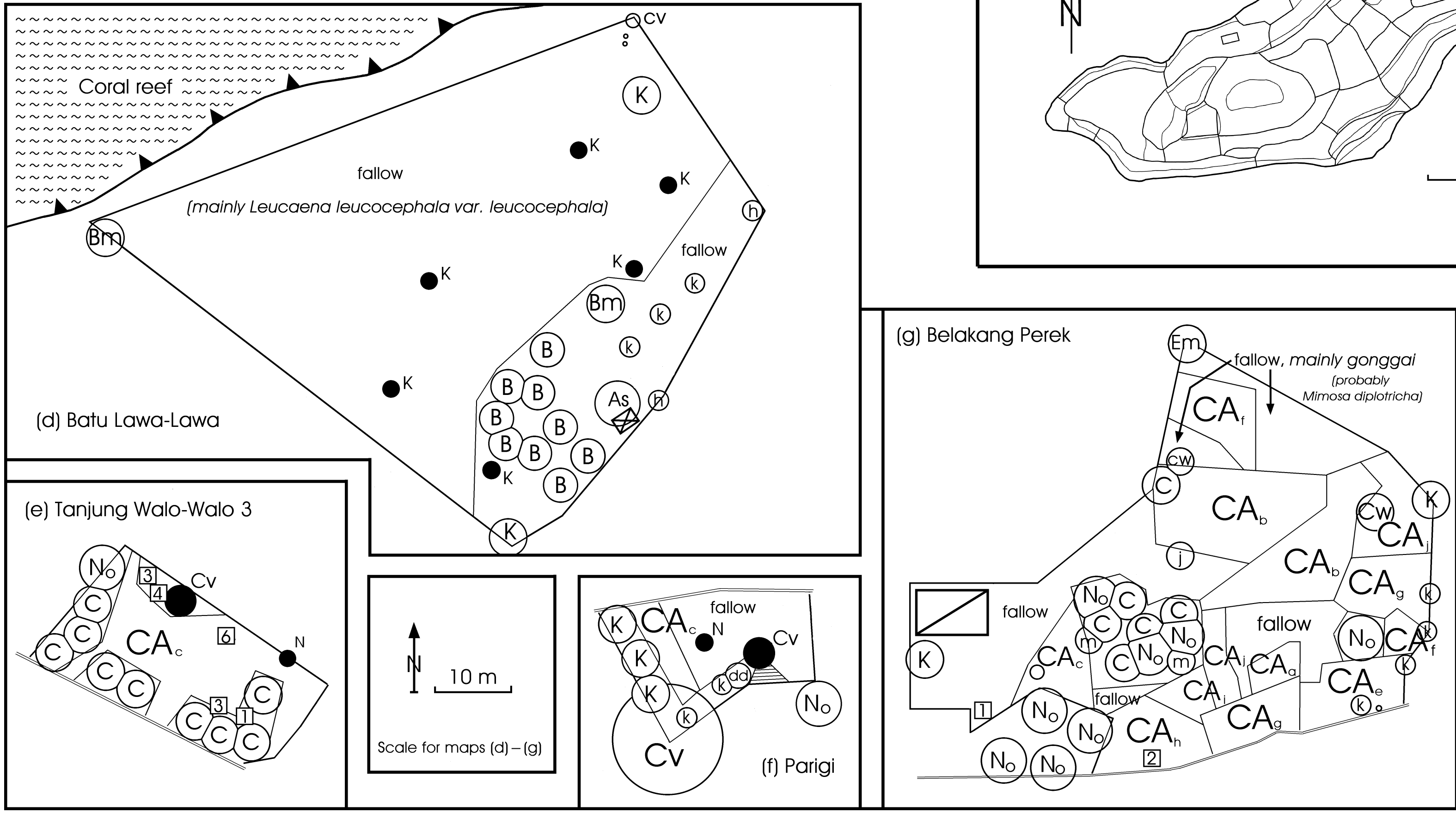
(d) Batu Lawa-Lawa; (e) Tanjung Walo-Walo 3;

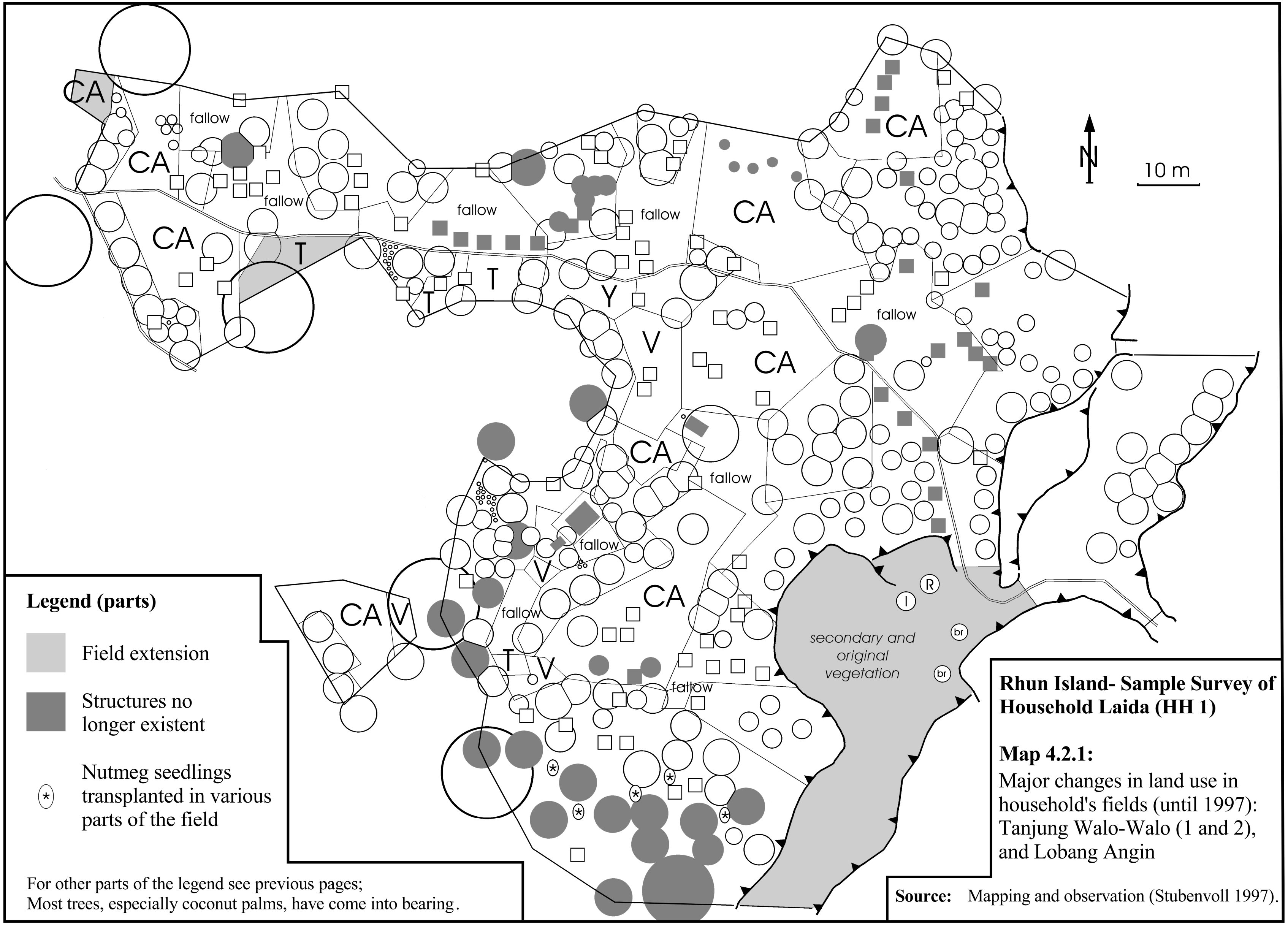
(f) Parigi; (g) Belakang Perek.

Source: Survey in Stubenvoll 1994.

For a legend see previous pages.







Legend (parts)

Field extension

Structures no longer existent

Nutmeg seedlings transplanted in various parts of the field

For other parts of the legend see previous pages;
Most trees, especially coconut palms, have come into bearing.

Rhun Island- Sample Survey of Household Laida (HH 1)

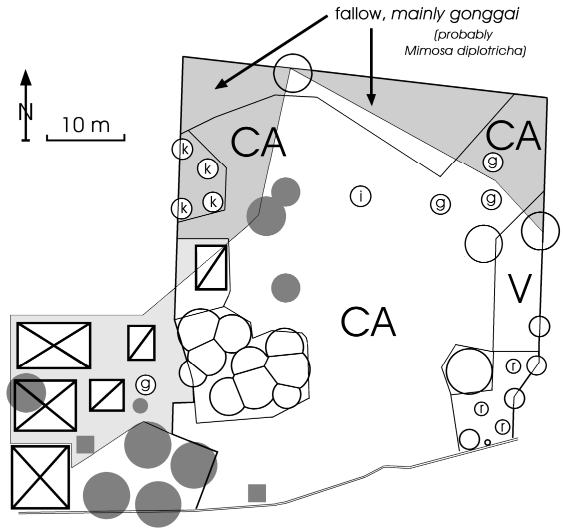
Map 4.2.1:
Major changes in land use in household's fields (until 1997): Tanjung Walo-Walo (1 and 2), and Lobang Angin

Source: Mapping and observation (Stubenvoll 1997).

Rhun Island - Sample Survey of Household Laida (HH 1)

Map 4.2.2: Major changes in land use in household's fields (until 1997): Belakang Perek

Source: Mapping and observation (Stubenvoll 1997)



Legend (parts)

Plot for home garden

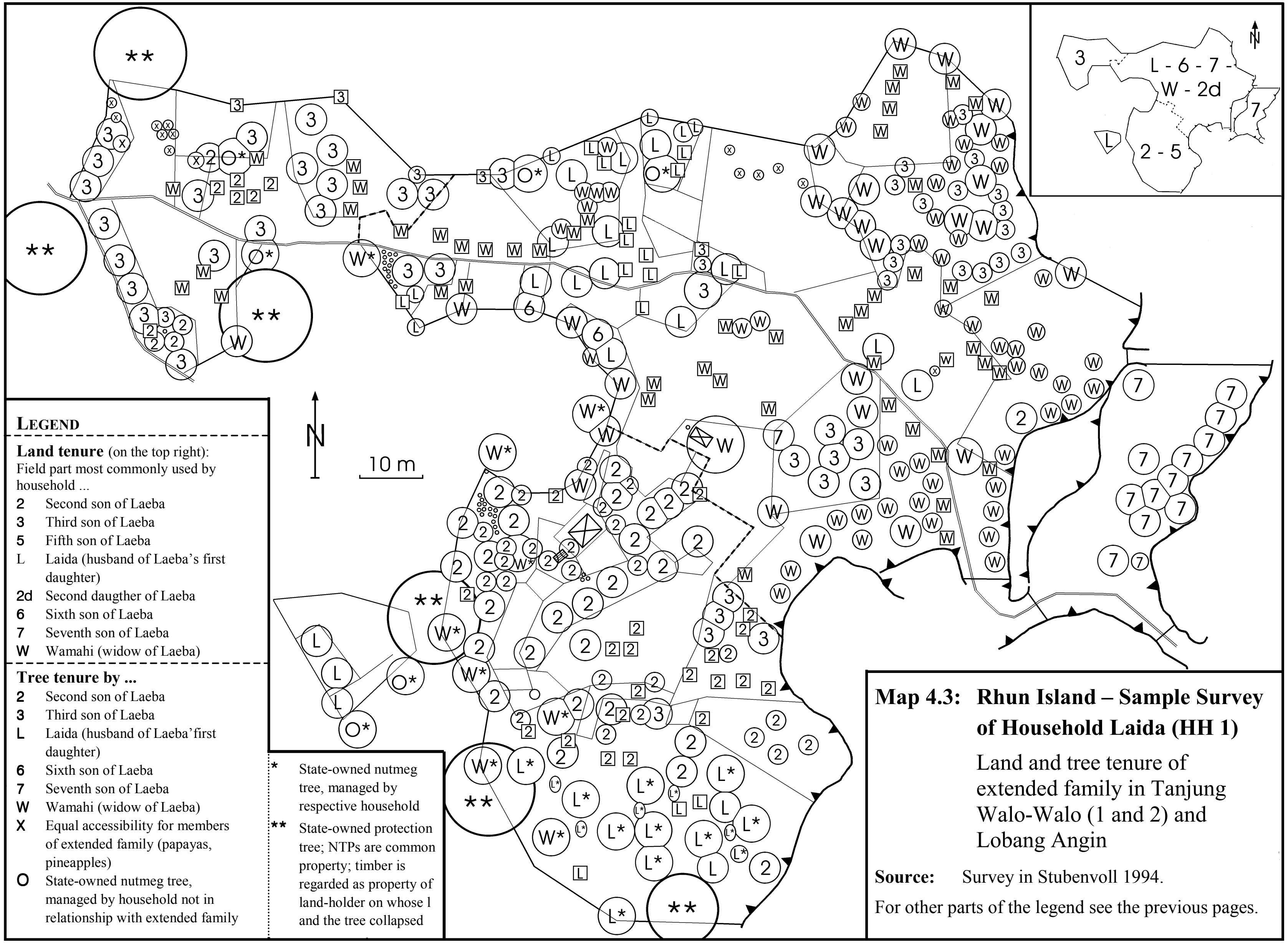
Field extension

Structures no longer existent

House (permanent)

House (semi-permanent)

For other parts of the legend see previous pages;
Except newly introduced trees, most other trees, especially coconut palms along the eastern field boundary and malay apple trees, have come into bearing.



Map 4.3: Rhun Island – Sample Survey of Household Laida (HH 1)

Land and tree tenure of extended family in Tanjung Walo-Walo (1 and 2) and Lobang Angin

Source: Survey in Stubenvoll 1994.

For other parts of the legend see the previous pages.

TIOOR ISLAND – SAMPLE SURVEY OF HOUSEHOLD PAULUS (HH 27)

LEGEND of Maps 5.1, and of Parts of Map 5.2

LAND USE TYPES

PF	Primary forest
PF – Bm	Bamboo stand in primary forest
PF – n	Young nutmeg trees interspersed in primary forest
SF	Secondary forest
slashed	Slashed secondary forest, not yet burnt
DF – 1.	Dry field, first year of cultivation
DF – 3.	Dry field, third year of cultivation
DF – 4.	Dry field, fourth year of cultivation
MG	Mixed garden
TG	Tree garden

TREES AND SHRUBS (most common)

(English – vernacular – *scientific names*)

Ba	Banana – Muk – *Musa* spp.
Bm	Bamboo – Bambu – GRAMINAE
Bn	Betel-nut palm – Vua – *Areca catechu*
C	Clove – Cengkeh – *Syzygium aromaticum*
Cn	Candlenut - Kemiri – *Aleurites moluccana*
D	Durian – Duran – *Durio zibethinus*
K	Coconut palm – Nuar – *Cocos nucifera*
Mg	Manggo – Mangga – *Mangifera indica*
N	Nutmeg – Bala – *Myristica fragrans*
R	Robusta coffee – Kof vunekvely – *Coffea canephora*
S	Sago palm – Kwera – *Metroxylon sagu*
Sa	Salak – Salak – *Salacca zalacca*

Small letters for trees not yet productive/fruiting

Matrices in Map 5.1.1. (on the bottom):

first number	Height of tree [m]
second number	DBH [m]
third number	Approximate age [years]

Note: Field survey in December 1997 (Stubenvoll 1997).

SUB-ANNUALS, ANNUALS, BI-ANNUALS, AND PERENNIALS CULTIVATED AS ANNUALS

(English – vernacular – *scientific names*)

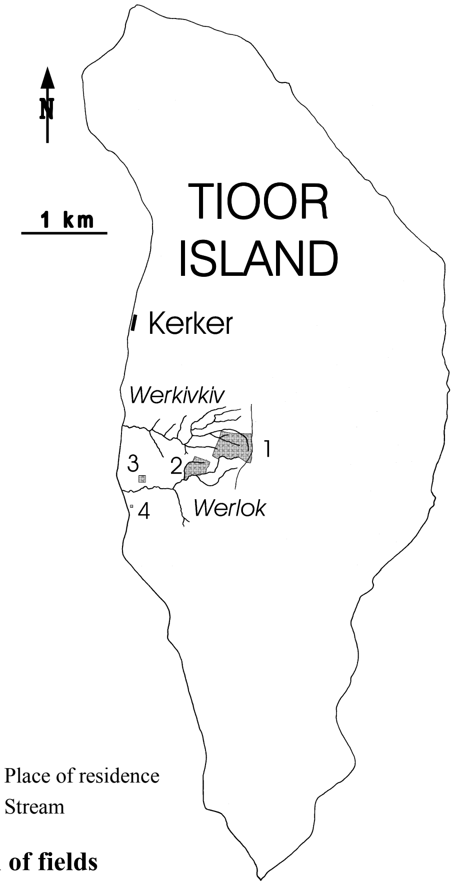
Ca	Cassava – Kasbe – *Manihot esculenta*
Ma	Maize – Sapulut – *Zea mays*
Mb	Mung bean – Kacang hijau – *Vigna radiata*
Ri	Rice – Pasah – *Oryza sativa*
Sp	Sweet potato – Uf – *Ipomoea batatas*
Ta	Taro – Huly – *Colocasia esculenta*
V	*Vegetables* – most common:
	Chilli – Bresentafiny – *Capsicum* spp.
	Cucumber – Komokomo – *Cucumis sativus*
	Eggplant – Toron – *Solanum melongena*
	Shallot – Bong vulvuly – *Allium cepa*
	Tomato – Kamatiny – *Lycopersicum esculentum*

In Map 5.1.1 (on the bottom):

O Inter-cropped taro plant

OTHER FEATURES

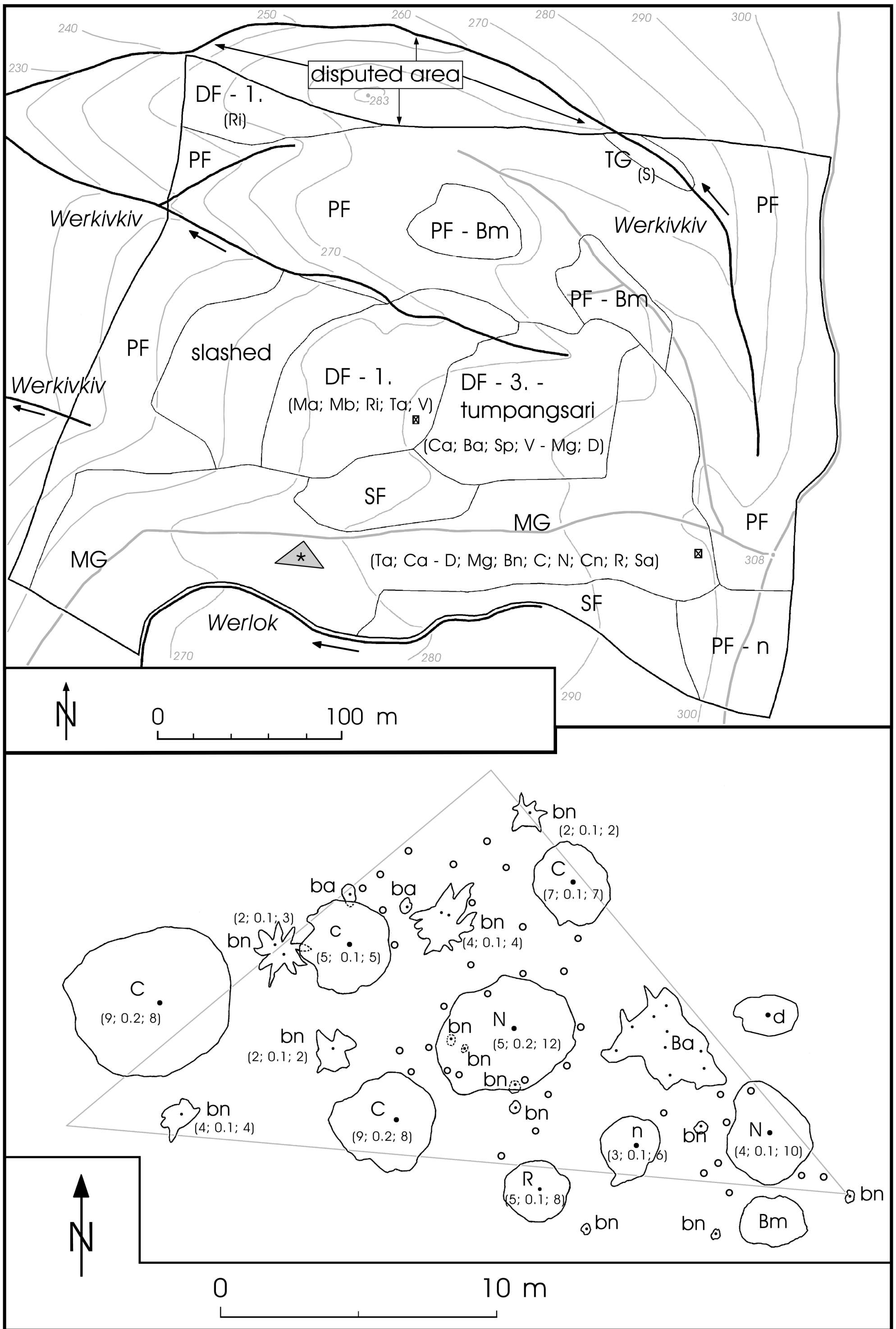
Werlok	Stream
	Field boundary
	Plot boundary
— *100*	Approximate contour line [m]
	Ridge
• *308*	Height above sea level [m]
⊠	Field hut
disputed area	Field area cleared by a relative of Paulus; plot formerly claimed by Paulus



Kerker	Place of residence
Werlok	Stream

Position of fields

1 Urit Aliminy
2 Kabtukun Wony
3 Vanoa Lenlus (not mapped)
4 Varun (not mapped)

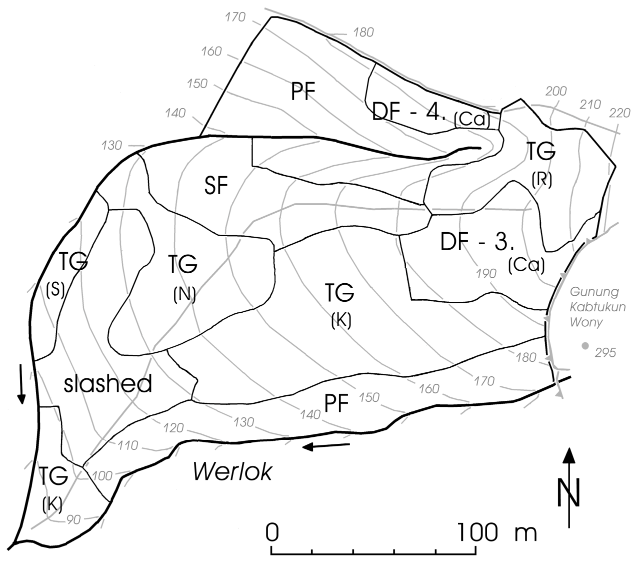


Tioor Island - Sample Survey of Household Paulus (HH 27)

Map 5.1.1: Land use in household's fields (1997): Urit Aliminy

Sources: Household interviews and mapping (Stubenvoll 1997).

Notes: For a legend see previous page; ⊠ (in map at the top): plot shown in map at the bottom.



Tioor Island - Sample Survey of Household Paulus (HH 27)

Map 5.1.2:
Land use in household's fields (1997): Kabtukun Wony

Sources: Household interviews and mapping (Stubenvoll 1997).

Notes: For a legend see previous pages.

Legend

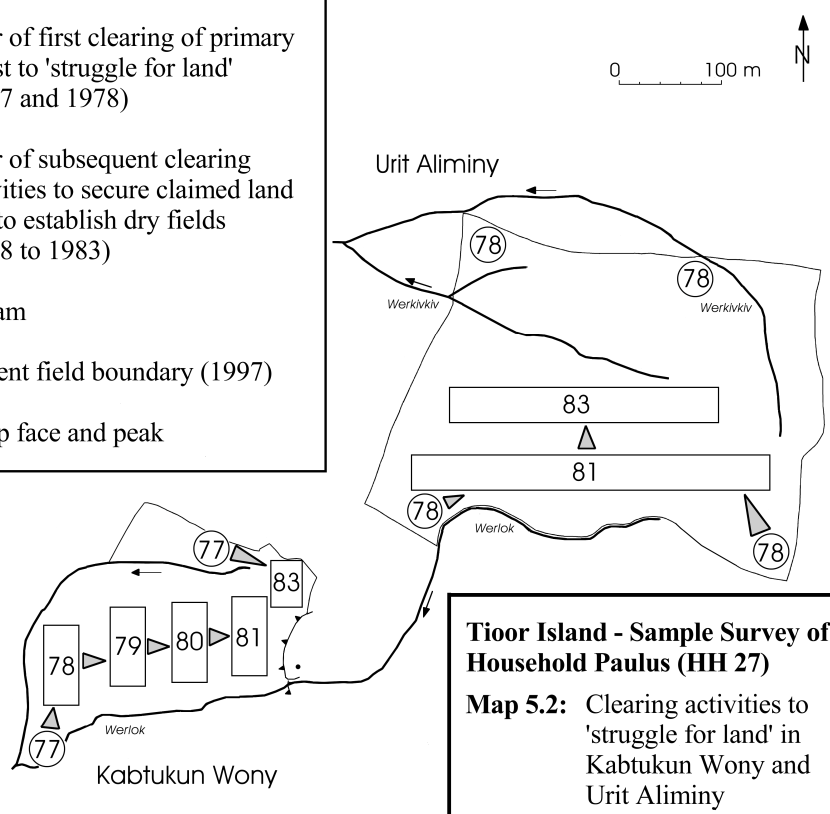
(77) Year of first clearing of primary forest to 'struggle for land' (1977 and 1978)

[78] Year of subsequent clearing activities to secure claimed land and to establish dry fields (1978 to 1983)

Stream (Werlok)

Present field boundary (1997)

Steep face and peak



Tioor Island - Sample Survey of Household Paulus (HH 27)

Map 5.2: Clearing activities to 'struggle for land' in Kabtukun Wony and Urit Aliminy

Sources: Household interviews and mapping (Stubenvoll 1997).

Maps 6: Sketched maps of settlements – Building material of houses

Legend of Maps 6.1 to 6.5

BUILDING MATERIALS OF HOUSES AND HUTS

A	permanent house: walls of cement stones or coral lime, timber, roof of sago thatch
B	permanent house: walls of cement stones or coral lime, timber, tile roof
C	permanent house: walls of cement stones or coral lime, timber, roof of corrugated iron
R	ruin
S	semi-permanent house: gaba-gaba walls, timber, roof of sago thatch
W	non-permanent hut (without walls): timber, roof of sago thatch
small letters	building under construction
✚	forge hut (without walls): timber, roof of sago thatch
*	copra kiln (without walls): timber, roof of sago thatch

TREES (only tall trees yielding edible fruits and seeds are shown)

K	ketapang (*Terminalia catappa*)
M	mangga (*Mangifera* L.)
T	asam jawa (*Tamarindus indica*)

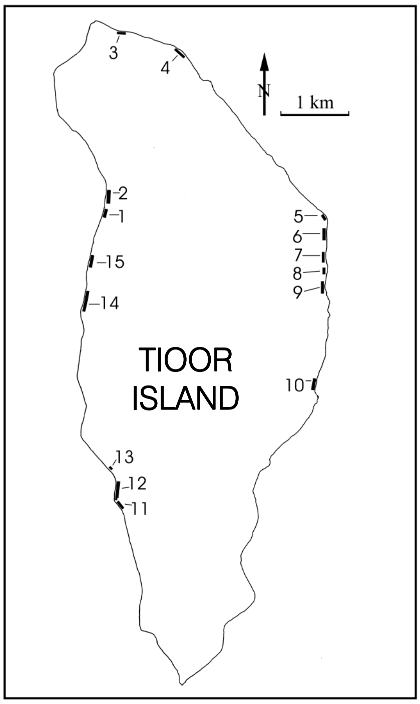
OTHERS

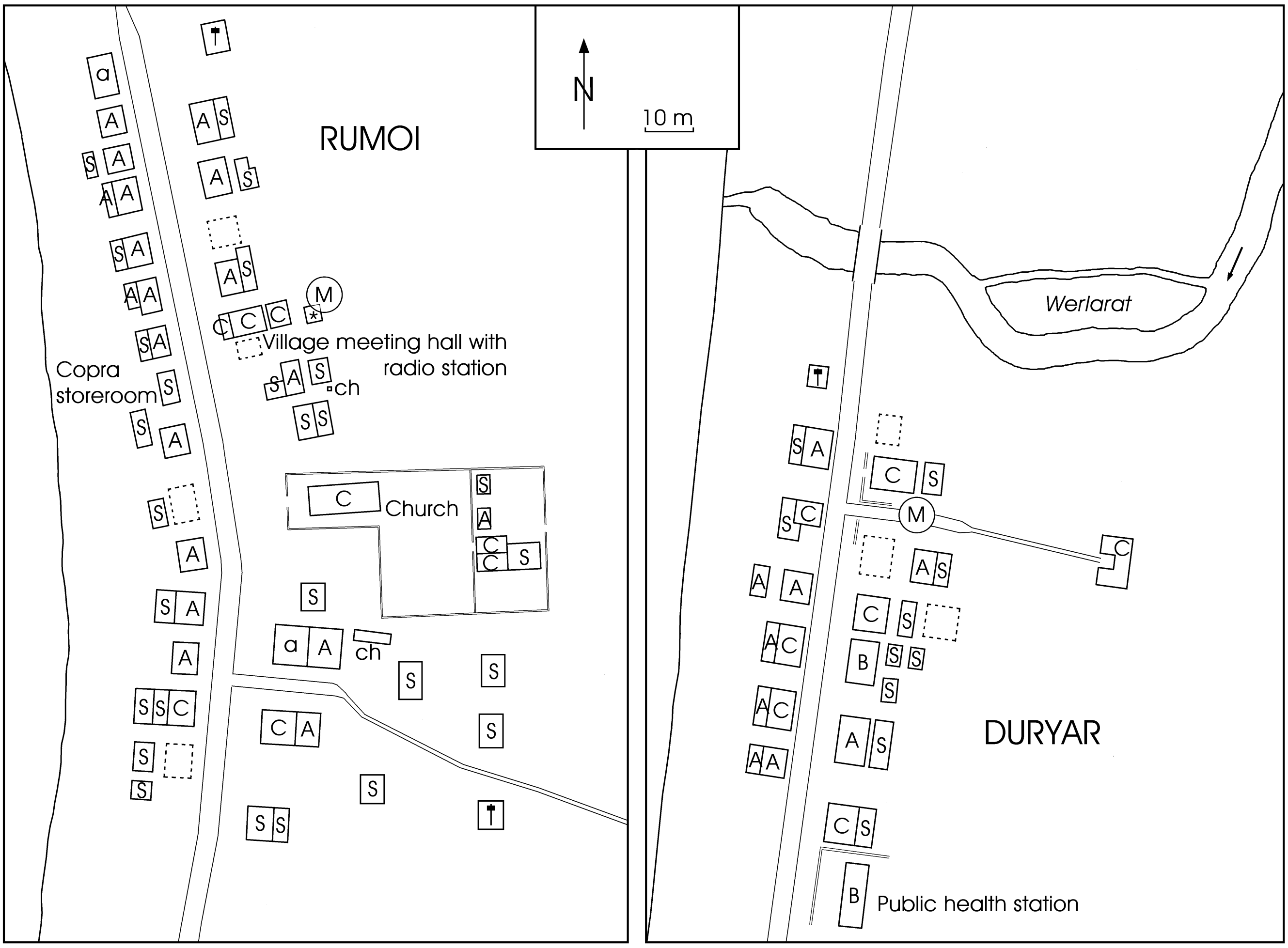
ch	chicken coop
go	goat stable
pi	pigsty
○	water tank, filled with running water from a stream via a plastic water conduit
Werjow	autochthonous name of stream
KAR	name of settlement
Kartengah	name of part of settlement
	fence
	way
	path
	course of stream
	shore line
	foundation (coral stones, cement stones)
	concrete bridge
	wooden bridge
	bridging (trunk of a tree)

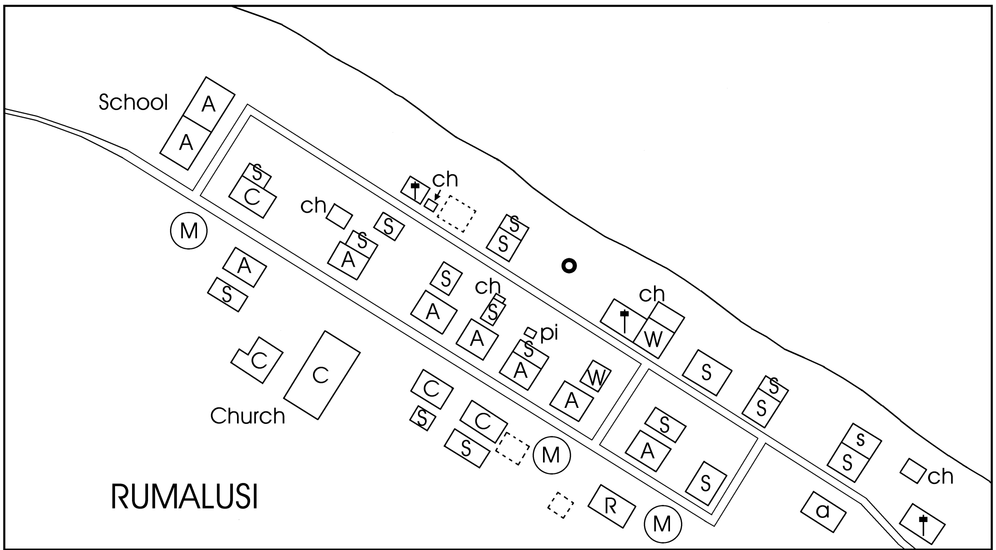
Note: Legend for Rhun Village is shown separately in Map 6.6.

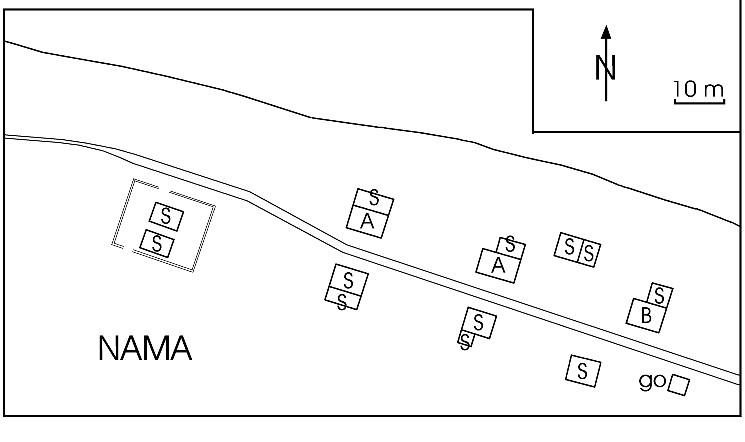
POSITION OF TIOOR'S SETTLEMENTS

1	Duryar	Map 6.1
2	Rumoi	Map 6.1
3	Nama (Rumalusi)	Map 6.1
4	Rumalusi	Map 6.1
5	Jawa	Map 6.2, Map 6.3
6	Lapang	Map 6.2, Map 6.3
7	Tengah	Map 6.2, Map 6.3
8	Wermaf	Map 6.2, Map 6.3
9	Baru	Map 6.2, Map 6.3
10	Mamur	Map 6.2, Map 6.3
11	Wertac	Map 6.4
12	Kelvow	Map 6.4
13	Nama (Kelvow)	Map 6.4
14	Kar	Map 6.5
15	Kerker	Map 6.5









Map 6.1: Sketched Maps of Settlements – Building Material of Houses

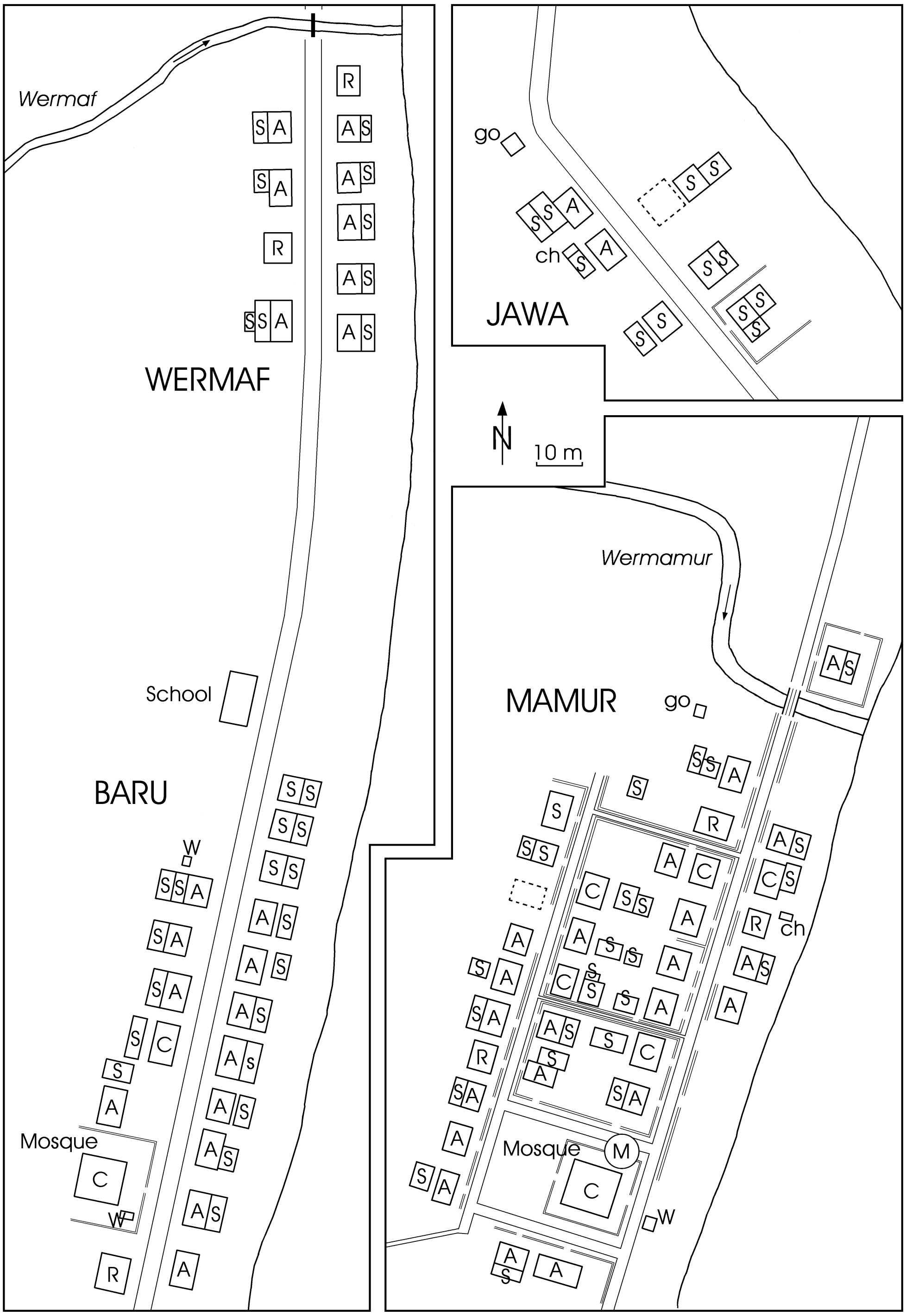
Tioor Village: Communities of Rumoi and Rumalusi

Source: Mapping (Stubenvoll 1997)

Rumoi community: Rumoi and Duryar settlements (on the the top);

Rumalusi community: Rumalusi and Nama settlements (on the bottom);

For a legend see previous page.



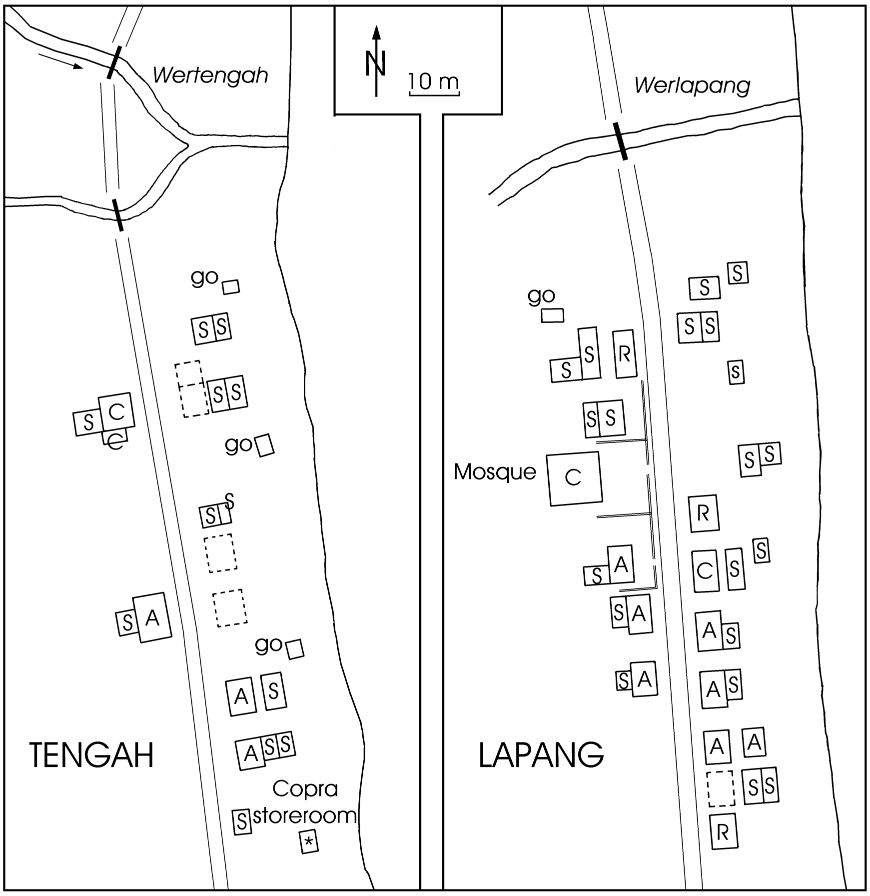
Map 6.2: Sketched Maps of Settlements – Building Material of Houses

Tioor Village:
Community of Wermaftengah –
Jawa, Wermaf, Baru and Mamur settlements

Source: Mapping (Stubenvoll 1997).

Wermaftengah community:
Jawa, Lapang, Tengah, Wermaf, Baru and Mamur settlements (from north to south);

See previous pages for a legend.



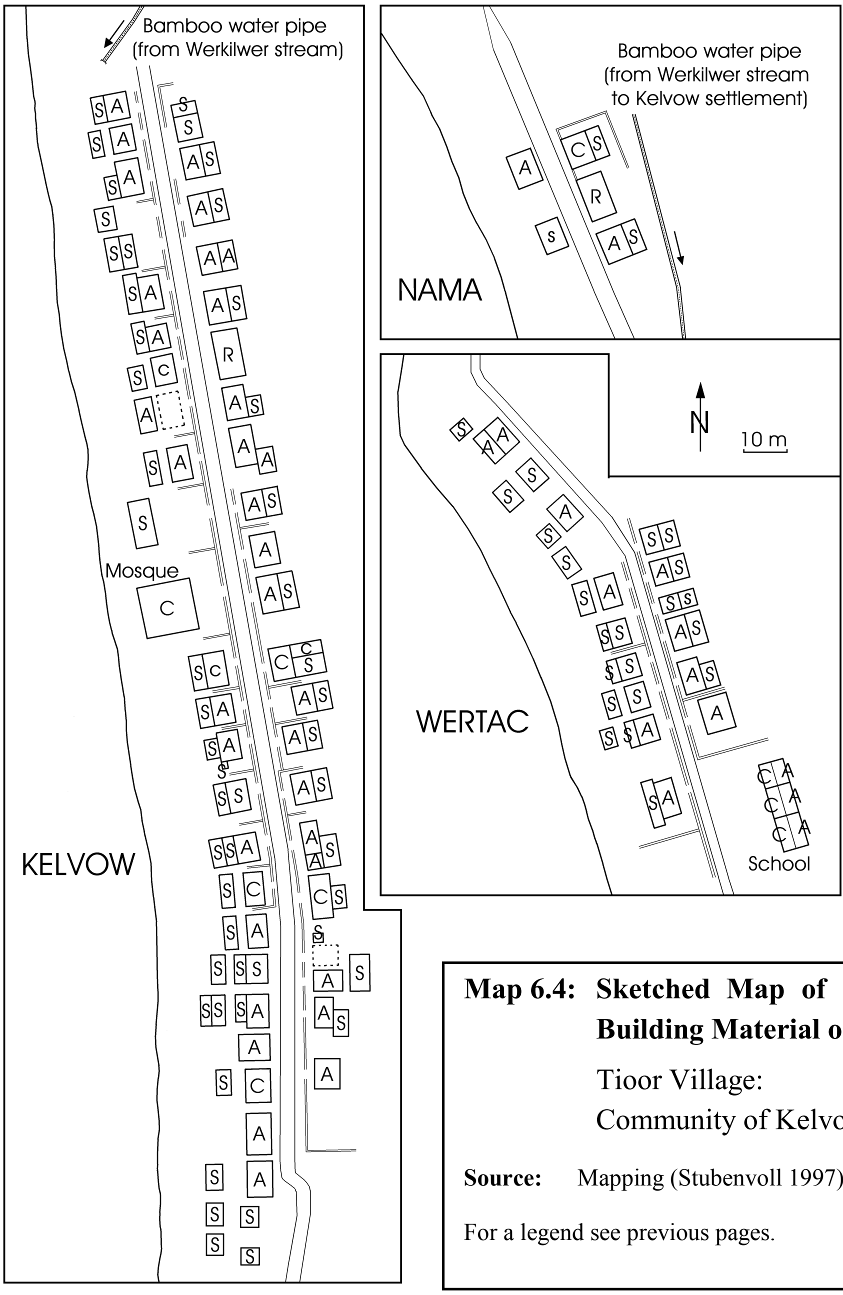
Map 6.3: Sketched Maps of Settlements – Building Material of Houses

Tioor Village:
Community of Wermaftengah –
Tengah and Lapang settlements

Source: Mapping (Stubenvoll 1997).

Wermaftengah community:
Jawa, Lapang, Tengah, Wermaf, Baru and Mamur settlements (from north to south);

See previous pages for a legend.

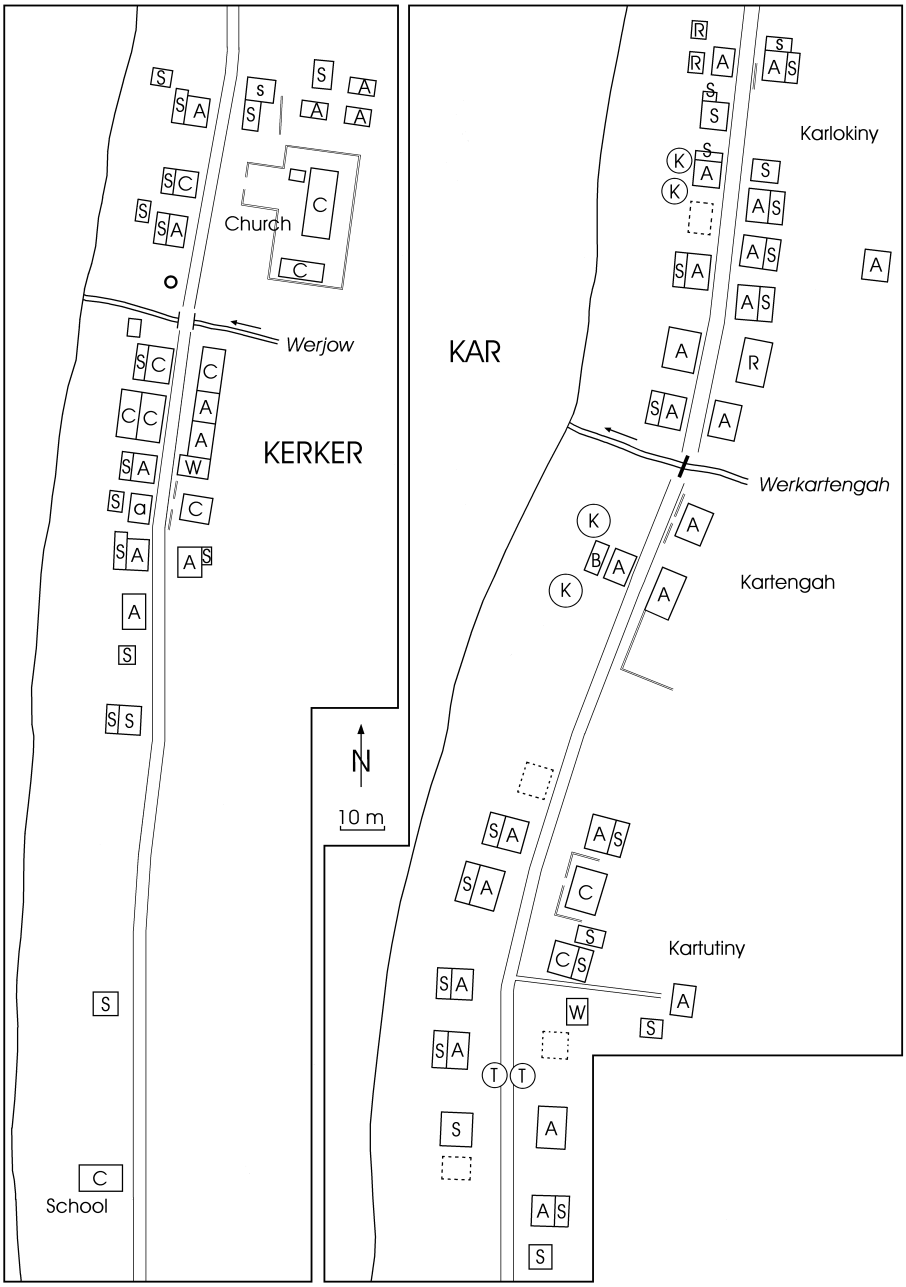


Map 6.4: Sketched Map of Settlements – Building Material of Houses

Tioor Village:
Community of Kelvow

Source: Mapping (Stubenvoll 1997).

For a legend see previous pages.

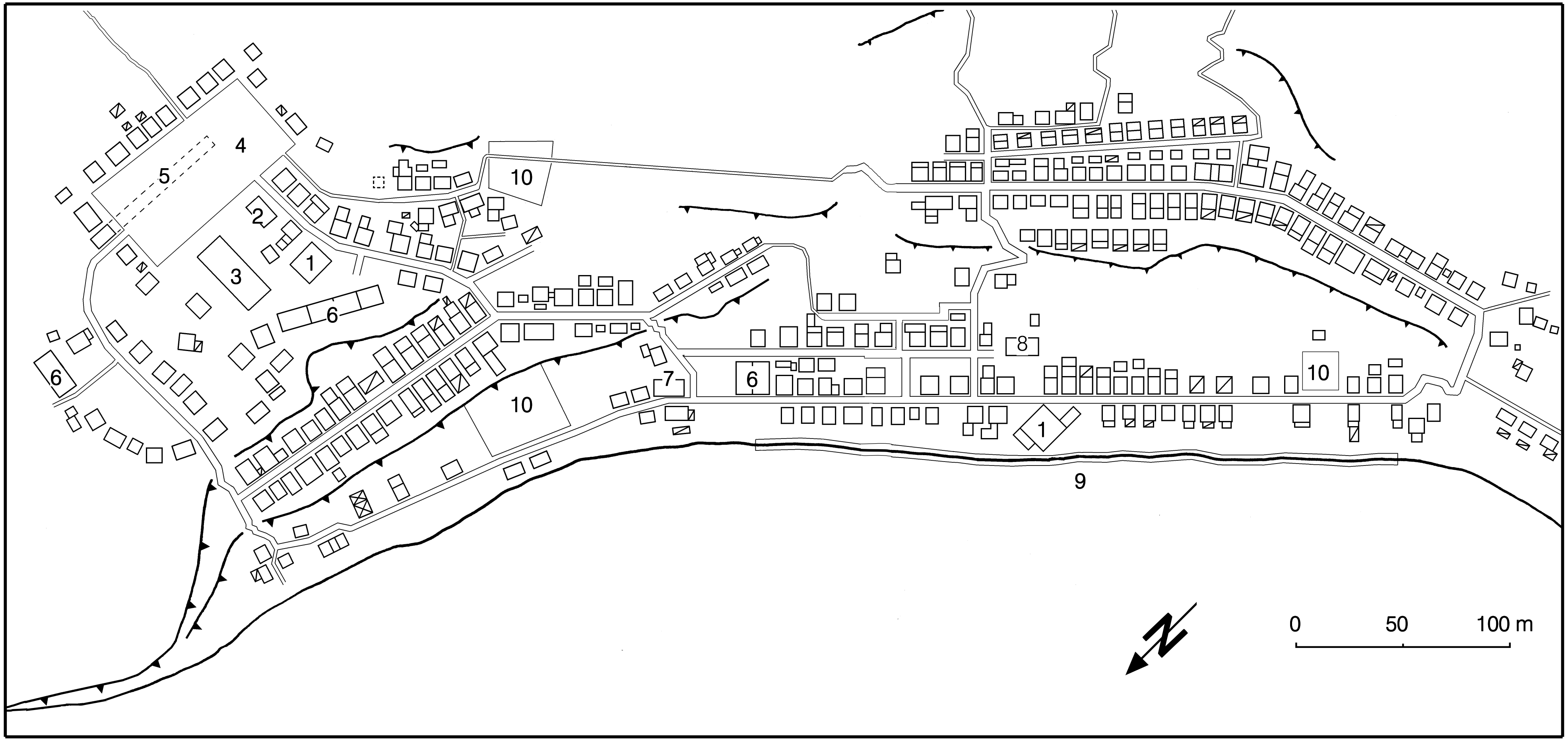


Map 6.5: Sketched Map of Settlements – Building Material of Houses

Tioor Village:
Community of Kerkar

Source: Mapping (Stubenvoll 1997).

For a legend see previous pages.



Legend

1 Mosque
2 Church
3 Nutmeg drying rooms
4 Soccer field
5 Approximate location of former labour line (until 1950s)
6 School
7 Public health station
8 Village meeting hall
9 Concrete dam
10 Cemetery

Cliff or steep face
Way and path
Foundation

Buildings (building materials)

Permanent (cement, timber, and corrugated iron or tile)
Semi-permanent (gaba-gaba walls, sago thatch, bamboo, timber)
Ruin

Map 6.6: Sketched Maps of Settlements – Building Material of Houses

Rhun Village

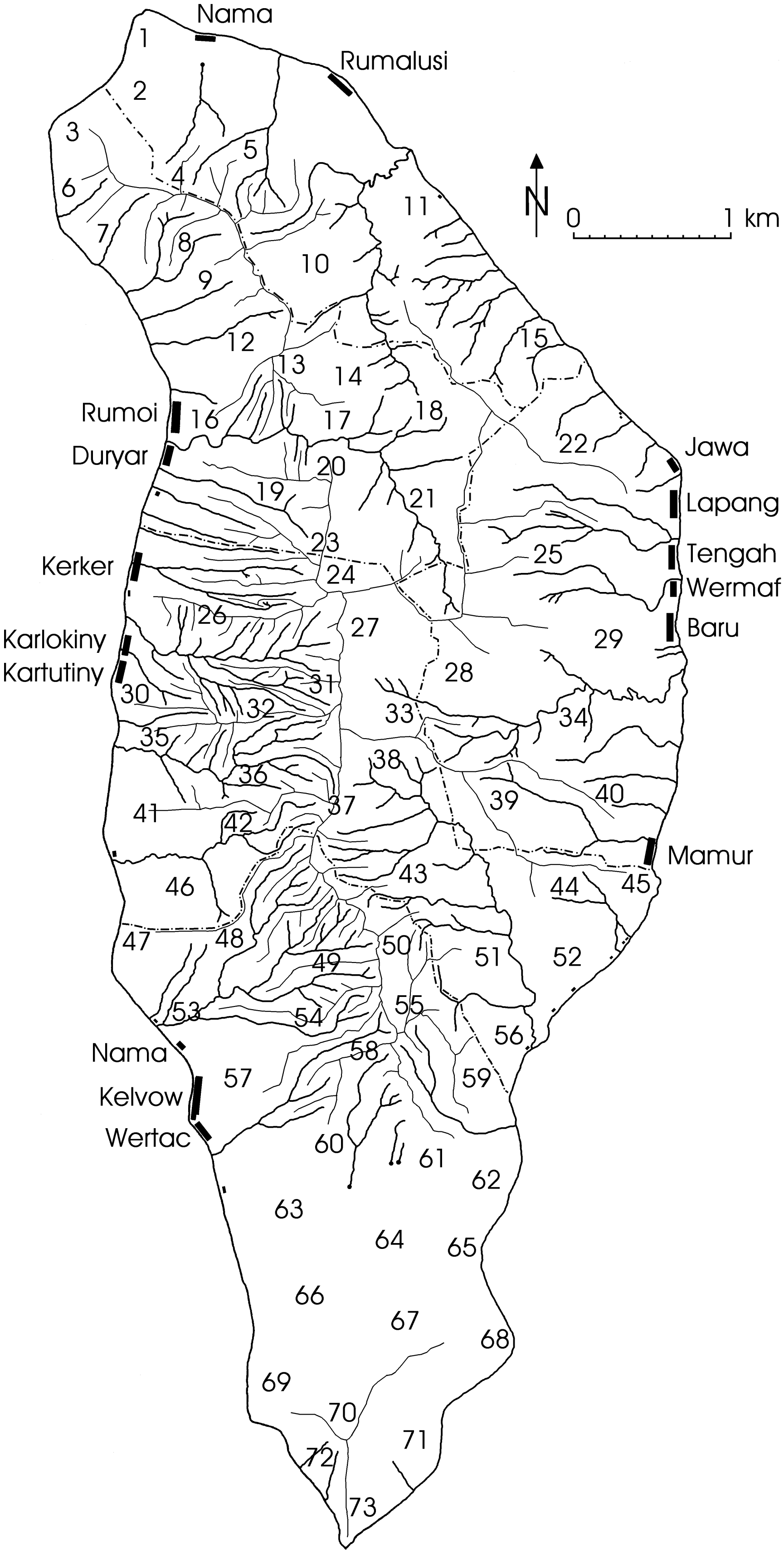
Sources: Stubenvoll 1994; Mapping (Stubenvoll 1996).

A hamlet, in a distance of about 300 m (southwestern direction) and consisting of five semi-permanent houses and a former labour line, is not shown for simplicity's sake.

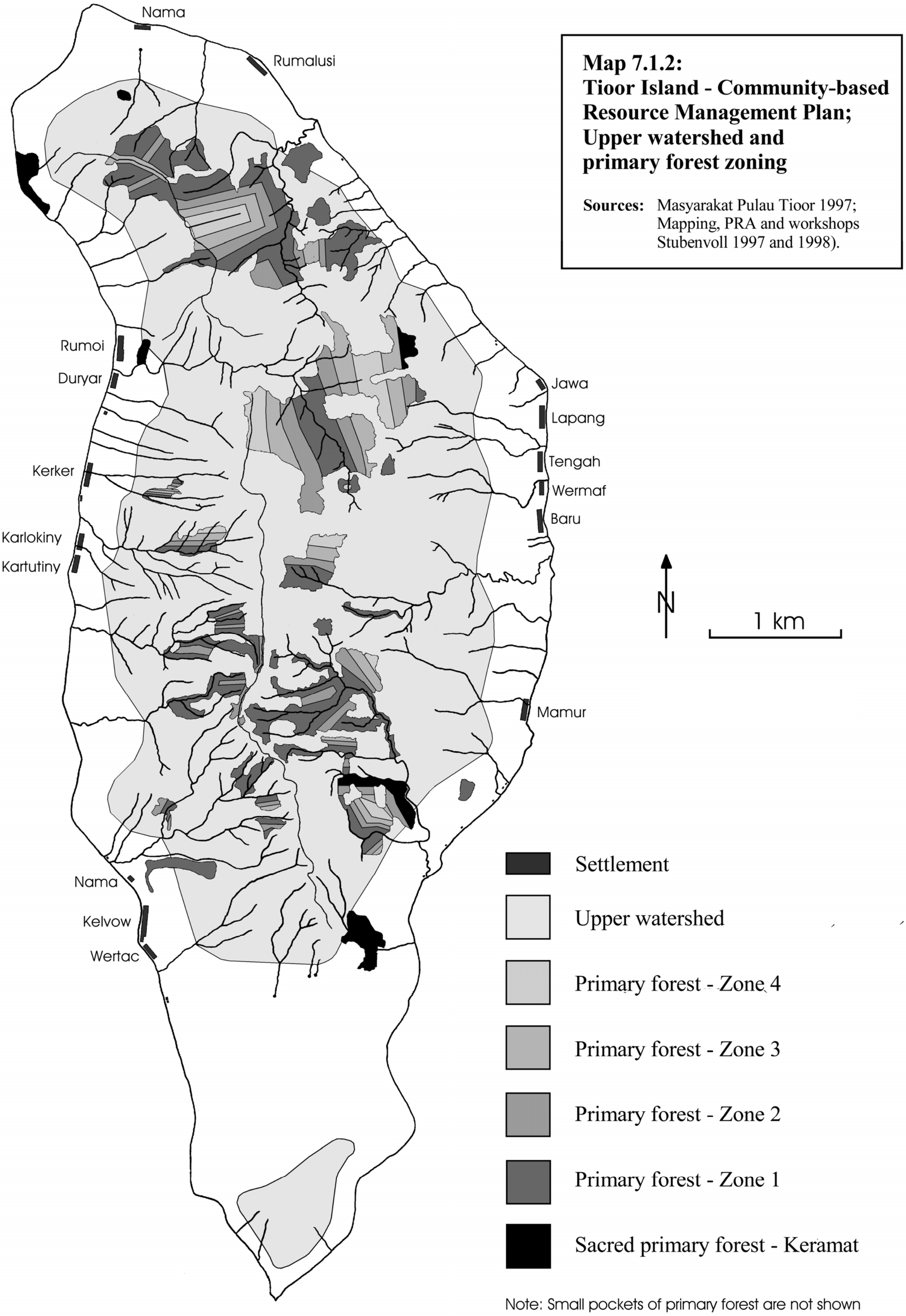
Note the different scale and legend of Map 6.6 and Maps 6.1 to 6.5!

Map 7.1.1: Tioor Island – Community-based Resource Management Plan; Autochthonous names of locations

Sources: Masyarakat Pulau Tioor 1997;
Mapping, interviews, and PRA (Stubenvoll 1997 and 1998).

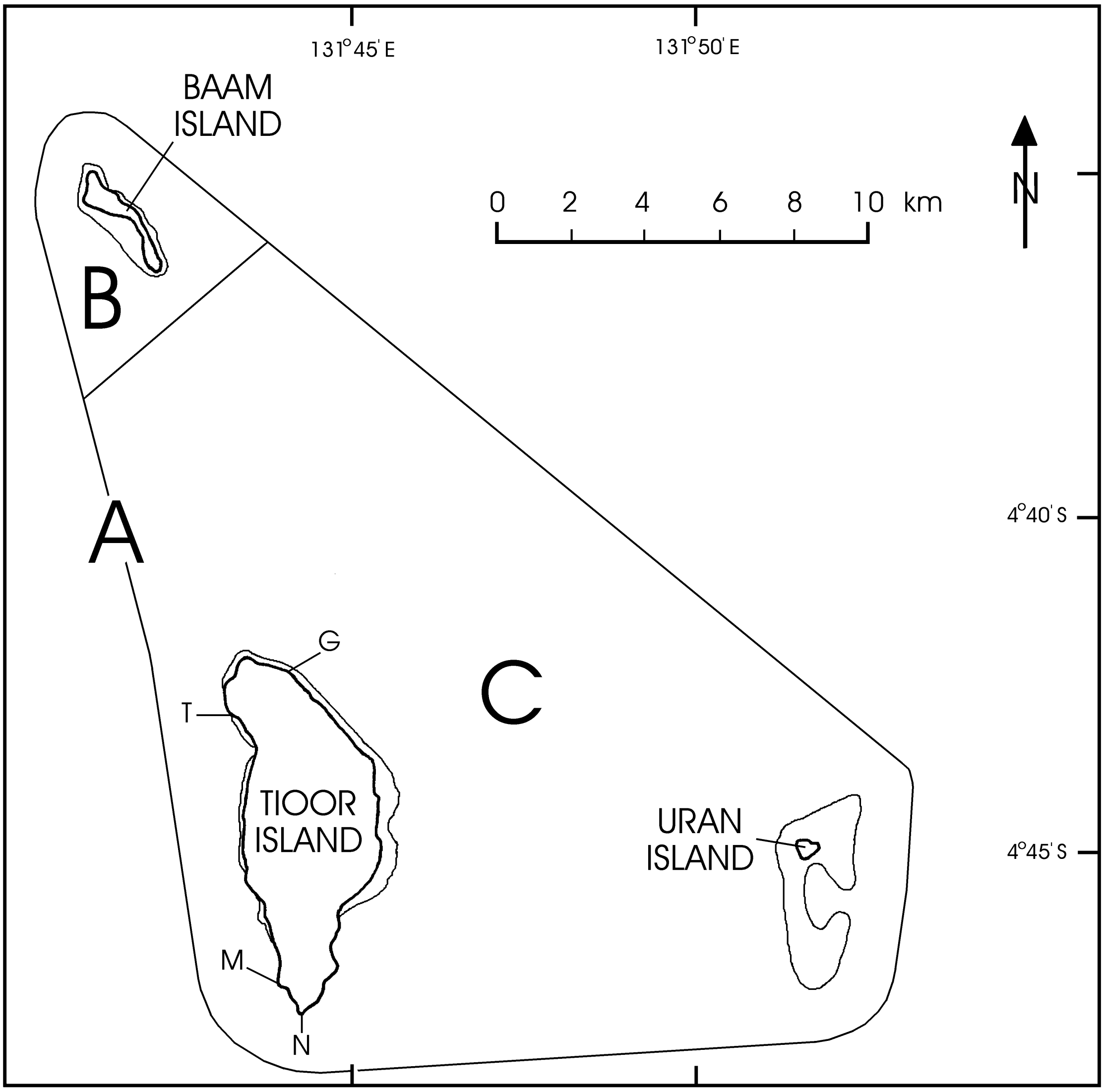


	NAME OF LOCATION
1	Gudang
2	Lokiny
3	Werwosal
4	Kovnan Batbotan
5	Werkier Uliny
6	Keramat Wergud
7	Tomtomut
8	Werkarunan Uliny
9	Bunga
10	Wervurun
11	Sameriny
12	Wermaruka Uliny
13	Kamukanangvua
14	Ampera
15	Vatlurkwai
16	Keramat Werlarat
17	Wer Uliny
18	Kaibaruk
19	Vakun
20	Teraginy
21	Werlarat Uliny
22	Keramat Kaibaruk
23	Lolabanyak
24	Ra Haveka
25	Kevalun
26	Kampung Baru
27	Ra Halena
28	Wersody Uliny
29	Wermaf Uliny
30	Vanoa Len
31	Werkar Uliny
32	Urit Apollo
33	Semelan
34	Wersody
35	Werkivkiv
36	Werkivkiv Uliny
37	Urit Aliminy
38	Wergus Uliny
39	Vafnabak
40	Wervurak
41	Vanoa Lenlus
42	Kabtukun Wony
43	Rota Wergus
44	Werkasera
45	Suai Matleliny
46	Werlok
47	Varun
48	Tar
49	Werkilwer Leliny
50	Wergus Karic
51	Keramat Wergus
52	Wergus
53	Labuan
54	Werkilwer Uliny
55	Bukiar
56	Kilkaba
57	Koly
58	Wertac Uliny
59	Keramat Taborfah
60	Momar
61	Taborfah
62	Vatmelir
63	Ketilet
64	Arwor
65	Surianiny
66	Benteng
67	Merotan
68	Tanjung Surianiny
69	Yab Taftafun
70	Benteng Harimau
71	Metreta
72	Tirah
73	Nuamatiny


Map 7.1.2:
Tioor Island - Community-based Resource Management Plan; Upper watershed and primary forest zoning
Sources: Masyarakat Pulau Tioor 1997; Mapping, PRA and workshops Stubenvoll 1997 and 1998).
Nama
Rumalusi
Rumoi
Duryar
Kerker
Karlokiny
Kartutiny
Jawa
Lapang
Tengah
Wermaf
Baru
Mamur
Nama
Kelvow
Wertac
N
1 km
Settlement
Upper watershed
Primary forest - Zone 4
Primary forest - Zone 3
Primary forest - Zone 2
Primary forest - Zone 1
Sacred primary forest - Keramat
Note: Small pockets of primary forest are not shown

Map 7.1.3: Tioor Island – Community-based Resource Management Plan; Sea territory and sasi for fishing nets

Sources: Masyarakat Pulau Tioor 1997;
Mapping, interviews and workshops (Stubenvoll 1997 and 1998)



SEA TERRITORY (see App. 4.2: Regulation III.10)

A Sea territory A (total sea territory)
B Sea territory B (common sea territory of Tioor and Tameer Warat, Kasiui Island)
C Sea territory C (exclusive sea territory of Tioor)

SASI FOR FISHING NETS (see App. 4.2: Regulation III.9)

G Tanjung Gurmatiny
M Tanjung Madaran
N Tanjung Nurmatiny
T Tanjung Tomtomut

OTHERS

Coast line
Edge of inner-sublittoral

Abbreviations of Autochthonous Names of Location units (and Division of Locations for Farmer Group; Group = Gr.)

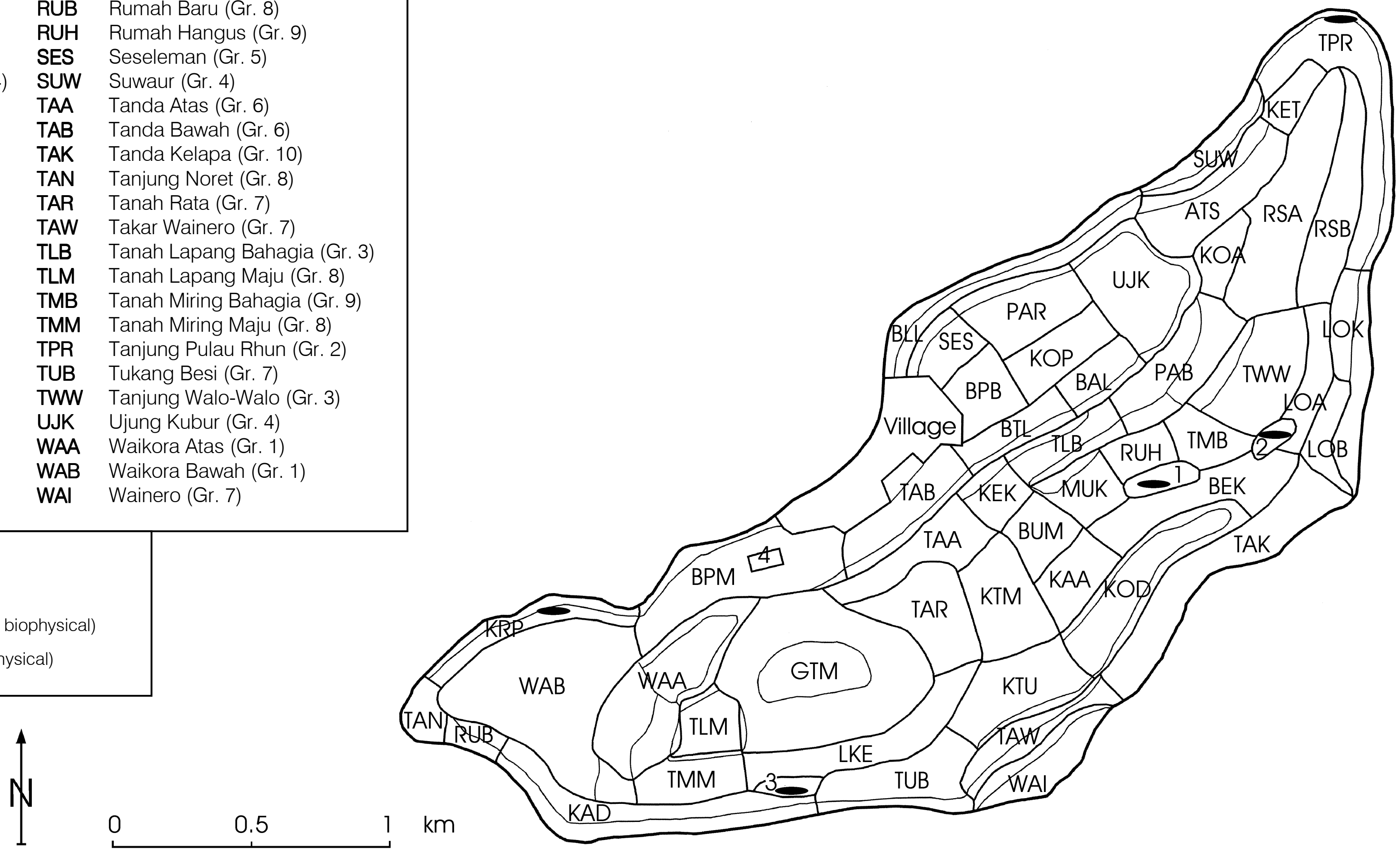
1	Kota Perempuan (Gr. 3)
2	Kota Laki-Laki (Gr. 3)
3	Keramat Kain Dulang (Gr. 8)
4	*Village (Christian settlement)*
ATS	Atas Suwaur (Gr. 4)
BAL	Batu Lutor (Gr. 5)
BEK	Belakang Kota (Gr. 9)
BLL	Batu Lawa-Lawa (Gr. 4)
BPB	Belakang Perek Bahagia (Gr. 4)
BPM	Belakang Perek Maju (Gr. 1)
BTL	Bawah Tanah Lapang (Gr. 5)
BUM	Bunga Melati (Gr. 10)
GTM	Gunung Tanah Merah (Gr. 1)
KAA	Kandang Ayam (Gr. 10)
KAD	Kain Dulang (Gr. 8)
KEK	Kenari Kensi (Gr. 10)
KET	Kebun Tembakau (Gr. 2)
KOA	Kota Aceh (Gr. 3)
KOD	Kolam Durian (Gr. 10)
KOP	Kolam Pisang (Gr. 5)
KRP	Keramat Pantai (Gr. 8)
KTM	Kolam Tanah Merah (Gr. 6)
KTU	Kolam Tanda Ujung (Gr. 6)
LKE	Lobang Kerbau (Gr. 7)
LOA	Lobang Angin Atas (Gr. 2)
LOB	Lobang Angin Bawah (Gr. 2)
LOK	Lokong (Gr. 2)
MUK	Muka Kota (Gr. 9)
PAB	Pala Bedeng (Gr. 3)
PAR	Parigi (Gr. 4)
RSA	Rumah Sakit Atas (Gr. 2)
RSB	Rumah Sakit Bawah (Gr. 2)
RUB	Rumah Baru (Gr. 8)
RUH	Rumah Hangus (Gr. 9)
SES	Seseleman (Gr. 5)
SUW	Suwaur (Gr. 4)
TAA	Tanda Atas (Gr. 6)
TAB	Tanda Bawah (Gr. 6)
TAK	Tanda Kelapa (Gr. 10)
TAN	Tanjung Noret (Gr. 8)
TAR	Tanah Rata (Gr. 7)
TAW	Takar Wainero (Gr. 7)
TLB	Tanah Lapang Bahagia (Gr. 3)
TLM	Tanah Lapang Maju (Gr. 8)
TMB	Tanah Miring Bahagia (Gr. 9)
TMM	Tanah Miring Maju (Gr. 8)
TPR	Tanjung Pulau Rhun (Gr. 2)
TUB	Tukang Besi (Gr. 7)
TWW	Tanjung Walo-Walo (Gr. 3)
UJK	Ujung Kubur (Gr. 4)
WAA	Waikora Atas (Gr. 1)
WAB	Waikora Bawah (Gr. 1)
WAI	Wainero (Gr. 7)

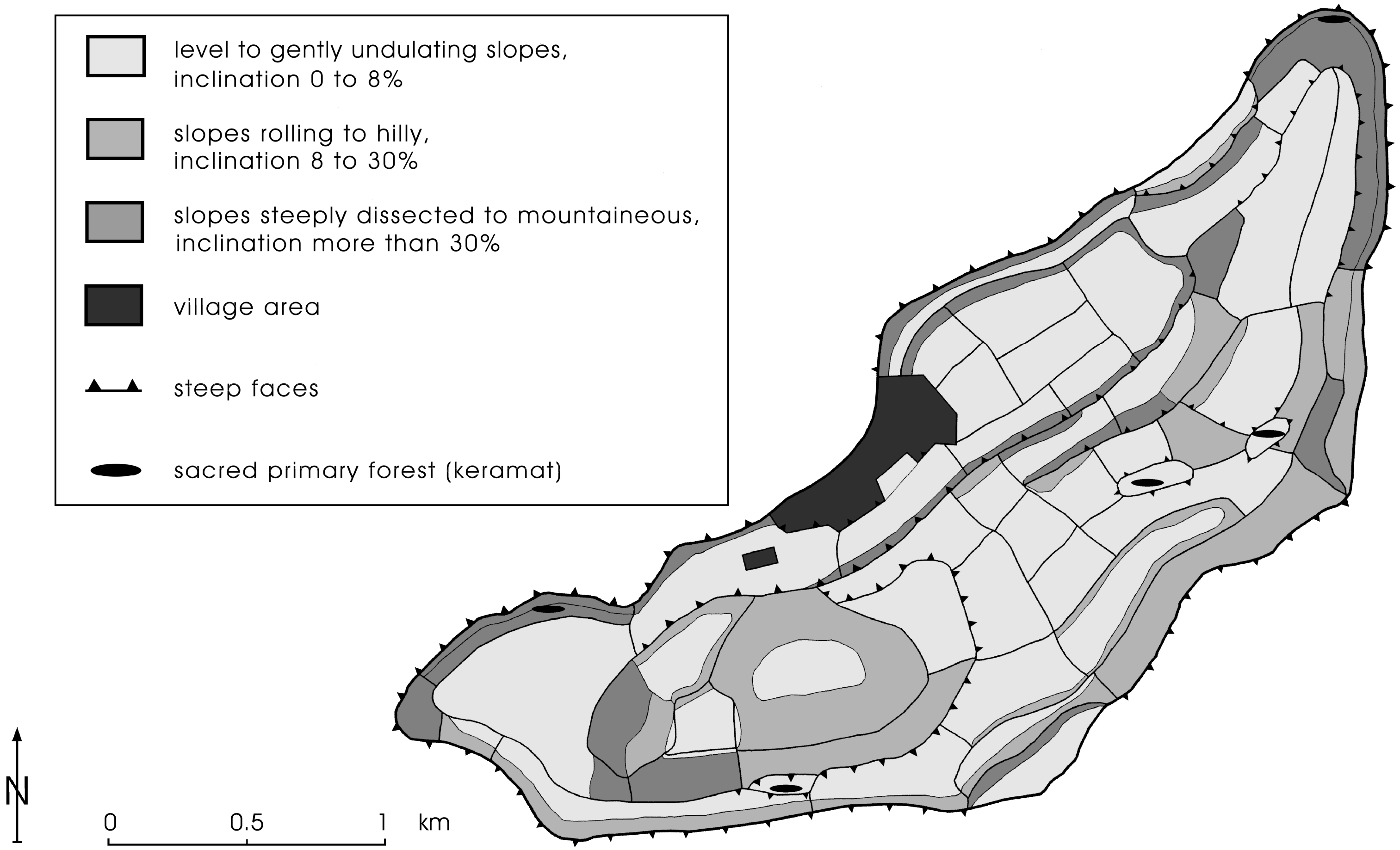
Others

- Sacred primary forest (keramat)
- Border of location unit (mental or biophysical)
- Border of location sub-unit (biophysical)

Map 7.2.1: Rhun Island – Community-based Resource Management Plan; Autochthonous names of location units

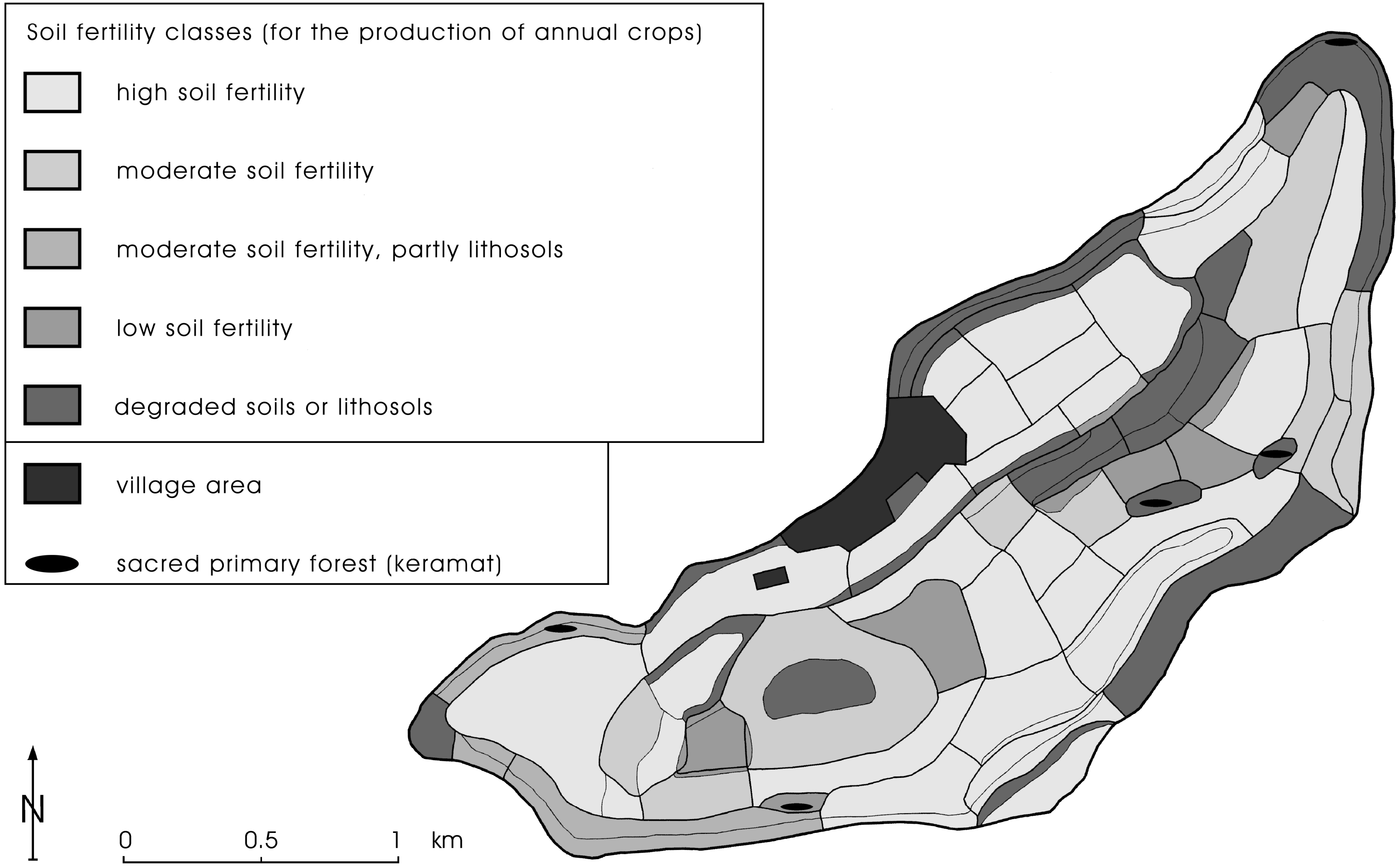
Sources: Stubenvoll 1994; Masyarakat Pulau Rhun 1996; Mapping, interviews, and PRA (Stubenvoll 1996).





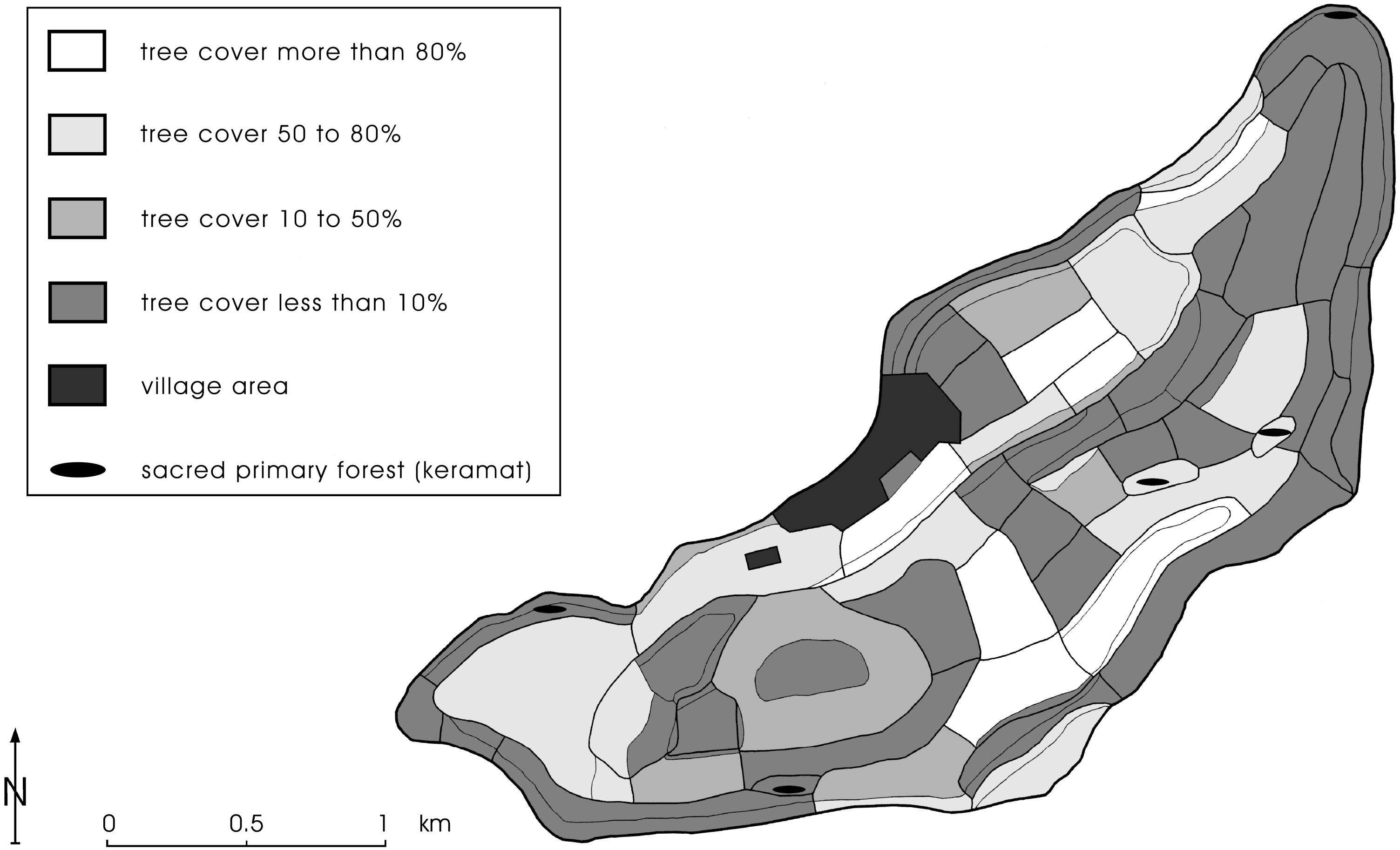
Map 7.2.2: Rhun Island - Community-based Resource Management Plan; Land evaluation: Inclination of slopes

Sources: Masyarakat Pulau Rhun 1996; Mapping, and PRA (Stubenvoll 1996).



Map 7.2.3: Rhun Island - Community-based Resource Management Plan; Land evaluation: Soil fertility

Sources: Masyarakat Pulau Rhun 1996; Mapping, and PRA (Stubenvoll 1996).



Map 7.2.4: Rhun Island - Community-based Resource Management Plan; Land evaluation: Tree cover

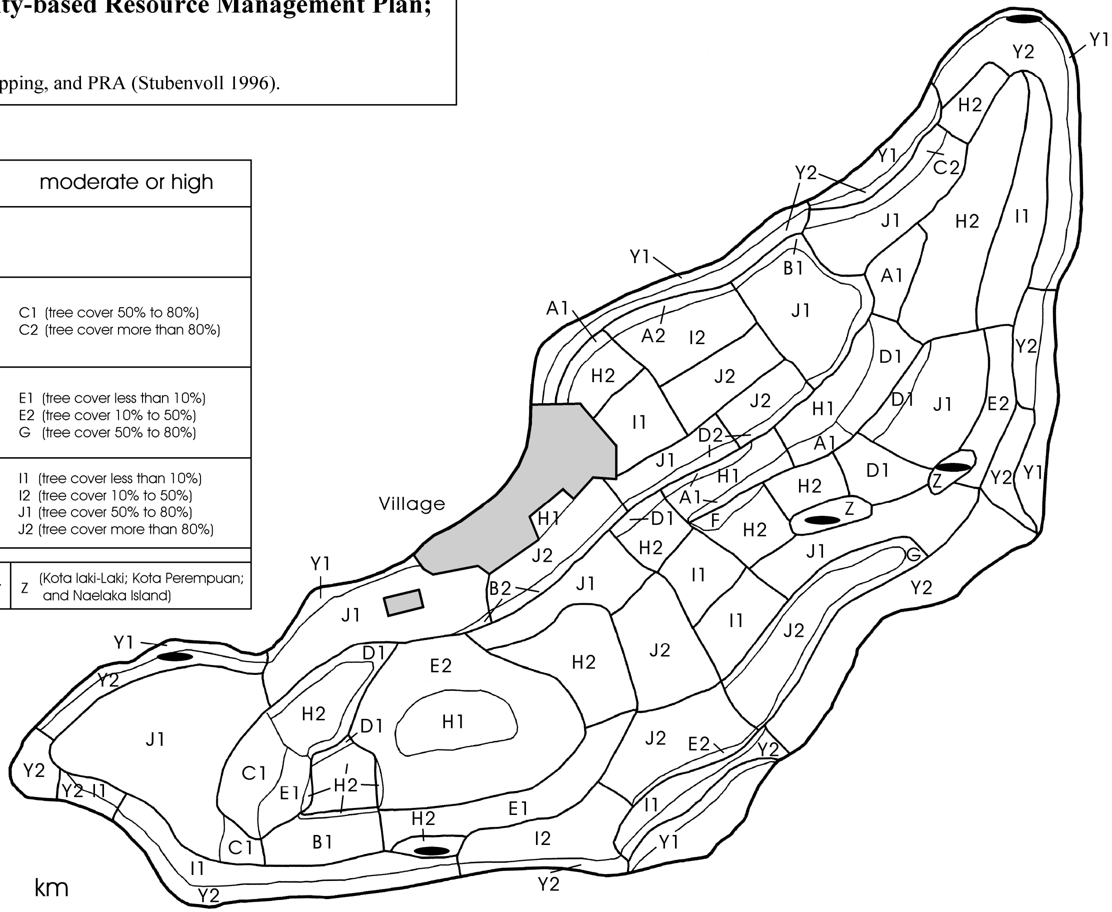
Sources: Masyarakat Pulau Rhun 1996; Mapping, and PRA (Stubenvoll 1996).

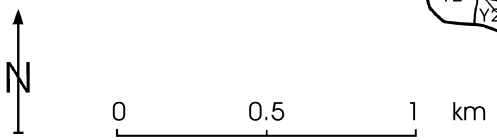
Map 7.2.5: Rhun Island - Community-based Resource Management Plan; Land units

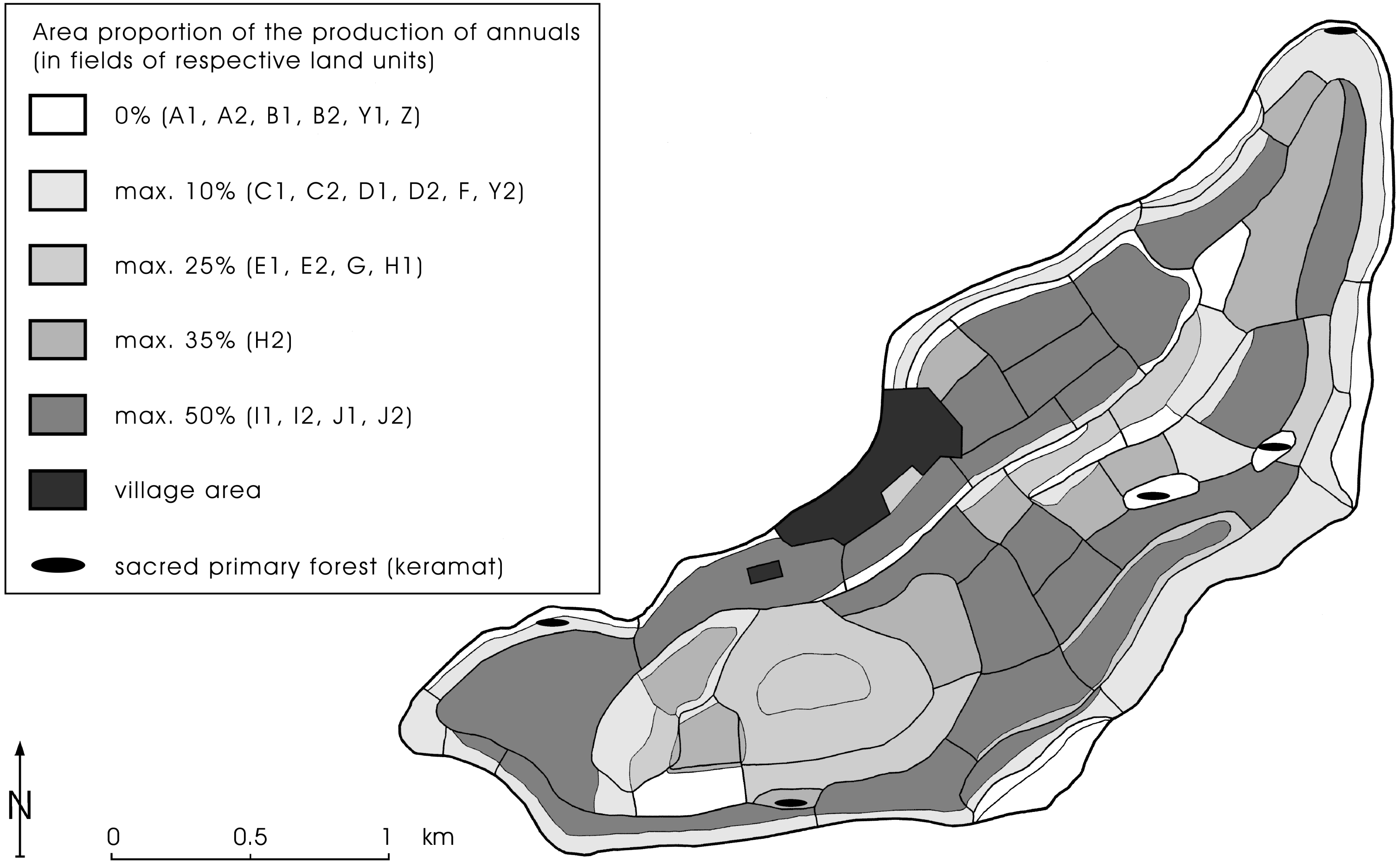
Sources: Masyarakat Pulau Rhun 1996; Mapping, and PRA (Stubenvoll 1996).

Soil fertility	degraded or low	moderate or high
Inclination of slopes		
more than 30%	A1 (tree cover less than 10%) A2 (tree cover 10% to 50%) B1 (tree cover 50% to 80%) B2 (tree cover more than 80%)	C1 (tree cover 50% to 80%) C2 (tree cover more than 80%)
8% to 30%	D1 (tree cover less than 10%) D2 (tree cover 10% to 50%) F (tree cover 50% to 80%)	E1 (tree cover less than 10%) E2 (tree cover 10% to 50%) G (tree cover 50% to 80%)
level to 8%	H1 (degraded soil; tree cover less than 50%) H2 (low soil fertility; tree cover less than 50%)	I1 (tree cover less than 10%) I2 (tree cover 10% to 50%) J1 (tree cover 50% to 80%) J2 (tree cover more than 80%)
Coastal zone	Y1 (low-lying) Y2 (upland)	Village forest: Z (Kota laki-Laki; Kota Perempuan; and Naelaka Island)

sacred primary forest

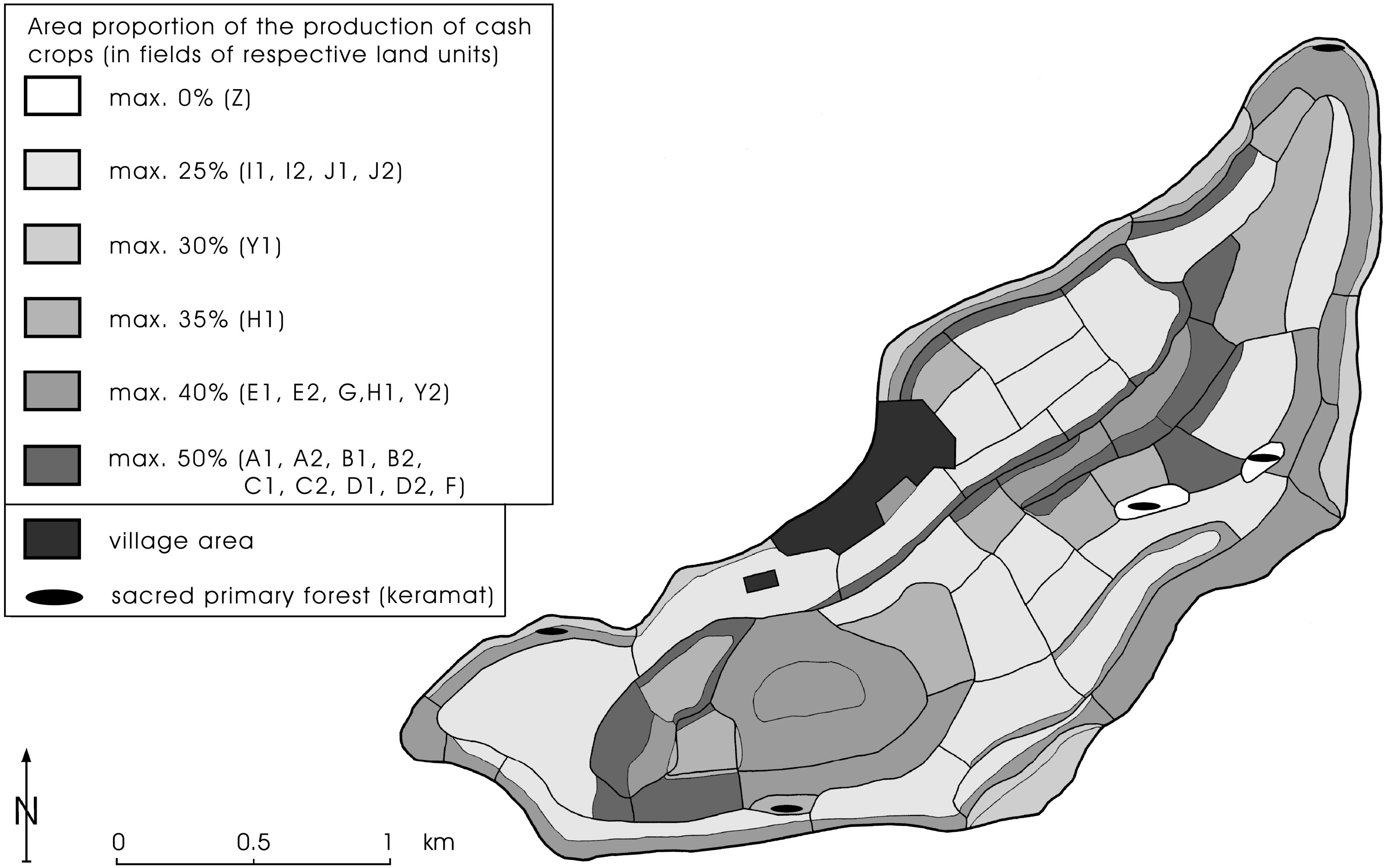






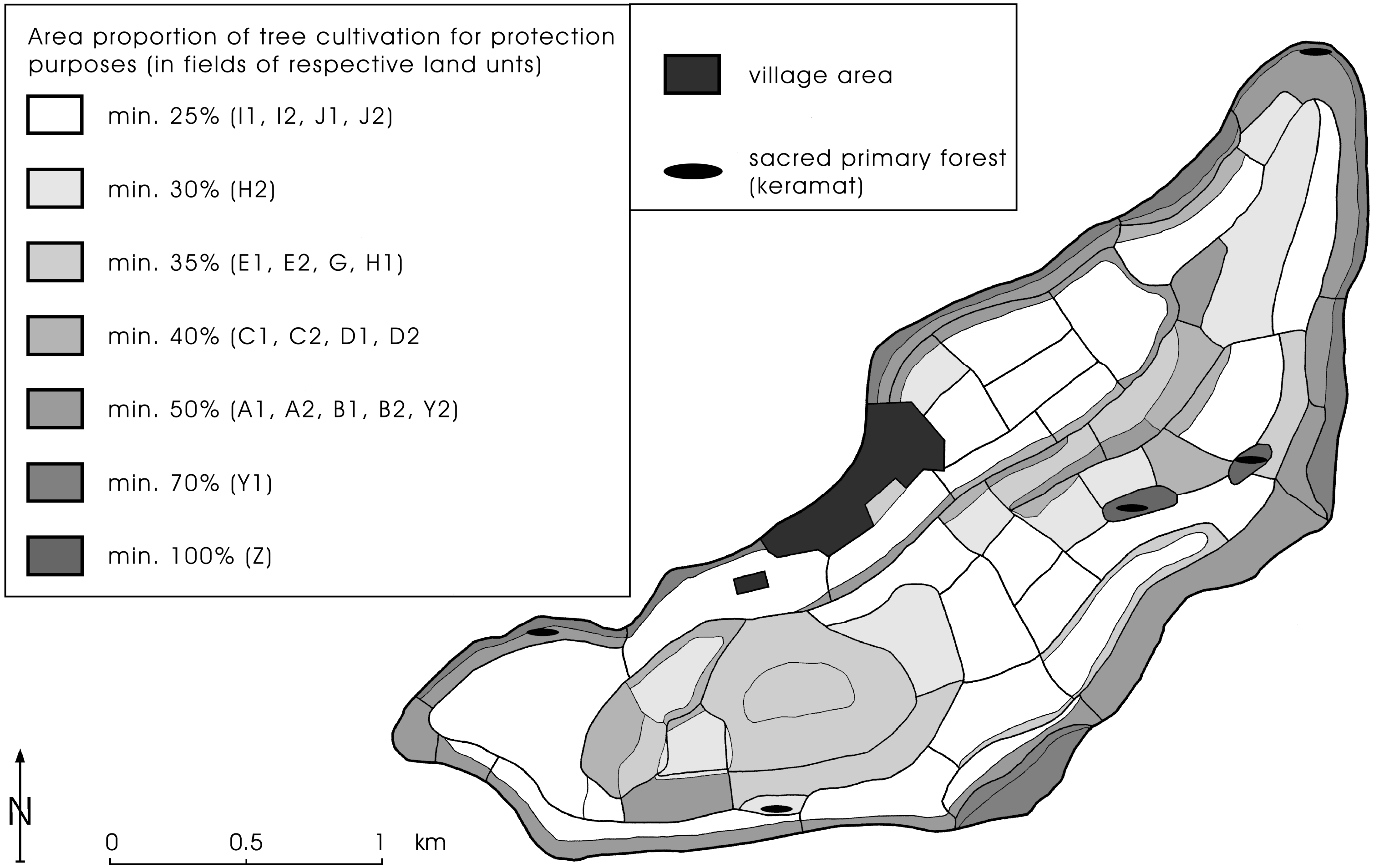
Map 7.2.6: Rhun Island - Community-based Resource Management Plan; Field area proportion of the production of annuals

Source: Masyarakat Pulau Rhun 1996.



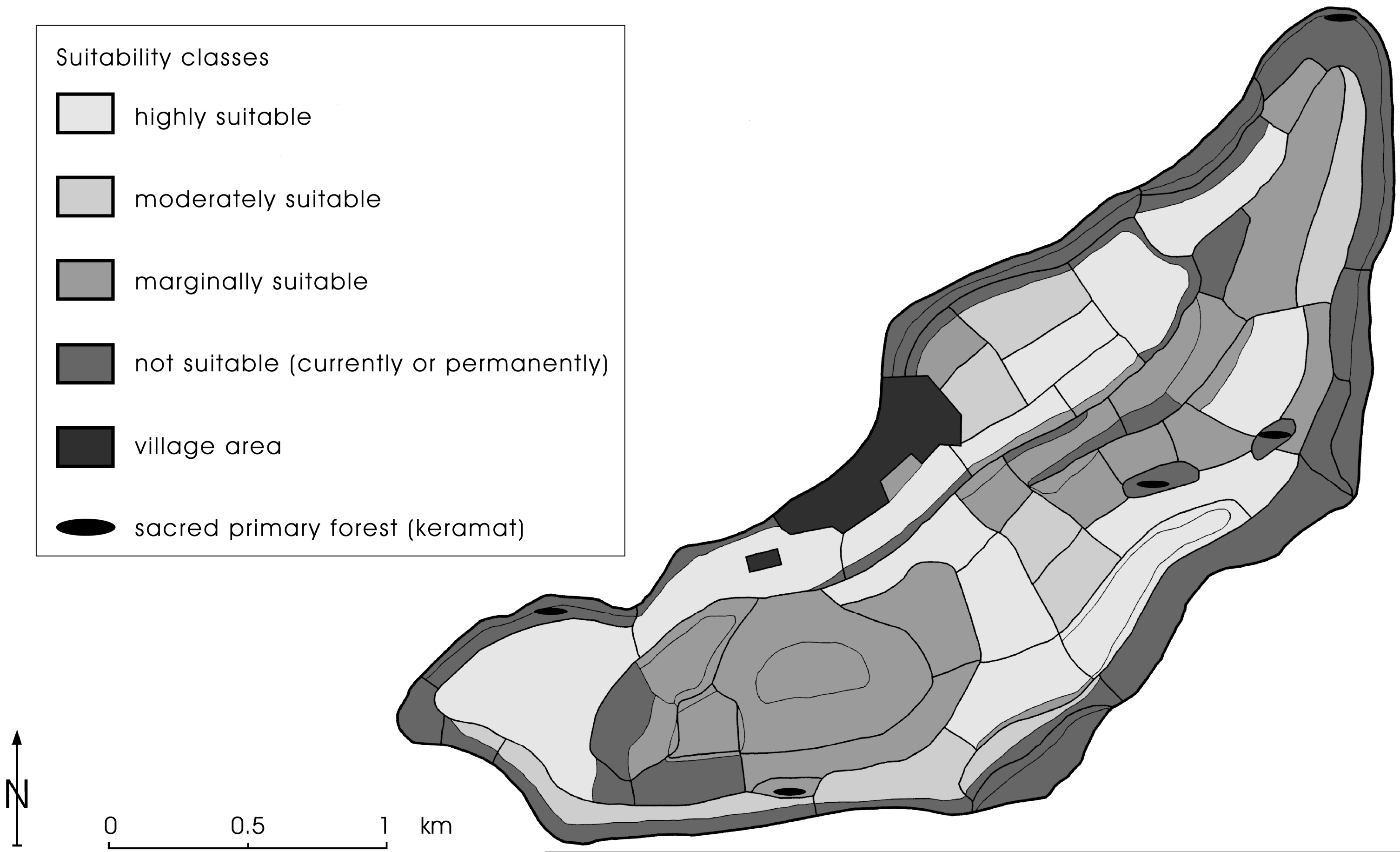
Map 7.2.7: Rhun Island - Community-based Resource Management Plan; Field area proportion of the production of perennial cash crops

Source: Masyarakat Pulau Rhun 1996.



Map 7.2.8: Rhun Island - Community-based Resource Management Plan; Field area proportion of tree cultivation for protection purposes

Source: Masyarakat Pulau Rhun 1996.



Map 7.2.9: Rhun Island - Community-based Resource Management Plan: Land suitability classification - Nutmeg cultivation with protection trees

Source: Masyarakat Pulau Rhun 1996.

Appendix 1.1: Identified plant species in Rhun and Tioor

Scientific name	Family	English name	Vernacular names	Primary use	Market range of primary product		Secondary uses	Land-use types
					Rhun	Tioor		
Abelmoschus critinus	MALVACEAE	?	-; naf	timber	n.i.	1	fib	SF
Acalypha caturus	EUPHORBIACEAE	?	-; dagan	vegetable	n.i.	1	med	TG; BV; SF
Aleurites moluccana	EUPHORBIACEAE	candlenut	kemiri; kemiri	spice	4	4	vof efn med tim fib tan gum poi sco orn	MG; TG
Allium cepa	LILIACEAE	shallot	bawang merah; bong	vegetable	3	1	med	DF
Allium tuberosum	LILIACEAE	Chinese chives	kucai; kucai	vegetable	1	1	spi med	DF; MG
Allophylus cobbe	SAPINDACEAE	tit-berry	-; kai betbetur	timber	n.i.	1	efn med hwa fue	?
Alstonia scholaris	APOCYNACEAE	white cheesewood	kayu susu; yagar	medicinal plant	1	1	tim fib lat poi hwa	MG; TG
Alstonia spectabilis	APOCYNACEAE	hard milkwood	-; rot	timber	n.i.	1	med	TG
Amaranthus tricolor	AMARANTHACEAE	amaranth	bayam; goran	vegetable	1	1	med dye poi orn	HG; DF; MG
Anacardium occidentale	ANACARDIACEAE	cashewnut	jambu mete; jambu mete	edible nut	5	5	vof veg spi med sug dye tan gum poi	MG; TG
Ananas comosus	BROMELIACEAE	ananas	nenas; kanyas	edible fruit	1	1	stb med sug fib poi hwa	MG; TG; DF; SF
Annona muricata	ANNONACEAE	soursop	nangka belanda; duran manuktan	edible fruit	1	1	ess stb med fib for poi	MG; HG; TG; DF
Annona squamosa	ANNONACEAE	sugarapple	sirikaya; duran	edible fruit	1	1	vof stb med sug for tan res poi	HG; MG
Anthocephalus chinensis	RUBIACEAE	kadam	samama; kai telia	timber	n.i.	1	efn med fib for sco	SF; MG; TG
Apium graveolens	UMBELLIFERAE	celery	selederi; -	vegetable	1	n.i.	-	DF; MG
Aquilaria cumingiana	TYMELEACEAE	?	-; lubily	medicinal plant	n.i.	1	tim awo	PF
Arachis hypogaea	LEGUMINOSAE	groundnut	kacang tanah; ?	pulse	3	1	vof veg med fib for	DF; MG
Archidendron ellipticum	LEGUMINOAE	?	-; kaswosar	timber	n.i.	1	med poi	TG; BV
Areca catechu	PALMAE	betelnut palm	pinang; vua	stimulant (chewing)	n.i..	2	vof veg med tim fib dye tan poi bmw pth	TG; MG
Arenga pinnata	PALMAE	sugar palm	aren; -	alcoholic beverage	2	n.i.	sta efn veg stb stm med tim fib poi bmw	MG; TG
Artocarpus altilis	MORACEAE	breadfruit	sukun; hukun	edible fruit	1	1	veg med tim fib for lat poi fue	TG; MG
Artocarpus heterophyllus	MORACEAE	jackfruit	nangka; kataverak vuly	edible fruit	1	1	veg med tim fib dye	MG; TG
Artocarpus integer	MORACEAE	chempedak	chempedak; kataverak chempedak	edible fruit	n.i.	1	veg med tim fib for dye tan lat res sco	TG: MG
Asystasia gangetica	ACANTHACEAE	?	-; busil	ornamental plant	n.i.	1	med	TG; BV
Averrhoa bilimbi	OXALIDACEAE	bilimbi	blimbing asam; ?	edible fruit	1	1	spi med sug tim	MG; TG; DF
Averrhoa carambola	OXALIDACEAE	starfruit	blimbing manis; -	edible fruit	1	n.i.	veg spi med sug tim	MG; TG
Avicennia marina	VERBENACEAE	?	-; ?	timber	n.i.	1	efn med dye tan sco fue	BV
Barringtonia racemosa	LECYTHIDACEAE	?	-; katufa	poisonous plant	n.i.	1	vof veg med fib tan	BV
Bouea macrophylla	ANACARDIACEAE	gandaria	gandaria; ?	timber	2	n.i.	efn veg spi med	MG; TG
Brassica juncea	CRUCIFERAE	Indian mustard	sesawi; sesawi	vegetable	2	2	vof efn spi med for	DF; MG

Scientific name	Family	English name	Vernacular names	Primary use	Market range of primary product		Secondary uses	Land-use types
					Rhun	Tioor		
Brassica rapa	CRUCIFERAE	caisin	sawi hijau; pecai menrana	vegetable	2	2	tub	DF; MG
Brassica rapa	CRUCIFERAE	petsai	sawi putih; pecai menfena	vegetable	2	2	tub	DF; MG
Bridelia tomentosa	EUPHORBIACEAE	?	-; lurukyiebar	medicinal plant	n.i.	1	tim tan	?
Caesalpinia bonduc	LEGUMINOSAE	?	-; karkardeder	medicinal plant	n.i.	1	-	BV; TG
Calophyllum inophyllum	GUTTIFERAE	Borneo mahagony	bintanggur; gubar	timber	1	1	vof efn ess med dye tan res poi hwa	BV; PF
Calophyllum sp.	GUTTIFERAE	?	?; gubarfat	timber	n.i.	1	-	SF; PF
Cananga odorata	ANNONACEAE	ylang-ylang	-; kubang	essential oil	n.i.	1	tim	TG; SF
Canarium indicum	BURSERACEAE	?	-; kier	edible nut	n.i.	4	vof med tim res ars poi sco hwa fue orn	TG; MG
Canarium vulgare	BURSERACEAE	Java almond	kenari; kier	edible nut	4	4	vof tim res ars sco hwa fue orn	MG; TG
Canavalia ensiformis	LEGUMINOSAE	sword bean	-; galifas wotan	cover plant	n.i.	1	pul veg spi med for	?
Capsicum spp.	SOLANACEAE	capsicum pepper	cabe; bresentafiny	spice	3	2	veg med dye poi orn	MG; DF; TG
Carica papaya	CARICACEAE	papaya	pepaya; kacela vuly	edible fruit	1	1	med vof veg stm lat poi	MG; DF
Casuarina equisetifolia	CASUARINACEAE	casuarina	kasuari; haleor	fuelwood	n.i.	1	med tim tan hwa orn	BV
Cayratia trifolia	VITACEAE	?	-; minawola	medicinal plant	n.i.	1	veg	TG
Ceiba pentandra	BOMBACACEAE	kapok	kapok; kabus	fibre	1	1	vof efn veg med sug for dye tan gum sco	MG
Celtis philippensis	ULMACEAE	nettle tree	-; kaknakin	timber	n.i.	1	med bmw	PF
Chromolaena odorata	COMPOSITAE	?	-; larmurag gunung	wayside plant	n.i.	1	-	SV; DL
Cinnamomum burmani	LAURACEAE	cassia	kayu manis	spice	3	3	ess med tim awo	TG
Citrullus lanatus	CUCURBITACEAE	watermelon	semangka; tumily	edible fruit	2	1	vof med for	DF; MG
Citrus aurantifolia	RUTACEAE	lime	jeruk nipis; vugar manipis	edible fruit	1	1	vof spi ess med sug tim	MG; TG; DF
Citrus auranthium	RUTACEAE	sour orange	jeruk asam; vugar matabara	edible fruit	1	1	spi ess stb med poi	MG; TG; DF
Citrus limon	RUTACEAE	lemon	jeruk limon; vugar ikan	edible fruit	1	1	ess stb med sug for	MG; TG
Citrus sinensis	RUTACEAE	sweet orange	jeruk manis; -	edible fruit	1	n.i.	ess med	MG; TG
Clerodendrum speciosum	VERBENACEAE	?	-; bobotubily	ornamental plant	n.i.	1	med	?
Clitoria ternatea	LEGUMINOSAE	butterfly pea	bunga biru; -	cover plant	1	n.i.	veg med for dye poi hwa orn	SV; TG
Cocos nucifera	PALMAE	coconut palm	kelapa; nuar	vegetable oil & fat	1	4	efn veg stb med sug tim fib for dye tan	TG; MG; DF; BV; HG
Coffea canephora	RUBIACEAE	robusta coffee	kopi; kof vunekvely	stimulating beverage	3	3	-	MG; TG
Coffea sp.	RUBIACEAE	?	-; kof vunlaleny	stimulating beverage	n.i.	2	-	MG; TG
Colocasia esculenta	ARACEAE	taro (dasheen type)	keladi; huly	tuber	n.i.	2	veg med fib for pth	MG; DF
Colocasia esculenta var. antiquorum	ARACEAE	taro (eddoe type)	keladi; huly	tuber	3	2	veg med fib for pth	MG; DF
Commelina moliflora	COMMELINACEAE	?	-; gialer	medicinal plant	n.i.	1	-	TG; BV
Cordia subcordata	BORAGINACEAE	sea trumpet	kanawa; kenoa	timber	1	1	med efn	BV

Scientific name	Family	English name	Vernacular names	Primary use	Market range of primary product		Secondary uses	Land-use types
					Rhun	Tioor		
Crinum asiaticum	AMARYLLIDACEAE	wild lily	-; lafagur	ornamental plant	n.i.	1	med poi	BV; TG
Cucumis sativus	CUCURBITACEAE	cucumber	ketimun; komokomo	vegetable	2	1	vof efn med poi	DF; MG
Cucurbita moschata	CUCURBITACEAE	pumpkin	labu; rab	vegetable	1	1	vof med	DF; MG
Cucurbita sp.	CUCURBITACEAE	?	?	vegetable	2	1	?	DF; MG
Curcuma longa	ZINGIBERACEAE	curcuma	kunyit; kuning	spice	1	1	tub ess med dye	MG; TG
Curcuma zedoaria	ZINGIBERACEAE	zedoary	-; vafnanglia	medicinal plant	n.i.	1	tub veg ess	DF; MG
Cymbopogon citratus	GRAMINAE	lemon grass	serai; tefmaf	essential oil	1	1	spi med fib sco	DF; MG
Derris elliptica	LEGUMINOSAE	tuba root	-; tufa	poisonous plant	n.i.	1	med	DF; MG
Desmodium laxiflorum	LEGUMINOSAE	?	-; hamia	medicinal plant	n.i.	1	fue	TG; BV
Dioscorea spp.	DIOSCOREACEAE	yam	ubi; uf, kombili	tuber	1	1	ess med fib dye poi bmw	DF; MG
Diospyros sp.	EBENACEAE	ebony	luriah; dir	timber	n.i.	2	-	PF; MG; TG
Dracontomelon dao	ANACARDIACEAE	New Guinea walnut	cerpati; -	edible fruit	2	n.i.	veg spi med tim	MG; TG
Durio zibethinus	BOMBACACEAE	durian	durian; duran	edible fruit	2	2	med tim dye tan	TG; MG
Endospermum moluccanum	EUPHORBIACEAE	cheesewood	anoa; tipan	medicinal plant	1	1	tim poi	SV; SF
Enydra fluctuans	COMPOSITAE	buffalo spinach	-; ragreginy merdeka	vegetable	n.i.	1	med	?
Erythrina variegata	LEGUMINOSAE	Indian coral	-; dur	shade tree	n.i.	1	pul veg med tim poi hwa orn	BV
Eugenia lineata	MYRTACEAE	guava berry	-; kai vulfuly	timber	n.i.	1	-	PF; SF
Ficus fistulosa	MORACEAE	yellow stem	-; reibubur	vegetable	n.i.	1	efn nar med	?
Ficus parvifolia	MORACEAE	benjamin tree	-; kafalun	ornamental plant	n.i.	1	med tim fib tan lat	TG; BV
Ficus septica	MORACEAE	?	-; koman wokar	medicinal plant	n.i.	1	nar poi	?
Ficus sp.	MORACEAE	?	-; koman matmitany	timber	n.i,	1	?	?
Ficus sp.	MORACEAE	?	-; koman salselab	timber	n.i.	1	?	?
Ficus variegata	MORACEAE	?	-; yabyab	wax-producing plant	n.i.	1	?	SF; TG; MG
Flacourtia inermis	FLACOURTIACEAE	governor plum	tomi-tomi; katombe	edible fruit	1	1	-	MG; TG
Garcinia mangostana	GUTTIFERAE	mangosteen	manggis; -	edible fruit	1	n.i.	vof med tim dye tan	TG
Gmelina moluccana	VERBENACEAE	grey teak	kayu titi; -	timber	1	n.i.	med	PF; SF
Gnetum gnemon	GNETACEAE	melinjo	genemo; -	edible seed	3	n.i.	veg	MG; TG
Hernandia ovigera	HERNANDIACEAE	hernandia	-; ninar	timber	n.i.	1	vof	SF; BV
Hibiscus tiliaceus	MALVACEAE	beach mallow	warok; var	fibre	1	1	med tim for bmw hwa fue	BV; MG; TG
Horsfieldia bacanica	MYRISTICACEAE	penarahan (T.)	-; bala wotan	timber	n.i.	1	-	PF
Horsfieldia bivalis	MYRISTICACEAE	penarahan (T.)	-; tubtub	timber	n.i.	1	efn	PF
Imperata cylindrica	GRAMINAE	alang-alang	alang-alang; kusu-kusu	thatch	1	1	stb med fib for bmw sco	DL; SV
Inocarpus fagiferus	LEGUMINOSAE	Tahitian chestnut	gayam; giam	ornamental plant	1	1	pul efn med tim for	BV; MG; TG

Scientific name	Family	English name	Vernacular names	Primary use	Market range of primary product		Secondary uses	Land-use types
					Rhun	Tioor		
Intsia bijuga	LEGUMINOSAE	Moluccan ironwood	kayu besi; perai	timber	2	3	pul med dye poi	PF; TG; MG
Ipomoea aquatica	CONVOLVULACEAE	water spinach	kangkung; kangkung	vegetable	1	1	med for	DF; MG
Ipomoea batatas	CONVOLVULACEAE	sweet potato	ubi; uf	tuber	1	1	veg stb med for poi	DF; MG
Ipomoea pes-caprae	CONVOLVULACEAE	beach morning glory	?; ?	medicinal plant	1	1	for dye sco	BV; TG
Kalanchoe pinnata	CRASSULACEAE	life plant	-; kerbaubau	ornamental plant	n.i.	1	med	TG; BV
Lagenaria siceraria	CUCURBITACEAE	bottle gourd	labu putih; -	vegetable	2	n.i.	efn med	DF; MG
Lansium domesticum	MELIACEAE	langsat	langsat; -	edible fruit	2	1	med tim dye poi	TG; MG
Leucaena leucocephala	LEGUMINOSAE	jumbie bean	kalamandingan; -	cover plant	1	n.i.	pul veg stb med tim for dye tan poi hwa	SV; MG
Luffa acutangula	CUCURBITACEAE	angled loofah	gambas; petola	vegetable	2	1	efn med	MG; DF
Lycopersicum esculentum	SOLANACEAE	tomato	tomat; kamatiny	vegetable	2	1	vof med for poi	MG; DF
Macaranga tanarius	EUPHORBIACEAE	?	-; kifat	tannin-producing plant	n.i.	1	efn stb med sug tim dye gum pth	SF
Mangifera foetida	ANACARDIACEAE	horse mango	-; mangga bas	edible fruit	n.i.	1	stb med tim poi	MG; TG; BV
Mangifera indica	ANACARDIACEAE	mango	mangga; mangga	edible fruit	3	1	veg med tim for dye res gum poi	MG; TG; BV
Mangifera sp.	ANACARDIACEAE	mangowood	pauh; mangga pauh	timber	1	1	efn	SF; TG
Mangifera sp.	ANACARDIACEAE	?	-; mangga telur	edible fruit	n.i.	1	?	MG; TG
Manihot esculenta	EUPHORBIACEAE	cassava	singkong, kasbi; kasbe	tuber	1	2	veg med for poi fue	DF; MG
Manihot glaziovii	EUPHORBIACEAE	Ceara rubber-tree	singkong karet; -	latex-producing plant	1	n.i.	vof sug poi orn	MG; SV
Maranta arundinacea	MARANTACEAE	arrrowroot	ararut; ?	tuber	1	1	vof veg med fib poi	MG; DF
Melanolepis	EUPHORBIACEAE	?	-; yofal	medicinal plant	n.i.	1	dye awo hwa fue	SF; BV; TG
Memecylon sp.	MELASTOMATACEAE	?	-; kai kertas	timber	n.i.	1	fue	PF
Metroxylon sagu	PALMAE	sago palm	sago; kwera	starch	n.i.	1	veg med tim fib for poi bmw pth	TG; MG
Momordica charantia	CUCURBITACEAE	bitter gourd	pepari; pepari	vegetable	1	1	vof stb med	DF; MG
Morinda citrifolia	RUBIACEAE	Indian mulberry	bengkudu; gusgus	dye-producing plant	1	1	efn veg ess med tim sco	MG; TG
Moringa oleifera	MORINGACEAE	horseradish	kelor; bet	spice	1	1	vof veg med fib for dye gum poi sco hwa	DF; MG
Musa spp.	MUSACEAE	banana	pisang; muk	edible fruit	3	2	veg stb stm med sug fib for dye wax bmw	MG; TG; DF; HG
Myristica argentea	MYRISTICACEAE	Papuan nutmeg	?; bala maslos	spice	n.i.	4	vof ess med	TG
Myristica fragrans	MYRISTICACEAE	nutmeg	pala; bala balbulis	spice	4	4	vof efn ess nar med	TG; MG
Nauclea purpurascens	RUBIACEAE	bangkal (T.)	-; pelmalar	timber	n.i.	1	-	PF; SF
Neonauclea glabra	RUBIACEAE	bangkal (T.)	emeng; weman	timber	2	2	-	PF; SF
Nephelium lappaceum	SAPINDACEAE	rambutan	rambutan; ?	edible fruit	2	n.i.	vof stb med tim dye tan fue	MG; TG
Nicotiana tabacum	SOLANACEAE	tobacco	-; tembakau	stimulant (smoking)	n.i.	1	vof stc med poi	DF
Nothaphoebe calista	LAURACEAE	medang (T.)	-; kai kuning	timber	n.i.	3	-	PF

Scientific name	Family	English name	Vernacular names	Primary use	Market range of primary product		Secondary uses	Land-use types
					Rhun	Tioor		
Ocimum americanum	LABIATAE	hoary basil	kemangi; kumangi	vegetable	1	1	ess med	HG; MG; DF
Operculina riedeliana	CONVOLVULACEAE	?	-; larbar	medicinal plant	n.i.	1	-	TG; BV
Orthosiphon aristatus	LABIATAE	Java tea	-; kumis kucing	medicinal plant	n.i.	1	-	TG; MG
Oryza sativa	GRAMINAE	rice	padi; pasah	cereal	n.i.	1	vof stb med sug fib for dye bmw fue	DF
Pandanus sp.	PANDANACEAE	pandanus	pandan; vakun	fibre	3	3	-	MG; DF; DL; BV
Paraserianthas falcataria	LEGUMINOSAE	batai (T.)	sika; wepa	shade tree	1	1	tim sco	SF
Pemphis acidula	LYTHRACEAE	?	-; kai papua	timber	n.i.	1	veg fue	BV
Persea americana	LAURACEAE	avocado	adpukat; -	edible fruit	1	n.i.	vof ess tim	MG; HG
Phaseolus vulgaris	LEGUMINOSAE	common bean	buncis; ?	pulse	3	1	veg	DF; MG
Phyllantus fraternus	EUPHORBIACEAE	?	-; ilmur	medicinal plant	n.i.	1	dye poi	TG; BV
Piper betle	PIPERACEAE	betel vine	-; sirih	stimulant (chewing)	n.i.	1	spi	TG; MG
Pometia pinnata	SAPINDACEAE	kasai (T.), matoa	-; ton	timber	n.i.	3	vof efn veg med	PF; TG; MG
Premna obtusifolia	VERBENACEAE	?	-; kora	medicinal plant	n.i.	1	fue	SF; TG
Psidium guajava	MYRTACEAE	guava	giawas; giawas	edible fruit	2	1	vof spi stb med sug tim dye tan hwa fue	MG; HG
Psophocarpus	LEGUMINOSAE	winged bean	kecipir; galifas	vegetable	1	1	tub pul vof med dye sco	DF; HG
Pterocarpus indicus	LEGUMINOSAE	red	lenggua; but	timber	2	3	veg ess med dye gum awo	SF; TG; (PF?)
Pueraria phaseoloides	LEGUMINOSAE	tropical kudzu	pupuk hijau; -	cover plant	1	n.i.	tub med fib	MG; TG; SV
Ricinus communis	EUPHORBIACEAE	castor oil plant	-; kai duan	vegetable oil & fat	n.i.	1	med spi for dye poi sco fue	?
Saccharum officinarum	GRAMINAE	sugar cane	tebu; tef	sugar	1	1	veg stb med fib for wax sco fue	DF; HG
Salacca zalacca	PALMAE	salak, snake fruit	salak; salak	edible fruit	n.i.	2	med bmw	MG
Santiria laevigata	BURSERACEAE	kedongdong	-; kier wotan	timber	n.i.	1	-	PF
Sauropus androgynus	EUPHORBIACEAE	star gooseberry	katok; katok	vegetable	1	1	efn med dye hwa	MG; TG
Scleria sp.	CYPERACEAE	?	-, woswas	medicinal plant	n.i.	1	stc pth	TG; BV; SF
Sechium edule	CUCURBITACEAE	chayote	labu siam; pepari	vegetable	1	1	tub efn for bmw	DF; MG
Sesbania grandiflora	LEGUMINOSAE	Agati sesbania	turi; -	shade tree	1	n.i.	veg med fib for dye tan gum fue	MG; DF
Setaria italica	GRAMINAE	foxtail millet	-; botan	cereal	n.i.	1	med for	DF
Sida acuta	MALVACEAE	?	-; sapu ternate	medicinal plant	n.i.	1	fib bmw	TG; BV
Solanum americanum	SOLANACEAE	glossy	-; kaymakmuk	vegetable	n.i.	1	efn med poi	DF; HG
Solanum lasiocarpum	SOLANACEAE	?	-; kaymakmuk	vegetable	n.i.	1	med	DF
Solanum melongena	SOLANACEAE	eggplant	terong; toron	vegetable	2	1	efn med	MG; DF
Sonneratia alba	SONNERATIACEAE	perepat (T.)	-; wokat	timber	n.i.	1	efn veg tan fue	BV
Spondias cytherea	ANACARDIACEAE	ambarella	kedongdong; kedongdong	edible fruit	1	1	veg tim gum	MG; HG
Stachytarpheta jamaicensis	VERBENACEAE	snake weed	-; taratafiny	medicinal plant	n.i.	1	veg for hwa	TG; BV
Sterculia subpeltata	STERCULIACEAE	?	-; paka-paka	medicinal plant	n.i.	1	veg	?

Scientific name	Family	English name	Vernacular names	Primary use	Market range of primary product		Secondary uses	Land-use types
					Rhun	Tioor		
Streblus ilicifolius	MORACEAE	jungle holly	-; magan	timber	n.i.	1	efn	PF
Syzygium aqueum	MYRTACEAE	water apple	jambu air; -	edible fruit	2	n.i.	med tim sco hwa	MG; TG
Syzygium aromaticum	MYRTACEAE	clove	cengkeh; cengkeh	spice	5	5	efn ess med tim dye	TG; MG
Syzygium cumini	MYRTACEAE	jambolan	jamblang; -	edible fruit	2	n.i.	stb med sug tim tan	MG
Syzygium malaccense	MYRTACEAE	Malay apple	jambu merah; mut	edible fruit	2	1	med	MG; TG
Tamarindus indica	LEGUMINOSAE	tamarind	asam jawa; asam jawa	edible fruit	4	1	pul vof veg spi stc med sug tim for dye	MG
Tectona grandis	VERBENACEAE	teak	jati; -	timber	4	n.i.	-	MG; TG
Terminalia catappa	COMBRETACEAE	Indian almond	ketapang; talia	tannin-producing plant	1	1	efn, tim	BV; MG
Theobroma cacao	STERCULIACEAE	cocoa	coklat; -	vegetable oil & fat	5	n.i.	stb med for sco	TG
Timonius timon	RUBIACEAE	?	-; anau	timber	n.i.	1	stc med poi	TG; SF
Toona ciliata	MELIACEAE	Indian mahagony	kasturi; -	timber	2	n.i.	med dye	MG; TG
Trema orientalis	ULMACEAE	charcoal tree	-; daman	fuelwood	n.i.	1	veg med tim fib for dye tan poi sco	SF; MG; DF
Trichosanthes cucumerina	CUCURBITACEAE	snake gourd	-; urbai	vegetable	n.i.	1	-	DF; HG
Urena lobata	MALVACEAE	Indian mallow	-; rafrafat	fibre	n.i.	1	med for dye	TG; SF
Vernonia cinerea	COMPOSITAE	?	-; kalarkaman	medicinal plant	n.i.	1	veg for	TG; BV
Vigna marina	LEGUMINOSAE	?	-; serefentac	cover plant	n.i.	1	veg med	?
Vigna radiata	LEGUMINOSAE	mung bean	kacang hijau; kacang hijau	pulse	n.i.	1	veg med for	DF
Vigna unguiculata	LEGUMINOSAE	yard-long bean	kacang panjang; ?	vegetable	2	1	pul	DF; MG
Wollastonia biflora	COMPOSITAE	?	-; larmurag	medicinal plant	n.i.	1	veg spi for poi	TG; BV; MG; SF
Zea mays	GRAMINAE	maize	jagung; sapulut	cereal	1	1	vof stb stm med sug fib for bmw sco fue	DF; MG
Zingiber officinale	ZINGIBERACEAE	ginger	jahe; vafnanglia	spice	1	1	ess med ars poi	MG; TG; DF

Abbreviations in columns:

English name (T.) Trade name of timber

Market rang
- **1** mere subsistence product
- **2** subsistence product, surpluses marketed only in island
- **3** subsistence product, surpluses marketed also outside of island
- **4** mainly market product, but also for self consumption
- **5** mere market product
- **n.i.** plant species not identified

Vernacular names first name (Rhun); second name (Tioor)

Land-use types (Sequence is approximately given according to declining importance or frequency of the plant species in the respective land-use type)
- **BV** Beach vegetation (including propagated species)
- **DF** Dry field
- **DL** Degraded land
- **HG** Homegarden
- **MG** Mixed garden
- **PF** Primary forest
- **SF** Secondary forest
- **SV** Secondary vegetation
- **TG** Tree garden

Secondary uses (Sequence of secondary uses is given randomly)

ars Aromatic resin-producing plants
awo Aromatic woods
bmw Plants used for making baskets, mats and wickerwork
dye Dye-producing plants
efn Edible fruit and nuts
ess Essential-oil plants
fib Fibre
for Feed plants including forage
fue Fuel plants
gum Gum-producing plants
hwa Hedge and wayside plants
lat Latex-producing plants
med Medicinal plants
nar Narcotic plants
orn Ornamental plants
poi Plants producing poisons and insecticides
pth Plants used for packing and thatching
pul Pulses
res Resin-producing plants
sco Shade and cover plants in agriculture
spi Spices and condiments
sta Sago and related starch-producing plants
stb Stimulants (beverage)
stc Stimulants (chewing)
sug Plants producing sugars, alcohols or acids
tan Tannin-producing plants
tim Timber
tub Tubers
veg Vegetables
vof Vegetable oils & fats
wax Wax-producing plants

Notes: Plant names and uses according to PROSEA handbook; supplemented by PRA, observation and interviews (Stubenvoll 1996 and 1997).

Sources: Herbarium collection by Stubenvoll (1996 and 1997) and analysis by Pusat Penelitian dan Pengembangan Biologi, LIPI, Bogor; PRA, interviews, and observation (Stubenvoll 1996 and 1997); Masyarakat Pulau Rhun 1996; PROSEA handbook, several volumes; Levang and de Foresta 1991.

Appendix 1.2: Unidentified plant species in Tioor

Vernacular name	Short description	Primary use and market range	Secondary uses	Land-use
Bong wotan	Herbaceous plant	Vegetable 1	n.a.	n.a.
Buka	Small tree (10m), fast growing, abundant in secondary forest	Timber for roof-construction of field huts 1	n.a.	SF
Cengkeh wotan	Small tree (15m), literally “forest clove”	Spice 5	n.a.	PF
Fagic	Medium-sized tree (20m), primary forest, heavily depleted	Fuelwood 1	Medicinal plant	PF
Fikfiga	Small tree (5m), heavily depleted	Edible fruit 1	n.a.	PF
Galyalyan	Fern	Vegetable 1	Medicinal plant	n.a.
Garmanminak	Herbaceous plant	Medicinal plant 1	n.a.	n.a.
Garterter	Small tree (15m), depleted in Tioor, frequent in Baam Island	Excellent fuelwood 1	Timber for boat construction, medicinal plant	n.a.
Gyamgyam	Medium-sized tree (30m), primary forest, depleted	Fuelwood 1	Timber for roof-construction of field huts	PF
Hemar	Small tree (15m), grows near settlement, nearly extinct	n.a.	n.a.	n.a.
Kai kau	Medium-sized tree (20m), secondary forest	Timber for roof-construction of houses 1	n.a.	SF
Kai matafuly	Small-sized tree (10m), grows at beaches	(Remark: contact of exudate with eyes may cause blindness; literally meaning: “red eye tree”)		n.a.
Kai tebtob	Medium-sized tree (20m), stilt roots, primary forest,	Edible fruit 1	Fuelwood, timber for house construction	PF
Kamlimyatapetur	Medium-sized tree (20m)	Medicinal plant 1	Fuelwood	n.a.
Kekindeder	A *Pandanus* sp., with prickly leaves	Medicinal plant 1	Fibre	n.a.
Kelymatiny	Small tree (15m), grows at sandy beaches, almost extinct	Shore protection 1	n.a.	PF
Kofat	Bamboo	Medicinal plant 1	For making of baskets, bags, etc.;	PF; MG
Kovnan	Bamboo	For construction (field huts, fences, etc.) 1	n.a.	PF; MG
Lafgugur	Small tree (15m), pioneer species in secondary forest, frequent	Timber for house construction (interior) 1	Medicinal plant, fibre	SF
Lagyegyar	Fern, widespread in degraded land around highest peak (Gunung Ra)	n.a.	n.a.	DL

Vernacular name	Short description	Primary use and market range	Secondary uses	Land-use
Laric	Small tree (10 m), heavy wood, frequent in Baam Island	Edible fruit 1	n.a.	PF
Medar	Small tree (5m), depleted	Medicinal plant 1	n.a.	n.a.
Mitan	Medium-sized tree (20m), depleted	n.a.	n.a.	n.a.
Pablubily	Herbaceous plant	Medicinal plant 1	n.a.	n.a.
Pasa-pasa	Small tree (7m), grows in secondary forest	Medicinal plant 1	Fuelwood	SF
Rei	Medium-sized tree (20m), unidentified *Acacia* sp. (*Leguminosae*)	Timber for house construction 1	Medicinal plant	n.a.
Rotan	Rattan	For making of baskets, bags, etc. 1	n.a.	PF
Ruak	Shrub, *Leguminosae*	Wood for cooking a kind of red-coloured tea 1	n.a.	MG, SF
Sumelan	Bamboo	n.a.	n.a.	n.a.
Tamlomur	Small tree (10m), coastal plains, heavily depleted	Fuelwood, charcoal production 1	n.a.	SF
Temar	Bamboo	n.a.	n.a.	n.a.
Terim	Bamboo	n.a.	n.a.	n.a.
Utan dodor	Herbaceous plant	Vegetable 1	n.a.	n.a.
Varfur	Bamboo	Medicinal plant 1	Culm for sago thatch production	n.a.
Weman	Tree	n.a.	n.a.	n.a.
Wepatac	Medium-sized tree (30m), grows at beaches, depleted, frequent in Baam	Timber for canoes, boat construction 1	n.a.	n.a.
Yeo	Small tree, literally "shark tree" as bark resembles the skin of sharks,	n.a.	n.a.	PF
TALI (Strings)				
Haluk	n.a.	Strings for sago thatch production 1	n.a.	n.a.
Karkem	n.a.	Strings for fixing sago thatch on roof 1	n.a.	n.a.

Notes: Abbreviations as in App. 1.1; **n.a.:** information is not available.

Sources: PRA, interviews, observation, and herbarium collection but impossible identification (Stubenvoll 1997).

Appendix 1.3: Unidentified plant species in Rhun

Vernacular name	Short description	Primary use and market range	Secondary uses	Land-use type
Akar olah-olah	Perennial herbaceous climber	Medicinal plant 1	n.a.	SF, MG, TG
Bambu batung	Bamboo (*Dendrocalamus asper*?)	Culms used as a building material 1	Young shoots used as a vegetable	MG, SF
Bambu cina	Bamboo (*Bambusa multiplex*?)	n.a.	n.a.	MG, SF
Bambu duri	Bamboo (*Bambusa bambos*?)	Culms used as a building material 1	Young shoots used as a vegetable	MG, SF
Bambu jawa	Bamboo	n.a	n.a	n.a.
Bambu sueleng	Bamboo (*Bambusa atra*?)	Culms used in basketry and fisheries 1	n.a.	MG, SF
Bambu tali	Bamboo (*Gigantochloa apus*?)	Culms used as a building material 1	Used in basketry and fisheries	MG, SF

Vernacular name	Short description	Primary use and market range		Secondary use	Land-use type
Cerpati hutan	Medium-sized tree	n.a.		n.a.	n.a.
Gaba-gaba	Medium-sized tree	n.a.		n.a.	SF
Gonggai	Straggling shrub, a *Leguminosae* (*Mimosa diplotricha*?)	Soil improver, regarded as a noxious weed	1	Fuelwood	SV, DL
Kalumpang	Medium-sized tree	Timber for house and boat construction	1	n.a.	SF
Kayu akar	Small tree	n.a.		n.a.	n.a.
Kayu kapor	Small tree	n.a.		n.a.	n.a.
Kayu keli	Medium-sized tree	n.a.		n.a.	n.a.
Kayu kira-kira	Medium-sized tree	n.a.		n.a.	PF
Kayu tiga-tiga	Medium-sized tree	n.a.		n.a.	SV
Kayu timur	Small tree	Fuelwood	1	Marking of field boundaries	MG, DFP
Kelor hutan	Medium-sized tree	n.a.		n.a	n.a.
Kudek	Vine, *Leguminosae*	Pulse	1	n.a.	DFP
Mameti	Small tree	n.a.		n.a.	SF
Rusok batu	Small tree, hard wood	Timber for construction of field huts	1	n.a.	SF
Talang	Small tree	Leaves used as vegetable	1	n.a.	MG, BV
Tombor	Small tree	n.a.		n.a.	SF
Tuing	Small tree; Leguminosae	n.a.		n.a.	n.a.

Notes: Abbreviations as in App. 1.1; **n.a.** information is not available;
Supposed scientific names (bamboos, *gonggai*) have to be treated with caution, as herbarium material was *not* collected!

Sources: PRA, interviews, observation, and partly herbarium collection but impossible identification (Stubenvoll 1996).

Appendix 1.4: Number of identified and unidentified plant species in Tioor and Rhun

Market range of primary product	Tioor identified	Tioor unidentified	Tioor total	Rhun identified	Rhun unidentified	Rhun total
Mere subsistence product	131	29	160	56	11	67
Subsistence product, surpluses marketed only in island	14	0	14	25	0	25
Subsistence product, surpluses marketed also outside of island	7	0	7	11	0	11
Mainly market product, but also for self consumption	6	0	6	5	0	5
Mere market product	2	1	3	3	0	3
Information not available	0	9	9	0	13	13
TOTAL	**160**	**39**	**199**	**100**	**24**	**124**

Sources: Appendices 1.1, 1.2, and 1.3.

Appendix 1.5: Timber trees in Tioor and Rhun – a selection

Species (**both islands**, Tioor, *Rhun*)	**Max. height**	**Use of timber**											**Frequency** (Tioor; Rhun)	**Remarks**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**		
Allophylus cobbe	25 m						x			x		x	3; n.i.	11: for field huts
Alstonia scholaris	50 m						x						2; 2	an important medicinal plant; the wood was formerly used for school blackboards
Alstonia spectabilis	20 m	x					x			x			3; n.i.	wood is stronger than from Alstonia scholaris
Anthocephalus chinensis	40 m				x		x						3; n.i.	wood is moderably durable under cover; secondary forest species
Aquilaria cumingiana	20 m												4; n.i.	is searched for low quality gaharu (aloeswood); in Tioor depleted
Archidendron ellipticum	5 m									x			4; n.i.	bark, and wood are used as a medicine; in Tioor seldom
Areca catechu	?						x						4; n.i.	in Tioor depleted; 7: used as an interior material in house walls
Arenga pinnata	20 m						x	x		x			n.i.; 2	multipurpose tree; leafstalks are used as firewood
Artocarpus altilis	30 m				x		x						2; 5	in Rhun recently introduced; edible fruit is the primary use
Artocarpus heterophyllus	20 m				x	x	x	x	x				1; 1	timber is resistant to termite attack, and classified as medium hardwood
Artocarpus integer	20 m		x			x	x	x					5; n.i.	durable/strong timber; edible fruit is the primary use; in Tioor recently introduced
Avicennia marina	10 m					x				x			5; n.i.	mangrove tree species; in Tioor almost extinct
Bridelia tomentosa	?						x		x			x	3; n.i.	8: tool handles; timber is a medium-weight hardwood
Calophyllum inophyllum	30 m	x		x	x	x		x					5; 5	timber is highly valued; in both islands almost extinct
Calophyllum sp.	40 m	x		x	x	x				x			2; n.i.	frequent in upland secondary forest
Canarium spp. (C. indicum, *C. vulgare*)	35 m		x		x		x			x			3; 3	in Rhun, C. vulgare is the most common shade tree in former nutmeg plantations in Tioor, C. indicum is most commonly introduced from Kur Island
Casuarina equisetifolia	40 m									x	x		4; n.i.	in Tioor depleted; produces good firewood and excellent charcoal; nitrogen
Celtis philippensis	30 m					(x)					(x)		3; n.i.	presently not used, as wood is very hard; it seems suitable for charcoal
Cocos nucifera	30 m						x						1; 1	wood is very hard
Cordia subcordata	10 m	x						x	x				5; 5	8: for carving, and machete handles; almost extinct; in Baam Island still common
Diospyros sp.	50 m	x				x				x			2; n.i.	highly valued timber in Tioor; for more information species identification needed
Dracontomelon dao	40 m		x				x	x					n.i.; 3	in Rhun occasionally planted in former nutmeg plantations; timber is highly
Durio zibethinus	40 m						x	x					3; 3	edible fruit is the primary use; the rind of the fruit may be used as a fuel
Endospermum moluccanum	25 m									x			4; 3	in Tioor depleted; fast growing species in secondary forest; soft and weak wood
Erythrina variegata	25 m												2; n.i.	the lightweight wood it presently not used; nitrogen fixing; ornamental tree
Eugenia lineata	40 m	x								x			5; n.i.	in Tioor almost extinct; durable timber is highly valued
Ficus parvifolia	30 m												5; n.i.	in Tioor almost extinct; wood is presently not used
Garcinia mangostana	25 m					x							n.i.; 5	heavy and very strong wood; edible fruit is the primary use; in Rhun almost
Gmelina moluccana	40 m				x		x	x					n.i.; 5	in Rhun almost extinct; highly valued timber for canoe hulls
Hernandia ovigera	10 m								x	x			4; n.i.	8: for machetes handles
Hibiscus tiliaceus	10 m	x								x			4; 2	in Tioor, depleted; in Rhun, increasingly planted into gardens
Horsfieldia bivalis	25 m											x	5; n.i.	in Tioor almost extinct; in Baam Island still common; 11: for field huts

Species (**both islands**, Tioor, *Rhun*)	**Max. height**	**Use of timber** 1	2	3	4	5	6	7	8	9	10	11	**Frequency** (Tioor; Rhun)	**Remarks**
Intsia bijuga	40 m			x		x	x				x		3; 5	in Rhun almost extinct; in Tioor main source of charcoal production
Lansium domesticum	30 m					x			x				5; 3	8: tool handles; in Tioor recently introduced; wood is tough and durable
Leucaena leucocephala	5 m									x		x	n.i.; 2	11: used as stakes for vines; shrubby variety; nitrogen fixing
Macaranga tanarius	10 m									x		x	2; n.i.	11: for field huts; yields a lightweight hardwood
Mangifera foetida	35 m						x						2; n.i.	wood is not durable; edible fruit is the primary use
Mangifera indica	45 m					x				x	x		2; 2	wood is fairly strong; edible fruit is the primary use
Memecylon sp.	10 m								x	x			3; n.i.	8: for axe handles; yields a heavy hardwood
Metroxylon sagu	20 m							x				x	1; n.i.	7, 11: petioles and midribs of leaves used as material for house anf field hut walls
Nauclea purpurascens	30 m					x	x						4; n.i.	in Tioor depleted
Neonauclea glabra	25 m	x				x							4; 4	timber highly valued in Rhun for boat construction; in both Tioor and Rhun
Nephelium lappaceum	35 m					x	x						n.i.; 3	wood is heavy and hard; edible fruit is the primary use
Nothaphoebe calista	50 m				x	x	x	x					5; n.i.	in Tioor almost extinct
Paraserianthes falcataria	30 m				x					x			2; 3	very fast growing species in secondary forest
Pemphis acidula	10 m									x	x		5; n.i.	in Tioor almost extinct; in Baam Island still common; wood is very hard and very
Pometia pinnata	50 m				x	x				x			4; n.i.	has the potential to be used in charcoal production; valued timber; in Tioor
Psidium guajava	10 m								x				5;2	wood is moderately strong, used for handles; in Tioor recently introduced
Pterocarpus indicus	20 m		x		x	x	x	x					4; n.i.	wood highly valued for furniture; is occasionally planted by farmers; in Tioor
Santiria laevigata	35 m				x					x			5; n.i.	in Tioor almost extinct; wood is moderately hard
Sonneratia alba	15 m									x			5; n.i.	in Tioor almost extinct; a mangrove tree species
Streblus ilicifolius	10 m								x				2; n.i.	8: for axe handles; hard and very durable wood
Syzygium cumini	20 m									x			n.i.; 3	multipurpose tree; edible fruit is the primary use
Tectona grandis	45 m		x			x	x		x				n.i.; 5	in Rhun recently introduced by some farmers; in nearby Hatta Island frequent
Terminalia catappa	25 m	x			x		x	x					3; 2	in Rhun occasionally planted; used as a traditional medicinal
Timonius timon	?									x		x	3; n.i.	11: for field huts; used as a traditional medicine
Toona ciliata	35 m		x	x			x	x					n.i.; 3	timber is highly valued; in Rhun used as a shade tree in former nutmeg
Trema orientalis	15 m									x			2; n.i.	bark produces a red-brown dye
Total number of species available for respective use of timber		**9**	**6**	**4**	**13**	**18**	**24**	**13**	**9**	**25**	**5**	**7**	**Total (of 59 species)**	
		5	4	3	7	9	14	9	5	8	2	1	Rhun (of 26 species)	
		9	3	3	12	15	18	9	8	22	5	6	Tioor (of 50 species)	

Notes: **Maximal height**... at preferable sites;
Use of timber: 1 ship construction (planks; keel; ribs); **2** ship construction (interior); **3** ship construction (poles; masts); **4** canoe hulls; **5** house construction (roof, heavy construction); **6** house construction (indoor application, doors); **7** furnitures; **8** crafts (carving; tools; see remarks); **9** fuelwood; **10** charcoal; **11** others (see remarks);
Frequency: 1 frequent; **2** common; **3** less common; **4** depleted or seldom (see remarks); **5** almost extinct or recently introduced (see remarks); **n.i.** not identified

Sources: Interviews, mapping, observation, PRA, and workshop sessions (Stubenvoll 1996 and 1997); PROSEA handbook, several volumes.

Appendix 1.6: Medicinal plants in Tioor

A. Number of plant species used for treatment of illnesses and pains

Classification	No. of species	Classification	No. of species
Antiparasitical (worms, malaria)	5	Genito-urinary (abortifacient, jaundice, kidney problems)	4
Repiratory system (cough, cold, influenza)	15	Obstretics (to ease labour)	1
Analgesic (head-, tooth-, stomach-, backache, labour pains)	8	Gastrointestinal (antidiarrhoeal, carminative, gastritis, indigestion, laxative)	10
Febrifuge	10	Dermatological (cuts, wounds, skin infection, rash, itch, boils)	8
Haematological (haemostatic, anaemia, post-natal	17	Musculoskeletal (tired and aching muscles, rheumatism, arthritis, broken	2
Anti-inflammatory	4	Others	7

B. Plant species and medicinal uses

Vernacular name	Scientific name	Family	Medicinal use	Plant part	Preparation	Remarks on other uses
Anau	*Timonius timon*	RUBICAEAE	against cough	bark	decoction; to drink	fuelwod
			post-natal strengthener	bark	decoction; to drink	
			to increase appetite	bark	decoction; to drink	
Bala	*Myristica fragrans*	MYRISTICACEAE	perfume	leaf	?	spice, fuelwood
			against stomach-ache	seed	powdered, roasted and mixed with water; to drink	
Bet	*Moringa oleifera*	MORINGACEAE	antiphlogistic	root	scraped, pressed and mixed with egg; to drink	vegetable
Bobotubily	*Clerodendron speciosissimum*	VERBENACEAE	against malaria	leaf	pounded, squeezed in water; to drink	
			against jaundice	leaf	pounded, squeezed in water; to drink	
Busil	*Asystasia gangetica*	ACANTHACEAE	against stomach-ache	root, leaf, stalk	decoction; to drink	
But	*Pterocarpus indicus*	LEGUMINOSAE	against diarrhoea	leaf, root	decoction; to drink	timber
Cengkeh	*Syzygium aromaticum*	MYRTACEAE	against tooth-ache	dried bud	-	spice
Dagan	*Acalypha caturus*	EUPHORBIACEAE	against ulcers	leaf	decoction; to drink	fuelwood
			febrifuge	leaf	decoction; to drink	
			against cough	leaf	decoction; to drink	
Dur	*Erythrina variegata*	LEGUMINOSAE	obstretric	leaf, bark	decoction; to drink	flowering is an indicator for fishing season of mora
Duran manuktan	*Annona muricata*	ANNONACEAE	against gastritis	leaf	pounded, squeezed in water; to drink	edible fruit
Gialar	*Commelina moliflora*	COMMELINACEAE	febrifuge	leaf	pounded, squeezed in water; to drink	n.a.
Giam	*Inocarpus edulis*	LEGUMINOSAE	against cough	leaf, bark	decoction; to drink	edible fruit, young leaves as a vegetable, fuelwood, for machete
Gusgus	*Morinda citrifolia*	RUBIACEAE	laxative	leaf	decoction; to drink	roots and bark as a red dye, traditionally used for tikar mats
			to cover up ulcers and wounds	young leave	-	
			against gastritis	ripe fruit	-	

Vernacular name	Scientific name	Family	Medicinal use	Plant part	Preparation	Remarks on other uses
Halia	*Zingiber officinale*	ZINGIBERACEAE	against indigestion	storage root	pounded and externally rubbed on the stomach	spice
			analgesic	storage root	pounded and prepared as a decoction; to drink	
Hamia	*Desmodium laxiflorum*	LEGUMINOSAE	against cough	leaf	decoction; to drink	fuelwood
Hekin deder	*Pandanus sp.*	PANDANACEAE	against measles	leaf	pounded, squeezed in water; to drink	root for making paintbrushs; leaf for tikar mats
Hukun	*Artocarpus altilis*	MORACEAE	haematic; for strength	leaf	decoction; to drink	edible fruit; timber
Ilmur	*Phyllantus fraternus*	EUPHORBIACEAE	against cough, malaria; analgesic	all plant parts	pounded, squeezed in water; to drink (adult) pounded, rosted, squezzed in water to drink	n.a.
Kafalun	*Ficus parvifolia*	MORACEAE	against cough	bark; root	pounded and prepared as a decoction; to drink	ornamental tree
			against tooth-ache	exudate	filled into a the hole of a sick tooth	
Kai betbetur	*Allophylus cobbe*	SAPINDACEAE	haematic	leaf	decoction; to drink	fuelwood
Kai duan	*Ricinus communis*	EUPHORBIACEAE	febrifuge	leaf	externally (compress)	n.a.
			hypotensive	leaf	pounded, squeezed in water; to drink	
Kalarkaman	*Vernonia cinerea*	ASTERACEAE	febrifuge; against cough	leaf	pounded, squeezed in water; to drink	n.a.
Kamlimyatapetur	unidentified tree		anti-inflammatory	leaf	decoction; to drink	fuelwood
Karkardeder	*Caesalpinia bonduc*	LEGUMINOSAE	against cough	leaf	pounded, squeezed in water; to drink	n.a.
Kaswosar	*Archidendron ellipticum*	LEGUMINOSAE	post-natal strengthener	leaf	decoction; to drink	fuelwood
			against cough	leaf	for children: decoction; to drink	
Kataferak vuly	*Artocarpus heterophyllus*	MORACEAE	to prevent jaundice	leaf	decoction; to drink	edible fruit, timber
			to prevent skin diseases	root	decoction; to drink	
Kecela sagrug	*Carica papaya*	CARICACEAE	against malaria	old leaf	decoction; to drink	edible fruit, leaves as a vegetable
				root	pounded, squeezed in water; to drink (small	
			against parasitical worms	old leaf	pounded, squeezed in water, mixed with salt; to	
				exudate	mixed with water and sugar; to drink	
				seeds	eaten raw	
			hypotensive	old leaf, unripe fruit	pounded, squeezed in water; to drink	
			febrifuge	ripe fruit	eaten raw	
			stimulates milk production after childbirth	unripe fruit	cooked in water; to drink	
Kerbaubau	*Kalanchoe pinnata*	CRASSULACEAE	febrifuge	leaf	externally placed on body	n.a.
Kifut	*Macaranga tanarius*	EUPHORBIACEAE	against small wounds	exudate	externally placed on wound	exudate used as a glue for musical
Kofat	unidentified bamboo		postnatal strengthener	leaf	decoction; to drink	for basketry, tools, construction
Koman wokar	*Ficus septica*	MORACEAE	contraceptive	root	decoction; to drink	leaf used as a wrapping material
			against skin disease *kaskadu*	exudate	externally placed on affected skin	

Vernacular name	Scientific name	Family	Medicinal use	Plant part	Preparation	Remarks on other uses
Kora	*Premna obtusifolia*	VERBENACEAE	post-natal strengthener	leaf	decoction; to drink	fuelwood
			to cover up ulcers, anti-inflammatory	young leaf	externally placed on affected skin	
			against influenza	leaf	decoction; to drink	
			antidiarrhoeal	root	decoction; to drink	
Kumis kucing	*Orthosiphon aristatus*	LAMIACEAE	against back-ache	leaf	decoction; to drink	n.a.
Kusu-kusu	*Imperata cylindrica*	GRAMINAE	post-natal strengthener	root	decoction; to drink	grass used as a roof thatch
Lafagur	*Crinum asiaticum*	AMARYLLIDACEAE	to cover up ulcers and wounds	bark	pounded and externally placed on affected skin	n.a.
Larbar	*Operculina riedeliana*	CONVOLVULACEAE	anti-inflammatory	leaf	pounded, squeezed in water; to drink	n.a.
			against ulcers caused by frambesia	leaf	pounded, squeezed in water; to drink	
Larmurag	*Wedelia biflora*	ASTERACEAE	against influenza	leaf, root	pounded, squeezed in water; to drink	
Lurukyiebar	*Bridelia tomentosa*	EUPHORBIACEAE	against tired muscles	leaf	n.a.	fuelwood
Minawola	*Cayratia trifolia*	VITACEAE	febrifuge	leaf	pounded, squeezed in water; to drink	n.a.
			to cover up ulcers, anti-inflammatory	leaf	externally placed on affected skin	
Muk katleba	*Musa sp.*	MUSACEAE	febrifuge	root	pounded, squeezed in water; to drink	edible fruit
Nuar	*Cocos nucifera*	PALMAE	against anaemia	bark	decoction; to drink	vegetable oil and fat (copra); alcohol; timber for construction
			against cough	young nuts	n.a.	
Pablubily	unidentified herbaceous plant		post-natal strengthener	leaf, root	decoction; to drink	n.a.
Paka-paka	*Sterculia subpeltata*	STERCULIACEAE	laxative	young leaf	cooked as avegetable	n.a.
Pasa-pasa	*unidentified tree species*		post-natal strengthener	leaf	decoction; to drink	fuelwood; timber for construction
			against cough	root	decoction; to drink	
Rafrafat	*Urena lobata*	MALVACEAE	against indigestion	leaf	decoction; to drink	n.a.
Reibubur	*Ficus fistulosa*	MORACEAE	post-natal strengthener	root	decoction; to drink	n.a.
Rot	*Alstonia spectabilis*	APOCYNACEAE	against indigestion	leaf	decoction; to drink	fuelwood
Sapu ternate	*Sida acuta*	MALVACEAE	to cover up ulcers	leaf	externally placed on affected skin	n.a.
Serefentac	*Vigna marina*	LEGUMINOSAE	against influenza of children	young leaf	pounded, squeezed in water; to drink	n.a.
Talia	*Terminalia catappa*	COMBRETACEAE	against indigestion	leaf	pounded, squeezed in water; to drink	edible seed; timber; fuelwood
			against cough	leaf	pounded, squeezed in water; to drink	
			against eye troubles	young leaf	squeezed and let fluid trickle into eye	
			against tooth-ache	bark	decoction; to gargle	
Taratafiny	*Stachytarpheta*	VERBENACEAE	against pinworms	leaf	pounded, squeezed in water; to drink	n.a.
Tefmaf	*Cymbopogon citratus*	GRAMINAE	post-natal strengthener	leaf, stalk	decoction; to drink	spice
			against tired muscles	root	decoction; to drink	
Var	*Hibiscus tiliaceus*	MALVACEAE	febrifuge	leaf	pounded, squeezed in water; to drink	timber; fibre; fuelwood
			post-natal strengthener	leaf	decoction; to drink	
Varfur	unidentifiied bamboo		post-natal strengthener	leaf	decoction; to drink	for basketry; used in roof thatching

Vernacular name	Scientific name	Family	Medicinal use	Plant part	Preparation	Remarks on other uses
Wer	*Ficus sp.*	MORACEAE	stimulates milk production after childbirth	leaf	decoction; to drink	timber for house construction
Woswas	*Scleria sp.*	CYPERACEAE	post-natal strengthener	leaf	decoction; to drink	n.a.
Yagar	*Alstonia scholaris*	APOCYNACEAE	febrifuge	bark	pounded, squeezed in water; to drink	timber for canoes and house construction
			against malaria	bark	pounded, squeezed in water; to drink	
			against indigestion	bark	pounded, squeezed in water; to drink	
			febrifuge	leaf, bark	decoction; to drink	
			against malaria	leaf, bark	decoction; to drink	
			against indigestion	leaf, bark	decoction; to drink	

Note: **n.a.** information not available

Sources: PRA sessions with a group dominated by women, who provided information on medicinal properties, and some men, who added information on other uses (Stubenvoll 1997). Classification (Table A.): Monk et al. 1997, 666.

Appendix 1.7: Nutritional properties of selected agricultural products

English name	Scientific name (Genera)	Energy value	Carbo-hydrate	Protein	Fat	Vitamin A	Thiamine (Vitamin B_1)	Riboflavin (Vitamin B_2)	Niacin (Vitamin B_3)	Vitamin C	Iron	Calcium
	Unit	**kJ/100 g**	**g/100 g**			**mg/100 g or IU; [1]: β-carotene**	**mg/100 g**					
Tubers and storage roots (edible portion)												
Taro	*Colocasia*	475	26	1.1	n.a.	n.a.	n.a.	n.a.	n.a.	15	n.a.	n.a.
Yam	*Dioscorea*	n.a.	15 – 25	1 – 2.5	0.05 – 0.2	0.017 – 0.18	0.08 – 0.09	0.02 – 0.03	n.a.	8 – 10	n.a.	n.a.
Sweet potato	*Ipomoea*	n.a.	n.a.	n.a.	n.a.	0 – 22[1]	n.a.	n.a.	n.a.	20 – 50	n.a.	n.a.
Cassava	*Manihot*	600	35	1.0	0.3	n.a.	n.a.	n.a.	n.a.	n.a.	Minerals: 1.0 g/100 g	
Arrowroot	*Maranta*	n.a.	19.4 – 21.7	1 – 2.2	0.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Cereals (edible portion)												
Rice (white)	*Oryza*	n.a.	80.4	6.7	0.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Foxtail millet	*Setaria*	1500	72.4 – 76.6	9.7 –10.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	5	28
Maize	*Zea*	1525	70	10	4.5	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Vegetables (edible portion)												
Amaranth	*Amaranthus*	n.a.	n.a.	n.a.	n.a.	4 – 8[1]	n.a.	n.a.	n.a.	60 – 120	4 – 9	300 – 450
Chilli (hot)	*Capsicum*	257	9.2	1.9	1.9	700 – 21600 IU	n.a.	n.a.	n.a.	242	1.2	14.4
Cucumber	*Cucumis*	n.a.	2.2	0.6	0.1	45 IU	0.03	0.02	0.3	12	0.3	12
Kangkong	*Ipomoea*	134	5.0	3.0	0.3	4000 – 10000 IU	n.a.	n.a.	n.a.	30 – 130	3.3	81
Loofah (young fruit)	*Luffa*	85	4 – 4.9	0.6 – 1.2	0.2	45 – 410 IU	0.04 – 0.05	0.02 – 0.06	0.3 – 0.4	7 – 12	n.a.	n.a.
Loofah (young leaf)	*Luffa*	n.a.	4	5.1	n.a.	9.2[1]	n.a.	n.a.	n.a.	95	11.5	56
Tomato	*Lycopersicon*	80	3.6	1.0	0.2	1700 IU	0.1	0.02	0.6	21	0.6	10
Cassava (fresh leaf)	*Manihot*	n.a.	n.a.	7	n.a.	reasonable amount	n.a.	n.a.	reasonable amount	n.a.	n.a.	n.a.

English name	Scientific name (Genera)	Energy value	Carbo-hydrate	Protein	Fat	Vitamin A	Thiamine (Vitamin B_1)	Riboflavin (Vitamin B_2)	Niacin (Vitamin B_3)	Vitamin C	Iron	Calcium
Bitter gourd (fruit)	*Momordica*	105 – 250	4 – 10.5	1.5 – 2	0.2 – 1	n.a.	n.a.	n.a.	n.a.	88 – 96	1.8 – 2	20 – 23
Horseradish tree (leaf)	*Moringa*	385	13.4	6.7	1.7	11300 IU	0.06	0.05	0.8	220	7	440
Star gooseberry (leaf)	*Sauropus*	310	6.9	7.6	1.8	10000 IU	0.23	0.15	n.a.	136	3.1	234
Eggplant	*Solanum*	100	4.0	1.6	0.2	n.a.	0.08	0.07	0.7	6	0.9	22
Yard-long bean (pod)	*Vigna*	125	5.2	3.0	0.5	167 IU	0.07	n.a.	n.a.	28	1.3	64
Edible fruits and nuts (edible portion of fruit/nut)												
Pineapple	*Ananas*	n.a.	14	0.4	0.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Soursop	*Annona*	n.a.	n.a.	n.a.	n.a.	n.a.	0.07			20	n.a.	n.a.
Breadfruit	*Artocarpus*	470 – 670	21.5 – 31.7	1.2 – 2.4	0.2 – 0.5	26 – 40 IU	0.1 – 0.14	0.05 – 0.08	0.7 – 1.5	17 – 35	0.4 – 1.5	18 – 32
Jackfruit (ripe fruit)	*Artocarpus*	395 – 410	18.9 – 25.4	1.3 – 2	0.1 – 0.4	175 – 540 IU	0.03 – 0.09	0.05	0.9 – 4	8 – 10	0.4 – 1.1	22 – 37
Jackfruit (young fruit)	*Artocarpus*	210	11.5	2	0.6	30 IU	0.12	0.05	0.5	12	0.4	53
Gandaria	*Bouea*	n.a.	n.a.	0.11	0.04	0.043[1]	0.031	0.025	0.286	75	0.31	6
Papaya	*Carica*	200	12.1	0.5	0.3	450	0.03	0.04	0.5	74	1.0	34
Durian (flesh)	*Durio*	520	28.3	2.5	2.5	n.a.	0.27	0.29	n.a.	57	n.a.	20
Melinjo (kernel)	*Gnetum*	1060	50	11	1.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Langsat	*Lansium*	238	14.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	19
Mango	*Mangifera*	225 – 350	13.2 – 20	0.3 – 0.8	0.1 – 0.2	n.a.	0.03 – 0.09	0.05 – 0.08	n.a.	14 – 62	0.1 – 0.2	9 – 25
Bachang	*Mangifera*	n.a.	25.4	1.4	n.a	0.218[1]	0.03	n.a.	n.a.	56	n.a.	21
Banana	*Musa*	275 – 465	27	1.2	0.3	trace amounts				n.a.	n.a.	n.a.
Rambutan	*Nephelium*	264	14.5	0.9	0.1	4 IU	n.a.	n.a	n.a.	31	n.a.	n.a.
Avocado	*Persea*	600 – 800	3.4 – 5.7	1 – 4	5.8 – 23	75 – 135 IU	vitamin B complex 1.5 – 3.2			n.a.	0.8 – 1	n.a.
Guava	*Psidium*	150 – 210	6.8	1	0.4	n.a.	n.a.	n.a.	n.a.	337	n.a.	n.a.
Malay apple	*Syzygium*	85	3.9	0.3	nil	253 IU	trace amounts		n.a.	0.1	n.a.	n.a.
Jambolan	*Syzygium*	277	14 – 16	0.2 – 0.7	0.3	trace amounts		0.01	0.3	5 – 18	1.2	8 – 15
Tamarind	*Tamarindus*	n.a.	41.1 – 61.4	2 – 3	0.6	n.a.	0.33	0.1	1.0	44	0.2 – 0.9	34 – 94
Pulses (edible portion)												
Groundnut (seed)	*Arachis*	2457	11.7	30.4	47.7	n.a.	good source of Vitamin B and E			n.a.	n.a.	n.a.
Common bean (seed)	*Phaseolus*	1453	62	22.6	1.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Common bean (green pod	*Phaseolus*	126	6.6	1.8	0.2	n.a.	significant amounts of Vitamin B_1 nd B_3			n.a.	n.a.	n.a.
Winged bean	*Psophocarpus*	1697	32	33	16	good source				n.a.	good source	
Mung bean	*Vigna*	1430	60	22	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Yard-long bean (seed)	Vigna	1420	59.1	22	1.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	104

Note: **n.a.** information not available;
Properties are approximate figures as variations may occur due to plant varieties, local environmental conditions, and method of preparation.

Sources: PROSEA handbook, several volumes.

Appendix 1.8: Economic marine species in Tioor

Vernacular name	Indonesian or scientific name	Size	Habitat	Spawn-ing ground	State of depletion		Gender specific activity	Fishing methods and tools	Main season of catch	Usual time of day of the catch	External users
					Form.	Pres.					
FISH species (vernacular name: gisgis)											
Mainly habitat 5											
Madrai[1]	?	0	5	5	1	4	F (M)	*sarefan*[2], traditional fish poison[3]	all	low tide (d)	none
Mainly habitat 4											
Harlor	?	1	4-5	5-4	1	3	F (d), M (n)	d: *sarefan*, machete, harpoon; n: gaslight, machete, trident	all	low tide (n)	none
Karberan	Mubara species	1	4-5	5	1	3	F, M	harpoon (M), fishhook	all	medium tide (n)	none
Kenai	Bulanak	1-2	4-5	5	1	4	F, M	*sarefan*, traditional fish poison, net	all	low tide	none
Kenkena	Samandar	1-2	4-5	5	1	3	F (M)	net (d), fishhook, trident, machete	all	low tide	none
Paglegar	?	1	4-5	5-4	1	3	F (d), M (n)	d: *sarefan*, machete, harpoon n: gaslight, machete, trident	all	low tide (n)	none
Sabakleker vatresiny	?	1	4-5	5-4	1	3	F (M)	fishhook, trident	all	low tide (n)	none
Ulfatur	?	1	4-5	5-4	2	3	F (M)	fishhook, trident	all	low tide	none
Gerwar	Gutana species	1-2	4-5-3	5	1	3	F, M	traditional fish poison, *sarefan*, net, bamboo spear, harpoon	all	low tide	none
Mitan	Gutana	1-2	4-5-3	5	1	3	F, M	traditional fish poison, *sarefan*, net, bamboo spear, harpoon	all	low tide	none
Kir	?	2	4	5-4	2	3	F (M)	harpoon, trident, *bubu*[4]	all	low tide	none
Badah	?	1-2	4-3	5	1	3	F, M	*sarefan* (F), harpoon (M), fishhook	all	low tide (n)	none
Barbarun	Kulit pasir species	1-2	4-3	5	1	2	F, M	trident, *sarefan*, fishhook, hand	all	low tide	none
Dekar	*Upeneus sulphureus*	1-2	4-3	5	1	3	M	trident, fishhook, harpoon, *bubu*	all	low tide	none
Duan	Kakatua species	2-3	4-3	?	1	2	M	harpoon, fishhook, trident, trident, machete	all	low tide (n)	none
Gahe	Durian	1-2	4-3	5	1	4	M	harpoon (in habitat 4-3), trident (in habitat 5)	all	low tide (n)	none
Galiusan	?	1-2	4-3	5	1	3	F, M	*sarefan* (F), harpoon (M), fishhook	all	low tide	none
Gof	Sakuda	1-3	4-3	?	1	4	M	*bubu*, fishhook, net, harpoon	all	low tide (n)	none
Gotan	Garopa besar	3	4-3	?	2	3	M	fishhook	all	low tide	none
Haunangkamat	?	1-2	4-3	5	2	3	F, M	*sarefan*, fishhook, *bubu*	all	low tide	none
Hoger	Garopa species	1-2	4-3	5	1	3	F (s), M (b)	*sarefan*, traditional fish poison in 5, harpoon, fishhook, *bubu* in habitats 4,3	all	low tide (n)	none
Kafafaf	Ketumbu	1-2	4-3	4-3	1	3	M	harpoon, *bubu*, (net)	all	low tide (n)	none
Kafus	Kakatua	1-2	4-3	5	1	3	M	trident (in hab. 5, n), *bubu* (in hab. 3-4, d), net,	all	low tide (n)	none
Kampuc	Sakuda species	1-2	4-3	5	1	3	M	fishhook, *bubu*, harpoon	all	low tide	none

Vernacular name	Indonesian or scientific name	Size	Habitat	Spawn-ing ground	State of depletion		Gender specific activity	Fishing methods and tools	Main season of catch	Usual time of day of the catch	External users
					Form.	Pres.					
Karbor	Sembilan	1-2	4-3	5	1	3	F, M	net (cloth), *sarefan*, traditional fish poison	August	low tide	none
Kelboban	Ikan hias species	1-2	4-3	5	1	4	F, M	*sarefan*, harpoon, *bubu*	all	low tide (n)	none
Kolkolar	?	1-2	4-3	5	2	3	F, M	fishhook, net	all	low tide (d)	none
Kon-kon	Kapas-kapas	1-2	4-3	5	2	3	F, M	fishhook, trident, net	all	low tide	none
Lakur	?	1-2	4-3	5	1	3	F, M	traditional fish poison, fishhook, harpoon, bamboo	all	low tide	none
Makaleor	?	1-2	4-3	5	1	3	F, M	*sarefan*, net, *bubu*, harpoon, fishhook	all	low tide (n)	none
Margurus	Kakatua species	2-3	4-3	?	1	3	M	harpoon, fishhook, trident, machete	all	low tide (n)	none
Markyab	Garopa kecil	1-2	4-3	5	3	3	F, M	*sarefan*, trident, fishhook	all	low tide	none
Matkafua	?	1-2	4-3	?	1	4	M	net, fishhook, harpoon, bamboo spear	all	low tide (n)	none
Neb	*Priacanthus tavenus*	1-2	4-3	5	3	3	F, M	machete, trident, harpoon	all	?	none
Vafyetyetiny	?	1	4-3	?	2	3	F, M	fishhook	all	low tide	none
Via	?	1-2	4-3	5	1	3	F, M	fishhook, harpoon, bubu	all	low tide (n)	none
Vis-vis	Kulit pasir	1-2	4-3	?	1	4	F, M	harpoon, *sarefan*, bubu	all	low tide (n)	none
Masmasan	?	1	?	5	?	?	F, M	*sarefan*, traditional fish poison	all	?	none
Mainly habitat 3											
Cecei	Kulit pasir species	1-2	3-4	5	1	3	F, M	fishhook, *sarefan*, *bubu*, harpoon, traditional fish	all	low tide	none
Hentuak	Ikan tanduk	2-3	3-4	5	1	3	M	*bubu*, net, harpoon, trident	Oct.-Dec.	low tide (n)	none
Hik-hik	Kulit pasir species	1-2	3-4	5	2	3	F, M	*sarefan*, traditional fish poison, fishhook	all	low tide	none
Huny	Kulit pasir species	1-2	3-4	5	1	3	F, M	fishhook, *sarefan*, *bubu*, harpoon, traditional fish	all	low tide	none
Kaywagir	?	1-2	3-4	5	3	3	M	harpoon	all	low tide	none
Nepaklakar	Kulit pasir species	1-2	3-4	?	1	2	M	traditional fish poison, harpoon, fishhook	Sept.-Nov.	low tide (d)	none
Pugun	?	1-2	3-4	5	1	3	F, M	*sarefan*, traditional fish poison, harpoon	all	low tide	none
Tabakfilfily	?	1-2	3-4	?	3	3	M	harpoon	all	low tide	none
Yettalyfalyfaly	?	1-2	3-4	5	3	3	F, M	trident, harpoon	all	low tide	none
Hopuk	Saku	1-2	3-4-2	?	1	2	M	*sawat*[5], net	all	low tide (n)	none
Mapnipis	?	1-2	3-4-2	?	2	3	M	harpoon, net	Apr.-Sept.	low tide (n)	none
Paut	?	1-2	3-4-2	5	1	3	F, M	*sarefan*, harpoon, fishhook, net	all	low tide	none
Sabak	Anjang	1-2	3-4-2	5	1	4	F, M	*sarefan*, traditional fish poison, net, fishhook, *bubu*, harpoon	all	low tide (n)	none
Kaparun	Kulit pasir species	1-2	3-2-4	4	1	3	M	harpoon	all	low tide (n)	none
Makaleo-kulkulit	Kulit pasir species	1-2	3-2	5	1	4	F, M	*sarefan*, harpoon, trident (n)	all	low tide (n)	none

Vernacular name	Indonesian or scientific name	Size	Habitat	Spawning ground	State of depletion		Gender specific activity	Fishing methods and tools	Main season of catch	Usual time of day of the catch	External users
					Form.	Pres.					
Mainly habitat 2											
Kabtukun-matuny	Kakatua	2-3	2-4-3	5	1	3	M	trident, *bubu*	all	low tide (n)	none
Ub	*Cypsilurus* sp.	2	2-4-3-1	1	1	2	M	*sawat*, net	Apr.-Sept.	low tide (n)	yes
Batakutmamin	?	2-3	2-3-4	?	3	3	M	harpoon, fishhook, *bubu*	all	low tide	none
Duranbelbela	Balobo	2	2-3-4	?	2	3	M	net, *sawat*, fishhook, *toba*[6]	all	low tide	none
Hulir	Lalosi	2	2-3-4	?	1	2	M	net, *bubu*	all	low tide	**yes**
Hulymar	*Rastrelliger* sp.	2	2-3-4	?	1	3	M	net	all	low tide (d)	**yes**
Laguran-manokfuliny	*Caranx* sp.	2-3	2-3-4	?	1	3	M	fishhook, harpoon, net	all	low tide	none
Laimarmarak	Sakuda species	2	2-3-4	?	1	3	M	harpoon, *bubu*, fishhook	all	low tide (n)	none
Tararoi	?	1-2	2-3-4	5	2	3	F, M	*sarefan*, traditional fish poison, net	all	low tide	none
Besok-besok	Balobo	1	2-3-4-1	1?	1	3	M	*sawat*, net, *toba*	Apr.-Sept.	low tide (n)	none
Laguran	*Caranx* sp.	2-3	2-3-4-1	?	1	3	M	harpoon, net, fishhook	all	all	**yes**
Nebur	*Hemirhamphus* sp.	1	2-3-4-1	4-5	1	3	M	net, *sawak* (n), *sobalnebur*[7] (n, formerly)	Aug.-Dec.	all	**yes**
Ampeckon	?	2-3	2-3	?	2	3	M	fishhook	all	all	none
Barubarunkok	Kulit pasir species	2	2-3	2	2	3	M	fishhook	all	all	none
Cagalar	?	2-3	2-3	?	2	3	M	fishhook	all	all	none
Hogarkenyas	Garopa species	2-3	2-3	?	2	4	M	fishhook, harpoon, *bubu*	all	low tide	**yes**
Huarmalos	Sakuda	2-3	2-3	?	2	3	M	fishhook, harpoon, *bubu*	all	all	none
Hulirkyekyeka	?	2-3	2-3	3	2	3	M	harpoon, *bubu*	all	all	none
Itar	Gutama besar	2-3	2-3	?	1	3	M	*bubu*, harpoon, net	all	low tide	none
Kampec	*Caranx* sp.	1-2	2-3	?	1	3	M	harpoon, net, fishhook	all	all	**yes**
Kurkurun	Ikan hias species	1-2	2-3	3	3	3	M	harpoon	all	all	none
Kuty	?	2-3	2-3	?	2	3	M	harpoon, fishhook	all	all	none
Lai	Lasi	2-3	2-3	?	2	3	M	net, trident	all	all	**yes**
Nabakok	Kulit pasir species	2-3	2-3	?	1	2	M	trident (n), net	Sept.-Nov.	all (mainly n)	none
Paknik	Kulit pasir species	2-3	2-3	?	1	2	M	harpoon, *bubu*	all	low tide	none
Tayas	Garopa merah	2-3	2-3	3?	2	4	M	fishhook, *bubu*, harpoon	all	low tide	**yes**
Toi	Garopa merah	2-3	2-3	3?	2	4	M	fishhook, *bubu*, harpoon	all	low tide	**yes**
Vacarap	Kulit pasir species	2-3	2-3	?	1	2	M	harpoon, net, trident (n)	Sept.-Nov.	all (mainly n)	none

Vernacular name	Indonesian or scientific name	Size	Habitat	Spawn-ing ground	State of depletion		Gender specific activity	Fishing methods and tools	Main season of catch	Usual time of day of the catch	External users
					Form.	Pres.					
Wosa	Weleng	2-3	2-3	?	1	3	M	fishhook	all	all	none
Dom	*Katsuwonus pelanus*	2-3	2-3-1	1	1	3	M	fishhook	all	all	**yes**
Dombib	*Auxis* sp.	2-3	2-3-1	?	1	3	M	fishhook, net	all	all	**yes**
Gaturanic	Mamin species	2-3	2-3-1	?	1	4	M	fishhook, *bubu*, harpoon	all	all	**yes**
Kabtukun	Kakatua besar	2-3	2-3-1	?	1	4	M	trident (n), *bubu*	Sept.-Nov.	all (mainly n)	**yes**
Kilpaut	*Caranx* sp.	2-3	2-3-1	?	1	3	M	fishhook, net	all	all	**yes**
Sek	?	2-3	2-3-1	?	2	3	M	fishhook	all	all	**yes**
Taktukily	?	2	2-3-1	?	2	3	M	fishhook, trident (n)	Apr.-Sept.	all	none
Tali-tali	*Decapterus sp.*	1-2	2-3-1	?	1	3	M	net, fishhook, *talikor*[8]	all	all	**yes**
Tegir	*Scomberomerus guttatus*	3	2-3-1	?	2	3	M	fishhook	all	all	**yes**
Wemurwac	?	2-3	2-3-1	?	2	3	M	net	all	all	none
Highighok	Kulit pasir species	1-2	2	2	2	3	M	fishhook	all	all	none
Kotan	Garopa besar sekali	3	2	2	1	4	M	fishhook	all	d	**yes**
Kwerakapuny	?	2-3	2	2	2	3	M	harpoon	all	all	none
Kua	Murea	2-3	2	?	2	3	M	harpoon	all	d	none
Domdomis	*Thunnus* sp.	3	2-1-3	?	2	3	M	fishhook	all	all	**yes**
Per	?	2-3	2-1-3	?	2	3	M	fishhook	all	all	none
Mamin	*Cheilinus undulatus*	2-3	2-1	2	1	4	M	fishhook, harpoon	all	all	**yes**
Mainly habitat 1											
Dor	Tuing-tuing	1	1-2-3-4	1	1	2	M	net, *sawat*	Apr.-Sept.	low tide (n)	none
Dukun	*Caranx* sp.	3	1-2-3	?	1	3	M	fishhook	all	all	**yes**
Derdif	*Thunnus albacores*	3	1-2	?	1	4	M	fishhook	all	d	**yes**
Torak	*Auxis* sp.	2-3	1-2	?	1	3	M	fishhook, net	all	d	**yes**
Balykidir	?	2	1	1	1	4	M	fishhook	all	d	**yes**
Findulis	?	3	1	?	2	4	M	fishhook	May-Sept.	d	**yes**
Hopuklayaran	*Xiphias gladiuus*	3	1	?	2	4	M	fishhook	May-Sept.	d	**yes**
Mora	?	2-3	1	?	1	4	M	fishhook	all	d	**yes**
Salaba	?	2-3	1	?	1	4	M	fishhook	all	all	**yes**
Vaftasik	?	3	1	1	3	4	M	fishhook	all	n	none
Venlakar	Lamadan	2-3	1	?	2	3	M	fishhook	all	d	**yes**
Yeo	Ikan hiu (8 shark species)	3	1-2	?	1	4	M	fishhook, net	all	d	**yes**

Vernacular name	English, Indonesian or scientific name	Habitat	State of depletion		Gender specific activity	External users
			Formerly	Present		
NON-FISH species						
Genuc	Jamur laut (polyp)	2-3-4	1	3	F	none
Gir	*Trochus niloticus*	2-3-4	1	4	F, M	**yes**
Gurita	Octopus	2-3-4-5	1	2	F, M	none
Hararaigoran	Jamur laut besar (polyp)	2-3-4	1	3	F	none
Harwak	Sea urchin species	3-4	1	3	F	none
Keb	Bêche-de-mer (5 species)	2-3-4	1	3	F, M	**yes**
Keran	*Eretmochelys imbricata*	1- (2-3-4-5-6)	1	3	M	**yes**
Kifar	*Turbo marmoratus*	2	1	4	F, M	**yes**
Moru	Crab species	?	?	?	F, M	?
Runy	*Dugong dugon*	1-5	3	4	M	**yes**
Sikajan	Squid species	1	1	2	M	none
Talalia	Crab species	?	?	?	F, M	?
Tarfur	*Triton tritonis*	2-3-4	1	3	F, M	?
Tataruga	*Chelonia mydas*	1- (2-3-4-5-6)	1	2	M	**yes**
Vafkany	Black coral	2	3	4	M	**yes**
Varun	Lobster	2-3	1	3	F, M	**yes**
Wany-wany (laur)	*Polychaete* worms (*Eunicidae*)	1-2-3-4-5	1 (only in April)[9]		F, M	none

Footnotes

1 madrai are several species of very small fish (length about 5 cm), although fry of certain bigger fish are falling into this category as well

2 traditional fish poison: e.g., pounded roots of *Derris elliptica*

3 sarefan: kind of basketry, with which fish are scooped from shallow water

4 bubu: fish trap, made from bamboo

5 sawat: kind of trident, made from *Areca catechu* trunks

6 toba: fishing method for certain fish species: a small kite keeps a float and the "fishhook" (in this case: a cobweb rolled up to a small lump, which the fish cannot swallow) at the surface of the s sea

7 sobalnebur or "api dalam sampan", literally meaning "fire in the canoe": a light in a canoe should attract fish jumping into the canoe; traditional method of fishing during the night, practised until fishing nets have been introduced

8 talikor: a fishing technique: the drive of fish shoals by a fishermen group

9 Laur: Laur worms are harvested only in the beginning of April when these organisms have mass reproduction. The short dry period in April is accordingly called 'musim laur' (literally meaning: laur season)

Notes: **Additionally, thirteen unidentified mollusc species are collected (bold: commercialised species)**:
Barasa, Galifas, Hi, Karmaraut, **Japing-japing**, Madoik, Ngaring (Mata tujuh), Ragaraga (Bia jari-jari), **Sekedaf**, Singapau, Vatfunik, Veda, Vuly

Abbreviations: M: male activity; **F:** female activity; **n:** night; **d:** day; **Form.:** formerly; **Pres.:** at present (1997); **hab.:** habitat

Columns: **Size**: **0** very small; **1** small; **2** medium; **3** big (according to autochthonous classification);
Habitat and spawning ground: see Fig. 5.7; sequence of habitats of fish species is given according to frequency;
State of depletion: **1** very frequent; **2** frequent; **3** seldom; **4** very seldom

Sources: PRA, interviews, and workshop sessions (Stubenvoll 1997).

Appendix 2.1: Results of soil analysis

No.	Texture										pH 1:25	Organic C	Total N	Available P (Bray)	Total K	Ca	Mg	Na	K	CEC	Total Base	Base saturation	Soil type
	Sand						Silt			Clay													
10^{-3} mm	2000 -1000	1000 -500	500 -250	250 -500	100 -50	**Total (%)**	50-20	20-2	**Total (%)**	**Total (< 2;**	H_2O	(%)	(%)	(ppm)	mg/kg	me/100 g						(%)	
I	1.2	11.0	8.1	7.3	13.2	**40.8**	19.9	22.5	**42.4**	**16.8**	5.26	2.18	0.20	1.75	n.a.	3.65	2.10	0.13	0.10	9.25	5.98	64.64	Eutric Fluvisol
II.1	0.8	3.8	13.2	19.3	10.6	**47.7**	6.1	26.7	**32.8**	**19.5**	4.67	1.79	0.13	0.88	n.a.	2.85	1.00	0.15	0.13	9.62	4.13	42.93	Dystric Cambisol
II.2	0.4	2.0	8.5	11.4	6.1	**28.4**	1.1	22.4	**23.5**	**48.1**	4.06	0.35	0.04	1.53	n.a.	2.00	1.50	0.16	0.11	9.70	3.77	38.85	Dystric Cambisol
III.1	7.0	5.8	5.3	9.1	12.9	**40.1**	10.0	22.7	**32.7**	**27.2**	4.11	1.44	0.07	1.97	n.a.	2.00	1.10	0.14	0.10	10.10	3.34	33.06	Lithosol
III.2	6.2	7.1	6.4	8.9	7.8	**36.4**	0.8	26.1	**26.9**	**36.7**	4.18	0.23	0.04	1.75	n.a.	1.75	1.10	0.12	0.10	9.13	3.07	33.62	Lithosol
IV	3.9	5.7	4.9	10.5	18.5	**43.5**	17.9	19.7	**37.6**	**18.9**	5.20	1.21	0.10	1.31	n.a.	3.45	2.10	0.20	0.14	9.15	5.89	64.37	Dystric Fluvisol
V.1	1.5	2.4	2.5	4.5	3.4	**14.3**	4.8	51.0	**55.8**	**29.9**	5.36	1.87	0.18	0.88	n.a.	3.30	2.00	0.17	0.12	9.20	5.69	61.84	Eutric Cambisol
V.1	1.4	1.6	1.5	2.5	2.2	**9.2**	9.1	13.6	**22.7**	**68.1**	5.23	0.78	0.08	1.31	n.a.	3.45	2.15	0.18	0.14	9.12	5.92	64.91	Eutric Cambisol
VI	n.a.	n.a.	n.a.	n.a.	n.a.	**n.a.**	n.a.	n.a.	**n.a**	**n.a.**	5.07	3.20	0.11	2.19	11.18	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Dystric Fluvisol
General, broad rating of values (from Landon 1991) (interpretation of plant nutrients is difficult in some cases [*], as it depends on a number of factors, such as pH, CEC, ratio of cations, soil texture, and different nutrient requirements)										very low		**<2**	**<0.1**							<5			
										low	**<5.5**	**2 - 4**	**0.1 - 0.2**			**<4**	<0.5			**5 - 15**		<20	
										medium	5.5 - 7	4 - 10	0.2 - 0.5	*	*	4 - 10	**0.5 - 4**	*	*	15 - 25	*	**20 - 60**	
										high	7 - 8.5	10 - 20	0.5 – 1.0			>10	>4			25 - 40		**>60**	
										very high	>8.5	>20	>1.0							>40			

Sources: Soil sampling by Roberth Liang 1997; Analysis by Soil and Plant Laboratory, University of Pattimura, Ambon 1997.

Appendix 2.2: Results of preliminary soil analysis during field survey

No.	Depth [cm]	Effective depth [cm]	Horizon	Drainage	pH (litmus paper)	Structure	Location	Geological formation	Topography[1]	Slope gradient	Altitude	Vegetation, land-use	Local name of soil type
I	2-13	40	A	very rapid	7	crumb	Nama[2]	RBN	coastal plain	3%	10 m	coconut tree garden	tentena vulfuly
II.1	5 – 24	115	A	very rapid	7	angular blocky	Baru	BMI	sloping upland	3%	105 m	coconut-clove tree garden	tentena vulfuly
II.2	43 – 80	115	B_1	rapid	6	angular blocky	Baru	BMI	sloping upland	3%	105 m	coconut-clove tree garden	tentena vulfuly
III.	4 – 24	50	A	very rapid	7	angular blocky	Kar	WSH	sloping upland	45%	180 m	coconut-clove-nutmeg tree garden	tentena vulfuly
III.	24 – 50	50	C	rapid	7	angular blocky	Kar	WSH	sloping upland	45%	180 m	coconut-clove-nutmeg tree garden	tentena vulfuly
IV	4 – 17	56	A	very rapid	6	angular blocky	Lok	WSH	coastal plain	3%	10 m	coconut-nutmeg-sago tree garden	?
V.1	5 – 25	124	A	rapid	7	spherical blocky	Kelvow	SWH	upland terrace	6%	40 m	coconut tree garden	tentena farfarus
V.1	25 – 60	124	B_1	moderate	6	spherical blocky	Kelvow	SWH	upland terrace	6%	40 m	coconut tree garden	tentena farfarus
VI	?	?	A	rapid	6	angular blocky	Rumoi	WSH	coastal plain	3%	10 m	coconut tree garden, without burning	tentena farfarus

Sources: Soil sampling and analysis by Roberth Liang 1997.

Appendix 2.3: Results of qualtitative soil analysis during field survey

Location	Community	pH (litmus paper)	Effective depth [cm]	Depth of A_1 horizon (humus) [cm]	Soil moisture in horizon ...		Texture	Slope gradient	Altitude	Vegetation, land use	Remarks
					A	B					
Bukiar	Kelvow	6.5	40	3	dry	moist	?	29%	260 m	nutmeg-coffee tree garden	first clearing in 1980s, no protection trees
Bukiar	Kelvow	5.5	more than 40	2	dry	moist	?	58%	245 m	dry field without burning; some remant forest trees	first clearing 1992 and cultivation of taro, now third crop: taro
Bukiar	Kelvow	6	40	5	dry	moist	loamy	58%	250 m	dry field without burning; no forest	first clearing in 1997; now first crop: taro
Urit Aliminy	Kerkar	6	33	4	moist	moist	clayey loam	27%	300 m	mixed garden (nutmeg, coffee, taro,	first clearing in 1980s (see Map 5.1.1)
Urit Aliminy	Kerkar	7	more than 40	7	moist	moist	clayey loam	29%	310 m	primary forest	(see Map 5.1.1)
Uritapollo	Kerkar	6	more than 40	3	dry	moist	clayey loam	30%	185 m	clove tree garden	no protection trees
Werkar	Kerkar	6	?	?	moist	moist	loamy	29%	70 m	nutmeg tree garden	protection trees (e.g., *Canarium indicum*)

Sources: Roberth Liang and Stefan Stubenvoll 1997.[3]

Notes for App. 2.1, App. 2.2, and App. 2.3:

1: Topography at site selected for soil sampling; **2:** Rumalusi community (north coast of Tioor); **3:** carried out in November 1997; total amount of rainfall from July till November: see App. 2.4.

Appendix 2.4: Precipitation during field survey

Month/1996	Rhun[1]	Max. in 24 hours[2]	Month/1997	Rhun[1]	Tioor[1]	Max. in 24 hours[2]	Mean (Banda Neira)[3]	Mean (Tual)[3]
Jan.	n. m.	n. m.	**Jan.**	302 mm (8)	n.m.	200 mm (23rd)	249 mm	295 mm
Feb.	n. m.	n. m.	**Feb.**	339 mm (12)	n.m.	54 mm (6th)	201 mm	280 mm
Mar.	n. m.	n. m.	**Mar.**	85 mm (8)	n.m.	15 mm (30th)	227 mm	320 mm
Apr.	n. m.	n. m.	**Apr.**	**i. m.**	**i.m.**	**i.m.**	328 mm	275 mm
May	**i. m.**	**i. m.**	**May**	**i. m.**	**i.m.**	**i.m.**	404 mm	248 mm
Jun.	**i. m.**	**i. m.**	**Jun.**	**i. m.**	**i.m.**	**i.m.**	349 mm	190 mm
Jul.	14 mm (5)	3 mm (19th)	**Jul.**	n. m.	76 mm (19)	29 mm (8th)	209 mm	100 mm
Aug.	189 mm (18)	111 mm (7th)	**Aug.**	n. m.	0 mm	---	104 mm	85 mm
Sep.	29 mm (4)	22 mm (13th)	**Sep.**	n. m.	4 mm (1)	4 mm (30th)	104 mm	100 mm
Oct.	354 mm (15)	66 mm (22nd)	**Oct.**	n. m.	0 mm	---	115 mm	125 mm
Nov.	14 mm (4)	8 mm (22nd)	**Nov.**	n. m.	16 mm (5)	6 mm (27th)	128 mm	165 mm
Dec.	**i.m.**	**i.m.**	**Dec.**	**i. m.**	**i.m.**	**i.m.**	238 mm	280 mm

Notes: **1** precipitation in mm (number of days with precipitation); **2** precipitation in mm (date of maximum); **3** mean monthly precipitation in mm (see Fig. 4.5).
n.m.: no measurements; **i.m.:** incomplete measurements, as field survey was interrupted for stays in Ambon.

Sources: Precipitation measurements (Stubenvoll 1996 and 1997).

Appendix 3.1: The farming system of 22 interviewed households

Household (Rhun)[4]	Dry fields (*kebun*)		Secondary vegetation (fallow)[1]		Clove tree gardens[2]		Other tree gardens[2]		Mixed gardens[3]		Primary forest		Sum
	hectare	**%**	**hectare**	**%**	**hectare**	**%**	**hectare**	**%**	**hectare**	**%**	**hectare**	**%**	**hectare**
1	0.41	24%	0.40	23%	0	0%	0	0%	0.92	53%	0	0%	1.73
2	0.38	21%	0.65	36%	0	0%	0	0%	0.78	43%	0	0%	1.81
3	0.44	37%	0	0%	0	0%	0	0%	0.66	55%	0.10	8%	1.20
4	0.13	62%	0	0%	0.08	38%	0	0%	0	0%	0	0%	0.21
5	0.40	42%	0.24	25%	0	0%	0	0%	0.31	33%	0	0%	0.95
6	0.18	18%	0.10	10%	0.07	7%	0.55	55%	0.10	10%	0	0%	1.00
7	0.50	67%	0.12	16%	0	0%	0.13	17%	0	0%	0	0%	0.75
8	0.60	30%	0.20	10%	0.50	25%	0	0%	0.70	35%	0	0%	2.00
9	0.10	6%	0.95	62%	0.10	6%	0	0%	0.40	26%	0	0%	1.55
10	0.48	30%	0.15	9%	0.08	5%	0.12	7%	0.78	49%	0	0%	1.61
Average	**0.36**	**28%**	**0.28**	**22%**	**0.08**	**6%**	**0.08**	**6%**	**0.47**	**37%**	**0.01**	**1%**	**1.28**

Household (Tioor)[4]	Dry fields incl. tumpangsari		Secondary vegetation (fallow)		Coconut tree gardens		Other tree gardens		Mixed gardens		Primary forest		Sum
	hectare	**%**	**hectare**	**%**	**hectare**	**%**	**hectare**	**%**	**hectare**	**%**	**hectare**	**%**	**hectare**
26	2.52	18%	7.74	55%	3.05	22%	0.69	5%	0	0%	0	0%	14.00
27	3.24	21%	1.07	7%	0.60	4%	2.29	15%	2.30	15%	5.81	38%	15.31
28	1.75	6%	9.80	32%	5.30	18%	3.20	11%	2.25	8%	7.70	25%	30.00
29	0.40	5%	3.10	36%	1.40	16%	1.60	19%	1.50	18%	0.50	6%	8.50
30	0.80	43%	0	0%	0.50	27%	0.25	14%	0.30	16%	0	0%	1.85
31	1.50	14%	3.25	31%	1.50	14%	1.25	12%	0	0%	3.00	29%	10.50
32	1.25	12%	4.80	46%	0	0%	1.75	17%	1.90	18%	0.80	7%	10.50
33	1.10	10%	3.40	31%	2.65	24%	2.85	26%	0.80	7%	0.20	2%	11.00
34	0.75	10%	2.50	32%	0	0%	0.25	3%	2.75	36%	1.50	19%	7.75
35	0.75	9%	2.75	33%	4.75	58%	0	0%	0	0%	0	0%	8.25
36	0.30	9%	1.65	47%	0.75	21%	0.30	9%	0	0%	0.50	14%	3.50
37	0.50	20%	0.70	28%	1.00	40%	0.30	12%	0	0%	0	0%	2.50
Average	**1.24**	**12%**	**3.40**	**33%**	**1.79**	**17%**	**1.23**	**12%**	**0.98**	**10%**	**1.67**	**16%**	**10.31**

Notes: **1** including short fallow in permanent dry field; **2** pure tree gardens without production of annuals; **3** including small tree gardens integrated into mixed gardens
4 including family's and clan's land.
Rounded fractions.
For a description of mapping activities see Ch. 3.1.2.

Sources: Household interviews, mapping and observation (Stubenvoll 1996 and 1997).

Appendix 3.2: Land-use types and areas in Tioor (evaluation of Map 3)

All areas in hectare	TIOOR ISLAND	Communities				
		Rumoi	Rumalusi	Wermaf	Kerkar	Kelvow
POPULATION (1997)	**1584**	**272**	**105**	**388**	**343**	**476**
No. of households (1997)	361	64	26	109	69	93
AREA	**2393.70**	**405.99**	**325.83**	**419.11**	**588.54**	**654.23**
% of island area	100%	16.96%	13.61%	17.51%	24.59%	27.33%
INHABITANTS per km²	**66**	**67**	**32**	**93**	**58**	**73**
Unmapped area	192.08	11.17	30.11	0	21.25	129.55
% of island/community area	8.02%	2.75%	9.24%	0%	3.61%	19.80%
MAPPED AREA	**2201.62**	394.82	295.72	419.11	567.29	524.68
All subsequently shown areas & percentages refer to **mapped** area						
TOTAL FOREST AREA	**1269.81**	**259.94**	**202.63**	**191.65**	**314.48**	**301.11**
% of island/community area	57.68%	65.84	68.52	45.73	55.44	57.39
Primary forest area	355.91	93.34	99.31	28.95	101.31	33.00
% of island/community area	16.17%	23.64%	33.58%	6.91%	17.86%	6.29%
Old secondary forest area	598.94	126.45	69.80	74.90	128.35	199.44
% of island/community area	27.20%	32.03%	23.60%	17.87%	22.63%	38.01%
Young sec. forest area	264.85	35.11	33.52	87.80	75.68	32.74
% of island/community area	12.03%	8.89%	11.34%	20.95%	13.34%	6.24%
Degr. land w. sec. forest	50.11	5.04	0	0	9.14	35.93
% of island/community area	2.28%	1.28%	0%	0%	1.61%	6.85%
Imperata land area	**33.97**	**4.31**	**0.17**	**0**	**23.09**	**6.40**
% of island/community area	1.54%	1.09%	0.06%	0%	4.07%	1.22%
DEGR. AREA (Lithosols)	**0.86**	**0**	**0**	**0**	**0.86**	**0**
% of island/community area	0.04%	0%	0%	0%	0.04%	0%

All subsequently shown areas & percentages refer to **mapped** area	TIOOR ISLAND	Communities				
		Rumoi	Rumalusi	Wermaf	Kerkar	Kelvow
TOTAL DUSUN AREA	**650.38**	**96.14**	**71.33**	**195.79**	**146.51**	**140.61**
% of island/community area	29.54%	24.35%	24.12%	46.72%	25.83%	26.80%
Coconut palm *dusun* area	361.53	72.29	56.43	75.20	100.11	57.50
% of island/community area	16.42%	18.31%	19.08%	17.94%	17.65%	10.96%
Sago palm *dusun* area	81.43	5.69	8.24	43.73	14.80	8.97
% of island/community area	3.70%	1.44%	2.79%	10.43%	2.61%	1.71%
Nutmeg *dusun* area	60.58	11.73	1.22	12.91	19.93	14.79
% of island/community area	2.75%	2.97%	0.41%	3.08%	3.51%	2.82%
Clove *dusun* area	57.91	1.3	2.8	27.84	3.15	22.82
% of island/community area	2.63%	0.33%	0.95%	6.64%	0.56%	4.35%
Coffee *dusun* area	16.47	0	0	4.43	0.8	11.24
% of island/community area	0.75%	0%	0%	1.06%	0.14%	2.14%
Mixed *dusun* area	72.46	5.13	2.64	31.68	7.72	25.29
% of island/community area	3.29%	1.30%	0.89%	7.56%	1.36%	4.82%
MIXED GARDEN AREA	**70.29**	**8.41**	**4.49**	**6.99**	**25.52**	**24.88**
% of island/community area	3.19%	2.13%	1.52%	1.67%	4.50%	4.74%
TOTAL DRY FIELD AREA	**163.42**	**23.27**	**14.37**	**22.79**	**55.08**	**47.91**
% of island/community area	7.42%	5.89%	4.86%	5.44%	9.71%	9.13%
Dry field area (*ladang*)	149.23	21.91	13.37	22.36	52.85	38.74
% of island/community area	6.78%	5.55%	4.52%	5.34%	9.32%	7.38%
***Tumpangsari* dry field area**	14.19	1.36	1.00	0.43	2.23	9.17
% of island/community area	0.64%	0.34%	0.34%	0.10%	0.39%	1.75%
SETTLEMENT AREA	**12.89**	**2.75**	**2.73**	**1.89**	**1.75**	**3.77**
% of island/community area	0.59%	0.70%	0.92%	0.45%	0.31%	0.72%

Notes: **dusun:** tree garden
tumpangsari: integration of perennials into dry fields (see Ch. 6.3.3)
sec.: secondary
degr. land w.: degraded land with ...
For more information on data collection see App. 5.3.

Sources: Participatory and transect mapping with villagers (Stubenvoll 1998).

Appendix 4.1: Community-based resource management plan of Rhun Island (TGDK Pulau Rhun)

(translated from: Masyarakat Pulau Rhun 1996, 11-22; The following chapters are not translated or shown here: introduction, principles, evaluation, recommendation, maps, and appendices. Principles are provided in Ch. 8.2.1. Maps were redrawn from the original document and are provided in Maps 7.2)

1. ORGANISATIONS

1.1 Community Organisation (LM)

Regulation R 1 (Characteristics of the LM)

R 1.1 The LM consists of three groups:
- Religious leaders (a Protestant and an Islamic leader);
- Community leaders (a man and a woman of every farmer group; see R 5);
- Village administration (village head secretary, chairwoman and her deputy of PKK, members of LKMD and LMD).

R 1.2 All regulations are constructed, evaluated, monitored and judged by the LM with the principle of discussion (*musyawarah*) to reach an agreement (*mufakat*) among LM's groups. Without co-operation of LM's, the community-based resource management plan will no longer be in effect.

R 1.3 The LM must restrict oneself to activities concerning the community-based resource management plan.

R 1.4 Members of the LM can step down or be replaced by another person by *musyawarah* and *mufakat*.

Regulation R 2 (Activities and responsibilities of the LM)

R 2.1 All regulations are made public by the LM. Thereafter, the regulations are put into effect.

R 2.2 The LM will regulate more details of the community-based development plan at a later stage, such as sanctions, fines, fees of utilisation rights concerning timber from community protection forest, and expense allowances for LM members by *musyawarah* and *mufakat*.

R 2.3 The LM has to meet half-yearly, and has to submit an annual report to the Government at regency level.

Regulation R 3 (Rights of the LM)

R 3.1 The LM has the right to collect taxes from the community, which are paid to the Government at regency level. A small part of these taxes, fees for utilisation rights for timber from community protection forests, and fines, are used for LM's funding.

R 3.2 LM funding regulations are constructed and made public at a later stage.

R 3.3 The LM has the right to deny (withdraw) land tenure rights of a family, who do not want to acknowledge (repeatedly violating) the regulations of the community-based development plan.

1.2 Farmer groups and other organisations

Regulation R 4 (Farmer groups and families)

R 4.1 All families farming in one of the ten sub-units of Rhun Island, each comprised of several traditionally named location units, form a farmer group. For a specification see the appendices.[1] Additionally, a youth group is formed.

R 4.2 Each farmer group elects two chairmen, i.e. one chairman, and one chairwoman. Farmer group No. 1 with some 70 households elects three chairmen/-women. All chairpersons are members of the LM.

R 4.3 All violations concerning the community-based resource management plan must be reported to one of the two chairmen/-women.

R 4.4 A farmer group meets quarterly for discussion about problems and activities in the fields. This is also for strengthening local capacity to successfully implement the community-based resource management plan.

R 4.5 Should a chairman/-woman step down, he/she has to be replaced by *musyawarah* and *mufakat* of the farmer group.

R 4.6 The chairmen/-women report to the LM before its half-yearly meetings.

[1] See Map 7.2.1.

R 4.7 Chairmen/-women have the right and responsibility to settle disputes about field matters among two parties. Such disputes have to be reported to the LM.

R 4.8 Each family is obliged to acknowledge the CRMP. This includes: to convince and to remind other members of the family about the CRMP.

R 4.9 Less serious problems and disputes may be settled by two parties themselves. It is sufficient to report those disputes to the chairman/-woman. It is not necessary to report them to the LM.

2. RIGHTS, RESPONSIBILITIES, SANCTIONS

Rights, responsibilities and sanctions are valid for all families.

Regulation R 5 (Rights)

R 5.1 Each family has the right to farm exclusively on their field holdings as long as the CRMP is in effect.

R 5.2 Each family has the right to farm their fields in accordance with the regulations of the CRMP.

R 5.3 Each family has the right to collect NTPs (latex, edible fruits and seeds) and to utilise fallen timber trees in the community protection forest. Fallen timber trees have to be reported first to the LM, their utilisation is subject to a fee (see R 19.4).

R 5.4 Each farming family has the right to get assistance from the agricultural service, such as seedlings and advisory service.

R 5.5 Each farming family has the right to use IDT funds for investments in the agricultural sector.

Regulation R 6 (Responsibilities)

All farming families have the responsibility:

R 6.1 ... to plant nutmeg trees, other trees yielding cash crops, and protection trees.

R 6.2 ... to protect, to preserve, and to maintain plantings, as well as fields and forests.

R 6.3 ... to protect the environment (forests, trees, soil) in their fields and surrounding areas.

R 6.4 ... to report all violations, which could limit development opportunities, to the chairman/-woman.

R 6.5 ... to report all violations, which could disturb the environment, to the LM.

R 6.6 ... to meet quarterly for discussions within their respective farmer group**.**

R 6.7 ... use their fields in accordance with the regulations of the CRMP.

R 6.8 ... to pay annually taxes via the LM to the Government at regency level.

R 6.9 Land tenure rights cannot be sold to other farmers. Land tenure rights can be leased to another farmer, if the latter acknowledges the regulations of the CRMP.

R 6.10 The Government at regency level will have the responsibility to renew the stewardship contract with the community for another term of 40 years, should the CRMP have proved its success.

R 6.11 The Government at regency level, especially the agricultural service, has the responsibility to assist the community.

Regulation R 7 (Sanctions)

R 7.1 Violations are recorded by the chairmen/-women and the LM.

R 7.2 Offenders are subject to a fine or another sanction, which is laid down and announced by the LM.

R 7.3 Repeated violations are faced with the withdrawal of land tenure rights of offending parties.

R 7.4 Repeated violations of a majority of the community are faced with the withdrawal of the stewardship contract by the Government at regency level.

R 7.5 Less serious violations are regulated by the families themselves, or among families or within the farmer group, so that the chairmen/-women and the LM are relieved of their duties.

3. AGRICULTURE AND FORESTRY

Staple food-crop production is as important as afforestation for the community. Afforestation will be most commonly carried out in areas that are presently devoted to permanent dry field agriculture, above all cassava. To counterbalance the area for afforestation and staple food-crop (*palawija*) production, the community can grow *palawija* in a limited way only. Limits of field area proportions for *palawija* production and afforestation differ in respective traditionally named location units (see maps and appendices).[2] Obviously it is difficult to exactly meet these area proportions, but each farmer should be able to achieve it in an approximate way.

Regulation R 8 (Agroforestry systems)

R 8.0 The CRMP is necessary as the community wants to shift from dry field agriculture to agroforestry.

Regulation R 9 (Plant species)

R 9.1 The CRMP regulates the production of plant species for each location unit, which is shown in the appendices.

[2] See Map 7.2.1, and Map 7.2.6 to Map 7.2.8.

R 9.2 Every farmer can individually choose the cultivated plant species, provided he/she meets the regulations of the CRMP and the field area proportion.

R 9.3 Plant species, which are not specified for production in a certain location unit, may also be grown (although this would not be wise). In rare cases, however, there are plant species which may not be cultivated in a certain location unit.

Regulation R 10 (Field area proportions)

R 10.1 The CRMP regulates the field area proportion for horticulture (production of *palawija*), perennial cash crops, and perennials for protection purposes in each location unit.

R 10.2 Each farmer is obliged to approximately meet the area proportion in his/her fields, in accordance to R 10.1.

3.1 Horticulture (Production of *palawija*)

Regulation R 11 (*Palawija* species)

R 11.0 The following *palawija* species can be distinguished: Plants yielding non-seed carbohydrates and vegetables. Additionally, grasses (cover crops and forages) are subsumed in this category. These *palawija* species are shown and evaluated in the appendices.

Regulation R 12 (Field area proportions for the production of *palawija*)

R 12.1 The field area proportions for the production of *palawija* depends on the location unit, in which the farmer's field is located, as well as on the size of a farmer's field. This field area proportion is defined as that part of the field where trees do not compete with annuals.

R 12.2 Every farmer is obliged not to extend the production of *palawija* to more than the allowed maximal field area proportion in the respective location unit (see appendices).[3]

R 12.3 Every farmer may decrease the field area proportion for the production of *palawija*, and instead equally extend the area for the production of perennial cash crops.

R 12.4 If a farming household faces difficulties in securing self-sufficiency by the limited field area proportion (due to a small field area, or due to a great number of individuals living in the household), and this household wants to extend the production of palawija to more than the allowed maximal field area proportion, permission from the LM will be necessary. The maximum of this kind of extension amounts to an additional 10%. This kind of extension would not be permitted, if a farming household produced *palawija* for marketing purposes or for relatives outside of Rhun Island on any of the household's fields.

Regulation R 13 (Production techniques)

R 13.1 Shifting cultivation (*berkebun huma*) may no longer be performed. Instead, perennials must be integrated in these locations.

R 13.2 Burning of fields has to be performed in a controlled manner. Before leaving the site, a fire has to be extinguished by the farmer.

R 13.3 The community will try to use the mukibat technique (grafting of cassava with the Ceara-rubber tree) for increasing yields of cassava. Once field experiments have proven to be successful, the mukibat technique will be ready for wider use. With this technique, field areas may be successively reduced, while keeping yields relatively constant.

R 13.4 In sloping land, farmers should plant palawija along contours in combination with hedgerows, consisting of trees and shrubs, such as lamtoro (Leucaena leucocephala) and turi (Sesbania grandiflora).

3.2 Agroforestry – cultivation of perennial cash crops

Regulation R 14 (Perennial cash crop species)

R 14.0 Perennial cash crop species are shown and evaluated in the appendices. In the upcoming regulations nutmeg will be distinguished from all other perennial cash crop species.

Regulation R 15 (Nutmeg cultivation)

R 15.1 Each farming family is obliged to cultivate nutmeg trees, because this tree is ecologically adapted to the Banda Islands.

R 15.2 Nutmeg cultivation is performed with the simultaneous planting of protection trees, such as kenari (Canarium vulgare) or kasturi (Toona ciliata) in accordance with the combined field area of household's fields suitable for nutmeg cultivation. The proportion of field area and number of cultivated nutmeg and protection trees is shown in the appendices. The maximum number amounts to 40 nutmeg trees and 6 protection trees (for households holding fields of a combined area of more than 1 hectare suitable for nutmeg cultivation).

R 15.3 Map 4.2[4] and the appendices specify those location units which are highly suitable, moderately suitable and marginally suitable for nutmeg cultivation

[3] See Map 7.2.6.

[4] See Map 7.2.9.

R 15.4 Should several households commonly hold fields, the combined field area is divided by the number of households for a determination of the number of cultivated nutmeg and protection trees.

R 15.5 In location units moderately and marginally suitable for nutmeg cultivation, the respective households must first plant protection trees. Some years later, when sufficient shade is available, nutmeg trees can be integrated.

R 15.6 **State-owned nutmeg trees** which are still productive are not included in the number of cultivated nutmeg trees (R 15.2), because these trees are ageing. Each farming household with the right to manage ten state-owned trees, has to rejuvenate them in accordance with the Government's regulation of 1987. Rejuvenated trees are state property.

Rejuvenation of ten state-owned nutmeg is carried out within a household's fields, even if the ageing trees are situated in fields of other farmers. In this rare case, the former household will be compensated by the latter. The LM will later decide the exact arrangement of compensations. The present arrangement of plots of state-owned nutmeg trees is no longer in effect, because these plots are too small. It would also be too confusing for the community-based resource management plan.

If a farmer had not received management rights of ten state-owned nutmeg trees in 1987, he is obliged to cultivate there ten trees in addition to the number of trees specified in R 15.2.

R 15.7 **Taxes** are paid to the Government at regency level. Taxes depend on the nutmeg harvest. Still productive, state-owned nutmeg trees are subject to the present tax regulations of the Government. Rejuvenated nutmeg trees – both state-owned and farmer-owned – are subject to tax payments with the age of 12 years. The tax per year and productive nutmeg tree amounts to the price equivalent of 0.5 kg of nutmeg, and 0.1 kg of mace. Average annual yield is some 2.5 kg of nutmeg and 0.5 kg of mace. Taxes are paid after the big harvest in August/September to the LM. The LM is obliged to send the paid taxes minus transaction and administration costs to the Government at regency level.

R 15.8 Registration of state-owned and farmer-owned nutmeg trees is carried out by the LM as soon as the trees have been rejuvenated/propagated.

R 15.9 Should a farmer cultivate nutmeg trees in addition to the number of trees specified in R 15.2, then these trees are free of tax payments, even if nutmeg trees subject to tax payments are to die. Of course, in such cases a farmer will have to rejuvenate the latter. Nutmeg trees which are free of tax payments will be registered by the LM as soon as these have been propagated.

R 15.10 Cultivation of nutmeg trees is carried out in location units highly suitable for nutmeg trees. If his field area is not sufficient, a farmer will have to cultivate nutmeg tree in location units moderately or marginally suitable for nutmeg trees (see R 15.5).

Regulation R 16 (Other perennial cash crop species)

R 16.1 Field area proportions for the production of perennial cash crops (including nutmeg trees) are shown in the appendices.[5] Every farmer is obliged not to extend the production of perennial cash crops to more than the allowed maximal field area proportion in the respective location unit.

R 16.2 Each farmer chooses the tree species and the plot of its propagation on his own, but in accordance with the field area proportion for the respective location unit.

R 16.3 Distance between productive perennial cash crops have to be arranged optimally. Overcrowded spacing is not allowed. If trees are planted at wider distances than the optimal figure, remaining space in between may be inter-cropped (for instance cocoa in between coconut groves). Examples of optimal distances are: Nutmeg 7 to 8 m; Clove: 7 to 8 m; Coconut: 8 to 9 m; Coffee: 3 to 4 m; Cocoa: 3 to 4 m. "Hexagonal planting" will result in more trees per area than "square planting" (for an explanation see appendices).

R 16.4 Perennial cash crops may be cultivated in mixed tree gardens or mixed gardens. Optimal distances have to be adapted accordingly.

R 16.5 All perennial cash crops, except state-owned nutmeg trees, are the property of farmers.

3.3 Agroforestry – cultivation of perennials for protection purposes

Regulation 17 (Perennial species for protection purposes)

R 17.1 Perennial species for protection purposes (or protection trees) can be distinguished between trees yielding edible fruits and other non-timber products, and timber trees. All these species serve above all protection purposes. Other functions are lesser, although important, too. Tree species for protection species are shown and evaluated in the appendices.

R 17.2 Perennials for protection purposes protect perennial cash crops, *palawija*, and soil from strong wind, overheated insolation, heavy rainfall, erosion, degradation, etc. Thus, these trees are important for the community and have to be integrated into the agricultural landscape by every farmer.

R 17.3 Suitability of perennials for protection purposes depends on the location unit. Suitability classes are shown in the appendices.

[5] See Map 7.2.7.

Regulation 18 (Field area proportions for the cultivation of protection trees)

R 18.1 Field area proportions for the cultivation of perennials for protection purposes are shown in the appendices and in Map 4.4.[6]

R 18.2 Each farmer chooses the tree species and the plot of its propagation on his own, but in accordance with the field area proportion for the respective location unit.

Regulation 19 (Community protection forest)

R 19.1 Community protection forest is situated in Kota Laki-Laki, Kota Perempuan, in other keramat areas, in Naelaka Island, and on slopes steeply dissected and mountainous without tenure of any farmer.

R 19.2 Protection trees in community protection forest and existing protection trees on fields may not be cut down.

R 19.3 Non-timber products (NTPs), such as edible fruits and seeds, latex, resins, etc., from community protection forest may be harvested by the community free of charge.

R 19.4 Fallen timber trees may be used by that person who reports that tree to the LM. He is responsible to rejuvenate that tree with two seedlings in the respective plot, and to pay a fee for the exploitation right to the LM. The fee depends on the tree species and its size, and will be later fixed by the LM. If several persons want to exploit timber of a fallen tree, exploitation rights will be auctioned.

Regulation 20 (Management procedures concerning protection trees)

R 20.1 Each family is obliged to plant protection trees in the fields and jointly in the community protection forest.

R 20.2 A variety of protection trees should be planted in fields, such as trees yielding edible fruits and timber, and trees growing to different heights. Protection trees in fields are peasant property.

R 20.3 By cultivating protection trees, each family should carefully consider their needs of various kinds of wood: fuelwood, timber for house and ship construction, etc. (for uses of timber of respective tree species see the appendices.)

R 20.4 Cultivated and naturally established protection tree seedlings must be protected. The owner reports the planting of the tree to the LM, which is then registered.

R 20.5 Along the coast, farmers must plant protection trees which protect the island and crops from strong wind and salt spray.

R 20.6 If a farmer wants to cut down one of his owned protection trees, he will need permission from the LM. This permission will only be given, if the farmer has already rejuvenated the tree in question.

R 20.7 Permission for cutting trees yielding timber for construction purposes below a size of 30 cm DBH will be rejected.

R 20.8 Selected cutting of branches from trees for fuelwood collection is possible without permission.

R 20.9 Each family should plant protection trees for soil improvement, such as certain Leguminosae (Leucaena, Sesbania, Acacia) and Casuarina equisetifolia.

3.4 Goat husbandry

Regulations on goat husbandry are necessary, because many problems arise from present goat husbandry management systems, such as browsing of tree seedlings and cassava of other farmers.

Regulation R 21 (Goat husbandry)

R 21.1 Each goat breeder must take care of his goats, so that they do not destroy tree seedlings and crops.

R 21.2 All goats have to be kept in stables. The breeder has to collect fodder (cut-and-carry system). Stables are constructed in the breeder's fields. Possible is also a stable constructed by several breeders.

R 21.3 Alternatively to R 21.2, a breeder may plant living fences along the boundaries of his field. Additionally he has to tether his goats to trees in his field and to protect his tree seedlings by fences.

R 21.4 Each breeder has to mark his goats with a collar.

R 21.5 A breeder can take forages only from his fields. He may collect forages in other fields, if he has got the permission of the respective farmer. Similarly, his goats may browse in fields of other farmers, if living fences enclose the plot.

R 21.6 In community protection forest goats must not be kept. Only grasses from these forests may be collected. Goats may browse on grass on the soccer field.

Regulation R 22 (Number of goats)

R 22.1 The number of goats is limited in accordance with the area and the productivity of a breeder's fields. Should the number of goats exceed this limit, goats have to be sold or slaughtered.

R 22.2 The exact limit of goats per hectare is regulated later by the LM. Until the regulation is passed, the number of goats per 0.25 hectare may not exceed 3 grown-up animals.

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[6] See Map 7.2.8.

Regulation R 23 (Freely browsing goats)

R 23.1 Freely browsing goats without a collar are the property of the LM, and are not the property of the breeder.

R 23.2 Goats tethered to trees on a field without a living fence are also the property of the LM. A newly established living fence is regarded sufficient in accordance to R 14.3.

R 23.3 Goats which have become property of the LM may be returned to the breeder after the latter has paid a fine. The amount of fines will be later regulated by the LM.

R 23.4 If a breeder can prove that the collar of a goat was removed by a third party, he does not have to pay a fine.

R 23.5 If a breeder can prove that his goat was removed and set free for browsing in another location by a third party, he does not have to pay a fine, too. Instead, a sanction will be imposed on the offending third party. The kind of sanction will be later regulated by the LM.

4. FIELD AND VILLAGE BOUNDARIES

Regulation R 24 (Field boundaries)

R 24.1 Present field boundaries are valid for the purpose of this community-based resource management plan.

R 24.2 Field boundaries are registered by the LM after a report (including the names of field neighbours) by the farmer. The LM has the right to settle disputes between two parties about unclear field boundaries.

R 24.3 Field boundaries may be changed in arrangement with the field neighbour, in order to straighten the boundary.

Regulation R 25 (Perennials planted along field boundaries)

R 25.1 Along field boundaries both parties have to plant trees, which mark the boundary and belong to both parties.

R 25.2 Only certain tree species may be planted along field boundaries, such as kelor (*Moringa oleifera*), singkong karet (*Manihot glaziovii*), kalamandingan (*Leucaena leucocephala*), pandan (*Pandanus* spp.), and the like (see the appendices).

R 25.3 Tree species yielding cash crops or which grow too tall, such as pala (*Myristica fragrans*), kelapa (*Cocos nucifera*), kasturi (*Toona ciliata*), may not be planted closer than 3 m to a field boundary (see the appendices).

Regulation R 26 (Field exchange)

R 26.1 Two parties can agree on exchange of (some of) their fields, should they both prefer to have one large field, rather than several small fields.

R 26.2 Exchange of fields is registered by the LM.

Regulation R 27 (Village boundary)

R 27.0 Permanent houses can only be constructed within the village boundary after permission from the LM is granted. The LM will regulate and mark the exact village boundary at a later time.

5. OTHER REGULATIONS

R 28.0 Some ten families presently do not hold any fields. They may lease fields from other farmers, if they also acknowledge the regulations of the CRMP.

R 29.0 Should a family emigrate from Rhun, their land tenure rights would be lost. However, the family could submit their tenure rights to another family, which would be registered by the LM.

R 30.0 Parents are responsible for violations of their children.

R 31.0 The community wants to construct a similar CRMP concerning the management of marine resources, should the land-use plan prove its effectiveness.

R 32.0 All regulations are put into effect on the 9th of October 1996. If the CRMP is not approved by the Government at regency level in Masohi until the 8th of October 1997, the CRMP will be withdrawn by the community.

Appendix 4.2: Community-based resource management plan of Tioor Island (TGDLK Pulau Tioor)

(translated from: Masyarakat Pulau Tioor, 1-9. Maps were redrawn from the original document and are provided in Maps 7.1)

I The Community Organisation (LM)

1. **The LM consists of four groups with a total of 37 members, as follows:**
   - Adat leaders (2 members);
   - Religious leaders (7 members; Catholic, Protestant, and Islamic leaders);
   - Community leaders (10 members; one man and one woman of every community);
   - Village administration (village head, community heads, secretary, chairwoman and her deputy of PKK, members of LKMD and LMD, and both one *Hansip* [civil defence person] and one *Kamra* [civil security person] not being member of the LKMD and LMD; thus, all together 18 members).
2. **The members of the community leaders** are elected by each community itself. Election takes place every three years immediately after closing sasi (*tutup sasi*) again. The candidates are proposed, and the members (one man and one woman) are elected with 50 percent of the votes plus 1 vote in each community. The community is responsible for organising an orderly and fair election.
3. **The LM** will be able to hold a meeting if more than 75 percent of its members are present (28 members or more). A LM's decision/regulation will be in effect, if at least 75 percent of its members present at the meeting agree to it (21 members or more, depending on the number of members joining the meeting).
4. **The LM has the right** (eventually in accordance to paragraph I.3)
   - to receive a budget from opening/closing sasi (buka/tutup sasi), from taxes of products leaving the island, and from fines;
   - to look for assistance from the regency Government, as soon as TGDLK will be approved by the regency Government;
   - to manage the use of the budget;
   - to receive compensation for expenses, which depend on the LM's budget (and which are fixed at a maximum of 40 percent of the total budget; this is a preliminary determination, as it is not clear yet, how much the potential budget will be);
   - to form the position of an overseer of the sea ('mandor laut');
   - to open and to close sasi;
   - to modify regulations already being in effect;
   - to put into effect new regulations.
5. **The LM has the right and the responsibility** to enforce the regulations of the TGDLK, via the LM's court, which consists of six members of the LM: One member of the Adat leaders, one member of the Religious leaders, two members of the Community leaders (from that community in which the case has to be settled), the village head and another member of the village administration. Any final ruling of the LM's court needs 100 percent of the votes (six votes).
   Following kind of sanctions may be principally passed by the LM's court: fine, public work, or public humiliation (i.e. the public, oral announcement of the violation by the violator, who must simultaneously carry a humiliation symbol and who is accompanied by a member of the LM, in the community concerned). Tools deployed for the violation may be confiscated or destroyed. In case of less serious violations, just one kind of sanction must be passed.
6. **The LM and all members of the LM have the responsibility:**
   - to implement and to police TGDLK;
   - to form the positions of: a chairman, a deputy chairman, a secretary, a treasurer, and a deputy treasurer;
   - to meet at least once per year;
   - to report to the community, via the community heads, about: outcomes of LM's meetings, new or modified regulations; opening and closing of sasi; LM's budget (state, cash flows);
   - to guard during open sasi;
   - to announce the opening of sasi and the date of closing sasi again, one day before sasi is due to be opened;
   - to control violations, such as looking for proofs and witnesses, and going to the location where the violation was carried out;
   - to work honestly;
   - to restrict oneself to activities concerning TGDLK;
   - to co-operate with all other groups of LM;
   - to apply innovations of development within the community;
   - to pay attention to TGDLK, because the regulations apply for members of LM, too;
   - to co-operate with, and to report LM's activities to, via the chairman, the regency Government, as soon as TGDLK is approved by the regency Government
7. **A member of the LM** is sanctioned in accordance to the sanctions of TGDLK, and his/her membership of LM must be revoked, should he/she violate TGDLK**.**
8. **A membership of LM** may be revoked should a member of the LM repeatedly fail to perform his/her duties**.**
9. **The community** has the right to propose new regulations, or the modification of existing regulations, to the LM, who is responsible for discussion these proposals at the next meeting.

10. **The community** must support all activities and decisions of the LM which are in accordance to TGDLK *and* which will not harm the community. The members of the LM must be honest.

II. Agreement reached on the community land-use plan (TGDK)

1. PRIMARY FOREST

1.1 Definition of primary forest zoning:[7]
In the upper watershed, primary forest must be protected (in the lower watershed primary forest is almost entirely cut down). The upper watershed is defined as that area where the stream has smaller tributaries. The upper watershed of a stream without any tributary is defined as the area around the upper half of the total length of the stream in question.
Zoning of the upper watershed is obtained by dividing the area into four zones (i.e., an equidistant division of the distance from the stream to the mountain ridge). **ZONE 1** is the area near the stream in question, **ZONE 4** is the area near the mountain ridge. **ZONE 2** is the area bordering to ZONE 1, whereas **ZONE 3** is the area bordering to ZONE 4.

1.2 Land management in primary forest is regulated as follows:
ZONE 1: *Protected forest*. It is only allowed to plant sago, bamboos, and rattans, which are property of the planter. Protected forest is common property.
ZONE 2: *Protected forest*. It is only allowed to plant sago, bamboos, rattans, and timber trees, which are property of the planter. Protected forest is common property.
ZONE 3 and 4: *Protected forest*. It is only allowed to plant sago, bamboos, rattans, timber trees, and fruit-producing trees which are property of the planter. Protected forest is common property.

1.3 Use of standing timber in primary forest is regulated as follows:
ZONE 1: A land user is not allowed to cut down or kill any forest tree.
ZONE 2 and 3: A land user may first kill a tree, and then cut it down, if:
a. he/she has planted twenty tree seedlings of the species in question, each of which has a height of 1m or more; and
b. he/she has a permission by the LM; and
c. the diameter at breast height of the tree in question is 60 cm or more; and
d. he/she pays a fee for the right to use the timber to the LM, which depends on species and size of the timber.
ZONE 4: A land user may first kill a tree, and then cut it down, if:
a. he/she has a permission by the LM; and
b. he/she pays a fee for the right to use the timber (for charcoal production, canoe hulls, and construction purposes) to the LM, which depends on species and size of the timber. Trees for fuelwood are free of a fee, but not free of permission.

1.4 Already collapsed timber in primary forest may be used. The land-holding party has the right of use and may leave it to another party in accordance with customary law. The intention to use the timber is reported to the LM. If a user plans to sell the cut timber to a trader, or if a trader wants to use the timber, the trader will have to pay a fee to the LM, which depends on the tree species.

1.5 It is not allowed to cut down any timber tree in primary forest for the purpose of collection of fruits nor for the purpose of cuscus hunting.

1.6 All other uses in primary forest are allowed, such as the use of rattans, bamboos, strings, and so on. The land-holding party has the right of use.

Sanctions

1.1 A tree species planted in a 'forbidden' zone may be removed by anyone. Repeated violation by the offender is additionally charged with a fine of Rp. 10,000.

1.2 An offender killing/cutting down a tree in ZONE 1, or killing/cutting down a tree in ZONE 2 or ZONE 3 without following the specified conditions, or cutting down a tree for the purpose of fruit collection or cuscus hunting, is charged with a fine of Rp. 500,000 or 100 days of public work, and public humiliation in all communities.

1.3 An offender killing/cutting down a tree in ZONE 4 without permission is charged with a fine of Rp. 250,000 or 50 days of public work, and public humiliation in all communities.

1.4 An offender not reporting the use of fallen timber in primary forest is charged with half of the fine which a trader would have to pay or with an equivalent of public work (one day is calculated as Rp. 5,000).

2. UNOCCUPIED LAND

2.1 To claim and clear unoccupied land requires a permission of the LM.

Sanction

2.1 Tenure of claimed or cleared unoccupied land without permission is not accepted. In case of damage to primary forest the sanctions II.1.2 or II.1.3 are deployed.

3. UPPER WATERSHED (WITHOUT PRIMARY FOREST)

3.1 In the upper watershed a land-holding party of secondary forest, dry fields, and tree gardens must create a mixed garden or a mixed tree garden. As a consequence, slash-and-burn will gradually disappear in the upper watersheds.

Sanction

3.1 After an admonition, an offender is charged with a fine of Rp. 50,000 or 10 days of public work. A second violation is charged twice as much. In case of repeated violation land tenure will be revoked.

[7] See Map 7.1.2.

4. Along streams (from the spring to the mouth/estuary)

4.1 In a strip of twenty meters along either bank of a stream it is not allowed to establish a dry field nor to kill/cut down any tree.

Sanction

4.1 An offender establishing a dry field along a stream faces a sanction as in sanction II.3.1. An offender killing/cutting down a tree along a stream is charged with a fine of Rp. 50,000 or 10 days of public work.

5. Field and tree garden boundaries

5.1 Each time a dry field is due to be established, the cultivating party must first report to the LM, to avoid disputes about field or tree garden boundaries.

5.2 On the field boundaries it is necessary to plant trees; trees should be relatively closely spaced. Trees on boundaries are planted by and belong to both parties sharing the field boundary. Tree species which can be planted are restricted to: cemara (*Casuarina equisetifolia*), kelor (*Moringa oleifera*), nangka (*Artocarpus heterophyllus*), kapok (*Ceiba pentandra*), kayu susu (*Alstonia scholaris*), kayu besi (*Intsia bijuga*), lenggua (*Pterocarpus indicus*), kenari (*Canarium indicum*), pinang (*Areca catechu*), gayam (*Inocarpus edulis*). Additionally, it is allowed to plant nenas (*Ananas comosus*), pandan (*Pandanus* spp.) or a living fence such as lamtoro (*Leucaena leucocephala*). Other species cannot be planted. Preferably, tree species are alternately planted.

Sanctions

5.1 If a dispute about a field boundary arises as a consequence of failure to report to the LM, the responsible party is charged with a fine of Rp. 10,000 or 2 days of public work. This fine does not include other costs such as compensations or fees for the *adat* hearing.

5.2 After an admonition each party sharing the field boundary is charged with a fine of Rp. 10.000 or 2 days of public work. A second violation is charged twice as much. Fines or public work will continue to be doubled, unless both parties do plant trees on the field boundary, or both parties want to forego their land tenure rights. Should a dispute arise concerning the tree species to be planted, each party sharing the field boundary is charged with a fine of Rp. 10.000 or 2 days of public work.

6. Registration of land

6.1 Every farmer must report his/her land and specify his/her field neighbours in the north, east, south and west of the fields to the LM. Moreover, trees planted at the field boundaries must be reported. The report will be registered, and is subject to an administration fee of Rp. 1,500.

6.2 The LM reports the registration of land to the village head for administration purposes.

Sanction

6.1 There is no sanction, because it is the sole risk of the farmer himself/herself, if there is no proof of his/her land and field boundaries.

7. Transaction of land

7.1 If land is submitted to another person, this will be regulated according to customary law (adat). However, it has to be reported to the LM by both parties, and is subject to an administration fee of Rp. 1,500.

7.2 If land is sold/bought, this must be also reported to the LM by both parties, and is subject to an administration fee of Rp. 1,500.

7.3 The LM reports the transaction of land to the village head for the village administration

Sanction

7.1 Should a transaction of land – both submitting and selling/buying – not be reported, each party is charged with a fine of Rp. 10,000 or 2 days of public work.

8. Fire

8.1 Burning of fields or charcoal production must be carried out with care, such as the deployment of group labour (*kerja masohi*).

8.2 The LM prohibits the burning of fields during the dry season (August until November or December). Charcoal production during the dry season must be carried out with even greater care, such as the use of water around the scene of the smouldering fire.

Sanction

8.1 Spread of fire to the fields, tree gardens, and forests of another party is regulated according to customary law (*adat*). If primary forest (owned by the cultivator himself, or by another party, or by the community) is damaged by fire, sanctions II.1.2 or II.1.3 are deployed.

9. Use of timber in secondary forest, fields and tree gardens

9.1 The people of Tioor are free to use timber in their individual locations, except in primary forest and along streams (see II.1 and II.4). Relatives from other islands must pay a small fee to the LM, should they want to export timber to their village. The owner of the timber must report on his/her relatives' plan. Timber which stays in Tioor is free of charge for relatives from other islands.

9.2 If a standing tree or its timber is due to be sold to a trader, the owner must report this to the LM. The trader pays a fee to the LM, besides the price of the timber for the owner of the tree. The fee depends on the size of the tree and is fixed by the LM.

Sanctions

9.1 If the owner of a tree does not report the export of timber by a relative, he/she is charged a fine as high as the fee for the relative.

9.2 If the owner of a tree does not report the selling of its timber to a trader, he/she is charged a fine twice as high as the fee for the trader. If the trader settling in Tioor refuses to pay the fee, the timber is kept by the LM until the trader relents. He then pays the fee and additionally the costs of keeping the timber. If the trader is not settling in Tioor and refuses to pay the fee, the timber is confiscated and becomes property of the LM.

10. THEFT

10.1 The sanction for theft is already regulated by a decree of the LKMD/LMD – a fine of Rp. 50,000: Rp. 25,000 for the owner of the stolen goods, Rp. 25,000 for the village administration [not for the LM!].

11. SHORE AFFORESTATION

11.1 Each land-holder of a coastal garden must densely plant protection trees in a strip of 15 metres width along the shore. Species which may be chosen are among others: bintanggur (*Calophyllum inophyllum*), ketapang (*Terminalia catappa*), pandan (*Pandanus* spp.), cemara (*Casuarina equisetifolia*), wokat (*Avicennia* and *Sonneratia* spp.), mangga (*Mangifera* spp.), and gayam (*Inocarpus fagiferus*). The tree species should be chosen and planted in a mixture of small, medium-sized and tall species.

Sanction

11.1 After an admonition an offender is charged with a fine of Rp. 50,000 or 10 days of public work. A second violation is charged twice as much. In case of repeated violation land tenure will be revoked.

12. AREA OF TGDK

12.1 TGDK is put into effect in Tioor Island, Uran Island, and in the southern part of Baam Island (Baam kecil).

III. Agreement reached on the community sea-use plan (TGLK)

1. It is strictly prohibited to remove **LIVING CORALS** and dead coral rocks from the sea. Coral rocks on the land, and igneous rocks and pebbles in the sea may be freely removed. The people of Tioor have the right to get credits from the budget of the LM for the purchase of cement, which must be paid back in instalments.

Sanction

1. An offender removing coral rocks from the sea is charged with a fine of Rp. 500,000 or 100 days of public work, and public humiliation in all communities.

2. The following **NON-FISH SPECIES** are subject to **temporary communal sasi**:

a. Lola (*Trochus niloticus*);
b. Batu lagar (*Turbo marmoratus*);
c. Japing-japing;
d. Kasuari laut (black coral);
e. Teripang (bêche-de-mers);
f. Tarfur (*Triton tritonis*); and
g. Sekedaf (mata tujuh species)

The specified species must not to be collected for **a period of three years**. Sasi will be lifted for a period of three days after an announcement by the LM on the day prior to its lifting. As long as sasi is lifted the specified species are subject to a limitation concerning their **size (sasi ukuran)**: It is allowed to only collect specimens which are bigger than the following sizes:

a. Lola: a diameter of four fingers or eight centimetres at its bottom side;
b. Batu Lagar: a diameter of four fingers or eight centimetres of its hole;
c. Japing-japing: a diameter of four fingers or eight centimetres at its central part; and
d. Kasuari laut: a height of one metre.

The LM must arrange a profitable marketing of the collected specimens after temporary sasi has to be put into effect again. Should a child collect a specimen during temporary sasi, his/her parents can avoid the sanction: the specimen is returned to the sea (if still alive), or is given to the LM (if dead).

Sanction

2.1 A poacher of a prohibited specimen is charged with a fine of Rp. 50,000 or 10 days of public work or public humiliation in all communities.

2.2 A buyer of a poached specimen is charged with a fine of Rp. 100,000. Additionally, the specimen is confiscated by the LM.

3. It is strictly prohibited to wilfully collect the following **NON-FISH SPECIES:**

a. Duyung (Dugong dugon); and
b. Jamur laut (genuc; a polyp species)

Sanction

3. An offender wilfully collecting these species is charged with a fine of Rp. 500,000 or 100 days of public work.

4. The following **NON-FISH SPECIES** are subject to **sasi ukuran**, i.e. it is strictly prohibited to collect specimens smaller than the following sizes:

a. Tataruga (green turtle): a length of its body of 80 centimetres;
b. Keran (hawksbill turtle): a length of its body of 50 centimetres; and
c. Udang (lobster): a length of its body of 30 centimetres.

Specimen bigger than the defined size may be collected.

Sanction

4.1 An offender collecting a turtle smaller than its allowed size is charged with a fine of Rp. 30,000 or 6 days of public work.

4.2 An offender collecting a lobster smaller than its allowed size is charged with a fine of Rp. 10,000 or 2 days of public work.

5. The following **FISH SPECIES** are subject to **temporary communal sasi:**

a. Mamin (Napoleon wrasse);
b. Gaturanic (a wrasse species);
c. Kotan (a garopa species); and
d. Kabtukun (a big kakatua species).

These species are subject to sasi for a period of three years. Sasi will be lifted after an announcement by the LM on the day prior to its lifting. Sasi will be put into effect again if necessary.

Sanctions

5. As in sanctions III.2.

6. All other **FISH AND NON-FISH SPECIES** may be caught without limitations.

7. If a **FISH OR NON-FISH SPECIES**, which is subject to sasi regulations, is accidentally caught (e.g., with a fishing line or a net), it must be returned to the sea unless it is already dead or seriously injured.

Sanction

7. An offender is charged the sanction of the respective paragraph.

8. It is strictly forbidden to use the following **METHODS AND TOOLS** of fishing:

a. Bombs;
b. Commercial fish poison (such as cyanide);
c. Fine-meshed nets;
d. Dragnets;
e. Linggis [kind of crowbar] for the destruction of corals; and
f. Talikor[8]

Sanctions

8.1 Bomb: a fine of Rp. 1,000,000 or 200 days of public work;

8.2 Commercial fish poison: a fine of Rp. 60,000 or 12 days of public work or public humiliation of offender in his/her community;

8.3 Fine-meshed net: a fine of 750,000 or 150 days of public work;

8.4 Dragnet: a fine of Rp. 500,000 or 100 days of public work;

8.5 *Linggis* for the destruction of corals: as in sanction III.1; and

8.6 *Talikor*: a fine of Rp. 5,000 for every participant, and a fine of Rp. 25,000 for the group leader.

9. The use of **NETS** (except of fine-meshed and dragnets entirely prohibited as in paragraph III.8) is not allowed in the following areas (**sasi ruangan**) [cf. Map 7.1.3]:

a. from Tomtomut to Tanjung Gurmatiny (northwest and northeast coast); and
b. from Tanjung Nuamatiny to Tanjung Madaran (southwest coast)

Sanction

9. An offender deploying a net in these areas is charged with a fine of Rp. 250,000 of 50 days of public work

10. SEA TERRITORY OF TIOOR AND EXPLOITATION RIGHTS OF EXTERNAL USERS

10.1 The **sea territory of Tioor** is classified by three different territories:[9]

Boundaries of sea territory A (or total sea territory):

North: 1,500 m from the northern low tide edge of Baam Island;

East: An imaginary line running in southeastern direction from 1,500 m from the northeastern low tide edge of Baam Island to 1,500 m from the eastern low tide edge of Uran Island;

South: An imaginary line running in western direction from 1,500 m from the southern low tide edge of Uran Island to 1,500 m from the low tide edge of Tanjung Nuamatiny (southern tip of Tioor Island);

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[8] See App. 1.8, footnote 8.

[9] See Map 7.1.3.

West: An imaginary line running in northern direction from 1,500 m from the western low tide edge of Tioor Island to 1,500 m from the western low tide edge of Baam Island.

Boundaries of sea territory B:
1,500 m from the low tide edge around Baam Island

Boundaries of sea territory C:
Sea territory C is defined as sea territory A minus sea territory B.

10.2 For the **villagers of Tioor** the regulations of the TGLK is put into effect in sea-territory C.

10.3 In sea-territory B, the regulations of the TGLK will be put into effect for the **villagers of both Tioor and Tameer Warat on Kasiui Island**, if there is an agreement reached on this TGLK with the village of Tameer Warat. As long as an agreement with the village of Tameer Warat cannot be reached, the regulations of the TGLK are not effective in sea-territory B with the exception of paragraph III.10.4 and sanctions III.10.

10.4 **External users** are not allowed to collect any marine resources in sea territory A, regardless of the status of sasi (lifted or closed), except:

a. villagers of Tameer Warat, who can collect marine resources in sea territory B; and
b. villagers of villages in a pela relationship with Tioor[10] who can collect marine resources like villagers of Tioor on the first day of their arrival in Tioor, and after reporting to the LM.

Sanctions (for external users)

10. Offending external users face a sanction in form of a fine. As long as the fine is not paid their belongings are kept as a security. Fines are outlined in the following:

10.1 Bomb: Rp. 2,500,000; fish haul is seized; vessel is kept as a security;

10.2 Commercial fish poison: Rp. 600,000; fish haul is seized; vessel is kept as a security;

10.3 Usual fishing net: Rp. 500,000; net is kept as a security;

10.4 Fine-meshed net: Rp. 1,500,000; net is destroyed; vessel is kept as a security;

10.5 Dragnet: Rp. 1,000,000; net and vessel are kept as a security;

10.6 Usual fishing line: Rp. 50,000 for each day of fishing or fish haul is confiscated;

10.7 Fishing line with several hooks: Rp. 250,000 for each day of fishing; baitfish are confiscated; fishing line and vessel are kept as a security;

10.8 If a non-fish specimen regulated by sasi is poached:

a. If the offender does not know about the regulations of TGLK, the specimen must be returned to the sea (if alive) or is confiscated by the LM for its budget (if dead);
b. If the offender knows about the regulation of TGLK he is charged a fine twice as high as for villagers of Tioor.

10.9 If a fish specimen of paragraph III.5 is poached: Rp. 1,000,000 per specimen; fish haul is confiscated; vessel is kept as security.

11. The position of an overseer of the sea (mandor laut)

11.1 The position of a mandor laut will be created, if the budget of the LM can guarantee his/her repayment of services. At least one mandor laut for the village will be created by the village head, or a maximum of one mandor laut for each of the five communities will be created by the community heads. The creation of the position is publicly announced, but not the name of the mandor laut which is a secret. Only the village head or the community heads, respectively, know the name(s) of the mandor laut.

11.2 The mandor laut oversees the regulations of the TGLK and reports all violations to the village head (or the respective community head, if five mandor laut are created).

11.3 The mandor laut gets a repayment for his services taken from the LM's profits of opening sasi (buka sasi), and a monthly repayment. About the amount of repayment the LM has to decide as soon as the position of a mandor laut will be created.

[10] See Ch. 5.4.2.

12. If a villager observes another villager offending the regulations of the TGLK, he must report the offender to the LM. The **WITNESS** gets a premium of 10% of the charged fine, or 10% of the days of public work can be claimed by him. Should the witness not report to the LM, he/she is charged the same sanction as the offender.

13. **REPORTING WITNESSES AND SAFEGUARDS OF AN OFFENDING EXTERNAL USER** get a premium of 60% of the charged fine paid by the offender. They equally apportion the premium. The LM gets the other 40% for covering its expenses such as keeping belongings as a security, and holding an adat council hearing.

IV. Period of TGDLK's validity and budget of the LM

1. TGDLK is put into effect on the **23rd of December, 1997**.
2. The **budget** of the TGDLK's implementation is covered by profits from lifting and closing sasi, from products leaving the island, fines and other sources (like future projects of the LM). The budget is used for administration costs, meeting costs, repayments of services of LM's members and overseers, the purchase of walkie-talkies and vessels, and so on. The budget can also be used for other investments, such as churches, mosques, public toilets, small projects, and so on.
3. After TGDLK has been put into effect, the community head will arrange the **election of the community leaders** (*tokoh masyarakat*). The LM will first meet after the next Ramadhan, i.e. in February 1998.
   Nonetheless, implementation and supervision will start on the 23rd of December, 1997. The chairman of the LM must report the validity of TGDLK to the Government at regency level in Masohi.

Appendix 5.1: Concepts of questionnaires

I. Interview With Household Head of First Selection Step (Manual)

Instruments: Tape-recorder, tapes, batteries, recording book, pens.

Preconditions:
- Basic information of all households is provided by key informants;
- Interviewees are selected;
- Interviewee accepts the interview;
- Interviewee accepts recording of the interview;

Otherwise: Information is noted during interview.

Time budget:
- Dependent on the interviewee, at least one hour for the interview;
- Notes on observations immediately after the interview (30 minutes);
- Transcription of recorded interview (at least four hours).

Manual

A. Introduction

Family structure: E.g., number of children (living in household, living elsewhere, temporarily absent for school etc., married, not married);
Relatives co-operating in agriculture, agroforestry and forestry.

B. Farming and land use

Places of fields (show a prepared sketched map; autochthonous name of location).

Estimated field area

Quality of soils and inclination

Annual plant species presently cultivated (each field separately)

Tree species and number of fruiting/not yet fruiting tree (each field separately)

Minor plant species (make eventually input like “vegetables”, “medicinal plants”)

Plant species formerly cultivated (especially annuals; each field separately)

Historical land use (first clearing activities, utilisation, introduction of trees; eventually: used already by parents)

Input of capital and technology (e.g., fertiliser, pesticides, tools)

Input of labour (paid labour, reciprocal help, etc.)

Animal husbandry

Hunting and use of forest products (timber, non-timber products)

Land tenure arrangements (exclusive, or inclusive with other family/clan members)

Marketing of agricultural products (place, producer prices, yield per period, fluctuations of price and yields)

Problems related to agriculture and peasant strategies

C. Off-farm economic activities

Types of off-farm economic activities, including household members

Importance in relation to agriculture

Type-specific questions concerning off-farm activities, e.g. fishing:

- subsistence/market orientation
- caught and collected species
- state of depletion
- marketing
- problems and strategies

D. Other socio-economic data

Kind of energy used by household (for cooking, illumination)

Estimated annual income, including household members

Cash requirements for certain items

Main staple food for household

(Observation: Building material, condition of house, inventory)

E. Final questions

General situation (development, comparison to former livelihood)

Most serious problems and constraints

Objectives, aspirations, hopes and fears

Comparison of livelihood formerly/presently (formerly: at least 10 years ago, depends on the age of the household head)

Agriculture (plans for the future, especially concerning extension of tree cultivation)

F. Description of management of one important crop/tree species
(out of taro, cassava, yam, sweet potato, rice, millet, maize, coconut, sago, nutmeg, coffee, clove, etc.)

Field preparation and propagation/planting

Seedlings

Husbandry

Harvest and yields

Yield trends

Post-harvest activities

Labour input and time calendar of agricultural events

G. Opportunity for the farmer to raise issues and questions

H. Informal talk (ask the farmer if he/she is interested in participatory field excursion and further questionnaires on a later day; thank the farmer for the interview)

II. INTERVIEW WITH HOUSEHOLD HEAD OF SECOND SELECTION STEP (SEMI-STRUCTURED INTERVIEW)

Instruments: Tape-recorder, tapes, batteries, recording book, paper, pens.

Preconditions:
- All interviews with household heads of first selection step are carried out;
- Interviewee agrees on participatory field excursion and further questionnaires;
- Interviewee accepts recording of the interview;

Otherwise: Information is noted during interview.

Time budget: One day for field excursion and interview.

SEMI-STRUCTURED INTERVIEW

In the respective field: open questions in a general way to stimulate discussion, accompanied by observation (this includes the purpose of cross-checking of information provided by the interviewee during interview with manual, cf I.).

1. I would like to know more about the history of land use in this field. When did you start cropping here? How and when did you enlarge this field?
2. How do you assess soil fertility in your field? How was it formerly? Are there any problems and how do you handle them?
3. How do you assess the importance of this field? Why?
4. How do you cultivate your field?
5. Why do (don't) you propagate tree species in your field? And why do you choose these species?
6. Which plans do you have regarding the cultivation of this field?
7. Can you clear new fields, or is this no longer possible?

Additionally questions about:

- age of propagated trees and origin of seedlings;
- seasonal calendar of agricultural events;
- gender-specific activities in fields.

At the end of the day: questions on socio-economic and cultural issues, such as yields, yield trends, prices, price fluctuations, agricultural inputs, farm income, agricultural organisations (e.g., labour), credits, indigenous knowledge (e.g., traditional medicines), and:

8. Which factors are most relevant for your agricultural activities?
9. Why has the socio-economic situation of the village so rapidly changed?

III. INTERVIEWS WITH HOUSEHOLD HEADS OF THE THIRD SELECTION STEP

(NARRATIVE INTERVIEWS with stimulating inputs, and an open discussion)

IV. MANUALS AND NARRATIVE INTERVIEWS WITH EXPERTS, OPINION LEADERS, AND KEY INFORMANTS

(concept depends on the interviewee and is worked out before the interview).

For all interviews: Information provided by previous interviews, observation and mapping was used for the concept of every interview. Thus, main discussion topics varied from one interview to another.

Appendix 5.2: Evaluation and interpretation of data

I. Data of interviews with a manual (Households HH 1 to HH 65) was evaluated and interpreted both quantitatively-statistically (Steps 1, 2 & 5) as well as inter-pretatively-reductively (Steps 1, 3, 4 & 5). In general, a similar approach to Lamnek (1989, 104-120) was followed:

Step 1 Transcription of recorded interviews
The recorded interviews were transcribed in Bahasa Indonesia as exactly as possible, and later typewritten with a computer. Comments on the interview situation were included, e.g. shorter and longer reflections, breaks, laughing, input and comments of other persons. Then the transcript and the recorded interview were compared to eliminate mistakes and misunderstandings.
The procedure for interviews which were not recorded started directly with Step 2.

Step 2 Separated analysis of each interview – quantitative-statistical step
Quantitative data provided by the interviewee (e.g., number of fields, field area, yields, income) was noted on a separate paper, and copied out into a matrix of all households.

Step 3 Separated analysis of each interview – interpretative-reductive step
Qualitative information was marked in the transcribed text, commented and copied out (in translated form) into notebook. Then, the reduced interview was commented and assessed. Most important statements were written additionally on index cards to which a headword and the page of the transcribed interview were added (for instance: headword "coconut garden - problems" for the statement "Yield has declined due to pest attack *Sexava*"). The headwords were arranged to groups of headwords. Statements relating to groups of headwords (of all household interviews) could then be compared more systematically in Step 4.

Step 4 Generalised analysis of all interviews
Variations and common features of the interviewed household were analysed and interpreted.

Step 5 Control phase
During the writing of the thesis, the respective part of the transcribed (or even the recorded) interview was consulted again to control doubtful or significant statements.

II. Data of semi-structured and narrative interviews was evaluated and interpreted similarly as in I. Step 2 was omitted, with the exception of household interviews of the second and third selection step. In this case quantitative data was compared with that provided in the first respective household interview.

Appendix 5.3: Remarks on data collection relating to Map 3

As discussed in Ch. 3.2 and Ch. 8.2.2, data collection relating to Map 3 (Land use and forest cover on Tioor Island, 1998) was performed by transect measurements and the measurement of the course of major streams and ridges. In the absence of aerial photographs and topographic maps of reasonable scale (e.g., 1 : 50.000 or larger), a base map of Tioor Island was obtained by enlarging the most recent, and accurate map available – RePPProt Map No. 2811 (1988), scale 1 : 250,000 – to a scale of 1 : 12,500.

In a first step, excursions on the island should make it easier to estimate the necessary amount of labour and time, as well as to choose the appropriate approach to carry out measurements.

In a second step, a sketched map of Tioor Island was drawn during several informal meetings with villagers using PRA methods. This resulted in a map showing most significant features of the island, such as location of settlements, permanent and non-permanent streams, approximate locations of specific land uses, changes of Tioor's coastline due to coastal abrasion, qualitative inclinations (5 categories from "flat" to "very steep"), sacred groves, and major paths. With this information, which was again checked by several field excursions, the participatory approach for data collection was developed.

For this, the handling of instruments as well as simple standard surveying methods – compass, clinometer, tape measure, triangulation, height and transect measurements – were introduced to interested villagers, and trained in several sessions. Then, two teams à three persons measured the course of major streams and rigdes (Werlarat, Werkar, Werkivkiv, Werlok, Werkilwer, Wergus, Wersody, Wervurun; Central ridge, Gunung Tar ridge, Northern Central ridge, Tomtomut ridge, Teraginy ridge, Wersody - Wermamur ridge) with tape measure and compass. Height differences between source and mouth of streams were trigonometrically adjusted. Only the measurements of Werlok and Werkilwer posed some difficulties due to existing waterfalls. There, the horizontal distance of the waterfall was estimated, and measurements were continued in the upper watershed above the waterfall.

Transect measurements at distances of 150 m to 200 m were then performed with clinometer, tape measure, altimeter and compass in east - west direction, and for practicable reasons in some cases (e.g., in the southern parts of the southern plateau) in north - south direction. Again, steep faces and very steep terrain were not measured. Height differences were trigonometrically adjusted. Additionally, triangular and height measurements supplemented data collection in open terrain. Data on terrain, vegetation, land use, streams, ridges and land-use problems (e.g., landslides) was recorded along the transect and its neighbourhood in intervals of 50 m.

Subsequently, the data collected was analysed and drawn into the map (scale 1 : 12,500). In the east of Tioor, near Wergus location, a considerable variation between collected transect data and the base map with regard to the extent of the coastal plain became manifest. This provides a hint on one particular interpretation problem of satellite images of small tropical islands: Images taken during the low-tide shows most of the eulittoral above the sea surface, so that the eulittoral may be wrongly interpreted as land. In the case of Wergus location, the broad fringing reef led to an error of the base map of approximately 100 m to maximally 200 m. Interestingly, in other parts of the east coast, the base map and collected data did not show any significant variations.

With regard to the accuracy of the land-use map, the following restrictions apply:

1. About 8% of the island could not be mapped, as collected data was insufficient or completely lacking. This was most commonly caused by heavy rainfall, so that transect measurements could not be completed. In other cases, steep terrain hindered data collection. It was therefore decided to provide qualitative information on primary and secondary land uses/forest cover, rather than to draw interpretation of insufficient data into the map.
2. Height measurements with the altimeter are not precise and were carried out irregularly. Therefore topographic data, especially contour lines, were not included in this *thematic* map.
3. Although the neighbourhood of the transect was recorded, the chosen equidistance of transects could be in some cases too wide for identifying small plots of different land use in between two transects. It is likely that a part of the field huts were also missed with this method, so that it was decided to omit them from the map.
4. Most streams are non-permanent. Only Werlarat, parts of Wergus and Wervurun are permanent. During the long drought of 1997, other major streams, such as Wersody, Werkilwer, Werkar and Werkivkiv had dried up. For simplicity's sake, this differentiation was not included in the map.
5. Paths were omitted from the map. In general, the most commonly used paths follow the coastline, and the course of streams and ridges. For instance, communication between east and west coast usually takes place along one of three paths (from north to south): (a) Laganymatiny – Keramat Kaibaruk – Werlarat – Rumoi; (b) Mamur – Ridge between Wersody and Wermamur – Keramat Gunung Ra – Werkar Ridge – Werkar – Kar; (c) Tanjung Vatmelir – Southern Plateau – Soccer field in south of Wertac.
6. The distinction between "old secondary forest" and "young secondary forest" was subjectively made by each team. In general, it was attempted to take the height of secondary forest trees as a primary indicator (approximate height of less than 5 to 6 m for "young secondary forest"). Occasionally, local knowledge of team members was decisive (beginning of fallow stage in 1992 or later for "young secondary forest").

Appendix 6: Glossary

adat	Customary law
atap	Thatch made from sago palm leaves
aung	Secondary forest
babinsa	Military person, usually a sergeant, who supervises and controls the village head
bakau	Mangroves
bengkawan	Sago palm leaves folded over a bamboo lath
bupati	Government officer in charge of a regency
camat	Government officer in charge of a district
dikasih cuma-cuma	To get something free of charge; used for agricultural goods
dinas	Government service
dodol	A kind of toffee made of palm sugar, coconut milk, durian flesh and sticky rice.
dusun	Tree garden; or community (part of a village)
dusun induk	Prime community
ewang	Primary forest
gaba-gaba	Midrib (rachis) of a sago palm leaf
gai-gai	Long pole of bamboo at which a sharpened piece of iron or a hook is attached on its end; for the harvest of nutmegs. In Banda Besar, the *gai-gai* is additionally equipped with a small basket around its end, so that harvested fruits are prevented from falling down (cf. Warburg 1897, 437)
ganti ongkos meja	The loosing party in an *adat* council hearing has to compensate the winning party's costs of *persiapan meja*
ganti rugi	Compensation; e.g. if trees and crops were destroyed by fire
gepe	Rhun: Cake-like form of about 12 kg of wet cassava starch, which is produced by peeling, rasping and squeezing cassava storage roots
gereja	Church
gotong royong	Mutual co-operation of villagers, community self-help
gudang makan	Granary
hak pakai	Usufruct right
hongi	Expeditions carried out by the VOC for the destruction of spice-yielding trees in areas outside of VOC's production monopoly plantations; and for the acquisition of slaves.
ikan asin	Salted and dried fish
imam	Islamic priest, communal prayer

kabupaten	Regency
kai kyakan	Tioor: Primary forest
kaleng	Tin can; used as dry measure for root crops, equivalent to about 18 kg
kamboti	Tioor: Rattan basket for transporting agricultural goods
kebun	Permanent dry field
kecamatan	District
kelompok tetap	Permanent agricultural group
keluarga	Family
kensi	Resin of Canarium L.
kepala adat	Adat leader
kepala agama	Religious leader
kepala desa	Village head
kepala dusun	Community head
kepala marga	Clan head
kepala RT	Head of a neighbourhood association
kepala soa	Head of a clan association
keramat	Sacred place, most commonly sacred forest
kerja masohi	Tioor: Mutual co-operation of villagers, community self-help
kewang	Guardians of the land and the sea
kolam	Basin, hollow
kota madya	Municipality
kulat pala	Edible mushroom, cultivated on decaying nutmeg pericarps
ladang	Dry field of shifting cultivation
lempeng	Pap of sago or cassava starch baked in a *porna*
linggis	Kind of crowbar for digging holes
lutlubak	Kur: Kind of cookie made of sago starch and seeds of *Canarium* L.
makan ramai-ramai	Joint management of fields by several related households
manga ras	Kur/Kaimear: Dry field of shifting cultivation; obtained by joint clearing of primary forest by a settlement and subsequent equal apportioning of the cleared land among all households
manggi-manggi	Tioor: Mangroves
manisan	Candied fruit produced from nutmeg pericarps
marga	Clan
megawah ras	Tioor: Dry field of shifting cultivation; obtained by joint clearing of primary forest by a settlement and subsequent equal apportioning of the cleared land among all households
magowa	Tioor: Dry field of shifting cultivation
meja makan	Literally "the common laid table"; village territory
merebut tanah	Struggle for land
mesjid	Mosque
monopoli tanah	Literally "the monopolisation of land" by a male heir who refuses to let a returning female heir have her tenure rights on tree gardens
mukibat	Grafting technique (*Manihot esculenta* and *Manihot glaziovii*, see Ch. 6.3.3)
musim kemarau	Long dry season (August until November)
musim laur	Short dry season (April)
myristicin	Toxic essential oil of nutmeg
nuar	Tioorese: Coconut
ongkos saksi	Costs for a witness in an *adat* council hearing
padi ladang	Dry field rice
palawija	Annual, sub-annul and bi-annual crops in dry field agriculture with the exception of rice
pamere	Cutting of herbs, grass, shrubs and small trees
Pancasila	The five basic principles of the state ideology of the Republic of Indonesia
papeda	Paste-like mass produced by boiling of sago starch
pastor	Catholic priest
pela	Traditional intervillage co-operation
pela tumpah darah	Traditional intervillage co-operation as a result of a post-war treaty
Pelni	National shipping line
pendeta	Protestant clergymen
perahu	Traditional sailing boat
perahu motor	Traditional boat equipped with a diesel engine
Perintis	Regional shipping line
perk	Dutch: Colonial nutmeg plantation; plural: perken
perkenier	European immigrants to Banda who leased the nutmeg plantations; most commonly deserving soldiers and servants of the VOC
perladangan berpindah-pindah	shifting cultivation
persiapan meja	Fee paid by two disputing parties for opening an *adat* council hearing
pes	Tioor: secondary forest
petuanan	Traditional community territory
pondok	Field hut
porna	Form made of baked clay for the baking of sago or cassava starch

Prajakarya	Regency Government's plantation enterprise managing the nutmeg plantations in Rhun and Hatta (1966-1986)
puskesmas pembantu	Public health station
raja	Literally "king"; traditional village head before the administrational reform in Indonesia in 1979
rangsum	Food rations for the plantation workforce until the 1950s
rubuh kayu	Clearing of trees
rumpun	Cluster of sago palms
sanere	*Adat* council advising the village head (*raja*)
sasi	Traditional resource management practice: the periodic ban on the harvesting of specified domesticated and non-domesticated resources, in the traditional community land or sea territory (*petuanan*)
sinole	Tioor: Fried cassava starch
soami	Rhun: Cassava "bread", produced by stewing of cassava starch
sopi	Spirit, produced by distilling *tuak* from *Arenga pinnata* or *Cocos nucifera*
swadaya masyarakat	Self-help of villagers without outside funds
tanah dati	Clan land
tanah longsor	Landslide
tanaman orang malas	Literally "the crop of the lazy people": bananas
taungya	Agroforestry system developed in Burma in the nineteenth century for the establishment of teak plantations (*Tectona grandis*). Farmers get temporarily limited usufruct right of state land for the establishment of dry fields, and have to integrate teak seedlings which belong to the government
tentena piakar	Tioor: Degraded land
tetelo	Newcastle disease of poultry
tikar	Handmade mat, made from dried *Pandanus* leaves
timbang tanah	Literally "to weigh the soil"
tokoh adat	Traditional leaders
tokoh agama	Religious leaders
tokoh masyarakat	Representatives of the community
tuak	Fermented alcoholic beverage from *Arenga pinnata* or *Cocos nucifera*
tumang	Basket for the storage of sago starch; approximately 15 kg
tumbuh sendiri	Naturally-established tree
tumpangsari	Farming system: the integration of perennials into a dry field, by which the plot will develop to a tree garden (*dusun*) and is therefore put out of the rotational cycle of shifting cultivation
uli lima/uli siwa	Two rival alliances in Maluku in the sixteenth century
wajwajawa	Tioor: Boiled cassava starch
wer	Tioor: Water; Prefix of stream names (e.g., Werlarat)

Appendix 7: Abbreviations

ASPIN	Asosiasi Pala Indonesia (Indonesian Nutmeg Association)
BAKIN	Badan Koordinasi Intelijens Negara (State Intelligence Co-ordinating Agency)
BAPPEDA	Badan Pembangungan Daerah (Agency for Regional Development)
BPPC	Badan Penyangga dan Pemasaran Cengkeh (Agency for Support and Trade of Cloves)
BPS	Biro Pusat Statistik (Central Bureau of Statistics)
CMR	Chemical Marketing Reporter
CRMP	Community-based Resource Management Plan
D & D	Diagnosis & Design
DAAD	Deutscher Akademischer Austauschdienst
FAO	Food and Agriculture Organisation of the United Nations
GOI	Government of Indonesia
GTZ	Gesellschaft für Technische Zusammenarbeit (Company for Technical Co-operation)
HH	Household
HPH	Hak Pengusahaan Hutan (Forest Utilization Licence)
HTI	Hutan Tanamaan Industri (Commercial Forest Plantation)
ICRAF	International Centre for Research in Agroforestry
IDT	Instruksi Presiden Desa Tertinggal (Presidential Instruction for Poverty Alleviation in Least-Developed Villages, 1994 – 1998)
IPK	Ijin Pengelolaan Kayu (Licence for Clear-Felling of Forests)
KB	Keluarga Berencana (Family Planning)
KS	Kantor Statistik (Agency of Statistics)
KUD	Koperasi Unit Desa (Federation of Village Co-operatives)
LIPI	Lembaga Ilmu Pengetahuan Indonesia (The Indonesian Academy of Sciences)
LM	Lembaga Masyarakat (Community Organisation)
LKMD	Lembaga Ketahanan Masyarakat Desa (Village Development Council)
LMD	Lembaga Musyawarah Desa (Village Deliberation Council)
MoA	Ministry of Agriculture
MoF	Ministry of Forestry
MPT	Multi-purpose Tree
NGO	Non-governmental Organisation
NTFP	Non-timber Forest Product
NTP	Non-timber Product
PKK	Pembinaan Kesejerahtan Keluarga (Family Welfare Programme)
PNP XVIII	Perusahaan Negara Perkebunan XVIII (State Plantation Enterprise XVIII)
PPD	Pusat Perkebunan Daerah (Centre for Local Government Plantations)
PPN	Pusat Perkebunan Negara (Centre for State Plantations)
PRA	Participatory Rural Appraisal
PROSEA	Plant Resources of Southeast Asia
PTPPB	Perseroan Terbatas Perkebunan Pala Banda (The Banda Nutmeg Plantation Enterprise Ltd.)
Repelita	Rencana Pembangungan Lima Tahun (Five-Year Development Plan)
RePPProT	Regional Physical Planning Programme for Transmigration
Rp.	Indonesian Rupiah
RRA	Rapid Rural Appraisal
RT	Rukun Tetangga (Neighbourhood Association)
SD	Sekolah Dasar (Elementary School)
SMA	Sekolah Menengah Atas (Upper Secondary School)
SMP	Sekolah Menengah Pertama (Lower Secondary School)
TGDK	Tata Guna Darat Kesepakatan (Agreement Reached on Land Use)
TGDLK	Tata Guna Darat dan Laut Kesepakatan (Agreement Reached on Land and Sea Use)
TGHK	Tata Guna Hutan Kesepakatan (Agreement Reached on Forest Land Use)
TGLK	Tata Guna Laut Kesepakatan (Agreement Reached on sea use)
UNECOSOC	United Nations Economic and Social Council
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UP	Universitas Pattimura (University of Pattimura, Ambon)
VOC	Vereenigde Oostindische Compagnie (Dutch East Indian Company)
WW II	World War II
ZOPP	Zielorientierte Projektplanung (Target-oriented Project Planning)

Note: Familiar abbreviations, like “km”, “ha”, “et al.” are not included in this list.

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20. Dez. 2000	Tag der wissenschaftlichen Aussprache

TIOOR ISLAND, MALUKU, INDONESIA:
Land Use and Forest Cover in 1998

Map 3 for the Dissertation:

Traditional Agroforestry and Ecological, Social, and Economic Sustainability on Small Tropical Islands

by S. Stubenvoll, September 2000

Remarks on land use and forest cover in unmapped areas	
1	Mostly secondary forest, additionally coconut tree gardens, dry fields, mixed gardens, and pockets of primary forest
2	Mostly coconut and sago tree gardens, additionally secondary forest, dry fields, mixed gardens, and pockets of primary forest
3	Mostly secondary forest, additionally dry fields with and without tumpangsari, nutmeg, coconut, sago and mixed tree gardens
4	Mostly secondary and primary forest, along Werkilwer sago and nutmeg tree gardens
5	Mostly mixed and tree gardens (clove, nutmeg, coffee), additionally dry fields, secondary forest, and pockets of primary forest
6	Mostly secondary forest and mixed gardens, additionally dry fields and clove tree gardens
7	Mostly secondary and primary forest, additionally coconut tree gardens along the coast, and dry fields, mixed gardens and tree gardens (clove, nutmeg, coffee) in the upland
8	Mostly secondary forest, additionally coconut tree gardens along the coast, dry fields, mixed and tree gardens (clove, coffee in the upland
9	Mostly secondary forest (also on degraded land), additionally coconut tree gardens
10	Mostly secondary forest, additionally coconut tree gardens along the coast and dry fields in the upland

Sources: RePPProT 1988 (base map); Transect Mapping by S. Stubenvoll, L. Kolatfeka, A. Dos, E. Kolatfeka, W. Kolatlena and C. Kolatlena

Note: In the text "Map 3" refers to this map.