/

INTEGRATING CONSERVATION AND DEVELOPMENT: THE ROLE OF LOCAL PEOPLE IN THE MAINTENANCE OF PROTECTED AREAS IN MADAGASCAR

Doctor of Philosophy Thesis

in Ecology

by

JOANNA DURBIN

The Durrell Institute of Conservation and Ecology

The University of Kent, Canterbury, Great Britain

ABSTRACT

In Madagascar, as throughout the world, protected areas were originally created with little consideration for local people. Conflicts have arisen as people continue to use resources within protected areas. A recent approach, integrated conservation and development, aims to provide alternative resources or other benefits to local people and promote local sustainable management of resources to alleviate pressure on protected areas.

At two project sites, Andohahela and Soalala, studies were conducted in two villages per site. Energetic, economic, cultural and ecological influences on resource use were investigated. Energy expenditure, resulting from distance travelled and effort required for extraction, limits resources used and collection zones in these primarily subsistence populations. Some commodities are traded, but the effort required for transport limits trade. Cultural influences, both traditional and political, also have a strong impact on resource use and management, for example resulting in apparently disadvantageous trade in rice for cattle immediately after harvest.

The species used and approximate amounts of resources extracted from different habitat types are documented for each site. Some local practices have a major impact on biodiversity, for example at both sites uncontrolled burning, often started for pasture regeneration, is a threat to forest areas. Extraction of locally important resources, such as wood and other materials for house and boat construction, tubers in periods of food shortage and plants used medicinally and ritually, have less impact. Resource management initiatives are proposed that take account of relative environmental impact, energetic, economic and cultural values of resources to local people, traditional management practices and social organisation. I conclude that development activities to maintain a protected area should integrate natural resource and cultural issues so that activities are directed at local practices with most impact on biodiversity and enable the social mechanisms and institutions for lasting conservation.

Résumé

A Madagascar, comme partout dans la monde, les aires protégées ont été créées à l'origine avec peu de considération à l'égards de la population locale. Des conflits ont surgi comme les gens continuent d'utiliser les ressources se trouvant dans les aires protégées. Une approache récente, la conservation et le développement intégrés, vise à pourvoir les gens de la région en d'autres ressources ou autres avantages, et à promouvoir la gestion et le renouvellement des ressources par la population locale afin d'alléger la pression sur les aires protégées.

Dans deux sites, Andohahela et Soalala, les études ont été menées dans deux villages par site. Des enquêtes ont été faites sur les influences énergétiques, économiques, culturelles et écologiques sur l'utilisation des ressources. La consommation d'énergie, résultant de la distance parcourue et l'effort requis pour l'extraction, limite les ressources utilisées et les zones de collecte au sein de ces populations qui produisent principalement pour leur propre subsistance. Quelques produits peuvent se trouver dans le commerce mais l'effort requis pour le transport limit le commerce de tels produits. Les influences culturelles, aussi bien traditionelles que politiques, ont aussi un grand impact sur l'utilisation et la gestion des ressources, se traduisant, par exemple, par la commerce apparemment désadvantageux en ce qui concerne le riz pour le bétail immédiatement après le moisson.

Les espèces utilisées et les quantités approximatives des ressources extraites des différents types d'habitat sont documentées pour chaque site. Quelque pratiques locales ont un impact majeur sur la biodiversité, par exemple, dans les deux sites, les incendies incôntrolés souvent provoqués afin de régénérer le pâturage, sont une menace pour les régions forestières. L'extraction des resources localement importantes, comme le bois et les autres matériaux pour la construction des maisons et des embarcations, les tubercules pendant les périodes de famine et les plantes utilisées de manières médicinales et rituelles, a un impact moindre. Des initiatives de gestion de ressources sont proposées, initiatives qui tiennent compte de l'impact relatif sur l'environnement, des valeurs énérgetiques, économiques et culturelles des ressources pour les gens de la région, des pratiques de gestion traditionnelles et de l'organisation sociale. Ma conclusion est que les activités de développement pour maintenir une aire protégée doivent intégrer les problèmes des ressources naturelles, et des considérations culturelles de telle manière que les activités soient dirigées sur des pratiques locales qui ont le plus d'impact sur la biodiversité et opèrent sur les mécanismes et institutions sociaux pour rendre possible une conservation durable.

ACKNOWLEDGEMENTS

I am very grateful to the Malagasy Government for permission to conduct this research, and would particularly like to thank M. Raymond Rakotonindrina (now of ANGAP), M. Georges Rakotonarivo and Mme. Celestine Ravaonoroarimanga at the Directorate of Waters and Forests (DEF) in Antananarivo.

I am also very grateful to Jersey Wildlife Preservation Trust (JWPT) and World Wide Fund for Nature (WWF) for funding this research, and to British Airways-Assisting Nature Conservation (BA-ANC) for contributing two return flights and a generous excess baggage allowance to Nairobi. My special thanks extend to: Dr Lee Durrell of JWPT who has been particularly supportive and encouraging throughout this research; Dr Sheila O'Connor of WWF Madagascar who gave me great support and guidance, and the rest of the staff of WWF Madagascar; Tricia Mingay and Dr Meg Gawler of WWF International; and Rod Hall at BA-ANC.

I would like to thank both my supervisors at the University of Kent, Dr Ian Swingland of the Durrell Institute of Conservation and Ecology and Prof. Roy Ellen of the Social Anthropology Department, for their encouragement and guidance.

I owe special thanks to my research assistants, Lala Jean Rakotoniaina, Dorety Razandrizanakanirina, and Roger Razafison Ilambo, for their invaluable help; they played a very important role in the success of this research, and were very rewarding companions. Andrin'Iranto Randriamanantena was also a great help in collecting plant specimens.

So many people in the villages I visited were very kind and welcoming, patiently answering my questions and allowing me to participate in their lives for a short period. I would particularly like to thank the following people and their families, with whom I lived during the fieldwork: Adany and Njaribe in Antsira, Jakoba Rabemanana and Manatry in Antanandava, Rokia Hassanaly in Soalala, Sinaotsy Bernard and Raliza in Esomony, and Dancilier and Pascaline in Eminiminy.

In addition, I would like to thank the following people:
David Stone, Jeff McNeely, Martin Nicoll and Alison Richard who encouraged me to embark on this research; Don Reid for his good companionship and logistical help, and the rest of the Project Angonoka staff in Madagascar; Jonny Ralambo and the rest of the team of the Andohahela project; Veloson Rajafetra and the rest of the staff of WWF-Education in Madagascar; M. Jean Philippe of DEF in Mahajanga; M. Randrianarisaona and the APNs of DEF in Soalala; the committees and members of the ASEs of the Soalala region; Al Hadj Djamaldine Said Ali and other ray aman-dreny of Soalala; Maurice Bloch, Mark Fenn, John Hough and Mamy Razafindrabe for their interest and advice; Mike Walkey, Joan England, Meredith Johnson and Jenny Rafferty at the University of Kent for their help with administration of this research project; my parents, who have been very supportive; and my husband, Frank Hawkins, whose encouragement at all stages of this research has been very important to me.

CONTENTS

APPENDICES

Chapter 1.

INTRODUCTION: THE IDEALS AND REALITIES OF PROTECTED AREAS

1.1 Why are areas protected?

The allocation and protection of areas for different types of current or even future use is not a new concept. Areas are set aside for hunting or as religious sanctuaries in many different cultures. In medieval Britain `forests' were tracts of royal land subject to special laws, usually concerned with the preservation of game (Rackham 1976, p. 152). The motive for making rules about the use of an area is often concern for future availability of a valued resource, such as timber or game. The control and limitation of access to the resource is designed to ensure a continued supply, sometimes equitably but often preferentially to those in power.

The institutions controlling resource use vary. In some cases limitations are enforced by a small community, enabling all its members to get a long term sustainable yield from the resource. Controlled access to trap lines among Cree Indians in James Bay, Canada (Berkes 1987), and trap limits within the defended territories of lobster-catching gangs on the Maine coast, USA, (Acheson 1987) are good examples. In many cases social hierarchy allows one group to ensure a continued supply of resources by limiting access of other groups, as in royal hunting reserves. In some cases the limitation of access to resources helps to maintain a leader's authority through ritual and patronage, using designated occasions to give their followers access to the resource. The great annual elephant hunts and mass hunts of the Lozi and Ndebele of central Southern Africa in the 19th century enhanced the power of the kings through the distribution of firearms and the resulting large amounts of meat (Mackenzie 1987).

All these circumstances may lead to conservation of the resource, usually for later use. The nature conservation movement has, in contrast, often resulted in protection of areas for uses not based on extraction of resources, such as tourism, scientific research, and even the esoteric knowledge that an ecosystem is protected from human interference. It must be recognised that conservation in all these guises not only has social and political implications, but is better enabled by certain social and political formations. It will be illustrated repeatedly throughout this thesis that it is impossible to divorce resource conservation from the social and political context in which it is pursued.

1.2 History of protected areas

Protected areas, in the form of national parks and nature reserves, are an important element of the modern nature conservation movement. Before examining their current objectives and characteristics it is instructive to consider their history. Although the model for modern conservation policies and for the role of protected areas is generally believed to have originated in the United States (Mackinnon *et al.* 1986, p. 3), local conditions and events independently shaped emerging nature conservation policies in the European colonies.

The evolution of different aspects of conservation in the Cape Colony of southern Africa, described by Grove (1987), provides a good example. As early as 1811 forests at Plettenberg Bay were reserved for the use of the Royal Navy, although it was later decided that the wood was unsuitable, which catalysed a debate on the fate of these forests and of the role of government in the management and ownership of forests in general. The conservation campaign was greatly influenced by two men representing different types of environmental preoccupation. Dr. Ludwig Pappe, the `Cape Botanist' (an official position from 1858) was concerned about the possibilities of species extinctions of the diverse and unique Cape flora which he was engaged in identifying and documenting. Rawson W. Rawson, Cape Governor from 1853, was concerned about the risks of deforestation and its supposed connections with rainfall decline. Their influence and the strength of public opinion, promoted by the large scale destruction of forests and deterioration of pastures and scrubland around Cape Town, resulted in the Forest and Herbage Preservation Act of 1859. Simultaneously a growing public interest in the protection of large mammals in the Southern Cape forests, which had been greatly reduced by hunting, resulted in a `Notice for the Preservation of Elephants and Buffaloes' in 1858 and the creation of the first `state' game reserves in Africa in Knysna and Tsitsikamme forests. The interest in protecting animals and forests was largely urban, and the measures encountered fierce opposition from rural settlers, accustomed to being able to act as they pleased. The second Cape Botanist, John Croumbie Brown, proposed a comprehensive set of measures to counteract soil erosion, drought and flooding through what amounted to state intervention in agriculture, proposals so unpopular with farmers and timber traders that they were rejected and Brown lost all political support.

Early conservation efforts in the Cape illustrate many of the characteristics of later conservation strategies throughout Africa and other colonial areas. Conservation of forests and wildlife took the form of government intervention, with appropriation of land

and imposition of regulations about the use of resurces on that land. The earliest measures were forest reserves to ensure future timber supplies for national requirements (such as for the Navy). Later, areas were protected in response to largely urban, educated public opinion influenced by the aesthetic appeal of large mammals, by moral arguments that man's impact should not cause the extirpation of God's creatures, and by the long term and broader scale consequences of environmental degradation exposed by scientists. Those who maintained a livelihood or derived personal gain from continued access to the resources protested vigorously at their protection.

It is clear that the extent of protection that resulted depended on the relative political power of the lobbies for and against conservation, and the ability of the Government to maintain protection once legislated. Evidently poaching remained an insoluble problem in the Cape game reserves (Grove 1987, p. 27). In the Cape, the white farmers were a political force, but the needs of black peasant farmers were rarely considered. However, in India the sheer size of the native peasant population meant that scientists' warnings of the link between deforestation, droughts and floods, leading to famine which might threaten the stability of the country, were heeded and stronger Government intervention and conservation policies were sanctioned (Grove 1987, pp. 28 & 35). Grove also remarks that although environmental concerns were raised in Europe and the United States in the 19th Century, "interventionist conservation policies were ... much easier to experiment with in the colonies" (p. 22).

The main conservation policies in the colonies were protection of forests, to control incursions of timber traders and protect watersheds, and the creation of game reserves. The widespread creation of game reserves in Africa around the turn of the century is linked to the history of hunting in the continent (Mackenzie 1987). The first European economic interests in Africa were for slaves, gold and ivory. Although initially most trade took place at ports, relying on locals to procure the commodities, from the 1850s expeditions penetrated into the interior to find and exploit new sources. From this period adventurers came to Africa to seek fame and fortune, often supplied by large scale slaughter of elephants for ivory. As elephant populations declined other large mammals were increasingly targetted. Mackenzie defines three stages in the history of non-subsistence hunting in Africa, the first being commercial hunting and the second being hunting to support the period of European settlement and colonial expansion. Local favour was won by the provision of meat, to the extent that even missionaries found that their position and local acceptance were secured by hunting. Meat from wildlife also supported large work teams for colonial endeavours, notably for the construction of the railways.

The third phase of hunting history is described by Mackenzie (1987) as `the Hunt'. Shooting large numbers of wild animals, preferably large mammals, became a fashionable sport. The drama of the huge expeditions, the impressive scenery, the plains teeming with game, the thrill of the hunt and the prestige of returning home with the trophies (horns, tusks and skins, often reassembled by taxidermists) all contributed to make `the Hunt' an emotive, romantic and highly respected activity. Some hunting was justified on scientific grounds, contributing to collections of the new Natural History Museums. The mythical qualities and social prestige of `the Hunt' did much to promote the vision of Afica as an unpeopled wilderness where wildlife abounded, despite the fact that humans had been present in Africa for millions of years and were an integral part of the African landscape (Nash 1982, Mackenzie 1987).

The free-for-all hunting spree took its toll on African wildlife, as did the introduction of diseases. The great rinderpest epidemic which spread from Eritrea to the Cape from 1887 to 1900 reduced cattle by 90% and also affected some wild ungulate populations (Bell 1987, Homewood and Rodgers 1991, p. 62). The reduction in game numbers was of particular concern to aficionados of `the Hunt' who campaigned for stricter rules. Many had witnessed, or were aware of the collapse of buffalo herds in America, and the demise of game in India and realised that protection was required if the last great hunting ground was to be maintained (Nash 1982, pp. 342-378). There were also fears about the extinction of species. Two large South African mammals, the quagga (*Quagga quagga*[1]) and the bluebuck *(Hippotragus leucophaeus)*, had already become extinct as a result of hunting and the rapid expansion of white ranchers (Adams and McShane 1992, p. 27). The native Africans, who had less political clout than other hunters, were increasingly denied access to wildlife, an important source of protein particularly in famine periods. Hunting restrictions were imposed through gun laws, game laws (which were generally less easily enforced), the imposition of game reserves and mostly by the eradication of game in populated areas. The 1886 Cape Act for the Preservation of Game restricted hunting to those who could pay for licences, and similar laws were passed in much of colonial Africa (Mackenzie 1987).

Meanwhile the conservation movement was developing in America, perhaps from similar initial motives but with a different outcome. The first national park was established at Yellowstone in 1872, followed in the late 19th and early 20th century by others, including Yosemite, Sequoia, Rocky Mountain and Grand Canyon National Parks (Hays

---

1 Sometimes classed as a subspecies of Burchell's zebra, *Hippotigris (burchelli) quagga* (Haltenorth and Diller 1980, p. 113).

1987, pp. 99-136). These areas were explicitly protected for the recreation and enjoyment of the general public (MacEwen and MacEwen 1982, p. 4). Proposals for their protection came from East Coast urban, educated explorers, big game hunters and naturalists, who felt that the state should protect these scenic areas from private ownership and development that would deprive the nation of its assets. Local residents were suspicious of the national park concept until it became clear that the park would attract money-spending tourists (Nash 1982, pp. 342-378). With the advent of the railway and the increasing use of automobiles, the national parks and other wildlands were visited by increasing numbers of tourists, and the appreciation of nature, dramatic scenery and wilderness became a popular movement (Hays 1987, pp. 99-136). The first national parks created in Africa were Albert National Park in the Belgian Congo in 1925 and Kruger National Park in South Africa in 1926. The South African park was promoted by an English game warden, James Stevenson-Hamilton, who was concerned that protection of the Sabi Game Reserve was ineffective, and persuaded the Government to confer greater protection using the economic arguments of potential income from tourism. The Albert National Park was rather different, as it was created in response to petitioning by scientists as a refuge to save the world's last gorillas and for scientific research. Entrance to the six million acre park was admitted only to research scientists and tourism was not allowed (Nash 1982, pp. 342-378). Such protected areas, which are designed to maintain ecosystems and protect endangered species with no human interference, are now termed `Strict Nature Reserves', or `Wildlife Sanctuaries' (see Section 1.3 below).

Increasing public alarm over the disappearance of species as a result of man's activities has been an important factor in the growth of the conservation movement. The publicity given to the plight of some of the larger mammals, such as the elephant, the great whales and the giant panda, helped to fuel this alarm, and to stimulate campaigns for measures to be taken for their protection. One reaction has been to justify bringing them into zoos for captive breeding, and indeed some species which have gone extinct in the wild, have been maintained in captivity, such as the California condor (*Gymnogyps californianus*) (Toone and Wallace 1994). However, such artificial conditions cannot be a viable long-term solution for all species, many of which probably require the conditions provided by their natural habitat for long term survival. A more satisfactory solution is to maintain their habitats. In this way many species may be `saved' in one area, including less obvious animals and plants such as endemic fungi, or insects which may not benefit from the same media attention. Many protected areas, like the Albert National Park, have been created to safeguard the habitat of an endangered species.

1.3 Modern arguments for protected areas

Large mammals and other conspicuous organisms are still used as flagship species for fundraising, and as indicators for monitoring the health of ecosystems, but many conservation organisations (such as World Wide Fund for Nature [WWF]) have largely dropped their single species approach and talk of protecting endangered ecosystems (WWF 1992). Although the rhetoric of conservation has now advanced beyond saving species or even ecosystems, the appeal to people's instinct that human impact on the earth must be limited is probably the most potent factor in eliciting public support for conservation projects. The powerful moral and aesthetic values that the largely urban, educated public of the more developed countries attaches to conservation of wildlife and wilderness areas are often not sufficiently acknowledged (Bell 1987).

The World Conservation Strategy, prepared in 1980 by three of the world's leading conservation agencies (The International Union for the Conservation of Nature [IUCN], WWF, and the United Nations Environment Programme [UNEP]), marked a turning point for conservation. It stated that conservation of living resources is essential for human development, identifying three main objectives of conservation:

"a. to maintain essential ecological processes and life-support systems (such as soil regeneration and protection, the recycling of nutrients, and the cleansing of waters), on which human survival and development depend;

b. to preserve genetic diversity, on which depend the functioning of many of the aforementioned processes and life-support systems, the breeding programmes necessary for the protection and improvement of cultivated plants, domesticated animals and microorganisms, as well as much scientific and mdeical advance, technical innovation, and the security of the many industries that use living resources;

c. to ensure the sustainable use of species and ecosystems (notably fish and other wildlife, forests and grazing lands), which support millions of rural communities as well as major industries" (IUCN/UNEP/WWF 1980).

It realigned conservation motives, stressing utilitarian aspects and making a powerful case for conservation to go far beyond its previous wildlife protection sphere, to become a fundamental priority in all sectors. It argued that the future success of not only conservation, but also of development, relied on being able to integrate the two. It highlighted the case of developing countries, where natural resources may appear abundant but where large rural populations depend entirely upon their continued availability. These populations are growing rapidly, and tropical ecosystems, such as rainforests, are often not resilient to disturbance (IUCN/UNEP/WWF 1980).

Within this new conservation ethos, protected areas are seen as a vital means to help safeguard the earth's genetic diversity, or `biodiversity', and the old mantle of saving key species and representative ecosystems is assumed under this guise. However, their role in maintaining essential ecological functions, and as part of regional land use zones to promote sustainable use of resources, are also stressed. Many forest reserves do protect water catchment areas which supply water to extensive regions, supporting agriculture and other industries, as well as human populations in towns and cities. The continued presence of forest provides continuous, filtered water while clearance would cause drastic consequences such as flooding, drought and siltation. There is growing evidence that undisturbed forest helps to maintain local rainfall and keep down temperatures, which may be important for local agriculture. Protected areas may protect breeding grounds or enable seed dispersal of species harvested outside the area. For example mangrove areas are often important breeding grounds for fish and crustaceans on which fisheries depend (Mackinnon *et al.* 1986, pp. 15-26).

A wide variety of types of protected areas are recognised, each type reflecting different motives and circumstances behind their creation (Mackinnon *et al.* 1986). In addition to the Strict Nature Reserves[2] and National Parks already mentioned, others include Protected Landscapes, which maintain natural landscapes characteristic of the harmonious interaction of man and land while providing opportunities for public enjoyment through recreation and tourism within the normal lifestyle and economic activity of these areas. The English national parks such as in the Yorkshire Dales and the Peak District come under this category. Others are Anthropological Reserves which allow the way of life of societies living a low impact lifestyle to continue undisturbed, such as the Kalahari Game Reserve of Botswana. The earlier game reserves are either included in the category of Managed Nature Reserves/Wildlife Sanctuaries, where controlled harvesting of resources is sometimes allowed, or may have been upgraded to a national park (as at Amboseli in Kenya). Forest reserves are included in the category of Resource Reserves, where natural resources are protected for future use. Some reserves are managed as part of a regional land management programme, in which different zones are allocated for different types of use, such as for timber, pasture, wildlife ranching, tourism, often with a core zone of total protection for conservation of biodiversity. An example of this approach is given by the Ngorongoro Conservation Area of Tanzania.

---

[2] IUCN have defined a system of 10 management categories (Mackinnon *et al.* 1986, pp. 19-20; see Appendix 1), which, where mentioned in this paragraph, are given capital letters.

The benefits of protected areas to people, for current and future use are stressed. Official IUCN protected area categories are given in Appendix 1.

1.4 Growth of protected areas

Governments are encouraged to adopt national conservation strategies, which often involve the creation of a network of protected areas of different types, fulfilling different functions, according to the characteristics of that country. Countries were exhorted to allocate ten percent of the national surface area in the Action Plan of the IIIrd World Congress of National Parks and Protected Areas held in Bali, Indonesia, in 1982 (Thorsell 1992). Increasing numbers of protected areas have been created during this century. The graph showing the cumulative increase in protected area in Francophone Africa (Figure 1) shows the general trend, although in other regions recent increases have been greater. The total global area protected increased by 80% in the 1970s (Mackinnon *et al.* 1986, p. 3), and by a further 80% in the 1980s, when 1,778 protected areas were created covering 142 million hectares (Thorsell 1992). Over 130 states have together established some 6,900 protected areas, covering nearly five percent of the

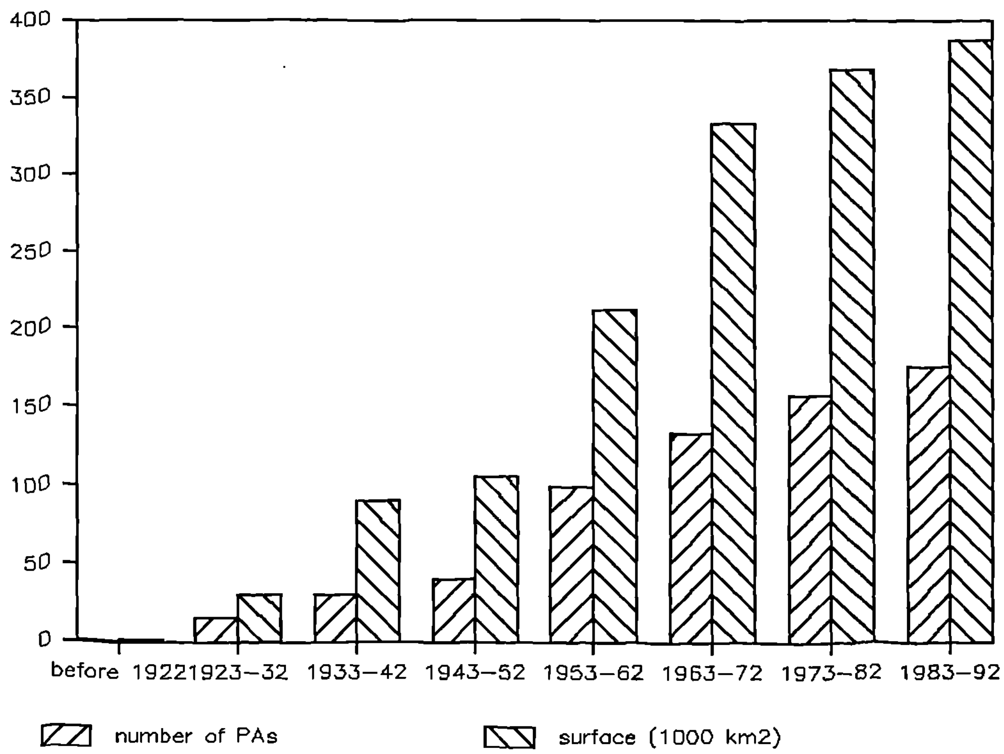


Figure 1. Cumulative growth in protected areas of IUCN categories I-V in the Francophone Afrotropical region

Source: Mbaelele 1992.

planet's land surface (McNeely 1992). Given that governments appear to be convinced of the advantages of creating protected areas, are these areas effectively protected and what are the issues that make them difficult to maintain?

1.5 Why protected areas are inherently difficult to manage

Many difficulties stem from the view of protected areas as wildlife sanctuaries that need protection from any direct human interference, and are managed by ecologists and scientists. In reality many protected areas are under pressure from continuing human use, and have been progressively eroded. In some cases the animals they were created to protect have been selectively extracted by poaching. In some areas resources outside the protected areas became degraded, making it inevitable that resources in the reserve would be used next. Such reserves clearly do not have good prospects for long term survival without intensive policing and law enforcement. Many developing countries simply do not have the resources, or in some cases the political will, to maintain expensive and unpopular support of protected areas. The clear fact is that conflicts exist over most protected areas.

Protected areas represent a store of often valuable resources such as agricultural land, protein, timber, firewood, or valuable minerals. Their use is usually either prohibited or severely restricted. There are often many groups that have an interest in gaining access to those resources, or indeed in maintaining the protected area, for example for tourist income or international prestige. Abel and Blaikie (1986) identified six different groups with conflicting interests and power with respect to the Luangwa valley protected areas system in Zambia: local hunter-cultivators, safari hunters, conservation pressure groups, international scientists, politicians and administrators, and commercial poachers.

In addition to this natural resource issue, the other main reason why protected areas are difficult to maintain is because of the differential power of the various parties. In other words, the issue is highly politicised. Often those who make the decisions about the creation of protected areas are not aware of, or perhaps concerned about, the conflicting interests of other groups. Protected areas nearly always represent intervention by central government, and they have usually been created through appropriation of land and imposition of restrictions. The creation of a protected area may seem a very good idea at the national level, giving a government a good image internationally, encouraging financial and technical assistance, and visits by foreign tourists who bring valuable foreign currency into the country. However, the creation of a protected area may seem a devastating injustice to subsistence farmers who are deprived of valuable land for cultivation or pasture, and who in some cases are evicted from their ancestral homes. Although politically marginalised groups may not seem relevant when reserves are created, they become highly relevant many years later when it becomes clear that the reserves are unmanageable without their support.

Conflicts with local people are common around protected areas as a result of various pressures. Access to traditionally used resources is often restricted; in some cases involving displacement of villages (Hough 1988). Resource deprivation may be exacerbated by rising populations (Lusigi 1981, Prins 1992). There may be disruption of local cultures and economies by tourists and increased depredation on crops and livestock by wild animals (Owen-Smith and Jacobsohn 1989). Parks are often seen as the playgrounds of bureaucrats and tourists (Carew-Reid 1990). Benefits are reaped by others while costs are paid locally. For example, in a study in Zambia it was estimated that less than one percent of safari hunting income went to local people (Lewis *et al.* 1990). Such conflicts generate resentment and hostility toward protected areas, sometimes leading to setting destructive fires, damaging park property and threatening or even murdering park employees (Hough 1988). Local people often disregard park rules, continuing to use protected lands for cultivation, pasture and resource collection (Berkmuller *et al.* 1990). Commercial poachers may be aided and encouraged by local people in return for some profit (Lewis *et al.* 1990). When there is local resentment to a protected area it is very difficult, and expensive, for the area to remain protected. Although often not acknowledged in decision-making processes, local people do have power with respect to the protected area.

1.6 New approaches to the maintenance of protected areas

It is now widely recognised that protected areas cannot be managed as biological islands but must be integrated within a broader ecological and human framework (Lusigi 1981, Western 1982, Mackinnon *et al.* 1986, Wells *et al.* 1992), particularly within the context of the political economy (Marks 1984, Abel and Blaikie 1986, Anderson and Grove 1987). In particular, it is recognised that local people's needs and aspirations must be taken into account, and alternative resources or other benefits provided to reduce conflicts and even win their support. This approach to protected area management is referred to as integrated conservation and development, and projects using the approach are often termed ICDs or ICDPs (Wells *et al.* 1992). Their aim is to ensure the long term stability of the protected area through the implementation of development activities within the area or its peripheral zone, so that pressure is alleviated from the reserve and people are assured of sustainable and improved livelihoods. These projects are often supported by international funding and technical assistance. They intend that the protected area should be part of a multiple land use strategy which promotes environmental stability and the sustainable use of resources.

Development as part of integrated conservation projects may cover a wide range of activities aimed at, for example, increasing productivity and income generation from agriculture, forestry, fisheries, local crafts and nature tourism; provision of community services, employment, and improving access routes. Income generation and improved access to social services are often given a high priority (Wells *et al.* 1992). In some cases a proportion of the gate receipts paid by park visitors are given to local communities, often in the form of a fund intended for local development projects (Western 1982). However, provision of financial remuneration and social services have not always been successful in promoting good relations between a park and its neighbours (Parry and Campbell 1992, Heinen 1993). Amboseli National Park in Kenya was one of the first to share park revenue with local people, from a substantial tourist income, but there has been continuing resentment and illegal use of the park. Many of the difficulties stem from the fact that only a small proportion of the promised benefits have been delivered, and the Maasai living adjacent to the park received little benefit from the tourist revenues received by the District Council (based 150 km away). At the nearby Maasai Mara Reserve better communication between park authorities and local people has alleviated much conflict (Talbot and Olindo 1990).

Hough (1988) advocates the use of conflict management techniques to improve relations between parks and local people. This approach encourages identification of stake-holders (including different groups within local communities), use of a third party negotiator, recognition of power differences, reduction in the degree of risk and uncertainty, and ensuring that agreements are binding and enforced. Although community participation and respect for traditional knowledge and values have persistently been shown to be fundamental to the successful implementation of development projects, the difficulties of ensuring that they occur must also be resolved.

As with all rural development projects the way in which they are implemented is fundamental to their success. Approaches to development have also evolved considerably during recent decades (Hough and Sherpa 1989). In the 1960s development was viewed by some as the inevitable consequence of the mobilisation of resources. The emphasis was on the transfer of Western technology and funds were invested in large scale projects like dams. Decisions were made at a high level and imposed on a location and its population. In the 1970s new models of development emerged based on redistribution and participation. Projects aimed to identify and provide basic needs such as adequate nutrition, water, shelter, health, education and employment. However, the planning was usually performed by educated urban bureaucrats working in government departments (Hough and Sherpa 1989). Such approaches were criticised for their inability to address the real issues of poverty and to reach the rural poor, and for creating dependency (Chambers 1983).

More recent approaches have aimed at community empowerment; enabling people to help themselves. Working through existing social institutions and catalysing local initiatives through which people are able to improve their lives, while maintaining their self-reliance, is believed to achieve a much more enduring change. A major difficulty in implementing such an approach is that it requires devolution of power over development resources. It also often requires longer time periods for implementation and considerable flexibility on the part of donors and planners.

However, improving living standards is not sufficient for success in these ICD projects, as they must also achieve long term stability of the regional ecosystem and maintenance of the protected area. The problem is essentially one of sustainable development. People living adjacent to protected areas in developing countries are often rural poor, distanced from health and education services and politically marginalised. How can investments be made to ensure lasting and secure livelihoods for local people that minimise resource depletion, environmental degradation, cultural disruption, and social instability? Development strategies must be ecologically sustainable over the long term, consistent with social values and institutions, and encourage `grassroots' participation in the development process (Barbier 1987). In addition to sustainable development, these projects must also achieve support for the protection of the protected area. In practice, the ranges of development benefits planned at many sites are not clearly linked to the maintenance of biodiversity, and in particular to the maintenance of the protected area (Wells *et al.* 1992).

1.7 Experiences in the implementation of integrated conservation and development

Although much has been proposed and written about integration of development with protected area management, there are few good examples of effective implementation. This may be because most projects have adopted such an approach within the last five years and significant results take longer to develop (Kiss 1990, Wells *et al.* 1992). It is also difficult to get unbiased project evaluations as most reports are written by implementation agencies who have a strong interest in promoting a positive image to ensure continued funding (Hannah 1992). In many cases funding is short term (for less than three years), and donors and governments like to see quantifiable improvements during this period. Projects often resort to quoting the numbers of trees that have been planted, or schools built, without assessing the long-term impact on the maintenance of the reserve. In many cases the development activities are still implemented on `top down' or `basic needs' models and have not achieved real community participation, let alone empowerment. Many projects still rely heavily on experts from the developed world and on bureaucrats from government departments, and do not invest sufficient time and research in the best way to promote sustainable development through community initiatives. There is certainly a role for these players, who often represent other groups with an interest in the protected area, but their influence must balance that of local people. There are many different levels of community involvement, from receipt of benefits, to participation in implementation, to consultation, to participation in decision-making, to responsibility for management and finally to ownership of the protected area. Often the possible extent of involvement is dictated by government policies or by other local conditions (Hough and Sherpa 1989).

There are some notable examples of extensive community participation with protected areas. Kakadu and Uluru National Parks in Australia are examples of real partnership in management. Much of the land in the park has been awarded to Aborigines and is now leased back to the national park; the landowners get rent and a share of profits from the park. Each park has a board of management with a majority of Aboriginal representatives. The parks are jointly managed by the management boards and the Director of National Parks and Wildlife. Draft management plans are prepared by the management board and the director of national parks and wildlife, and adequate time and procedures are then provided for public submissions and public comment before the plan is submitted to the Government for legal empowerment (Press 1992).

An amendment to the Fauna (Protection and Control) act in Papua New Guinea in 1974 ensured that Wildlife Management Areas can only be set up at the request of local landowners, who retain ownership and decide the regulations and restrictions to be imposed. By 1990 there had been 50 requests by local communities for the creation of such areas, with 11 operational. Local groups see these protected areas as an opportunity to protect their land for their own future use and to give them protection from outside exploitation. The establishment of the areas requires seven to eight years of discussions. Difficulties occurred where there was insufficient communication between government agencies and local people, and where government agencies dominated negotiations. The rules regulating use of the protected areas promote traditional practices and traditional authority to achieve sustainable use and conservation of biodiversity (Carew-Reid 1990).

In the Annapurna Conservation Area an independent non-governmental organisation, the King Mahendra Trust for Nature Conservation, has provided the vehicle to enable local people both to benefit from the tourism potential of the region and to start to address local environmental problems. Local forest management committees have established tree nurseries and plantations of fodder and fuelwood. Farmers and tourist lodge operators participate in self-help training courses (Hough and Sherpa 1989). Another famous example of local people initiating and managing a protected area in order to protect a forest area of traditional importance to them are the Kuna Indians and the Kuna Yala Biosphere Reserve in eastern Panama (Gradwohl and Greenberg 1988). These are examples where far from being excluded from a protected area, local people continue to live within the area and have chosen to embrace conservation objectives, which they perceive to be complementary to their own.

Many existing protected areas are not in a position to benefit from such a partnership due to a history of exclusion, imposition of regulations and mistrust. It is ironic that in some areas where people lived with wildlife, and had been part of the landscape for many thousands of years, in some cases maintaining wildlife populations and certain balances in the ecosystem through traditional practices, they were excluded as a perceived threat to wildlife. Their exclusion and the restrictions imposed in the name of conservation and development have in some cases made their subsistence livelihood more difficult (Turton 1987, McCabe *et al.* 1992), caused the breakdown of traditional regulations and practices that were sustainable (Little and Brokensha 1987), and caused resentment leading to attacks on the park and its wildlife (Western 1982).

Pastoralists of savanna areas of Africa have often been removed from protected areas, despite the fact that their cattle herds have shared pastures with wildlife for thousands of years. The Maasai of Kenya and Tanzania rarely killed wildlife except in periods of food stress (Collett 1987), and despite conservationists claims that their livestock management led to overgrazing there is often little evidence that this was more than an argument for displacing them (Homewood and Rodgers 1987). Periodic, controlled burning of savanna practised by indigenous people has been recognised as an important management tool, preventing much more destructive fires which can occur in areas protected from fire, for example in Nairobi National Park (Homewood and Rodgers 1991, p. 103), and in Kakadu National Park in Australia (Hill 1983).

Maasai were originally allowed to remain within Game Reserves in Kenya (from their creation in the early 1900s), in recognition of their long history of coexisting with wildlife in the region. However, they were excluded from the fertile Amboseli basin on the creation of a National Park in 1974, as a result of lobbying by conservationists (Western 1982). This denied them access to fertile, dry season pasture, and the planned compensatory water supplies have never worked satisfactorily. They have continued to use grazing in the park and have speared rhinoceroses and elephants as an expression of their discontent (Lindsay 1987, Talbot and Olindo 1990). Attempts to channel some development activities through Maasai group ranches surrounding the national park have not generally been successful. Some Maasai are starting irrigated cultivation adjacent to the park, partly because they are not convinced of the security of continued benefits from the park. Conflicts are aggravated as wildlife damage crops (Lindsay 1987).

Despite the creation of the National Park at Amboseli, the area is too small to maintain the large numbers of wildlife which rely on surrounding lands for wet season pasture (Western 1982). So local people are still called upon to share their pasture with wildlife, something which many now resent, as a result of their lack of sympathy for the national park. In this case, employing a protected area model, despite recent management goals promoting the reconciliation of people and wildlife, has actually disrupted a pastoralist tradition in which people had coexisted with wildlife for at least 2,500 years (Collett 1987). In other areas, agricultural methods may not be compatible with wildlife conservation and people cannot be included in an area where wildlife conservation is a major objective.

This raises some important issues about the widespread use of protected areas which exclude local people to promote conservation of biodiversity. The presence of people is not mutually exclusive with maintenance of biodiversity. Traditional farming systems tend to maintain a much more diverse landscape than modern agricultural systems, because secondary vegetation and mature forest patches are maintained as necessary elements of the livelihood base (Alcorn 1991). In addition, protected areas themselves may be of inadequate size to maintain an ecosystem, particularly to maintain populations of migratory animals or those with large home ranges, and wildlife may rely on surrounding lands (Frankel and Soulé 1981).

In recognition of these issues, protected areas are being increasingly integrated with regional land management schemes. These often have a strictly protected core area surrounded by buffer areas where non-extractive uses (such as tourism, research and education), low-impact traditional use, or other controlled uses are authorised

(Mackinnon *et al.* 1986). An example of this approach is the Ngorongoro Conservation Area (8,292 km^2) in Tanzania of which 250 km^2 in the Ngorongoro Crater is preserved as a National Park for tourism (Homewood and Rodgers 1991, p. 8), and the surrounding area maintains 23,000 Maasai pastoralists living from traditional cattle and small stock husbandry (1987 population figure given in McCabe *et al.* 1992). Biosphere reserves, of which about 300 have been declared worldwide since the concept was launched by the UNESCO Man and the Biosphere programme in the 1970s, are planned along similar lines (Batisse 1982, Wells *et al.* 1992). Although the concept promotes incorporation of the needs and perceptions of local people into the establishment and management of reserves, many biosphere reserves have been created around earlier reserves, which provide the strictly protected core area. The existing management has rarely had the resources, inclination or ability to modify their approach and local people resent what they perceive as the extension into their own territory of restrictions associated with the protected area (Wells *et al.* 1992). However, the regional approach to conservation, considering the much wider implications of the protected area, the regional stability of ecosystems and the maintenance of biodiversity must be an important development for effective conservation.

In some cases conservation of wildlife is being promoted on private land, where the economic returns of conservation are exploited. A good example of effective conservation on communal land is the CAMPFIRE (Communal Areas Management Programme for Indigenous Resources) programme in Zimbabwe. Local communities manage wildlife for tourism, sport hunting and meat. They are given technical assistance by the Department of National Parks and Wildlife Management, and by the non-governmental organisation, Zimbabwe Trust (Murindagomo 1990). In other cases private nature reserves used for tourism have been very profitable, as at Berenty reserve in Madagascar. These examples demonstrate that where wildlife or forests have a value for those with power over their maintenance, there is strong motivation for their conservation. These initiatives do, however, rely on government policy, national and international legislation, the local institutional environment and other factors enabling them to realise the economic potential. Both sport hunting and culling of wildlife for meat have been impossible in Kenya since the national ban on hunting imposed in 1977, which greatly reduced potential benefits from maintaining wildlife, for example for the Maasai group ranches surrounding Amboseli Reserve (Talbot and Olindo 1990). This is another example where the aesthetic and moral values of Western conservationists have not necessarily aided the cause of conservation.

Both the motives for conservation and the role of protected areas in achieving conservation have evolved during the last century. Although there is now a strong emphasis on creating sustainable livelihoods and stabilisation of regional, and even global, ecosystems through rational use of renewable resources, the conservation of biodiversity and preservation of intact natural ecosystems are still given great importance. Protected areas are seen as a vital means to achieve conservation of biodiversity, and also as a focus for regional sustainable development. Although protected areas are generally no longer promoted as biological islands protected from all human interference, imposed by central government with no concern for surrounding conditions and resource use, the legacy of such management remains. Despite the efforts now being made around many established protected areas to improve the benefits to local people, it is often hard for the same management authorities to reform their previous repressive approach, the legislation associated with the protected area often remains inflexible, and the history of conflicts are not easily forgotten. New protected areas have a better chance of being set up in a sensitive and participative way. However, as a result of practical and political considerations, protected areas often cannot be created in the prime areas for the protection of representative ecosystems, but have been created in more isolated areas where there are fewer conflicts over land (Balmford *et al.* 1992). Ecotypes which can be transformed into good agricultural land are often less well protected, for example, protected areas in eastern Madagascar cover four times more mid-altitude and montane moist forest than lowland rainforest (Hawkins 1994). Even if new approaches reconcile local people to maintenance of a forest reserve in a remote mountain range, unless the environmental issues of populated areas, such as fuel requirements, wood supply and soil erosion, are resolved, developing countries will increasingly suffer economic and social hardships resulting from environmental degradation. Conservation efforts must strike a balance between the idealism of maintaining representative ecosystems and biodiversity, the realities of the difficulties involved in maintaining them, and the broader role of conservation in ensuring sustainable livelihoods in less perfectly protected areas.

1.8 Protected areas in Madagascar

Madagascar has a high profile in international conservation circles, due to its unique flora and fauna. It separated from the great southern continent of Gondwanaland 120 to 165 million years ago (Rabinowitz *et al.* 1983). Animals and plants which subsequently reached the island have evolved in isolation (Richard and Dewar 1991). More than 80% of plants are endemic, approximately 78% of mammals, over 90% of reptiles and amphibia and 54% of birds (Jenkins 1987). The flora and some higher animal taxa, notably of the primate order, are exceptionally diverse (Richard and Dewar 1991). It has three main ecological zones: rainforest in the east, dry deciduous forest in the west, and spiny bush forest in the south (Jenkins 1987). It is believed to have been about 90% forested around 2,000 years ago but less than 34% of the original eastern rain forest remains (Green and Sussman 1990) and less than 25% of the island is now covered with native woody vegetation (Jenkins 1987). Many of the larger fauna are now extinct, such as the elephant birds (Aepyornithidae: ratites), of which the largest species were 3 m tall and weighed up to 500 kg (Langrand 1990). A 17th century French visitor described a species of lemur the size of a calf (Flacourt 1661 in Grandidier *et al.* 1913). At least 25 species of mammals, ratites, and tortoises, all of them larger than their closest surviving relatives, have become extinct within the last 2,000 years (Richard and Dewar 1991). The role of man in these extinctions has been much debated. It is likely that the loss of essential habitats, often as a result of forest clearance for agriculture and pasture, has played an important role, and hunting and competition with domestic livestock may have accelerated extinctions (Dewar 1984).

Man is believed to have arrived in Madagascar in the early part of the first millennium A.D. (Dewar 1984). There were almost certainly several waves of arrivals, some groups originating in South East Asia, and believed to have come to Madagascar after spending some time on the East African coast. There were also early African and Arab arrivals (Verin 1986). It is remarkable that modern Malagasy speak one language, although with different dialects. There are numerous ethnic groups, many reflecting the areas of dominance of earlier kingdoms. There were Arab trading posts on the north and west coasts of the island from the 10th century. Europeans visited and traded with Madagascar from the early 16th century (Verin 1986).

Madagascar became a French colony in 1896, and achieved independence in 1960. After the First Republic which continued many colonial policies, there was a dramatic change to Marxism during the Second Republic, created in 1975 (Covell 1987). The country slowly became more open to ecomonic and political links with the non-communist world from the late 1980s, consolidated by the adoption of a new constitution and election of a new Government in 1992 and 1993, with the creation of the Third Republic. There are now around 12 million people, a population growing at 3% per year (average 1980 to 1990), of which 75% were rural in 1990. However, the average population density is only 20 per square km because it is large country (582,000 square km). The per capita GDP is less than 200 US dollars. Main exports are vanilla, prawns, coffee, cloves and cotton cloth. Tourism is growing rapidly and now rivals shellfish as the country's primary foreign currency earner (EIU 1993).

Most forest clearance has occurred as a result of the activities of subsistence farmers, including **tavy** (slash-and-burn cultivation), clearance for pasture, and accidental burning by uncontrolled fires set to encourage new growth for grazing (Jenkins 1987). As early as 1808, Andriampoinimerina, the founder of the Merina kingdom in the central highlands of Madagascar, is reported to have condemned destruction of forests because they provided livelihoods for many people and timber for construction of houses (Histoire des Rois III quoted in Abé 1984, p. 104). In 1881 Queen Ranavalona II decreed in Article 105 that any person discovered using fire to clear primary forest would be imprisoned in irons for five years (Abé 1984, p. 105). In 1903 the French colonial Government announced severe penalties against burning, either for forest clearance for cultivation or for renewal of pasture. These measures were highly unpopular and political rebellion and ethnic resistance have been repeatedly expressed by burning (Olson 1984). In some areas local communities deliberately burned forests, which belonged to the state, to convert them to pasture which they could use and exercise control over (Coulaud 1973, quoted in Olson 1984, p. 182). Following the severe repression of a popular rebellion in 1947, laws against clearance of primary forest were more rigorously applied and offenders severely punished. The rebellion centred on the east coast where the appropriation of land for colonial settlers and concessions and the rules about slash-and-burn cultivation had had most impact (Oxby 1985). Control of forest use and burning are associated with repressive central authorities, and transgressions of these regulations are associated with freedom and rebellion.

The first protected areas were ten strict nature reserves (RNI: see Appendix 2 for a list of official categories) created in 1927 which aimed to protect representative ecosystems. Access was strictly limited to authorised scientific researchers and government officials. Two more were added in 1939 and 1952. The 1950s, just prior to independence, saw the creation of 15 special reserves (RS), which were generally smaller than the nature reserves (RNI average size 49,960 ha, RS average size 23,600 ha) and were created in order to complete the sample of protected ecological formations (Andriamampianina 1981). The special reserves usually allowed no human interference, although limited local traditional use was sometimes permitted. Two national parks were created in 1958 and 1962, which included recreation and education of the general public in the aims and sometimes allowed local traditional use (Nicoll and Langrand 1989). During the first republic one RNI (30,000 ha) was degazetted and six smaller special reserves (average size 2,700 ha) were created, some protecting endangered species such as the largest extant lemur, *Indri indri*, at Perinet-Analamazaotra and another lemur, the aye-aye (*Daubentonia madagascariensis*), at Nosy Mangabe (Andriamampianina 1981). One hundred and fifty-eight forest reserves have also been created, covering approximately 2,671,000 ha, which are theoretically protected from commercial exploitation while generally allowing local subsistence use. They are protected for potential future commercial use, and therefore cannot be considered as securely protected areas. There are four no-hunting reserves which involve suspension of hunting rights in very approximately defined areas (Nicoll and Langrand 1989). The most recent additions to the protected area system are three national parks (average size 25,200 ha) and another is due to be created imminently (DEF/ANGAP 1992). National parks are the most flexible category within Malagasy legislation, allowing tourism and some designated local uses. There has been a clear evolution from large protected areas from which people are excluded, to smaller such areas, and finally to medium-sized areas which allow some use. Figure 2 shows the growth in protected areas in Madagascar, and Appendix 2 gives a list of categories and map of protected areas in Madagascar.

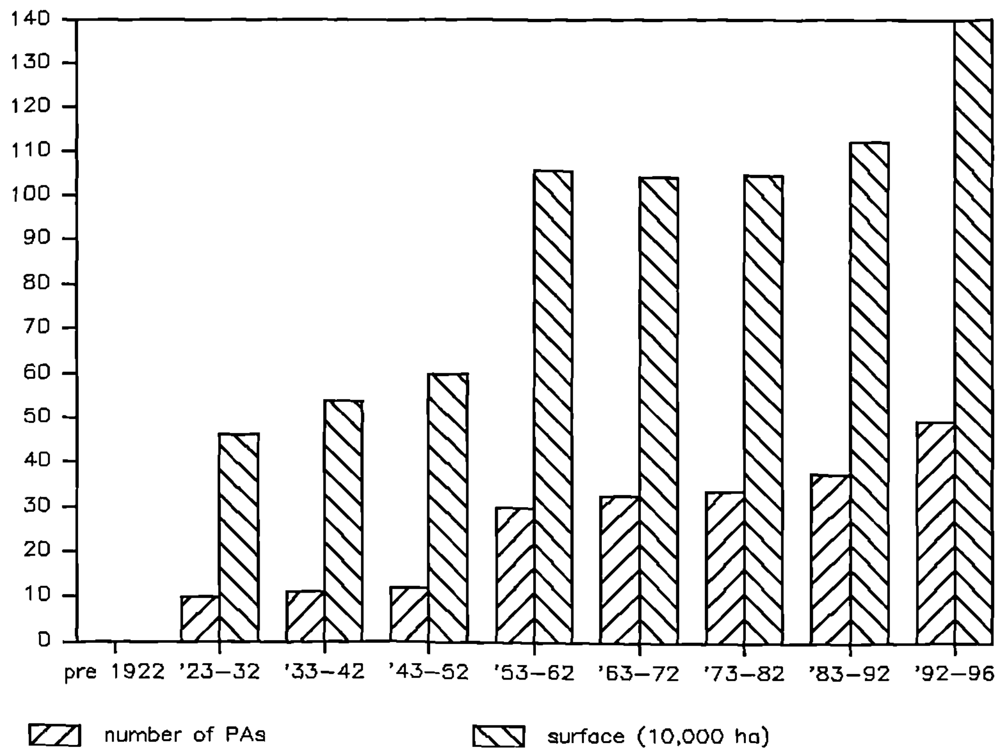


Figure 2. Graph showing the growth in protected areas (Strict Nature Reserves, Special Reserves and National Parks) in Madagascar

Consideration for local communities was minimal in the initial planning and management of the majority of reserves. Many are now suffering from acute pressure from local exploitation as resources outside the reserves have been depleted, the local people perceive no benefit in maintaining the reserve and the authorities do not have the resources to police the area (Nicoll & Langrand 1989). Policing, carried out by employees of the Waters and Forests Department (DEF), was strict in colonial times. Local people at Andohahela Strict Nature Reserve in the south-east say that they were told that the forest was taboo (**ala faly**), were given no explanation for its protection and were punished if discovered in the reserve. From 1972 official control over local forest resources was relaxed, partly with the aim of ensuring rural political support for the regime (Ghimire 1991). The Government's financial difficulties of the 1980s also reduced the capacity of the forest department to protect reserves, as almost no funds were available to support protected areas (Hannah 1992).

Madagascar launched a National Conservation Strategy in 1985 and ratified an Environmental Action Plan (EAP) in 1990, which was prepared in collaboration with the World Bank, United States Agency for International Development (USAID), United Nations Educational, Scientific and Cultural Organisation (UNESCO), United Nations Development Programme (UNDP), Cooperation Suisse and WWF. The 20 year EAP is divided into four five-year phases, and promotes an integrated approach to conservation, sustainable development and utilisation of natural resources. The biodiversity component of the EAP is coordinated by the National Association for Protected Area Management (ANGAP) of which the executive committee includes both government and private representation (WWF 1992). The biodiversity component currently focuses on protected areas and plans to create 15 new areas during the first phase, to make a total of 50, covering a total of 1.4 million ha (approximately 2.4% of the national surface area, with another 4.5% in forest reserves) (DEF/ANGAP 1992). Nine high priority localities have been identified for integrated conservation and development projects. These are implemented by international and national non-governmental organisations (NGOs) (such as WWF, Conservation International, Duke University, Care International and Missouri Botanical Gardens) in collaboration with government agencies under the coordination of ANGAP. Principal funding agencies for the biodiversity component are USAID, the World Bank, Norwegian Cooperation, KfW (Kreditanstalt fur Wiederaufbau), UNDP and UNESCO (Greve 1992).

Madagascar has long been an international conservation priority, because of its unique flora and flora and the high rate of destruction of native habitats (WWF 1992, Sayer *et al.* 1992). The nationalist marxist regime severely restricted outside involvement from 1972, but as a result of Government policy changes in the late 1980s, it has again become receptive to Western investment and technical assistance. Madagascar, with its depressed economy and large rural population which relies on the declining productivity of natural resources, is an obvious target for sustainable development initiatives. The

EAP provides a structure through which substantial financial and technical assistance are being channeled into the country.

Protected areas are receiving a high profile in sustainable development and conservation activities. The Government's past inability to maintain them has been resolved by contracting management to independent NGOs. This may be at the expense of strengthening the capacity of government agencies to assume management in the future (Hannah 1992). Substantial future funding for protected area management is anticipated from gate receipts from tourism, following the model of many African countries (Wells 1988). Although the increases in tourist arrivals in Madagascar are encouraging (an increase from 39,000 tourist arrivals in 1989 to a forecasted 68,000 in 1994), further expansion will require substantial improvements in infrastructure and tourist accommodation (EIU 1993). Due to the lack of large game animals, Madagascar is unable to use hunting tourism to fund conservation, and it is even doubtful whether Malagasy wildlife, often hidden among trees in forests, has a similar allure to the vast plains teeming with game for which sub-saharan Africa is so famous. Another obstacle is the sensitivity of international tourists to political unrest, and although Madagascar now appears a relatively stable democracy, tourism may not always be a secure source of funding. It will be important that protected area management is implemented in such a way that it is effective in the long term without requiring continued high financial input.

Although there is a protected area network in Madagascar with plans for its expansion, many protected areas are inherently unstable due to lack of local support. It is for this reason that the research reported here aimed to investigate whether integrated conservation and development projects based around protected areas could be effective in promoting maintenance of biodiversity and sustainable development. This question was investigated by analysing the conflicts between local people and selected protected areas and by considering what measures might be taken and how they should be implemented to ensure the maintenance of the protected area.

Chapter 2.

THE DYNAMICS OF PEOPLE AND THE ENVIRONMENT: DEVELOPING AN ANALYTICAL FRAMEWORK

2.1 Degradation or Conservation

Where a human population relies on a renewable natural resource it would not seem to be in their interest to over-exploit that resource, limiting availability in the future, but there are repeated examples where this occurs. The existence of alternatives, the relative importance of the resource to the community and the time frame of degradation affect the implications of over-exploitation for the community. The over-grazing of common pastureland has often been quoted (Hardin 1968, Peters 1987, Berkmuller *et al.* 1990). In Botswana over-grazing by cattle is causing degradation of fragile Kalahari grassland to a denuded and unproductive landscape, a process commonly referred to as desertification, characterised by the extension of patches of bare ground, replacement of more palatable grass species with woody and thorny shrubs, drying up of water sources and erosion of topsoil by wind, sheet wash and gulleying (Cooke 1983). The depletion of fisheries by over-fishing has been widely observed (Durrenberger and Palsson 1987, McCay 1987). The California sardine fishery was recorded at 750,000 tonnes per year in 1936-7, had reduced to 17 tonnes per year in 1957-8. It has never recovered, presumably because anchovies, a competitor, took over the ecological niche made available by over-fishing the sardines (Ehrlich and Ehrlich 1981). In many areas of the world people have to travel long distances or pay relatively high prices to satisfy their daily fuelwood requirements because of the lack of nearby firewood resulting from over-exploitation (Harrison 1987, Pretty and Scoones 1989, Basnet 1992).

Although habitat change has usually been the main factor in the extinction of animal species, there are many examples of over-hunting contributing to their demise. Intensive hunting by the Maoris in New Zealand, combined with predation by introduced rats and dogs, are considered to be amongst the causes of extinction of about 40 species of birds, including the giant flightless moas, in a few hundred years (Ehrlich and Ehrlich 1981, Pernetta and Hill 1984). Hunting and egg collecting by early man in Madagascar is thought to have been instrumental in the disappearance of the elephant birds (Aepyornithidae), especially in the south of the country where few habitat changes have occurred (Dewar 1984).

Resource degradation is not, however, the inevitable result of man's use of natural resources. There are numerous examples of resource use within the rates which allow for renewal. In some cases this is due to scale; the level of use is too low to make an impact. This often occurs where there is a small human population and where the resource is vigorous and abundant. Many semi-nomadic hunting and gathering communities are in this category, where people live at low densities and use resources over a wide area, moving on if resources become depleted, returning only after the resources have recovered. The same strategy is employed by many swidden agriculturalists, where cultivated land is left fallow as secondary forest for long periods between cultivation (for example five to 15 years in the case of the Banjarese of South Kalimantan, Indonesia [Dove 1983], and up to 20 years in the Sudanian zone of Africa [Shepherd 1992]), creating a stable production system. In these cases sufficiently large land areas (alternative resources) are required, and resource exploitation often leads to degradation if there is an increase in human population density.

In other cases the human community has evolved behavioural strategies to keep the level of exploitation below critical limits. For example the `perimeter defended' territoriality practised by Maine lobster-fishing communities has been shown to maintain local lobster populations while other nearby lobster populations with open access fishing have been depleted. Access to lobster fishing grounds are limited to members of a `harbour gang' and the number of traps set are limited, but the catch is maintained, at a lower production cost, because there is increased yield per trap (Acheson 1987). Local community control of commercial white-spined sea urchin, *Tripneustes ventricosus*, collection in St. Lucia, where a limited season was enforced and outsiders were excluded, has proved effective in maintaining harvesting levels, in contrast to the greatly diminished harvest at a site with open access (Smith and Berkes 1991). Management of resource use may go beyond limiting offtake, to actions to increase the productivity of the resource. The Coccamilla of the Upper Amazon, eastern Peru, put all household garbage, faecal material and animal entrails into the lake, which acts to improve fish yields (Stocks 1987). Traditional woodland management in Africa's tropical dry forests frequently involves actions which encourage some species and eliminate others, or which encourage trees to produce different end products such as thin poles or thick timber (Shepherd 1992).

I propose that all resource-use regimes which result in maintained resource supply can be considered `conservation' in a broad sense. The Concise Oxford Dictionary (Sykes 1977) defines `to conserve' as "to keep from harm, decay or loss, especially with a view to later use". This implies that conservation actions are conscious, rational actions, which allow future options for use. Although rules governing access to and harvesting of resources may be conscious, rational measures, such as the restriction of numbers of lobster pots by Maine harbour gangs (Acheson 1987), they may be customary, traditional measures, such as women and children being restricted from eating larger game animals, and men from eating frogs, reptiles and small animals among the Wopkaimin of Western Province, Papua New Guineau (Pernetta and Hill 1984), which splits the extractive pressure. In the case of customary measures, conservation is often more passive than active, especially if there are no mechanisms for adaptation with changing resource availability. Such cases should be classed as conservation, but might be described as not adaptable. What qualifies as conservation varies more with the definition of the goals of conservation. Where conservation is the maintenance of resources for future use, active management to enhance useful resources is included. However, conservation is now often associated with the maintenance of biodiversity for as yet unknown uses, in which case management actions which cause local extinction of currently unwanted species are not consistent with conservation. There is clearly a role for both, and conservation of biodiversity must occur within a managed landscape where current and future known uses are given a high priority.

Traditional (or pre-industrial) societies are often believed to live in harmony with nature. Although it is clear from some of the above examples of resource degradation that this is not always true, there are many examples of conservative use within such societies (eg Johannes 1978). People from such cultures commonly see themselves and their actions as an integral part of the environment, which is respected and revered, rather than a separate, foreign world to be exploited and conquered (Croll and Parkin 1992). In most cases they have a long history of resource use in the same region, long enough for the impact of their actions to be incorporated into resource use practices. Immigrants often have less respect for the environment and less knowledge of the impact of their actions, leading to degradation of resources. This may have been the cause of over-hunting by both the Maoris and early settlers in Madagascar, who are relatively new arrivals (within the last 2,000 years).

A major reason for modest resource offtake among traditional societies has been because there was no use for surpluses. In some cases the technology available limited resource offtake. The opening of markets for surpluses and the introduction of new, more efficient resource harvesting technology have repeatedly been seen to transform low, sustainable levels of use to high, frequently unsustainable levels of use. A dramatic example is given by the case of the American plains bison, which occurred in massive herds of 30 to 40 million individuals. The native Americans did not hunt them in large numbers until they got horses from the Spaniards, but it was the arrival of the European settlers and railways from the 1860s which caused a catastrophic decline. Two and a half million bison were killed annually from 1870 to 1875, and the last great herd of 10,000 was killed and transported to the coastal cities for meat in 1883, leaving a meagre 500 when they were officially protected in 1900 (Ehrlich and Ehrlich 1981).

2.2 Ecological approaches in anthropology

Why do some human populations persist in extracting natural resources which cause environmental degradation which is not in their ultimate interests? Under what conditions are resources degraded and under what conditions are they actively conserved by the community? Anthropologists, geographers, biologists, economists and politicians have considered these phenomena from their various perspectives.

Ecology is the study of living organisms in relation to their habitat and environment. Biologists traditionally studied plants and animals and some of the general principles they developed have been applied to human ecology: the study of human relations with the environment. The concepts of systems ecology were adopted by a number of anthropologists (Moran 1990a). Human behaviour and the environment were considered as variables in functional systems, regulated by interactive processes such as negative and positive feedback (McCay 1978). Studies focussed on the flow of energy through small-scale communities (eg Rappaport 1967). Solar energy and collection of non-cultivated resources were considered as inputs to the system while market trading represented both output and input.

Ecosystems have been acknowledged as a useful concept, stressing the importance of the environmental context for the explanation of human behavioural phenomena, and providing a useful research tool to organise data collection, to model input/output relationships and to define hypotheses (Moran 1990a). Agroecosystem analysis has, for example, proved useful in agricultural research and development where systems analysis in a workshop environment enables a multidisciplinary approach, defining key research questions and guidelines for development (Conway 1985). There are, however, several fundamental criticisms of the ecosystem approach (Moran 1990a). An over-emphasis is often placed on the importance of energetic efficiency in explaining system functions with a tendency to ignore historical and cultural factors. It proved difficult to define the boundaries of the ecosystems studied; a fundamental requirement for the ecosystem method. Rappaport (1967) defined boundaries according to territoriality. Ecosystems must be considered at a defined level, and a complete picture is only given by considering a nested hierarchy of systems. In the natural living world these are usually considered at the levels of organism, population, community, ecosystem, biome, and biosphere, and in agriculture they can be considered at the levels of field, farm, village, watershed, and region. As Conway (1985) has pointed out, a basic feature of such hierarchies is that the behaviour of higher systems cannot be readily discerned from a study of the level of lower systems, so that each level in the hierarchy has to be analysed in its own right. Anthropological ecosystem research has tended to concentrate on the village level which gave site-specific information, relevant but not sufficient for region-wide statements and analyses.

Perhaps the most serious problem with the approach occurs where ecosystems are considered to be self-regulating, self-organising systems, controlled by information-carrying feedback loops, for which equilibria and homeostasis are goal states and their ultimate `function' is the survival or self-perpetuation of the system. Evolutionary ecology challenges these assumptions by the application of the basic postulates of natural selection; that each individual acts to maximise the probability of the survival of their genes, through reproduction and the survival of their offspring (Krebs and Davies 1984). It is not the system or the community that acts to ensure its survival, but the individuals within the system, although it may be in their interests to cooperate with other individuals in the community. These principles have been used to develop models such as `optimal foraging theory' which are used to explain prey choice, diet breadth, habitat utilisation, optimal patterns of movement and time allocation as a result of individuals acting to maximise their total expected benefit per unit of foraging time. They can also be applied to spatial organisation to explain aspects such as territoriality, resource competition and predator defence (Smith 1984).

The classic phenomenon of common pasture over-grazing used by Hardin to illustrate the `tragedy of the commons' (Hardin 1968) can be understood by considering the costs and benefits to individuals rather than the community as a whole. Each herdsman takes the rational decision that it is in his interests to add an extra cow, despite the fact that over-grazing may occur. The costs of the resultant over-grazing are shared by the community, but the individual gain of one cow goes directly to the owner. It is only after drastic over-grazing has occurred that the incremental benefit to the individual finally reduces to the point where it is not worthwhile to add another animal. This is long past the point where the costs outweigh the benefits to the community as a whole. Hardin used this model to predict the inevitable over-population of the planet and the diminished satisfaction of visitors to national parks as visitor density increases. McCay advocated a similar shift of emphasis from systems ecology to `people ecology', considering the problems and hazards facing individuals and how they respond as a more apt way to understand community behaviour (McCay 1978).

2.3 Ecology and economics

Both ecology and economics are centrally concerned with the allocation of scarce resources between competing consumers (Bernstein 1981). In contrast with the majority of anthropologists, economists are concerned not only with understanding human behavioural motivation but also its manipulation and control, for example assessing the use of price changes and tax and subsidy incentives to promote certain types of behaviour. There has been some application to conservation programmes within this discipline (eg McNeely 1988, Dixon and Sherman 1990, Munasinghe 1992). Although economics traditionally focussed on the relatively short term financial implications of strategies, there has been increasing recognition of the long term importance of a healthy environment, not only for the maintained supply of valued resources, but also for indirect services and future potential. Interest in environmental economics has grown, and attempts have been made to construct a framework incorporating economic and ecological processes and values (Bernstein 1981, Pearce *et al.* 1988, Tisdell 1989).

Environmental economics covers the relationship between the economic system and the environmental resources that support it, for example by supplying inputs such as minerals, forest products, soil quality and water. There is a wide spectrum of resources and functions, such as the environment's ability to degrade and recycle waste products and the value of biodiversity for potential products and stability through diversity (Pearce *et al.* 1988). The new approaches aim to take the economic phenomenon of externalities into account, where the activity of one group affects the welfare of others who have no direct control, through the market system, over that activity (Bernstein 1981). Pollution is a prime example, where the true long term costs to the wider human population are not perceived by the polluter.

Although the recognition of longer term ecological issues in economics is to be lauded there are numerous methodological difficulties with its application. One attempt to reflect the true costs of goods and services from the environment is offered by energy analysis. The total solar energy costs of producing goods and services, their `embodied energy', is converted to a financial value using a dollar/calorie ratio derived from the ratio of gross national product (GNP) to the total energy cost of producing goods and services to the economy. Such values are demonstrably difficult to calculate and open to large errors, especially as the GNP is based on the current system of undervalued natural resources. In addition, the method does not recognise that the decisions of individuals, which determine market prices, are based on perceived contribution to their welfare, and not the intrinsic value of a resource (Bernstein 1981).

Another more widely accepted technique that has evolved to analyse the economic implications of different strategies is the application of `cost-benefit analysis'. The benefits of one strategy, such as the creation of a forest national park, are compared against the opportunity costs of not adopting another strategy, such as the clear felling of the same forest for timber. This technique also relies on the ability to express all relevant values in pecuniary terms. In an attempt to include dimensions such as future, as yet unknown, uses of resources and the holistic value of preserving biodiversity, the concept of `total economic value' has been proposed (Pearce *et al.* 1988).

Total Economic Value =

Use Value (value of commodity of direct utility)

\+ Option Value (potential user expressing an option to use the commodity at some later date, but there is no certainty of use)

\+ Existence Value (the value of commodities that have no current or future use).

Some economists write the equation differently, separating use values (direct use value + indirect use value + option value) and non-use values (existence value + bequest value). Bequest value is the value that people derive from knowing that others will be able to benefit from the resource in the future (Munasinghe 1992). To estimate the existence and option values, economists tend to measure the public's `willingness to pay'. The same technique is used to determine environmental costs, so that the costs of damage from pollution are evaluated on the basis of how much people are willing to pay to avoid such damage (Bernstein 1981, Tisdell 1989). It has been shown that people are willing to pay for existence values, for example in a laboratory experiment in North America people bid real money, which they were given at the beginning and were allowed to keep if unspent, to prevent a plant species becoming extinct (Boyce *et al.* 1990 in Shaw 1991). Similarly, people pay extra for recycled toilet paper and `environmentally friendly' products, showing a willingness to pay for products which do less environmental damage. The technique does have the advantage that it is based on the decisions of the individual; however, their willingness to pay is in turn based on the value structure of the existing, consumption-oriented economic system that has led to the current imbalances in environmental and economic costs and benefits, and will probably not lead to environmental stability.

Environmental or resource accounting is increasingly applied at the national level to determine the effects of policy decisions and incentives to promote the sustainable use of resources in developing couuntries (Pearce *et al.* 1988). For example, cost-benefit analysis was applied to the national economic implications of the implementation of the Korup National Park and integrated development programme in Cameroon. The project benefits were seen to greatly outweigh the costs, taking into account the opportunity costs (the potential benefits of an alternative strategy) of lost timber value and forest use (WWF/EEC/ODNRI 1989). Similarly the benefits of maintaining Ichkeul National Park protecting a wetlands area in Tunisia have been calculated to outweigh the opportunity costs of not building dams to provide water for irrigation of crops, only using use-values such as benefits from fisheries, grazing, tourism, water purification and supply, and sewage treatment. Although a formal agricultural irrigation project was shown to be more productive, the associated costs using expensive technology and capital-consuming methods meant there was a smaller net profit (Thomas *et al.* 1991).

Although direct and indirect use benefits are most widely used in the justification of protected areas, non-use or *in absentia* benefits of nature reserves have been presented as a primary motivation for the conservation of wild lands (Pearsall 1984). Non-use values are generally considered to be more applicable in developed countries, where the public's willingness to pay for existence value can be valued and extracted, for example through membership of conservation organisations (Thomas *et al.* 1991). Willingness to pay will obviously vary widely with ability to pay, and similar principles applied in developing countries would yield very different values. For comparison the gross domestic product (GDP) per capita in Madagascar in 1988 was 167 USD (United States dollars), while an average figure for developed market economies was 17,387 USD (UNCED 1990).

Some methods developed to measure willingness to pay in developed countries have been applied to conservation projects in developing countries. The travel-cost method uses the visitors' willingness to pay transport and other costs to visit scenic or recreational areas as an indicator of the value of such a place (Munasinghe 1993). This has been used to calculate the value of ecotourism by local visitors to a rainforest reserve in Costa Rica. Each household was willing to pay an average of 35 USD to visit the site, giving a net product value of 1,250 USD per ha (foreign visitors contribute a much higher travel-cost valuation but were treated here at the same value as local visitors) (Tobias and Mendelsohn 1991). In this case the relatively affluent Costa Ricans visiting the park enable a valid valuation using techniques developed for industrialised countries.

The contingent valuation technique uses surveys and hypothetical questions to determine consumers' willingness to pay for protecting or improving environmental quality. This technique was recently used by a World Bank study in Madagascar for both local people and foreign tourists, in combination with other techniques. The value of a national park to foreign tourists was calculated using the travel-cost method to be 24 USD annual mean value per trip, and 65 USD by contingent valuation, which asked how much they would be willing to pay to visit a new national park. The opportunity cost to households living adjacent to the park, of land lost for potential cultivation and forest used for firewood, was valued at 91 USD annual mean value per household. The contingent valuation which asked villagers how important it was to protect the forest for its role in soil protection, prevention of flooding, recreational value (asked whether primary forest was more `fun' than secondary forest), preservation of ancestral graves and to pest control, suggested that a payment of rice equivalent in value to 108 USD per year per household would compensate for loss of use of forest and land in the park (Munasinghe 1993).

The higher willingness to pay of foreign visitors, calculated using the contingent valuation, than they are currently paying, according to the travel cost valuation, perhaps reflects additional existence values incorporated into the contingent valuation. Munasinghe (1993, p. 53) claims that the close correlation between opportunity cost valuation and contingent valuation for local people confirms their usefulness for economic evaluation of national parks. I disagree and believe that this example simply illustrates how difficult it is to get valid results using such techniques in a rural situation in a developing country. The prices used for conversion to USD are probably inaccurate; the price of rice fluctuates widely with season (eg by 100%), and firewood and other forest products are rarely traded in villages so that prices in towns are irrelevant in isolated villages. There is no discussion of available alternatives; it is assumed that all firewood and all new land for cultivation will come from the new park area. A loss in access to firewood would probably be best satisfied by a long-term reforestation programme of suitable fuel wood, not the panacea of cash or rice compensation. Finally, no explanation was given of how the contingent valuation compensation for the loss of use of park land was calculated.

Application of environmental accounting may be relevant at national levels to orient governments toward environmental issues. However, I would contend that the analysis of human behaviour in relation to the environment in purely economic terms is not applicable at a local subsistence level in a developing country. Environmental economics assumes that `rational economic man' is as helpful an abstraction for the developing world as for a Western consumer. People are assumed to respond to economic signals in a continous fashion so as to maximise their own welfare (Pearce *et al.* 1988). Within subsistence economies financial motivation may exist but will be inadequate for a complete understanding.

A further complication exhibited in the above example is the consideration of costs and benefits at different levels. Who pays the costs and who receives the benefits? Even if the aggregate net cost of the park to local people is shown to be less than aggregate net value to tourists, what mechanism is there for the value exhibited by tourists to be paid to local people? It was shown in the survey of foreign visitors that almost 50 % of the total cost of the trip is spent on foreign travel (Munasinghe 1993). Thus perhaps half of their travel cost value enters the national economy, paying for national travel and accommodation, but only a small amount goes towards park entrance fees (approximately 11 USD of an average of 1,484 USD spent in Madagascar [from Munasinghe 1993, p. 50]). A proportion of those fees must go towards maintaining park infrastructure, and the central government would prefer to receive some revenue. Although the costs to local people may come into the national resource accounting equations, measures to provide compensation depend on a variety of practical and political considerations. The value of non-wood rainforest products, such as fruit and rubber, harvested sustainably from Amazonian rainforest has been shown to be significantly higher than clear felling for timber, or sustainable selective logging (Peters *et al.* 1989). However, the importance of the immediate revenues from timber extraction to the national economy, the government and influential private business, may mean that the high, long-term value of the resource to large numbers of local peasant farmers and the regional economy is inconsequential in national decision-making. Most resource use strategies evaluated at the national level consider the impact on GNP, but a good economic decision at the national level does not always imply stability or equity when considered at other levels, such as from the point of view of local people. Similarly at the international level, where people in industrialised countries exhibit, and are willing to pay for, existence values of reserves in developing countries the conservation movement must provide a mechanism for this value to reach those who are paying the local cost of maintenance of the reserve.

Another major difficulty in applying economics to ecology is in reconciling the different time frames. Economics is biased towards the evaluation of short term benefits and costs, while the environmental consequences of actions are usually evident in the much longer term. Economists tend to apply discount rates, such that benefits in 10 years time are typically worth 35% of their real value, and 12% after 20 years, calculated at a 10%

discount rate typically applied to investments in the developing world (Pearce 1993). Costs are given the same treatment. If no discounting took place, the benefits of a low sustainable yield would far outweigh a one-off harvest. Similarly the long term costs of global warming and pollution would dramatically inhibit our pollution today. Pearce (1993) proposes that for environmental projects a discount rate of 2 to 5% is appropriate but such low rates are rarely used. In three examples rates of 5 to 8% were employed: 6% for Tourist Lodge Development, Ngamiland Botswana (p. 142 in Swanson and Barbier 1992), 8% for Korup social cost-benefit Analysis in Cameroon (Ruitenberg 1989, p. 158 in Swanson and Barbier 1992), and 5% for financial returns to non-timber products and other forest uses in one hectare of forest at Mishana, Rio Nanay, Peru (Peters *et al.* 1989, p. 157 in Swanson and Barbier 1992). Economics employs discounting for the good reason that human beings often make decisions in that way, and the level of discounting can vary dramatically in different circumstances. Chambers (1983) contends that the poor, through necessity, give high priority to immediate satisfaction of needs and the avoidance of risk and it is the enlightened rich who can afford to give priority to sustainability or higher productivity.

Economic analysis also tends to concentrate on components of habitats, rather than the integrated whole. Often if one part of an ecosystem is removed this involves an external cost through loss of function in another. For example, Brazil nut plantations in South America failed because they required pollination by a rainforest bee (Pearce *et al.* 1988). It ignores the fact that ecosystems differ in resilience to stress, and that there are ecological limits to resource use (Bernstein 1981). The uncertainty of the impact of the loss of different species and the irreversibility of extinction has led some economists to argue that the value of preserving a species could far outweigh the costs of its conservation, and provision should be made to guarantee its continued existence (Bishop 1978). This has become known as the `safe minimum standard' approach, and implies an extremely cautious attitude toward risk taking where the uncertainty and complexity of ecosystem dynamics and future human use of resources are concerned (Tisdell 1989). Species rescue conservation projects are, however, notoriously expensive, difficult to achieve when the wider causes of the impending extinction are not resolved, and may not be the best approach to ensuring environmental stability.

2.4 The quest for sustainable development

In reality the complexity of natural ecosystems and human societies is such that the models described so far appear only to address certain aspects rather than consider the complete problem as an integrated whole. Some of these complexities have been recognised in the debate on the goals of, and means to achieve sustainable development. Even in its simplest terms with respect to the harvesting of a natural resource `sustainability' can mean many things: sustained yield in terms of volume or value, or constancy of natural capital stock (eg soil, water, biomass) irrespective of yield. In economics sustainability has been used to mean the maintenance of standard of living, implying an increased use of resources as the population rises. For development projects sustainability involves the continued yield of benefits after donors have withdrawn support. Sustainable development has come to represent a more complex set of goals leading to economic, ecological and social stability over the long term. The economic aspect of sustainable development may be described as maximising the flow of income while maintaining the stock of assets that yield these benefits. Conway (1985, p. 35), referring to agroecosystems, describes sustainability as "the ability of a system to maintain productivity in spite of a major disturbance, such as is caused by intensive stresses or a large perturbation". Expanded to a more general application the ecological aspect of sustainable development emphasises the maintenance of ecosystems and protection of biodiversity such that natural systems maintain their resilience and natural ability to adapt to change (Munasinghe 1992). Redclift (1987) has made strong arguments for the importance of social and political elements of sustainable development. The most ubiquitous social goal in definitions of sustainable development is enabling future generations to meet their needs, or intergenerational equity. The demand for equity between generations is logically extended to equity within generations (intragenerational equity), giving priority to satisfying the needs of the poor. The basic mechanism envisaged for achieving this amounts to redistribution with sustainable growth. As benefits of growth are not usually equitably distributed within or between societies, there is clearly a fundamental political and institutional dimension to achieving sustainable development (Simon 1989). The primary objective of sustainable development can be stated as to "reduce the absolute poverty of the world's poor through providing lasting and secure livelihoods that minimise resource depletion, environmental degradation, cultural disruption, and social instability" (Barbier 1987, p. 103). In order to achieve this, Barbier proposes that development strategies must be ecologically sustainable over the long term, be consistent with social values and institutions, and encourage `grassroots' participation in the development process.

In an attempt to propose a theoretical framework for sustainable economic development Barbier (1987) suggested that it is necessary to consider the interactions between three systems: biological, economic and social. He suggested that the system goals might include:

economic system goals
- satisfying basic needs
- equity enhancing
- increasing useful goods and services

social system goals
- cultural diversity
- institutional stability
- social justice
- participation

biological system goals
- genetic diversity
- resilience
- biological productivity.

It is acknowledged that not all aspects can be maximised simultaneously in all situations. As conditions change there is a continuous dynamic system of tradeoffs. The aim is to maximise goals across all systems by an adaptive process. The qualitative elements are inseparable and cannot be measured by any concept of direct economic gains, therefore decisions must be made on a combination of both quantitative and qualitative information. Goal programming has been proposed to enable decision making through modelling of relations between defined variables reflecting the goals of different systems, such as genetic diversity (number of species), goods and services (value of production), food production (joules), energy use (joules), and equity (household income). The programming model is used to assist in defining resource allocation strategies that come as close as possible to meeting the specified target levels for the respective goals, taking account of the relative importance assigned to each goal (Cocklin 1989). Although such an approach might prove useful in some circumstances, the goals overlooked because of the need for measurable indicators, the difficulty of defining mathematical statements to represent the complex relationships and the large amount of data required, make the applicability limited. The best approach is probably to define goals and priorities, to select indicators where appropriate, and to qualitatively assess the trade-offs and probable implications of different strategies, using the goal programming structure as a decision-making tool.

Considering mechanisms for implementing sustainable development it is useful to consider in more detail the conditions under which resource conservation occurs. Hardin's influential paper (1968) predicted that all common property resources were doomed to over-exploitation and that state intervention (enforcement of modest resource use by coercion) or privatisation (internalising the costs) were the only remedies. There are, however, numerous examples of cooperation between people to limit resource use within rates which allow for resource renewal (see Section 2.1). Hardin recognises only three types of ownership: state, private and open access (which he calls `the commons'). There is another category which is communally owned. In many traditional societies some resources are communally owned. Often those resources which are needed by all, are of diffuse productivity and low or unpredictable yield, tend to be common property with equal though not unrestricted rights to group members. Smaller, more easily divisable and more highly productive areas, which are economically defendable, may be owned and inherited by individuals (McCay and Acheson 1987). For example, the Cree Indians of eastern James Bay in Canada only have individual territories for hunting of beaver and Canada goose, which are the most productive and predictable game (Berkes 1987).

A review of the above literature on common property resources suggests that the conditions under which their conservation occurs are:

i) group members are frequently interacting individuals,
ii) the behaviour of users can be monitored and there are mechanisms for dealing with individuals who break the rules,
iii) the resources are defendable against outsiders, and
iv) the impact of use on resource stocks can be determined and there are mechanisms to adapt rules with changing availability of the resource.

The benefits of such behavioural systems appear to benefit the group, so individuals seem to be acting in group interests, which is contrary to the maxim that individuals always work in their own interest, maximising genetic survival. Group cooperation can still be explained without abandoning the tenets of natural selection. It has been shown that cooperation or altruism between non-related individuals will evolve when reciprocating individuals have a high probability of future encounters; so that when resources are given, there is a high probability of receiving resources in the future (Axelrod and Hamilton 1981). Vampire bats roosting communally give food to neighbours after a successful hunting expedition (Wilkinson 1984). Cooperation and reciprocity is most evident among long-lived social species such as chimpanzees, lions and African elephants, and we exhibit similar traits (Heinen and Low 1992). Human groups tend to cooperate over resource use where there is high inter-relatedness and where there is a high frequency of contact over a long period; when other members are people that can be trusted. However, simple trust is often not sufficient and the requirement to be able to monitor the actions of others and to sanction those who break the rules has also been shown to be important.

Common property regimes have been championed as a model for sustainable development (Berkes 1989). They provide access to resources equitably, sustainably and at reasonable cost. Where they are able to adapt to new changes and cope with stress and shocks they are also stable and resilient. The challenge is to create the conditions under which they will thrive. Creating such institutions anew is a difficult task, but there is a growing interest in maintaining, enhancing or recreating traditional management systems to control the use of resources. In many countries the advantages of traditional management systems were unrecognised and governments, especially colonial administrations, imposed new rules, undermining traditional control. For example, the British colonial administration in Lesotho in the 1930s enforced a new strategy of contour banks for prevention of soil erosion, which actually created erosion gulleys, without even acknowledging, let alone evaluating the existing traditional systems using grassy field boundaries (Showers and Malahela 1991). In the worst cases there has been transformation from common property resources with the associated rules for sustainable use, to open access resources (even state owned resources may become open access if enforcement is minimal) where uncontrolled over-exploitation has occurred, leading to degradation. The national Government of Nepal introduced state control of forests in 1957, undermining traditional local management, and although new laws were passed in 1977 in an attempt to return the ownership and management of forests to the people, there has been very limited return to traditional methods (Sattaur 1987). Other cases where efficient traditional systems have been identified and strengthened without disruption have been more successful. The Japanese common-property fishery system, **iriai**, is an example where modern natural resource management legislation can be designed to support and strengthen traditional common property systems successfully (Berkes and Farvar 1989).

There has been growing recognition of the relevance of not only social institutions, but also indigenous technical and ecological knowledge for conservation and sustainable development. As mentioned above (Section 2.1) traditional societies often remain sufficiently long in one region to build up immense knowledge of their environment and the impact of their use on resources. This knowledge has been woven into the fabric of their cultural inheritance, such that beliefs, knowledge and practice are integrated with, and form part of the ecology of their immediate environment. Anthropology thus has a fundamental role in conservation and development, by contributing the "ways in which people bring their cultural imaginations to bear on the utility of resources...Anthropologists are not just concerned with technical or ecological questions, but with the construction of knowledge and the power and pressures behind choices and decisions" (Croll and Parkin 1992, p. 3). Conservation and development will only be adopted locally where it makes sense, and since decision making is based on our cultural backgrounds, it must make sense culturally. The social and cultural mechanisms of resource use are hence a vital element in the quest for sustainable development.

2.5 Investigating local people and protected areas: an integrated approach

The aim of a protected area project is to ensure the stability of the protected area, its continued maintenance being a means to protect biodiversity. As described in Chapter 1, the conflicting concerns of groups interested in the maintenance of the protected area, or the alternative uses of the resources it protects, are such that stability may be hard to achieve, and will always be dynamic. An equilibrium is required between the conflicting interests. A protected area may be justifiable in economic and political terms at the national level, but this research is concerned with stability at the local level. A major objective of many protected area projects at the local level is to ensure that people have no need for the resources in the reserve, by ensuring a productive and stable provision of resources, at least sufficient to satisfy basic subsistence needs, in areas outside the protected area. Even if this is achieved, the area will not necessarily be protected from encroachment and resource extraction, as the protected area may still represent a supply of valued resources which can be used to improve the quality of life. Beyond decisions made purely on the advantages of extracting reources, people who resent the imposition of a protected area may well destroy parts of it in protest. In Madagascar areas are burned illegally as a political statement against the authorities. A recent study found that attitudes of residents toward a nearby protected area in Nepal were generally negative (when asked in a survey whether overall they liked or disliked the reserve, and why), despite some measurable economic benefits stemming from the reserve, such as providing thatch and fish for their own use and sale. Respondents tended to over-estimate the costs of the reserve, for example exaggerating the occurrence of crop damage and size of permit fees, and under-estimated the benefits (Heinen 1993). The presence of the park must therefore also be socially and culturally stable. Expensive enforcement of park rules is not ideal, and a more efficient and equitable solution is to ensure that the maintenance of the protected area receives the support of local people, such that they respect the rules and even defend the area from use by outsiders. It must be recognised that there is a continuous spectrum from enforcement with a hostile local community, to a supportive local community where no enforcement is required. Many protected area projects may require some legal enforcement of rules to protect resources within the area.

In many cases the local instability of protected areas is recognised, and funds are increasingly being made available to invest in the local area in order to create stability. The problem is essentially one of sustainable development, making investments to ensure lasting and secure livelihoods for local people that minimise resource depletion, environmental degradation, cultural disruption, and social instability (see Section 2.4 above).

How can the above review of approaches to understanding and influencing human use of the environment help to define a useful approach to the investigation of how to reconcile local people and protected areas? It is clear that different approaches have their strengths but are criticised for not incorporating or giving sufficient weight to other aspects. Attempts to consider all factors quantitatively from one perspective, be it energy flow or financial units, encounter repeated problems with valid translation into a new field, and do not reflect all influences acting to determine resource values. Energy flow and environmental economics do not reflect the importance of historical and political factors. Social and cultural understanding does not explain how people satisfy basic needs and the importance of trade. All must be set within the context of ecological constraints and goals, such as resource availability, resilience to use and the maintenance of biodiversity. The integrated approaches to sustainable development exemplify the relevance of a multi-disciplinary approach.

Many of the criticisms of energy flow approaches were directed at their exclusion of other factors, and their application within the framework of homeostatic and self-regulating systems. I believe that as part of an integrated approach to understanding people's use of resources, energy analysis has an important role to play. People do make resource use decisions on how much energy or effort is required to collect them. This is particularly true in the rural societies I have studied in Madagascar where many basic resources are collected from the environment, but may also be applied to decisions in industrial societies about whether to go further to purchase a different product. The energy required to collect a resource is closely linked to its changing availability and distribution, and is thus an important feedback link in the modification of resource collection to maintain future stocks. I propose that time spent and distances travelled in the collection and processing of resources are a measure of the effort (or energy) used (although may not be proportional). Resource consumption, particularly the satisfaction of basic needs, can also be usefully considered from an energy perspective. Although prices may vary, a certain energy value is required to provide sufficient food or fuel. The energy approach seems very relevant in the societies studied, where many of the resources used to satisfy basic needs (such as food, shelter and cooking fuel) are cultivated or collected, and financial values are hard to ascribe.

Although it would not make sense to attempt to describe all resource uses in financial terms, especially where there is a large subsistence component, some resource decisions are clearly made on financial grounds. Where there is a market for resources, collection or production is greater than that necessary to satisfy basic needs, and the nature of the markets influence resource use. Some resource consumption is supplied by trade, and the reliance on traded goods in relation to those cultivated and collected is an important aspect in understanding people's use of natural resources.

Cultural, social, historical and political factors are clearly important influences on resource use in every society. Much resource consumption is dictated by what is culturally important or socially acceptable. Social control of resource use may also greatly influence the impact of resource use on the environment, as seen from the examples of the common-property regimes described above. Finally, the influence of environmental variables on resource use, and the environmental impact, are clearly of fundamental importance in a protected area project, where the main objectives are regional ecological stability and maintenance of resources in the protected area.

I propose that in order to understand the factors affecting local people's behaviour in relation to resources it is useful to consider resource use from four different perspectives: energetic, economic, cultural and ecological.

1. The **energetic** perspective considers the role of energy expenditure and consumption in influencing resource use. Energetic analysis considers those factors which can be converted to calories such as the effort required to collect a resource, which can be reflected in distances travelled and time spent.

2. The **economic** perspective considers the extent to which market supply and demand plays a role in and influences resource use. Economic analysis can be made by assessing elements to which a monetary value can be assigned.

3. The **cultural** perspective considers all social influences on resource use, which may result from a combination of social organisation, local beliefs and customs, or political influences.

4. The **ecological** perspective considers the environmental impact of resource use, for example on size, distribution and resilience of wild plant and animal populations.

The economic, energetic and cultural factors act together to define the value of resources and drive people's behaviour in relation to those resources. This behaviour may affect the ecological system, altering the availability of useful resources, depending on the level of use and the resources' resilience. Economic and energetic values can be measured from observation of people's behaviour, in terms of `willingness to pay', financially or energetically. Energetic willingness to pay is shown by the effort expended in collecting and processing a resource, which is indicated by the time allocated to that activity and the distances travelled to collect the resource. The cultural influences cannot be measured directly but can be inferred by their influence over energetically and economically expressed behaviour.

These three dimensions are highly interdependent and act together to determine the value of a resource. They can be considered like three connecting cogs that turn together to determine behaviour. The relative influence, or the size of the cog, of each element will vary with the resource, the time, the place and between individuals.

There are outside influences affecting each element which apply a leverage or a resistance to that cog. For example the demand outside the local community for a particular resource will determine the income that can be generated from collecting and selling that resource, so increasing the economic benefit per unit of resource.

The availability of resources affects the energetic effort required to collect them. In this way a feedback link is established from the effects of behaviour on the ecological system, which may act to reduce the availability of a resource, resulting in an increased energetic cost per unit of a resource. The response to that increased cost may be to reduce consumption proportionately. Alternatively, if cultural or economic values increase, because the commodity is very necessary or important, consumption may stay at the same level (or increase) at the increased cost.

Behaviour is continually adjusted in response to changing influences from the different factors, tending towards an equilibrium. There is integrated evaluation of influences, and impact on behaviour may be immediate or with some delay. The equilibria are frequently unstable. For example, in the ecological system, collecting behaviour may continue, even to the point of extinction of the collected resource. The feedback is either not strong enough, is not well perceived,

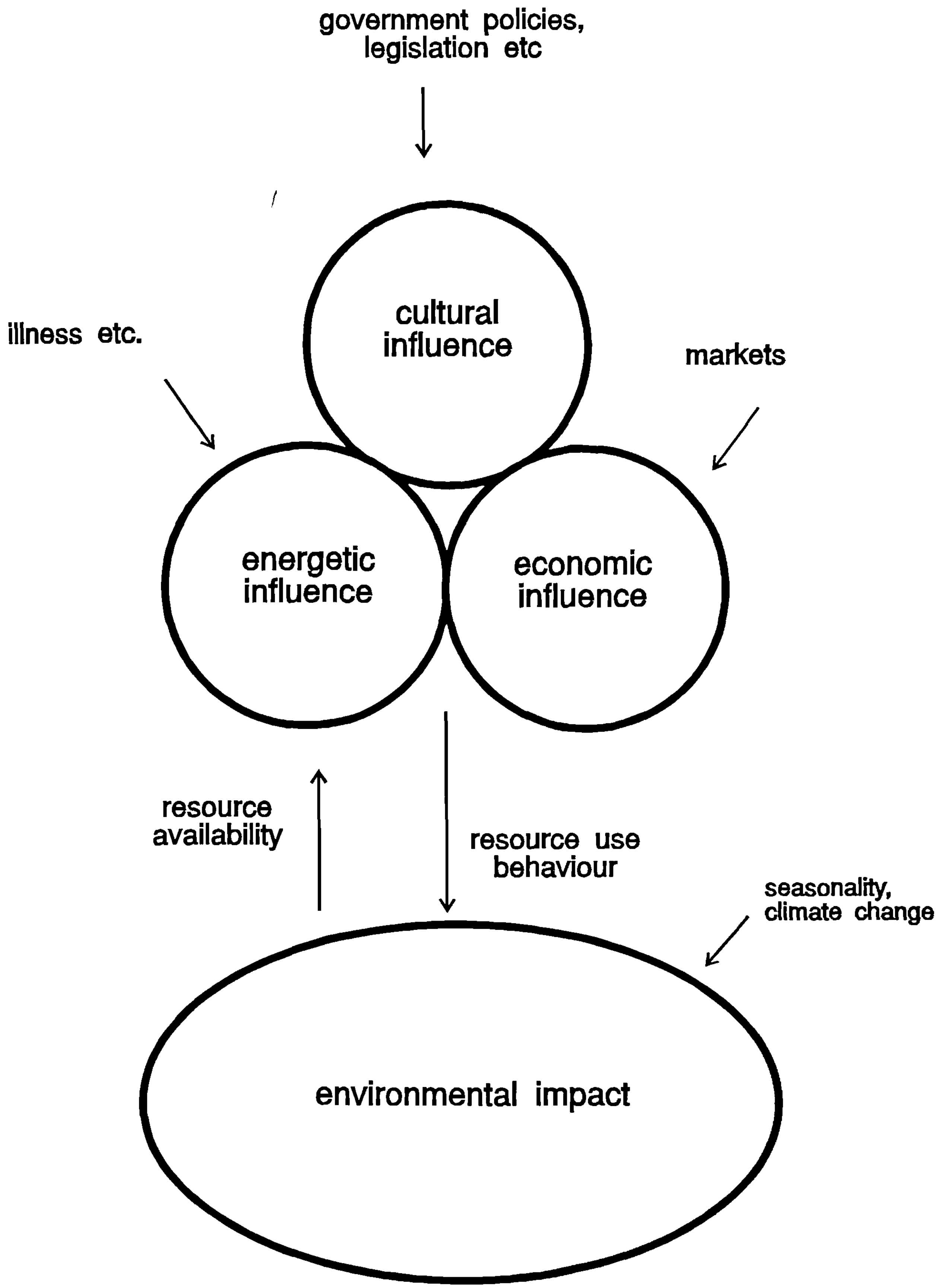


Figure 3.

Schematic diagram showing the combined influences on resource use behaviour or is overridden by stronger economic or cultural factors. See Figure 3 for a diagrammatic representation of this model.

In order to investigate the role of local people in the maintenance of a protected area the following research questions were pursued:

i) how do people use natural resources?

ii) what factors influence their use?

iii) what are the environmental impacts and implications for maintenance of the protected area?

iv) how should protected area management plans integrate local people's interests to ensure maintenance of the protected area?

People's resource use and the factors influencing their use were investigated from energetic, economic and cultural perspectives. These analyses are presented for the two case studies in Madagascar in Chapters 4, 5 and 6 respectively. As each perspective gives a different view of the same issues, considering each one shows the influences of the other factors. For example seemingly irrational financial decisions can be explained by considering cultural influences. People can be seen to pay more for convenience, or saving energetic effort. People spend longer collecting resources which have cultural significance. The importance of the different factors varies according to the cases considered; in modern Western societies economic factors are very important, and behaviour is very sensitive to prices, taxes and the like. What is the relative importance of the different factors in these case studies in Madagascar?

The environmental impact was investigated from the local people's perspective, by recording the species used and local knowledge of their availability and distribution. Resource use maps and local perceptions of changing availability give a picture of the uses affecting the protected area and the resources vulnerable to overexploitation. This ecological perspective is presented in Chapter 7 and the implications for the management of the protected areas are discussed in Chapter 8. The protected area management was considered from critical observation of the activities of the protected area projects to date, and suggestions are made from the economic, energetic, ecological, and cultural analyses.

I also believe that protected area project goals should be redefined beyond their traditionally narrow conservation objectives. From consideration of the four perspectives, I propose modifying protected area project goals following Barbier (1987):

ecological goals

- maintain the protected area such that biodiversity is conserved
- ensure sustainable use of resources outside the protected area
- maintain and improve productivity of resources outside the protected aréa

energetic goals

- satisfy basic human needs; for example food security and adequate shelter
- minimise effort required in satisfying basic needs

economic goals

- increase opportunities for income generation, and ability to respond to such opportunities
- target income at those bearing cost of protected area maintenance

cultural goals

- promote cultural and social acceptance of and support for the protected area
- promote institutional stability
- ensure participation

All goals should be seen to have an impact on the ecological goals which are the primary goals for a protected area project.

I propose that both the goals of protected area projects, and strategies employed to achieve those goals, should be considered using such an integrated approach. Development benefits associated with conservation cannot be reduced to financial concerns, nor be considered solely in terms of provision of resources but must have the cultural approval of the people involved, and be appropriate within the wider national culture, politics and institutions.

Chapter 3.

RESEARCH METHODS AND STUDY SITES

3.1 The focus and scope of the research

The analytical framework developed in Chapter 2 seeks to promote an integrated understanding of the role of local people in the maintenance of protected areas, by taking energetic, economic, cultural and ecological factors into account. My own research has attempted to apply this approach to protected areas in Madagascar, to determine different factors affecting local people's use of natural resources and their relations with a nearby protected area, and to demonstrate the utility of such an approach. A case study approach was adopted; research was limited to two protected areas in Madagascar and to two villages, or settlement centres, at each of these sites.

A compromise was required between studying a larger sample, from which results would be more confidently representative of the full set of cases, and studying some cases in more detail. The advantages of a participant-observation (or ethnographic) approach are that detailed first-hand knowledge is gained, and there is greater probability of the wider context of certain activities or beliefs being understood. The research typically continues over one or more years, during which time the researcher often learns the local language, and is able to gain the confidence and trust of the people. Despite the fact that a researcher can never be fully integrated into the life of a community, the knowledge and understanding of the society studied is likely to be much more profound and accurate than that gained from other less intensive methods.

Apart from the time and commitment required from the researcher, the greatest disadvantage of such an approach is that detailed research is limited to one place, which may not be representative of the wider population. Another drawback is that research is limited in time, often to a year, which may be unrepresentative, for example during a period of drought or famine. However, researchers are often able to put the unusualness of their observations in context through discussion with their informants. Other methods often sample an even shorter time frame and do not cover seasonal variations.

Surveys, using questionnaires, may be used to study a greater percentage of the population. Techniques have been developed which maximise the representativeness of samples and the validity of responses. Samples should be randomly selected from the entire population and questions should be carefully worded, after sufficient earlier research to ensure that the questions are meaningful and adequately reflect the subject under study. Appropriate statistical techniques must be employed to ensure that data are presented accurately and correct conclusions are drawn. There are many pitfalls which might introduce bias and invalidate results, and a certain amount of qualitative research is always necessary both for preparation and to put the results of a survey into context. Quantitative information from surveys and qualitative information from participant observation are complementary and can be effectively used in conjunction. The relative usefulness of the different research techniques depends on the subject and level of the research.

A macrolevel (region-wide) study requires aggregate data from a broad and representative sample of the universe in question. A microlevel study involves the observation of individuals in a population to understand the internal dynamics of a population (Moran 1990b). It is necessary to define the level at which research is conducted, and to be clear of the applicability of that research to other levels. Observations and conclusions reached at each level are often distinct from relationships and features observable and relevant at another level. Higher levels often set constraints for lower levels, and hierarchy theory predicts that higher levels can be used to predict the outcome of an event on a lower level, but it is more difficult to move in the opposite direction (Fox 1992).

While national models are necessary for government planning and to target international assistance, and regional models are important for management and planning of a particular protected area, this research specifically aimed to investigate local people's use of natural resources and their relations with a protected area. It was therefore most appropriate for this research to be conducted at a village-level, investigating individuals and small-scale communities. It should be noted that the insight gained at this level, although vital in ensuring the success of integrated conservation and development, is not adequate to form regional or national policies, which require more generalised research at a higher level. While the majority of research effort and time was devoted to the study villages some regional perspective was gained by short visits to other villages in each region, and a national perspective was gained by some short visits to other protected areas.

I originally wanted to work at three protected areas in Madagascar, but it became clear that both the time taken in travelling between sites, and the time needed to become familiar with a third area and a new set of people would detract too heavily from the time available for fieldwork. I therefore decided to work at two contrasting sites. At each site I decided to concentrate on two village centres, also with contrasting characteristics. In this way I could exploit many of the advantages of the ethnographic method, but study at least two villages to get a clearer understanding of the limitations and characteristics of each sample. In particular I found it was an advantage to spend several weeks at each visit and return to villages repeatedly so that people became used to my presence, were more welcoming when I visited their houses, treated me less as a special visitor to whom a meal should be given, and were more willing to answer questions. In addition I was able to visit the same villages at different seasons during the two year fieldwork period, which was very important to learn about changing activities and availability of resources over the annual cycle.

3.2 The study sites

The two protected area sites were chosen both for their contrasting characteristics and because of possibilities for collaboration with conservation projects already working in each area. Andohahela was among the first reserves to be created in Madagascar and is a strict nature reserve, allowing no local use or tourism. An integrated conservation and development project was started in 1989, which aimed to improve the relationship with local people. World Wide Fund for Nature (WWF) has been closely involved with the planning and management of this project since 1987, in collaboration with the Malagasy Government. Their interest in and support for my research enabled me to study villages where the project has been active. It also meant that the findings of the research will contribute to the planning and management of the protected area project.

At Soalala, Jersey Wildlife Preservation Trust (JWPT) and the Malagasy Government, are developing proposals to create a protected area to protect an endangered tortoise. JWPT supported my research to ensure that there was an emphasis on collaboration with local people in the recommendations for, and subsequent development of a protected area.

These two protected area projects are therefore at different stages of implementation of integrated conservation and development projects, have a different history of conservation measures, are in different biogeographical regions, and are among people of different ethnic groups.

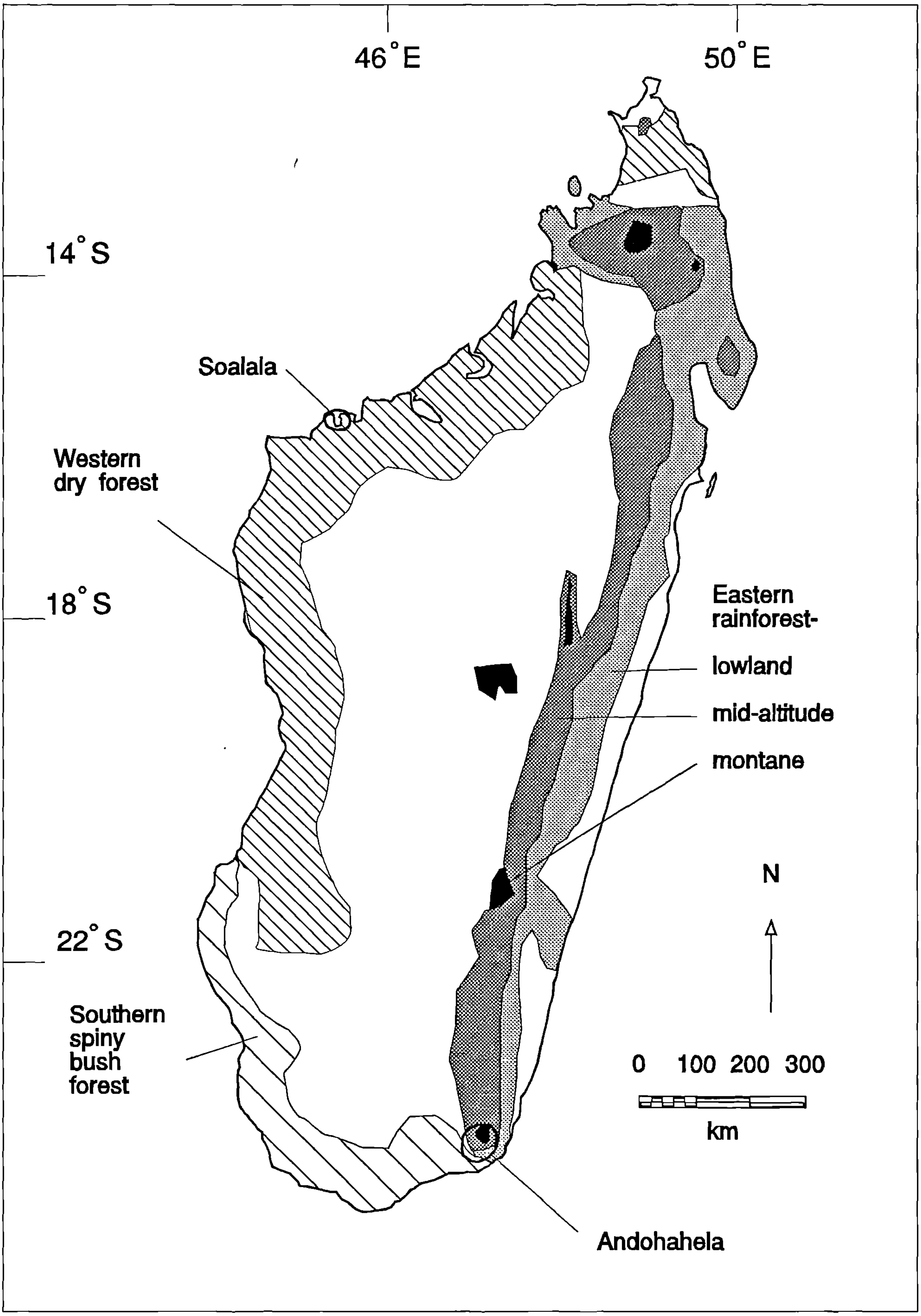


Figure 4. Map of Madagascar showing zones where different forest types occur and showing study sites

3.3 Andohahela

Reserve history

The Andohahela reserve (Réserve Naturelle Intégrale No. 11: 24°30'- 58'S, 46°32'- 52'E), in the extreme south east of Madagascar (Figure 4), was first established in 1939 and boundaries were officially marked around an area of 76,020 ha in 1966. It is a strict nature reserve; access is forbidden except for scientific research (authorised by the Ministry in charge of the administration of water and forests) and any local use of resources or alteration of the natural environment is strictly forbidden (Nicoll & Langrand 1989). The integrated conservation and development project (initiated in 1989) has been funded by the United States Agency for International Development (USAID), WWF and private American foundations, and managed by the Directorate of Waters and Forests (DEF) and WWF (O'Connor 1990). Since 1992 the para-statal National Association for Management of Protected Areas (ANGAP), set up under the Environmental Action Plan (see Chapter 1, Section 1.8), has taken over the management role of DEF.

Regional biogeography

The reserve is the third largest protected area in the country and covers an unusually varied area including sub-montane and montane moist forest typical of the Eastern Region (or East Malagasy regional centre of endemism) and spiny thorn forest typical of the dry Southern Domain (part of the West Malagasy regional centre of endemism) (White 1983, Nicoll and Langrand 1989) (Figure 4). The reserve is divided into three non-contiguous parcels (Figure 5) of which the largest (63,100 ha, Parcel 1) covers the Andohahela massif (rising to 1,972 m) and represents the southernmost extension of eastern moist forest. Parcel 2 (12,420 ha) covers spiny thorn forest, and Parcel 3 (500 ha) covers a belt of vegetation transitional between spiny forest and eastern moist forest, with a high density of the locally endemic triangular palm *(Neodypsis decaryi)* (Jenkins 1987).

The fauna includes species typical of the east and the south. Some primate, bird and reptile species present in Parcel 1 are replaced by taxonomically similar but ecologically different species in Parcel 2. As a result the entire reserve represents an area of particularly high biodiversity, with 13 primate species recorded (Nicoll and Langrand 1989).

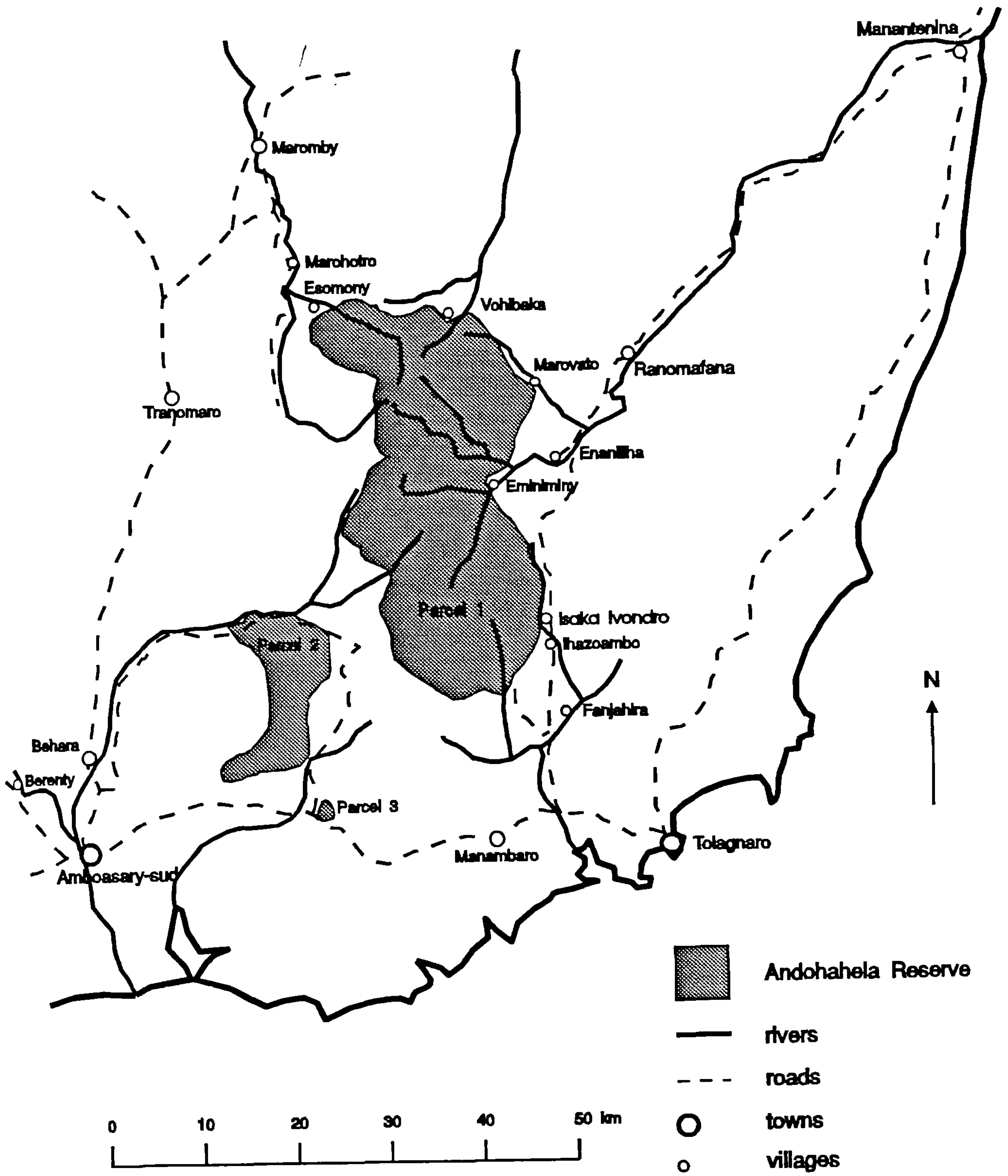


Figure 5. Map of the Andohahela area

Climate

The climate in Parcel 1 is humid, with annual rainfall of 1,500 to 2,000 mm, while Parcel 2 is much drier with annual rainfall of 600 to 700 mm (Nicoll and Langrand 1989). Donque (1972) describes the sharp boundary between the semi-arid southern climate and the tropical damp climate of the south east coast as a `pluviometric fault', running along the Anosy mountain chain, over which Parcel 1 lies. The meagre annual rainfall on the western side is aggravated by the great irregularity of precipitation (see graphs of weather data in Appendix 3). From 1990 to 1992 annual rainfall was particularly low (mean at Behara 376.2 mm [Service Météorologique, Antananarivo]), and caused three years of very poor harvests. The locally recognised seasons are: **fahavaratra**, the wet, cyclone season (December to April); **asotry**, the colder, drier season (May to August); and **lohataona**, the warmer, spring season (September ~~and~~ to November). Cyclones hit Madagascar relatively frequently, mostly occurring between January and March, bringing high winds and rainfall, and can cause great devastation (Jenkins 1987). Parcel 1 is an important water catchment area which supplies water to adjacent agricultural areas, including extensive irrigated rice fields.

Local ethnic groups

People of the Antanosy ethnic group inhabit the eastern area of the reserve (Parcels 1 and 3) and the area to the west of Parcel 2 is predominantly inhabited by people of the Antandroy ethnic group. Anosy is the name of the region around Fanjahira (south east of Parcel 1), the original governing centre of the Antanosy region (Flacourt 1661 in Grandidier *et al.* 1913, Kent 1979). At the time of Flacourt's visit (1656-1660) there was an elite which he referred to as `blancs' (whites) called Zafiraminia (descendants of Raminia) who ruled over the `noirs' (blacks). The Zafiraminia were descendants of Arabs, who arrived on the east coast of Madagascar at the end of the 13th or early 14th century (Beaujard 1983, p. 39), although it is likely that they arrived in Anosy in the 15th century (Kent 1979, p. 82). The racial distinction is no longer evident around Andohahela, but some Arab influences, particularly the arts of divination, astrology and healing, play an important role in local culture.

The Antanosy primarily grow irrigated rice (*Oryza sativa*) and raise cattle. Rice is both the main food and the main cash crop. Cattle are important economically and culturally; they are used for the preparation of rice fields, for sacrifices, for example at funerals, and for ritual exchange, for example for bridewealth. The Antandroy, who inhabit the inhospitable arid area of south west Madagascar, are mainly pastoralists, raising cattle and goats, but cultivating maize (*Zea mays*), sweet potatoes (*Ipomoea batatas*) and millet

(*Pennisetum americanum*) when rainfall allows. The two groups speak different dialects of the Malagasy language.

Regional administration and economy

The Andohahela reserve is in the administrative Province of Toliara, and spans the two Fivondronona (next administrative level) of Tolagnaro and Amboasary-sud. The region is linked by very poor roads north west to Toliara (380 km) and north to Fianarantsoa (400 km). There are usually three flights per week connecting Tolagnaro with Toliara and Antananarivo. Tolagnaro is a minor port, and sisal (from plantations near Amboasary-sud) and seafood are the main local exports. Tourism is increasingly contributing to the local economy. There are six hotels catering for international tourists, many of whom visit nearby private lemur reserves, for example at Berenty (10 km north west of Amboasary-sud). Negotiations are in progress on a proposal to extract titanium ore from coastal areas north of Tolagnaro which would be a 30 to 40 year project creating around 500 jobs (EIU 1993).

Threats to the reserve

Deforestation resulting from bush fires, slash-and-burn cultivation and wood-cutting has progressively eroded several areas of the reserve. Pasture areas are burned annually to stimulate new growth and kill parasites, and these fires often become uncontrolled. Cattle and goats roam freely in many areas in the reserve. There is some hunting of animals for food. Construction wood is extracted for local use. Charcoal is made south of Parcel 2 for sale in nearby towns and threatens to encroach into the reserve. There is selective collection of plants for food and medicinal purposes. Collection of seeds and young plants of rare ornamental species, such as the triangular palm, occurs (Nicoll & Langrand 1989).

Reserve management

The activities of the Andohahela Project include the construction or repair of small irrigation canals or water diversions for irrigation of agricultural land and village water supply adjacent to the reserve, with one completed by 1993 and several others planned. In exchange the local people make a commitment not to cut trees or clear land above the dam to protect against the destructive effects of erosion. Nature protection agents (APNs) have been recruited from 11 villages after approval by the village. A central project team has been recruited, including a community development agent and two education staff. Twelve village tree nurseries have been established which are managed by village representatives employed by the project. Trees are planted by individuals or community groups. Several market garden demonstrations have been given and tools and seeds have been distributed. Primary schools in nine villages are supported by the project education programme, which includes environmental training for teachers, provision of school materials and encouragement to grow school gardens and plant trees. Firebreaks have been created along many of the boundaries, organised by the APNs.

The study villages: Eminiminy and Esomony

The two villages chosen for this study in the Andohahela region were Eminiminy, on the wetter eastern side of the Andohahela massif, and Esomony on the drier western side (Figure 5). They are both populated by people of the Antanosy ethnic group and their main activities are rice cultivation in irrigated, terraced rice fields and cattle rearing. Manioc (*Manihot esculenta*), sweet potatoes, maize, beans (such as *Phaseolus vulgaris, Vigna unguiculata, Voandzeia subterranea*) and other vegetables are also grown. Bananas (*Musa* sp.), oranges (*Citrus* sp.), papaya (*Carica papaya*) and mangoes (*Mangifera indica*) are grown everywhere, but lychees (*Litchi chinensis*) jack fruit (*Artocarpus heterophylla*), avocados (*Persea americana*), pineapple (*Ananas comosus*) and coffee (*Coffea* sp.) are only grown on the east side of the reserve. Pigs and poultry are raised in both villages, and sheep and goats are raised in Esomony. Each village is surrounded by hamlets, some of which are occupied seasonally, and are considered locally to be part of the village. Although these hamlets were visited often they were not included in household surveys.

The nearest markets to Eminiminy are Ranomafana (25 km) and Ihazoambo (17 km) and all commodities must be carried by foot. The nearest markets to Esomony are Maromby (27 km), Tranomaro (27 km) and Besakoa (35 km), also only reached by foot. The main commodities sold are rice and dried manioc with coffee at Eminiminy. These market towns are the main source of household commodities such as salt, soap and paraffin for lamps, as well as clothes and other goods not produced locally. There are no shops in either village, but some traders bring commodities to the village. Cattle are either traded with specialist traders, at markets, or locally.

	Eminiminy	Esomony
1. Population	337	551
2. % popn < 15 yrs	48.6	45.7
% adult literacy	68.9	35.1
% adults born elsewhere	6.8	24.6
% adults born > 50 km	0.0	5.3
3. No. households	58	116
avge people/household	5.8	4.8
No. buildings	74	173
avge buildings/household	1.3	1.5
4. % households		
cultivate rice	80.0	100.0
manioc	100.0	81.8
sweet potato	55.3	77.3
maize	20.0	59.1
raise cattle	46.7	86.4
sheep	0.0	27.3
goats	0.0	13.6
pigs	66.7	59.1
hens	66.7	63.6
ducks	13.3	9.1

Sources:
1. and 3. from census of all households in village March/April 1993
2. from survey of 20 households in January 1992
4. from survey of 15 households in Eminiminy and 22 households in Esomony in March/April 1993

Table 3.1. Andohahela study villages: demographic and agricultural data

Both villages have primary schools and the nearest secondary schools are at Ranomafana and Tranomaro. Primary school attendance is between 50 and 70%, varying with season, with less than 20% continuing to secondary school. The nearest health centres are at Sakatany (12 km from Eminiminy) and Maromby or Tranomaro. However, these are very poorly stocked and for all but minor ailments people must go to state hospitals in Ambovombe or Tolagnaro or to a Lutheran hospital at Manambaro. The difficult and relatively expensive journey to these centres (bush taxis are available from the market towns), and the expense of food and lodging for patient and carers in a large town, often inhibit hospital attendance.

The Lutheran mission has been active around Tolagnaro for over 100 years. There are Protestant and Catholic congregations in both villages, although they receive only sporadic visits from church staff. Some medicines are distributed through the Catholic church.

Both villages are less than 2 km from the boundary of Parcel 1, although at Esomony much land in the reserve is savanna with the nearest dense forest about 10 km east of the village. The villages are immediately surrounded by savanna, with patches of secondary forest from around 1 km from the village (see sketchmaps of the areas around each village in Appendix 11)./

They are both pilot villages of the Andohahela project (of which there are 13 in total), and villagers have been involved in tree planting and market gardening projects. A few people have been employed by the project as APNs and as tree nursery workers. Primary schools in both villages participate in the project education programme.

3.4 Soalala

Regional biogeography

The angonoka or ploughshare tortoise (*Geochelone yniphora*), is restricted in the wild to the region surrounding the town of Soalala, north west Madagascar (Figure 4). Angonoka occur in areas of bamboo scrub often associated with patches of deciduous forest around Baly Bay (15°57'- 16°08' S, 45°17'-22' E), where the dominant vegetation is fire-derived palm savanna. There are four known angonoka sites, of which the smallest and best-known at Cape Sada is less than 200 ha and contains at least 50 tortoises (Smith *et al.* 1994) (Figure 6).

Remaining forest in the Soalala region is typical of the Western Domain of the Western Malagasy regional centre of endemism (Nicoll and Langrand 1989). Although much is now either severely degraded or converted to palm savanna, some patches remain, including an area of around 10,000 ha of primary forest in the Belambo region west of Baly Bay (Faramalala 1988). There are around 10,000 ha of mangroves in sheltered areas of bays (within 30 km of Soalala) (SGM 1958) (Figure 6).

The angonoka is the largest extant Malagasy land tortoise and has a characteristic projection from the front of the plastron, whence derives the name `ploughshare tortoise' (see Figure A12.8, Appendix 12). The angonoka is extremely rare and considered to be in danger of extinction (Jenkins 1987, Durrell *et al.* 1993). Other wildlife of interest in the region include Decken's sifaka *(Propithecus verreauxi deckeni*, High Priority conservation rating [Mittermeier *et al.* 1992]), and the Madagascar fish eagle *(Haliaeetus vociferoides*, Endangered [IUCN category, Jenkins 1987, also the source of following

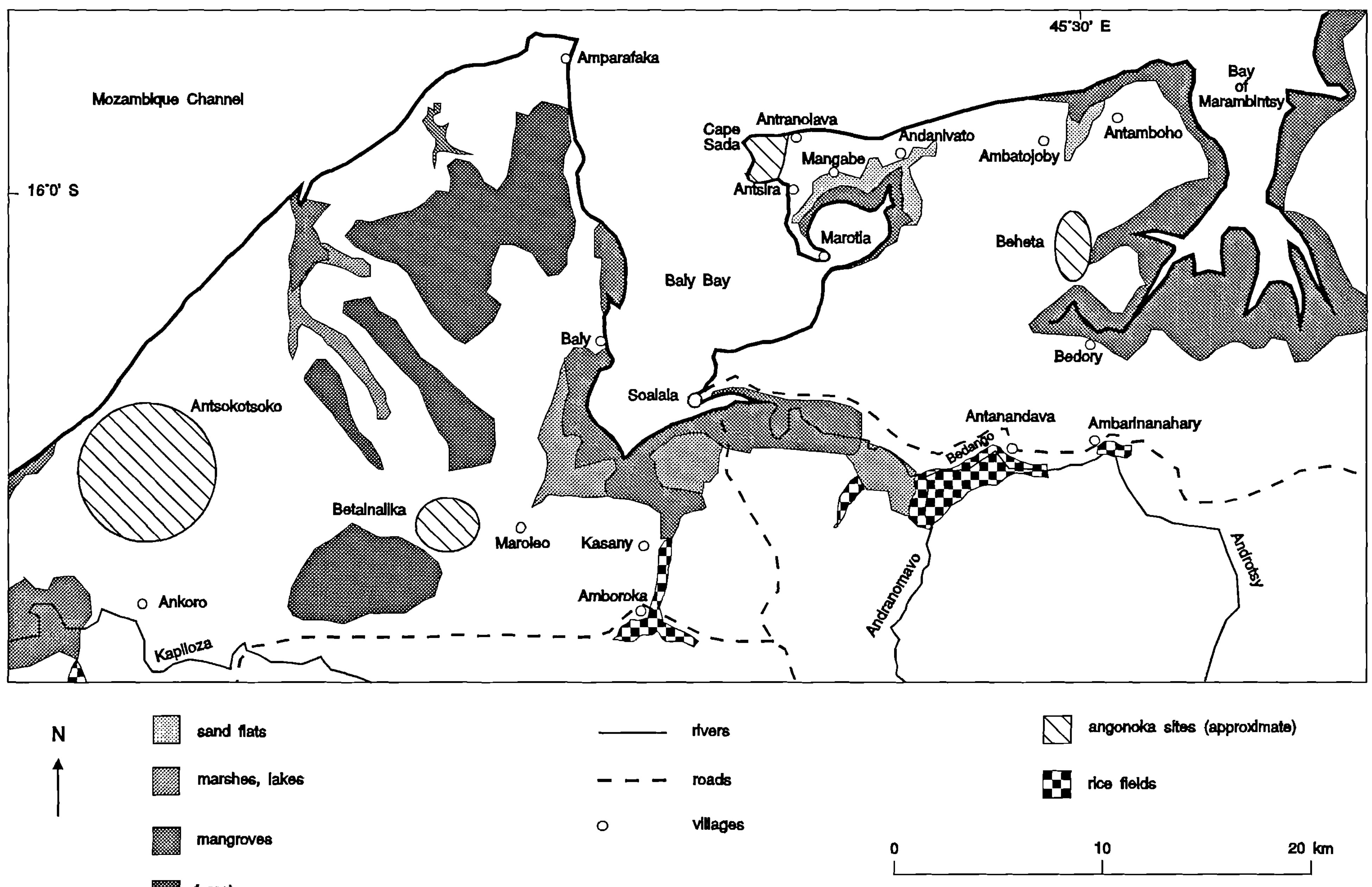


Figure 6. Map of the Soalala area

IUCN categories for turtles given in parentheses]). In addition, dugongs *(Dugong dugon)* and five species of sea turtle occur: green turtle *(Chelonia mydas*, nests on offshore islands, Endangered), olive ridley *(Tortuga olivacea*, nests locally, Endangered), loggerhead turtle *(Caretta caretta*, nests locally, Vulnerable), hawksbill turtle *(Eretmochelys imbricata*, nests locally, Endangered) and leatherback *(Dermochelys coriacea)*.

Climate

Precipitation is strongly seasonal, with over 90% of the mean annual rainfall occurring from December to March. The wet season (November to April) is locally called **asara** and the cooler dry season (May to October) is called **faosa**. At Mitsinjo (60 km east of Soalala) average annual rainfall was 1,345 mm from 1983 to 1992 (range 293.0-1831.6 mm) (Service Météorologique, Antananarivo). As in the Andohahela region there was lower than average annual rainfall from 1990 to 1992 (average of 573.9 mm from 1987 to 1992; range 293.0-872.6 mm) and crop production was much reduced (see Appendix 3 for weather graphs). Cyclones can also cause great devastation in this area; the cyclone `Andry' of December 1983 was particularly destructive around Soalala.

Local ethnic groups

The Soalala area is predominantly populated by people of the Sakalava ethnic group. The extensive Sakalava kingdoms of Menabe, centred in the Morondava valley, and Boina, based around Mahajanga, were created in the mid 17th century by the Maroserana dynasty who originated in the south west of the country (Kent 1979, Feeley Harnik 1982). The region around Soalala, known as Ambongo, is populated by several different groups. The coastal people are Kajemby, who live on the coast from Soalala to the Bay of Boina, 75 km north east of Soalala (Verin 1986, p. 157). Their own history of their origin is that they came from an island called Mijomby (or Mojomby), which was flooded in retribution for their rich and decadent lifestyle, whence they fled to Madagascar. A similar tale is told by some people in the Comores (Verin 1986, p. 50). Verin (1986, p. 50) suggests that Mijomby was in Mozambique, although popular belief places it between the Comores and Madagascar. The Kajemby were certainly installed around the bays of Baly and Marambintsy prior to the Sakalava conquest (Verin 1986, pp. 141-142).

Arab and Islamised peoples from the East African coast founded trading settlements on the northern Malagasy coast from the 10th century. A group originating in the Persian Gulf settled in the Bay of Mahajamba (200 km north east of Soalala) in the 15th century. Their descendants founded coastal settlements further south, including sites in the bays of

Marambintsy (30 km east of Soalala) and Baly (a settlement called Baly, 5 km west of Soalala) at the end of the 16th and early 17th centuries. Their descendants, known as Antalaotsy (people from overseas), have maintained their Muslim religion. These settlements provided important trading links with Islamic settlements in Mozambique, Zanzibar and the Comores, and later with Europeans on the French Mascarenes, and Dutch and English ships (Verin 1986).

The town of Soalala was not founded until 1880. The daughters of the Sakalava Boina king, Andriantsoly (who converted to Islam and took refuge on the Comores, after Merina conquest in the 1820s, relinquishing sovereignty to his sister (Feeley Harnik 1991, pp. 88-90)), had been living in the Bay of Marambintsy, but moved on to Baly after their settlement was sacked by the people of Boeny. The Muslim chief of the district at Baly advised that it was not safe for them to remain there, and they left to found a new settlement on the eastern side of the bay. Soalala, meaning `safe journey', refers to the blessing the princesses Safitamo and Safiambala were given when they left Baly (**soa** means `good' and **lalana** means `route') (Verin 1986, p. 355). Most people of the town of Soalala are practising Muslims, of which many are Antalaotsy, with some Indians, Comorians and Arabs of more recent arrival. All speak Malagasy, although there are many Swahili words, as in much of north western Madagascar.

Throughout the region there are many people descended from former African slaves, called Makoa. Slaves were bought in large numbers by Sakalava in exchange for cattle throughout the 18th and 19th centuries. Sada (1 km north east of Antsira, now abandoned) and Ankokotra (3 km north east of Soalala) are described locally as having been Makoa villages of freed slaves. Makoa have now been absorbed among the Sakalava.

Fishing and some subsistence agriculture are practiced on the coast with irrigated rice cultivation further inland; cattle rearing is also important. As in Andohahela, cattle are important economically, both to help prepare the rice fields by trampling, and to sell in times of need, and are also very important culturally for sacrifices at funerals and on other occasions, and as bridewealth.

Regional administration and economy

Baly Bay is in the Province of Mahajanga, and Soalala town (approximately 1,000 people) is the administrative centre of the Fivondronona. It is linked by very poor roads (only passable by 4-wheel drive from May to November) to Mahajanga, 120 km north east. Two flights per week link Soalala with Mahajanga and towns further south (usually a 20 seater plane with only three seats reserved for Soalala passengers). Prawns and fish are the main exports from the region. Local fishermen either sell fresh produce to representatives of Mahajanga-based companies or sell dried produce directly in Mahajanga. Increasing numbers of larger boats from Mahajanga and further afield fish offshore and in Baly Bay. Shark fins and sea cucumbers are sold to visiting traders for export abroad to Chinese communities. Traders based in Soalala buy cashew nuts (*Anacardium occidentale*) and some rice for export from the region. Cattle are bought by traders for export to inland cattle markets. There is no tourism.

Local importance of natural resource conservation

Local people rely on the remaining forest for construction wood for houses, boats and pig-proof enclosures for cultivation, for edible roots, for ravinala *(Ravenala madagascariensis)* leaves used in salt-making and for small scale traditional uses such as for medicines and facepacks. Several areas of deciduous forest have been destroyed by uncontrolled bush fires which people say have been particularly destructive since the passage of a devastating cyclone in December 1983. As in the Andohahela region, pasture areas are burned to stimulate new growth and kill parasites, and the fires often become uncontrolled. The remaining patches of forest are consequently used more heavily and people have to travel greater distances to collect resources. People also say that there has been a reduction in surface water, that lakes and rice fields are filling with sand as a result of erosion from surrounding hillsides and that the quality of the pasture has been reduced by repeated burning.

Threats to tortoise populations

The main threats to the angonoka are believed to be the destruction of habitat by fire and possibly the activities of a dense population of bush pigs *(Potamochoerus larvatus)* which may dig up the nests and eat eggs and young tortoises (Juvik *et al.* 1981, Curl *et al.* 1985, Reid 1990). The bush pigs also make cultivation very difficult, particularly of root crops such as manioc, as strong wooden fences must be maintained. The effects of uncontrolled bush fires and the activities of bush pigs are therefore potentially destructive for both man and the angonoka. Angonoka are not collected for food as they are taboo for much of the local population, but they are kept locally as pets as it is believed that they protect poultry from disease. It is possible that past trade in tortoises as maritime provisions and for export to the Comores contributed to the decline in population (Juvik *et al.* 1981).

Conservation action

Project Angonoka is a programme managed jointly by JWPT and DEF which aims to protect the angonoka from extinction and to promote the protection and sustainable use of the environment in the Soalala region. A captive breeding programme based at Ampijoroa, 150 km east of Soalala, and managed by JWPT and DEF, was begun in 1986. It has produced 108 young tortoises (D. Reid pers. comm. May 1994) and it is hoped that re-introduction to the Soalala region will be possible in the future. Recommendations for creation of a reserve are being developed by JWPT and DEF. Such a reserve may take the form of a Special Reserve, covering one or more tortoise areas (for example Cape Sada and Beheta, although with further research, areas to the west of Baly Bay may seem more appropriate). Special Reserves are often designed to protect certain animal or plant species, and although hunting, fishing, pasturing of livestock, collection of natural products and introduction of vegetation and animal species are usually forbidden, in some cases local people retain rights to collect natural products and use routes through the reserve (Nicoll and Langrand 1989).

Workshops, organised by Project Angonoka in collaboration with WWF-Education (a Malagasy team, funded by WWF, promoting environmental education in Madagascar), were held in Soalala and four villages adjacent to proposed reserve sites. They generated awareness of and interest in the environmental problems in the region, some of which are related to the plight of the angonoka, and stimulated local people to suggest development projects. These are now being organised through associations for the protection of nature (ASE) which were created in Soalala and the four villages following the workshops. One village ASE has organised the rehabilitation of a well, and other activities include planting cashew nut trees and adoption of measures to control bushfires. The ASEs have received very limited financial and logistical support from Project Angonoka; the aim is that they will become autonomous organisations that can raise funds locally and apply to various governmental and non-governmental organisations to fund their own projects.

Study villages: Antsira and Antanandava

The two villages chosen for this study in the Soalala region were Antsira and Antanandava (Figure 6, and see the sketchmaps of the areas around each village in Appendix 11). Antsira, 12 km north east of Soalala and on the east perimeter of Baly Bay, is a small hamlet, 1 km south of the tortoise area at Cape Sada. The population (around 30) forms a community unit with people of the villages of Marotia (around 150 people), Antranolava (around 10 people), Mangabe (around 10 people) and Andanivato (around 10 people). Many of them lived in one large village at Andanivato until around

15 to 20 years ago. People at Antsira specialise in catching fish and prawns for sale. Sea turtles are caught for local consumption. Locally made outrigger sailing canoes (**laka**) are used for fishing and for transport. Some crops such as manioc, maize, bananas, sugar cane (*Saccharum officinarum*), beans, squashes, tomatoes and onions are grown on a small scale in gardens which are fenced against bush pigs. Wild pigs are rarely hunted and domesticated pigs are never raised throughout the Soalala region, as it is taboo for many people to eat or handle pork (largely as a result of Muslim influence). Salt is made by evaporation, both to preserve fish and to trade for rice. Hens are raised for family consumption, and turkeys are usually raised for sale. A couple of households own a few cattle.

Antanandava, 17 km east of Soalala on the road to Mahajanga, is about 13 km south west of Beheta, another tortoise site. It was chosen for this study because the Beheta area is within the pasture domain of Antanandava families. The Antanandava population (around 240) has close community links with Bedory (around 15 people), which has access to the sea in the Bay of Marambintsy. Antanandava borders the flood plains of the Bedango river, which are intensively cultivated with rice in the dry season, from April to December. The permanent residents are joined temporarily in the wet season by sharecroppers from surrounding villages. In the dry season the village population is reduced as some people move temporarily to fish on the coast or take their cattle to seasonal pastures. There is some small scale cultivation of manioc and other crops in fenced gardens, as at Antsira. Poultry are raised, as at Antsira, and a greater proportion of households have cattle. Cattle are used in preparation of rice fields and to pull ox-carts, which are used for transport.

Project Angonoka seminars were held in both Antanandava and Marotia (which was well attended by people from Antsira) in October 1991 and ASEs now exist in both villages. The ASE in Marotia has planted cashew nut trees, and has organised the village population to reline the well. The ASE at Antanandava was formed later and is not yet active.

Soalala is the nearest market town to both villages, reached from Antsira by outrigger canoe, or by a short canoe crossing at Marotia and a 10 km walk, and from Antanandava by a 16 km walk or ox-cart journey. Rice and fresh fish are sold in Soalala for the local market. There are several grocery and hardware stores in Soalala (many owned by ethnic Indians, known locally as Karany), where paraffin, soap, sugar and other goods not produced locally are sold. There is a small shop in Marotia and another in Antanandava, although these are often poorly stocked.

	Antsira	Antanandava
1. Population	31	240
2. % popn < 15 yrs	35.5	51.8
% adult literacy	35.0	66.7
% adults born elsewhere	50.0	37.0
% adults born > 50 km	30.0	11.1
3. No. households	10	75
avge/household	3.1	3.2
No. buildings	22	131
avge/household	2.2	1.8
4. % households		
cultivate rice	0.0	93.3
manioc	50.0	50.7
raise cattle	20.0	64.0
hens	50.0	64.0
ducks	0.0	24.0
turkeys	50.0	12.0

Sources:
All Antsira data are from census of all households in September 1992.
Antanandava data 1., 3. and 4. are from census of all households in February 1993; 2. are from survey of 10 households in October 1992

Table 3.2. Soalala study villages: demographic and agricultural data

There is a primary school building in Antanandava, but there was no teacher from 1988 to 1992. Around 80% of school-age children in Antanandava attended school once it was functional. The primary school in Marotia was destroyed in a cyclone in 1983 and has not been re-built. The nearest primary school to Antsira is therefore in Soalala. None of the school-age children in Antsira attend school. The nearest secondary school is in Soalala.

The nearest health centre to Antanandava is 5 km east at Ambarinanahary, although this is very poorly stocked. There is a hospital with a doctor (although since 1992 there has only been a temporary doctor who is not always present), nurse and midwife at Soalala, which also suffers from lack of equipment and medication.

There is a small protestant church and a small mosque at Antanandava, each run by a family. Soalala has a strong Muslim influence and has three mosques. The Christian churches are mostly attended by government staff from other regions of Madagascar.

3.5 Timing of fieldwork

The fieldwork for this research was conducted during three visits to Madagascar between July 1990 and May 1993., The following activities were undertaken during each visit:

July 1990 - December 1990

- negotiation of a research agreement and a protocol of collaboration between the Malagasy Government and DICE
- visits to potential study sites at Beza Mahafaly, Andohahela and Montagne d'Ambre
- two months preliminary fieldwork at Soalala in September/October

April 1991 - January 1992

- three visits to Andohahela
  - 3 weeks in each study village in April/May 1991
  - 3 weeks in each study village in September/October 1991
  - 10 days in each study village in January 1992
- two visits to Soalala
  - 3 weeks in each study village in July/August 1991
  - 10 days in each study village in November/December 1991

June 1992 - May 1993

- two visits to Andohahela
  - 3 weeks in each study village in July/August 1992
  - 1 week in each study village in March/April 1993
- three visits to Soalala
  - 10 days in Antanandava in June 1992
  - 2 weeks in each study village in September/October 1992
  - 1 week in each study village in January/February 1993
- visit to Ranomafana National Park in November 1992
- visit to Morondava forestry management project December 1992
- three months (February to May 1993) working for WWF at Andohahela to coordinate socio-economic studies during the reformulation of the project

A total of five visits were made to each study village, which were well distributed across the locally recognised seasons (see Appendix 4).

6.6 Research methods

The main research methods were:

i. interviews

individual interviews: with key informants, heads of households, women, traditional healers;

group interviews: with community groups, household groups or informal groups of men or women;

ii. structured household surveys: census, time allocation, food consumption;

iii. inventories of useful plants: construction materials, food, fuel, medicinal, ritual;

iv. participant observation; participation in agricultural and resource collecting and processing activities.

i. Interviews

Some interviews were organised in advance to discuss a particular topic with either an individual or a group, but most were started opportunistically. All interviews were semi-structured or informal, employing a set of themes and topics to form questions in the course of a conversation, without the use of questionnaires. Such interviews give informants the opportunity to develop their answers outside a structured format and have been used widely by social researchers. The set of topics to be investigated were usually prepared in advance, and opportunities were sought to cover these topics with a variety of people. Interviewees were prompted to cover all required topics, and further sessions were sought where information was incomplete.

Group interviews, recording consensus opinion after public debate, tend to control exaggerated and unfounded assertions. Individual interviews also play an important part by showing individual variation in beliefs and practices. We used both types of interview. Individual interviews often became group interviews as other people came to hear what we were discussing.

Special efforts were made to survey the knowledge and attitudes of women in the community, by interviewing women with no men present. Depending on social structure women and/or men may be inhibited at mixed sessions. The role of women in resource management was investigated as they may serve as a particular focus for conservation efforts. Women may make important contributions to domestic management although not formally recognised in the political structure of the community (Owen-Smith and Jacobsohn 1988).

One or more university students or graduates acted as research assistants at each site, participating in research design and data collection. I tried to find people who came from the study area, or had lived there for some time, and had good knowledge of rural life. At Andohahela, Roger Razafison Ilambo, a 4th year economics student at the University of Antananarivo who is Antanosy from Manantenina (70 km north east of Andohahela), was a research assistant during all visits. In Soalala, Lala Jean Rakotoniaina, a sociology graduate of the University of Antananarivo, was a research assistant for the first two field visits (September/October 1990 and July/August 1991). He had worked as the `Chef de Circonscription Scolaire', responsible for school management and teacher training, in the Soalala region from 1979 to 1981 and had continued to work in north west Madagascar. He knew the local dialect, and had many good friends and contacts in the area. Dorety Razandrizanakanirina, a student of the Ecole Normale Niveau Trois at Antananarivo, training to be a teacher of Malagasy and specialising in Anthropology, accompanied me as research assistant for the final four field visits to Soalala. She used the field visits to prepare her final year thesis on beliefs and customs relating to the fauna of the Soalala region. The costs of her fieldwork and production of her thesis were covered by Project Angonoka. She had also worked for ten years in north west Madagascar so knew the local dialect and customs and was quickly accepted.

Almost nobody in the study villages spoke French. Initially, all interviews were translated into/from French by the assistant, but as my knowledge of Malagasy improved I would only ask for clarification of some details. The assistant and I would discuss in advance the sort of information we wanted to investigate. As opportunities arose to talk to various villagers, the assistant ensured that the conservation flowed smoothly and we both asked questions.

We used some techniques and methods of `Participatory Rural Appraisal' during group interviews. These field techniques were developed by rural development researchers and project personnel working in developing countries (Chambers 1991). The objective is to get villagers to describe and explain their use of resources, their priorities, problems and concerns, and their suggestions for changes, with researchers acting only as catalysts and prompters (Gueye and Schoonmaker-Freudenberger 1991). One technique is for villagers to make a plan of the village on the ground, marking features and explaining the importance of different regions. Other techniques include drawing transects across the village, marking changes in soil-type, changes in dominant vegetation and changes in land use, and drawing calendars of agricultural work, food availability and other aspects that change seasonally. Information is presented in diagrams in large scale in full view of everyone involved so that all additions are debated (see Figure A12.15, Appendix 12).

ii. Structured household surveys

The household is often used as a sample unit for social research. Households are usually based on kin relationships of marriage or descent and combine a dwelling unit, unit of economic cooperation, and the unit within which most reproduction and early childhood socialisation takes place (Netting *et al.* 1984). In developing countries, particularly in rural areas, they are the most common unit of production as well as consumption. Different household definitions may be relevant in different societies, including, for example, a common source of the major part of income, sleeping under one roof or in one compound, a common source of food, or answerable to the same head (Casley and Lury 1981).

Households are an important social unit in the study villages, both as units of production and consumption. Although larger extended families may decide on management and allocation of rice fields and management of cattle, each smaller family unit or household has their own stock of rice and other food. When one household exhausts their own stored food supply, they may receive food from other households, but continue to prepare and consume their food separately. Unmarried men tend to sleep together away from their families, but return to the household for meals. For this study it was therefore most appropriate to define households in terms of common food preparation and consumption. In some rare cases, households temporarily merged with others for food consumption; for example in Antsira when a son's household ate with his parents for about six months when his wife was occupied with the birth and care of a child.

ii.a. Census and household surveys

A complete census was made of each study village once during the fieldwork period to ascertain the village population, number and composition of households, the number of buildings per household and main livelihood activities. Sample surveys of households were conducted at different stages of the fieldwork to survey relationships within households, the mode of recruitment to households, length of time in the area, literacy rates, school attendance rates and main livelihood activities.

ii.b. Time allocation

The allocation of time is a basic element of ethnographic description. Daily activity schedules were often investigated by describing activities in detail for a small number of individuals over a limited time period. Schedules were either constructed from detailed interviews, or from observation, or from a combination of the two. Such methods are time comsuming (particularly direct observation, which is the most reliable), and in the interests of collecting a wider variety of information often only limited fieldwork time was dedicated to time allocation studies. However, activities in most subsistence economies display marked seasonal differences and the seasonal variation must be represented, or accounted for in discussion of the results. The sample should also be sufficiently large to be representative of the population, especially if variations within the population, such as with gender, are of interest.

In an attempt to improve the representativeness of time allocation data, Johnson (1975) pioneered a random spot-check sampling technique. Random visits were made to a set of households (time of visit was pre-selected randomly) and the activities of all household members on arrival were recorded. In this way data were obtained for 13 households on 134 days over 10 months resulting in 3,495 observations of individuals (Johnson 1975, pp 302-303). From these data it was possible to describe average activity seasonally and over the whole year.

This methodology was adopted for the time allocation studies done for this research. The aim was to describe the proportions of time spent on different activities to allow analysis of time spent on activities related to exploitation of the environment, agriculture and trading, time spent on commercial and subsistence activities, and gender activity differences. The activities of all adult members (15 years and over) of chosen households were recorded on arrival for random visits during daylight hours. Time allocation data were collected four times at each study village to provide coverage during different seasons.

Initially, eight households were chosen in each site. Households were selected from different extended family groups. This meant that they were usually widely spaced within the villages as related households tend to live in the same area. The households selected were those with which good contact had been made during the first fieldwork periods and who were willing to be visited and questioned regularly. Time allocation studies only commenced during the second fieldwork period in each village. In later fieldwork, household selection was extended so that a wider sample could be covered. In such cases the visit to a particular household was swapped, often for a nearby related household. Decisions about visits to alternative households were made each morning when the visit schedule for the day was determined, to avoid the tendency to record only households where people were available at the time of the visit.

Visits were made in the eleven hours between 7 am and 6 pm. Although some work did start as early as 5 or 6 am and continue until 7 pm, especially in the summer when daylight hours were longer, very early and late visits were not made among themselves and we felt that we would not be welcome. The hours for visits to each household were selected randomly by drawing pieces of paper from a bag early each morning. Visits were made at some time during the specified hour. In practice fewer visits were made from 12 am until 2 pm because the family we stayed with expected us to eat a meal with them, and we hesitated to disturb people while they were resting during the hottest time of the day. The schedule was broken if opportunities arose to discover more about a subject of interest, or if an important village event, like a funeral, was taking place.

Visits varied from short encounters, when brief enquiries were made in passing, to extended visits where a wide variety of information was collected in addition to time allocation. The length of the visit depended largely on the availability of household members for discussion. The activities of all members of the household over 15 years old were recorded. Enquiries were made about the whereabouts and activities of those not present, and verifications were made later where possible. Where no-one was present neighbours were asked, and sometimes the family was visited later to ask what they had been doing.

For analysis, observations of men and women were allocated to the following categories:

- Collecting: non-cultivated plant food, fishing and hunting, artefact materials, construction materials, firewood, water, materials for trade
- Preparation: non-cultivated food, artefacts, construction, firewood, cultivated food, traded goods
- Agriculture: rice, manioc, other crop, cattle, other livestock
- Trading and wage labour: at market, local trading, paid labour, collecting donated goods (eg. food aid)
- Hygiene: personal hygiene, hair care, washing clothes, washing dishes
- Cultural events: funerals, village meetings, ritual etc.
- Other activities: receiving visitors, visiting in the village, visiting further afield, resting or sleeping, ill, minding children, eating

The range of data collected, difficulties encountered collecting the data and resulting biases in the data are given in Chapter 4, Section 4.3, prior to presentation of results.

ii.c. Food consumption

Food consumption studies present many of the difficulties of time allocation studies. The collection of accurate data is time consuming, and is often intrusive, especially if food is weighed. The population sample and seasonal distribution of data are often unsatisfactorily limited. Nietschmann (1973) did dietary surveys of three families at various times of the year, and Ellen (1978) made detailed records of food eaten by two households for four months, supplemented by a qualitative survey of a larger number of households over a 16 month period. For this study I aimed to widen the population sample, and collect data during different seasons.

Food consumption information was collected during visits made for the time allocation study, and households were thus selected by the same means. As with the time allocation study, the size and randomness of household samples were initially hampered by our limited access to households, but improved substantially from the second data collection period in each village.

I decided that detailed data on weights of different foods consumed, although desirable, was not compatible with collection from a larger sample of households as it necessitates being present at meal times to either weigh or estimate food quantities. The type and source of food eaten at meals were collected by dietary recall. Members of the household (usually the women who had prepared the food) were asked the number and content of the previous day's meals. Quantities which they found easy to give were recorded, such as the number of **kapoaka** of rice or beans (**kapoaka** are condensed milk tins used ubiquitously as a standard measurement throughout Madagascar, 350 cm^3, equivalent to approximately 0.285 kg rice). Quantities of foods such as greens, meat, manioc and sweet potato were not recorded because people found them difficult to estimate. The sources of the foods were recorded; whether they had been cultivated, collected from the environment, bought or given. Snacks were not included because of the difficulty of measuring such informal food consumption. The numbers of people more and less than 10 years old were noted for each household.

Data were analysed as numbers of person meals of different foods. The staple (main carbohydrate: rice, manioc, maize etc.) was treated separately from the **laoka** (sauce eaten with the staple: manioc leaves, fish, tomatoes etc). Where only one food, such as fruit, was eaten at a meal, this was treated as staple food. Where two staple or laoka foods were eaten at one meal each was treated as half a meal. To get an indication of what proportions of people in the villages were eating different foods each household's average meals were multiplied by the adjusted number of people in the household (N).

It was assumed that children under 10 years old eat on average half the food of an adult and unweaned children were not counted.

$$N = A + (0.5 \times C)$$

where A is the number of household members 11 years or older, and C is the number of children weaned and up to 10 years old. The adjusted household membership was used to calculate the number of person meals of each staple and laoka food per meal for the households sampled. Where several days' records exist for a household they have been averaged to give an average daily contribution of different foods from different sources for that household before being aggregated with data from other households. Percentages have then been calculated from the total sample of households for each category of staple and laoka.

The range and analysis of data collected in this study are given in Chapter 4, Section 4.2.

(iii) Inventory of useful plants

Information was collected about the uses made of a wide variety of plants with their local name and their distribution. Specimens were collected, pressed and sun-dried for identification, initially by the herbarium of Parc Zoologique et Botanique de Tsimbazaza in Antananarivo and ultimately by Missouri Botanic Garden. Andrian'Iranto Randriamanantena, a student at the Polytechnic of Antananarivo, assisted with the collection of plant specimens and information about plant use in Andohahela in September and October 1991. The number of specimens collected and identified at each site, together with lists of plants used for different purposes, are given in Appendix 10. Plant nomenclature follows Mabberley (1987).

Chapter 4.

FOOD AND WORK: SUBSISTENCE FROM AN ENERGETIC PERSPECTIVE

4.1 Introduction

Humans consume and expend energy to ensure continued livelihood and to maintain their accustomed lifestyle. An ecological study, which considers a society in relation to its environment, examining its use of and impact on natural resources, will benefit from an analysis of energy use and requirements. An energetic analysis can consider different strategies and means employed to select and extract resources effectively and energetic factors affecting decision making about resources. Such analysis is particularly relevant for subsistence societies, where the primary activity is the maintenance of livelihood by extracting and processing natural resources.

The aim of this chapter is to use an energetic perspective to consider resource use and relations with the environment in four study villages in two protected area sites in Madagascar. I try to determine:

i) what the basic resource requirements are and how they are satisfied;
ii) how activities and resource use are divided between wild resources, agriculture and trade;
iii) to what extent these activities and uses are driven by subsistence requirements as opposed to commercial influences;
iv) how energetic factors limit and influence resource use.

An energetic analysis of human populations should consider energy consumption, energy flow and energy expenditure. Energy consumption can be considered in terms of the types and amounts of resources used. Resources can be categorised according to how they are supplied; for example from the non-domesticated environment, agriculture, or trade. Energy flow is determined by how resources are used, whether they are consumed as food, fuel, shelter or used in production, or whether they become products which are distributed or traded. The quality of different types of a resource may vary with how effective they are for the use to which they are put. For example, a hardwood pole used for house construction may represent the same biomass as a softer wood pole, and have required the same human energy for collection and processing, but last longer, therefore represent greater energetic value. The amount and time scale of use are also important when considering the impact of resource use. Energy expenditure can be considered in terms of the energy or effort expended by people in different activities. In theory, energy investment in the collection and processing or production of a resource can be compared with the energy provided by that resource, to show the relative efficiency of different kinds of resource use practices.

Energetic analysis has been carried out in the application of the ecosystem concept to human populations, for example using energy flow and energy efficiency to show the adaptation of human communities to environmental conditions (Rappaport 1967, Morren 1986). While such studies had some success in demonstrating the importance of energetic factors and the environmental context, they were criticised for relying too heavily on energetic efficiency as the most important limiting factor and neglecting social, political, legal and historical dimensions (Moran 1990a). In addition, they considered the population as a whole, overlooking variations between members, and the factors affecting decisions made by individuals.

I therefore intend that the energetic perspective presented here is not exhaustive or prescriptive, but provides a useful insight into some of the factors affecting resource use, which must be considered in conjunction with commercial and cultural influences discussed in later chapters. Energy consumption, in the form of food consumed, and energy expenditure, indicated by time allocated to different activities, are used as a means to characterise the four different study villages, and to put the scale of use of wild foods and other non-cultivated resources into perspective. Variations in resource use and activities allow comparative analysis of environmental and energetic influences in each region. Variations within the populations give a more detailed understanding of the resource management decisions affecting individuals. Energetic constraints and influences are considered in relation to wild resource collection and agricultural production.

4.2 Energy consumption: food provision from different sources

Data collection

Food consumption was studied in the four study villages at four different times of the year (only three at Antanandava), to establish the types and sources of foods during different seasons. The methods used are described in Chapter 3, Section 3.6. Detailed information on weights of different foods was not collected, except for quantities of rice, so a strict analysis of energy consumed is not possible, but the type and source of staple food (main carbohydrate at a meal, such as rice, manioc or maize) and **laoka**[1] (sauce of meat, fish or vegetables eaten with the staple food) at meals were collected for a range of

---

1 **laoka** is the word used in most of Madagascar, although in Soalala **kabaka** is usually used

households. This has been compiled into numbers of person-meals (with children 10 years or less assumed to consume half a person-meal), with data over several days for one household averaged to contribute only a day's meals to the village sample total. Staple and laoka are treated separately. The proportions of staple and laoka meals cultivated, bought, collected and given helps to show to what extent people rely on wild collected food, cultivated food, or bought food, and what types of food predominate in each category.

Table A4.2 in Appendix 4 describes the data collected in each sampling period. The average sample proportions of total village households per period were 12.4% for Antanandava (average of 99.5 person-meals), 52.8% for Antsira (average of 36.5 person-meals), 9.3% for Esomony (average of 151.5 person-meals) and 19.0% for Eminiminy (average of 228.5 person-meals).

The number and timing of meals eaten each day varies between households and seasonally, often according to food abundance and work requirements. The mean number of meals per day varied from 2.13 to 3.00 (see Table A4.2, Appendix 4). When there is plenty of staple food available, three meals are eaten. The first, early morning, meal is smaller, often rice with little or no laoka, with a larger meal after the morning's work at any time from 12 am to 3 pm. The main meal is usually eaten in the evening, at or after dusk. People working away from the village may eat their mid-day meal separately, when they return from work, and the evening meal is usually eaten together. In both regions the men are served first by the women, who eat separately or later. Where little food is available adults usually only eat twice per day but children are given three meals. Snacks were not included in the study because of the difficulty of measuring such informal food consumption. Snacks often included fruit, sugar cane, insects (such as grasshoppers and cicadas, mostly eaten by children), coffee (or tea in Soalala) with sugar, and food remaining from previous meals, such as **ampango** (rice burned on to the pan).

Data collected during four different periods at each village (three at Antanandava) are well spaced seasonally so the data from each village have been aggregated (by calculating means of percentage person meals over all sampling periods) to give an approximate mean annual food source pattern which can be compared between villages (Table 4.1)

TABLE 4.1. Table showing means of percentages of different food types eaten at meals at each village in all sampling periods. All meals contained staple, whereas laoka figures are percentages of meals with laoka.

STAPLE	Antanandava	Antsira	Esomomy	Eminiminy
rice	93.3	78.8	77.4	59.0
manioc	1.2	13.4	10.0	21.8
maize	0.0	0.0	10.4	11.7
other	5.5	7.8	2.2	7.5
	100.0	100.0	100.0	100.0
cultivated	64.9	17.0	63.1	73.4
bought	24.2	78.2	23.3	12.4
collected	3.6	2.3	0.5	2.5
given	7.3	2.5	13.1	11.7
	100.0	100.0	100.0	100.0
LAOKA				
beans	0.0	0.00	17.8	14.9
meat	15.0	10.5	26.1	14.3
fish	72.2	70.5	3.7	3.3
vegetables	11.1	6.2	52.4	61.4
other	1.7	12.8	0.00	6.1
	100.0	100.0	100.0	100.0
cultivated	18.6	9.2	59.9	68.1
bought	23.2	14.8	23.2	4.6
collected	44.6	67.2	6.9	5.3
given	13.6	8.8	10.0	22.0
	100.0	100.0	100.0	100.0

Cultivated: includes food from cultivated plants and domesticated animals (including eggs, milk and beef etc).
Bought: includes all food bought or traded by the household
Collected: includes all non-cultivated food
Given: includes food given within the community and food donated as part of an international aid programme.

Staple foods

Rice (*Oryza sativa*) was by far the most common staple followed by manioc (*Manihot esculenta* [= cassava]), with most manioc and least rice consumed in Eminiminy (Table 4.1). Although maize (*Zea mays*) provided more than 10% of staple meals in the Andohahela villages (Esomony and Eminiminy), the majority of this was donated as food aid2, so this was probably atypical. Other staple foods included bananas (*Musa* spp.),

[2] During the study period from April 1991 to April 1993 the Andohahela villages had poor harvests (particularly 1990/1 to 1991/2) and were given some international food aid. People in Esomony received monthly food aid of rice or maize from November 1991 to March 1993 from the World Food Programme which was operating a famine relief programme in southern Madagascar. Most people in Eminiminy

sweet potato (*Ipomoea batatas*, in Andohahela), and some collected wild tubers, fruit and seeds.

Very little staple food is derived from non-cultivated sources. Staple food at meals is over 60% cultivated in all rice cultivating villages (Antanandava in Soalala, and Esomony and Eminiminy), while at the fishing village, Antsira (Soalala), only 17% is cultivated and the majority of staple food is bought. Staple food in the `given' category at the Andohahela villages was mostly food donated as part of an aid programme, but, as in the Soalala villages, some was given as support within the community, often to older people by members of their extended family.

Rice is the preferred staple everywhere. People claim that it is the only food that makes them feel full (**mahavoky**), which has been observed by other fieldworkers (eg. Feeley-Harnik [1991, p. 193] among Sakalava north of Soalala, and Grandidier [1928, p. 35]). Having plenty of rice is as important as having a good laoka, such as meat. It is considered shameful if no rice is available for a visitor (**vahiny**). Rice is also important as food during ceremonies and is stored for such events. One of the few families with rice remaining in Eminiminy in August 1991 said that they had deliberately stored rice as they expected that their elderly mother would die. If rice is scarce it is saved for the evening meal, although rice is thought to be important for infants and rice may be specially prepared for them during the day.

Rice is cooked with more water (**vary sosoa**) if there is no laoka or if little rice is available, or cooked until dry and separated (**ampangoro** in Andohahela, **vary maiky** in Soalala). Water is heated (but not boiled) with rice burned onto the pan to make a hot drink, usually drunk after meals (**ranon'ampango**). White rice is always measured in **kapoaka**3 and it was usually possible to ascertain how many kapoaka of rice were cooked at each rice meal. Averages for each sampling period are shown in Table A4.2 (Appendix 4) (range 0.15-0.30 kg rice per person-meal). Although people claim that adults should eat one kapoaka of rice per meal, averages were often considerably lower, both because the morning meal is smaller, and often because there was insufficient rice. There was quite a large variation between households in the amount of rice per person meal. In Esomony in January 1992 one household ate only 0.18 kg rice per person per day while another ate 0.54 kg per person per day, and the maximum recorded for a household was 1.0 kg rice per person per day in Antanandava in June 1992. There

---

received maize and beans (`pois de cap') for one month in September and October 1991, as emergency aid after a fire in the village.

3 A **kapoaka** is a condensed milk tin measure of 350 cm^3 equivalent to approximately 0.285 kg of white rice.

were also variations in consumption within households, with men eating much larger quantities.

Manioc is used as a way to make rice supplies last longer. Gathered wild staple foods are seen as emergency foods, which are collected only when all other supplies are exhausted, depending on the household's ability to buy food.

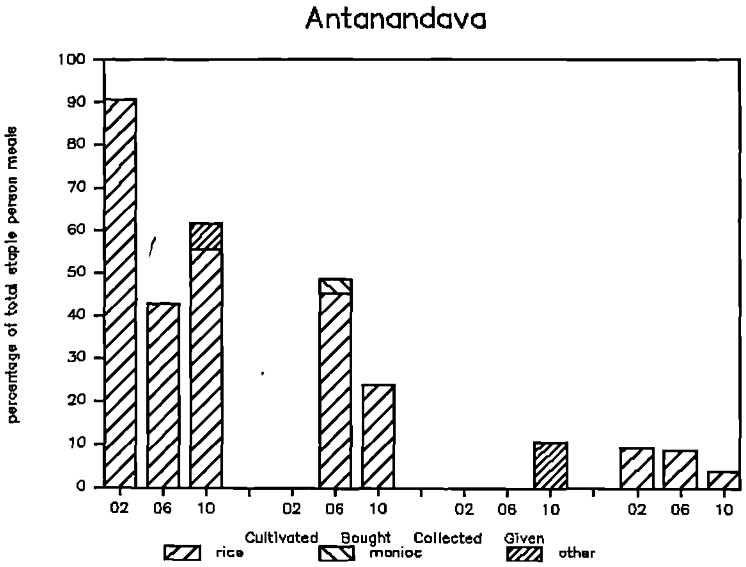
Laoka

The percentage of meals with laoka, or sauce, was very variable and ranged from 24% in Eminiminy in October 1991, to 95% in Antsira in July 1992 (Table A4.2, Appendix 4). The amount of laoka was also very variable, but this was not measured. Fish provided over 70% of laoka in the Soalala villages, while less than 4% in the Andohahela villages (Table 4.1). In the Andohahela villages laoka was mostly vegetables, and 15% or more was beans or pulses. Other laoka food included coconut (*Cocos nucifera*), papaya (*Carica papaya*), and some collected wild foods like locusts (*Nomadacris* sp., *Locusta* sp.: Griveaud 1981, p. 51), nuts, and palm hearts. Interestingly, swarms of locusts in the Andohahela region in June and July 1992 were considered favourably as a food source, as the rice harvest was almost over, they did not attack manioc and almost no crops were damaged, however, in March and April 1993 locusts were considered a terrible pest, while still providing a nutritious food source, as they damaged rice plants.

In Antsira and Antanandava much laoka was collected non-cultivated food, while most was cultivated in the Andohahela villages. Fish is an important source of protein in the Soalala region, but other types of non-cultivated food make only a small contribution to the sauce part of the diet. Most laoka is cultivated in the Andohahela villages, usually in the form of vegetables like manioc and sweet potato leaves but some meat, milk and eggs. More laoka is bought in Antanandava and Esomony, than at Antsira and Eminiminy. Some laoka was `given' as food aid at Eminiminy, while Esomony only received staple foods as aid.

Seasonal variation in staple food supply

A breakdown of types of food provided from different sources in different seasons at each village gives a clearer picture of the factors affecting food supply (Figures 7 and 8). The months where most staple food is cultivated generally indicate the seasons when households do not require supplements of bought or collected food. The agricultural calendars in Appendix 6 show the harvest period of different crops in each region.



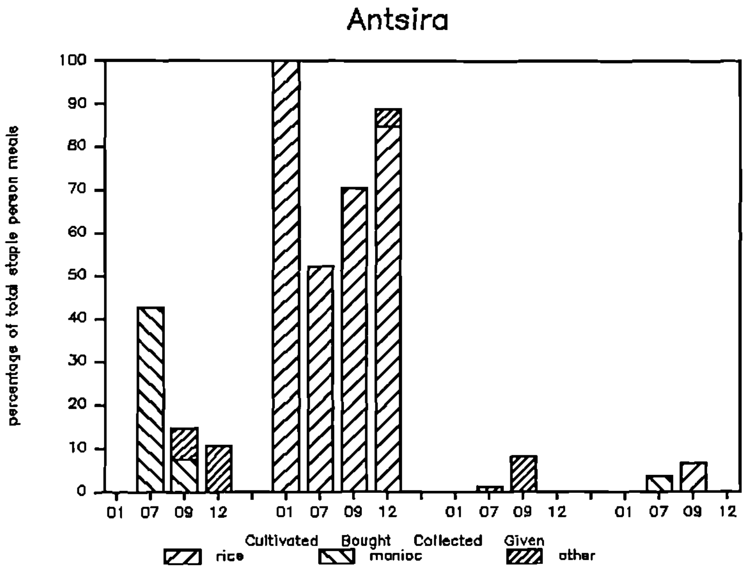
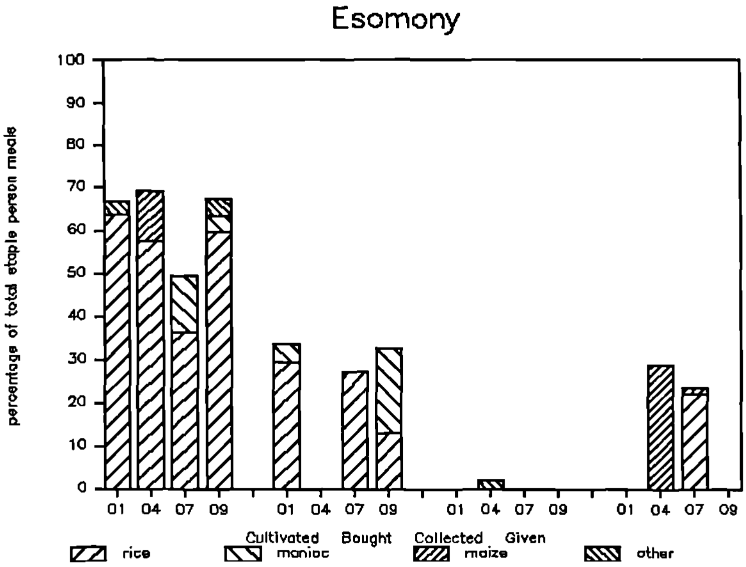


Figure 7. Graphs showing the type and source of staple food in different periods for the Soalala study villages
01 = Jan, 02 = Feb etc.
1st group `cultivated', 2nd group `bought', 3rd group `collected', 4th group `given'

In Antanandava, cultivated rice is most available in the months following the main rice harvest in December (Figure 7). Cultivated rice is least available when stocks are depleted around June, but some of the new harvest is available by October. In Antsira, manioc, planted when the ground softens at the start of the rains in November and December is ready for harvest in July, but stocks are failing by September, and in January all staple food was bought. Nearly all bought staple food was rice. Collected non-cultivated staples were waterlily tubers (**makamba**, *Nymphaea* sp.) in Soalala villages in September and October, and some arrowroot (**kabija**, *Tacca pinnatifida*) in Antsira in July.



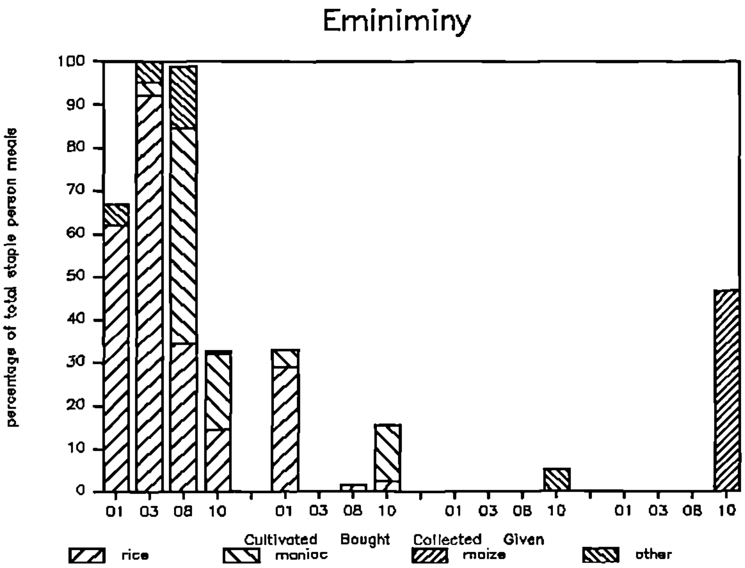


Figure 8. Graphs showing the type and source of staple food in different periods for the Andohahela study villages
01 = Jan, 02 = Feb etc.
1st group `cultivated', 2nd group `bought', 3rd group `collected', 4th group `given'

In the Andohahela villages, the pattern shown in Eminiminy (Figure 8) is that expected, where rice becomes available with the first rice harvest in January and remains available until some months after the final harvest in June, after which rice is scarce. Manioc is usually available from June to October, sweet potato from August to December, and maize from January to April, depending on rainfall. In Esomony, cultivated rice consumption was relatively high in September, suggesting that most households still had rice supplies available. Cultivated rice consumption was probably lower than expected in April and July because people received food aid. The level of consumption in relation to other food depended when the latest distribution had been made. In January 1992 the last delivery of rice (4.5 kg per person) had been almost four weeks previously and none remained, but in July 1992 and April 1993 rice and maize respectively had been distributed just before the food consumption study. Similarly the food aid received in Eminiminy in October 1991 probably depressed the percentage of cultivated food eaten at meals.

The main bought staple food was rice, with some manioc when available. In Eminiminy, tubers of Indian shot (**lingirotsy**, *Canna indica*) and **via** (*Typhonodorum lindleyanum*) were collected in October and jack fruit seeds (**ampalibe**, *Artocarpus heterophyllus*) in January[4]. In Esomony, prickly pear fruit (**raketa**, *Opuntia* sp.) were collected in April.

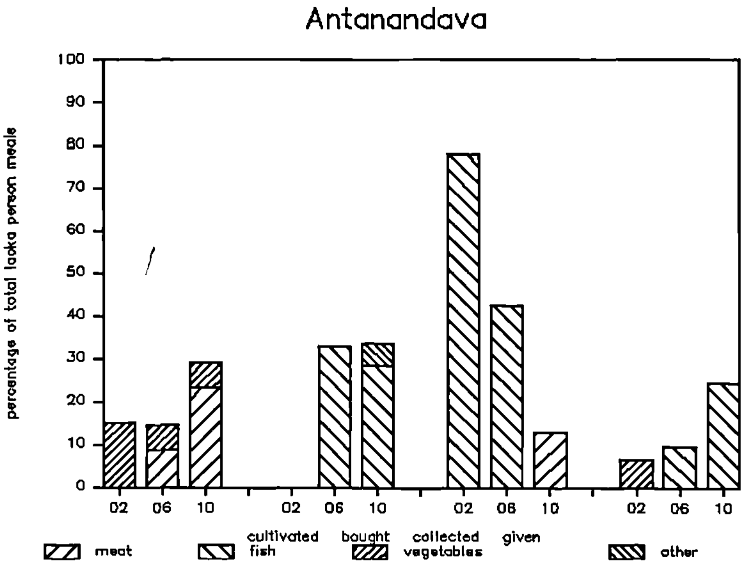
Seasonal variation in laoka food supply

In the Soalala area (Figure 9), the main laoka is fish which was mostly collected in Antsira, and collected in Antanandava in February and June, but also traded there in June and October. I believe that this is because in June, and particularly October, rice cultivation work is demanding in Antanandava and less time is available for fishing. In October, some wild duck (mostly white-faced whistling ducks [**vivihy**, *Dendrocygna viduata*], and knob-billed ducks [**angongo**, *Sarkidiornis melanotus*]) were caught in noose traps over ripening rice. Meat is cultivated (chicken and eggs), bought (beef) or collected (turtle at Antsira, and duck at Antanandava).

Other laoka recorded in this study were collected palm hearts (**satra mira**, *Hyphaene shatan*) and cashew nuts (**mahabibo**, *Anacardium occidentale*) at Antsira, bought coconut at Antanandava, tea and sugar drunk with manioc for breakfast at Antsira (included as a meal because of the high sugar content), and cultivated vegetables like manioc leaves and squashes.

---

[4] Cashew nuts *(Anacardium occidentale)* in Soalala, prickly pear *(Opuntia* sp.) and jack fruit *(Artocarpus heterophyllus) in* Andohahela, and mangoes *(Mangifera indica)* at both sites, have been classed as wild, non-cultivated resources as although they are introduced plants, they are treated locally as wild resources. The ownership history of many such trees and plants is not known, and many may have seeded naturally. Some mango and cashew trees are privately owned, usually grown in gardens, but the majority grow wild around existing and disused settlements, and are collected as wild resources.



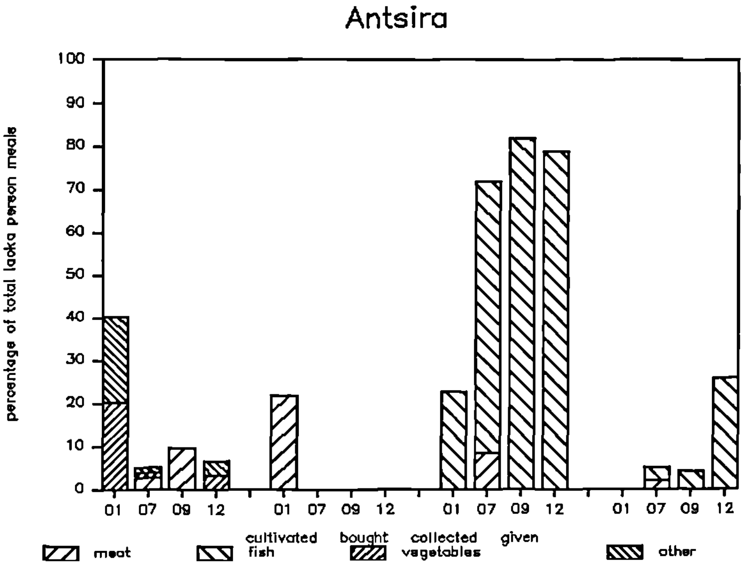


Figure 9. Graphs showing type and source of laoka food in different periods for the Soalala study villages
01 = Jan, 02 = Feb etc.
1st group `cultivated', 2nd group `bought', 3rd group `collected', 4th group `given'

In the Andohahela villages (Figure 10) the majority of laoka food is cultivated; mostly manioc and sweet potato leaves and other leafy vegetables (known generically as **traka** in this region), but some tomatoes, beans, aubergines and papaya, and some milk in Esomony in the wet season (shown in Figure 10 in January and April). Milk is available in Esomony but rarely in Eminiminy due to different management of cattle; cattle are guarded in the village overnight in Esomony for protection from cattle thieves. There is more traded laoka at Esomony, particularly milk, meat, fish and beans.

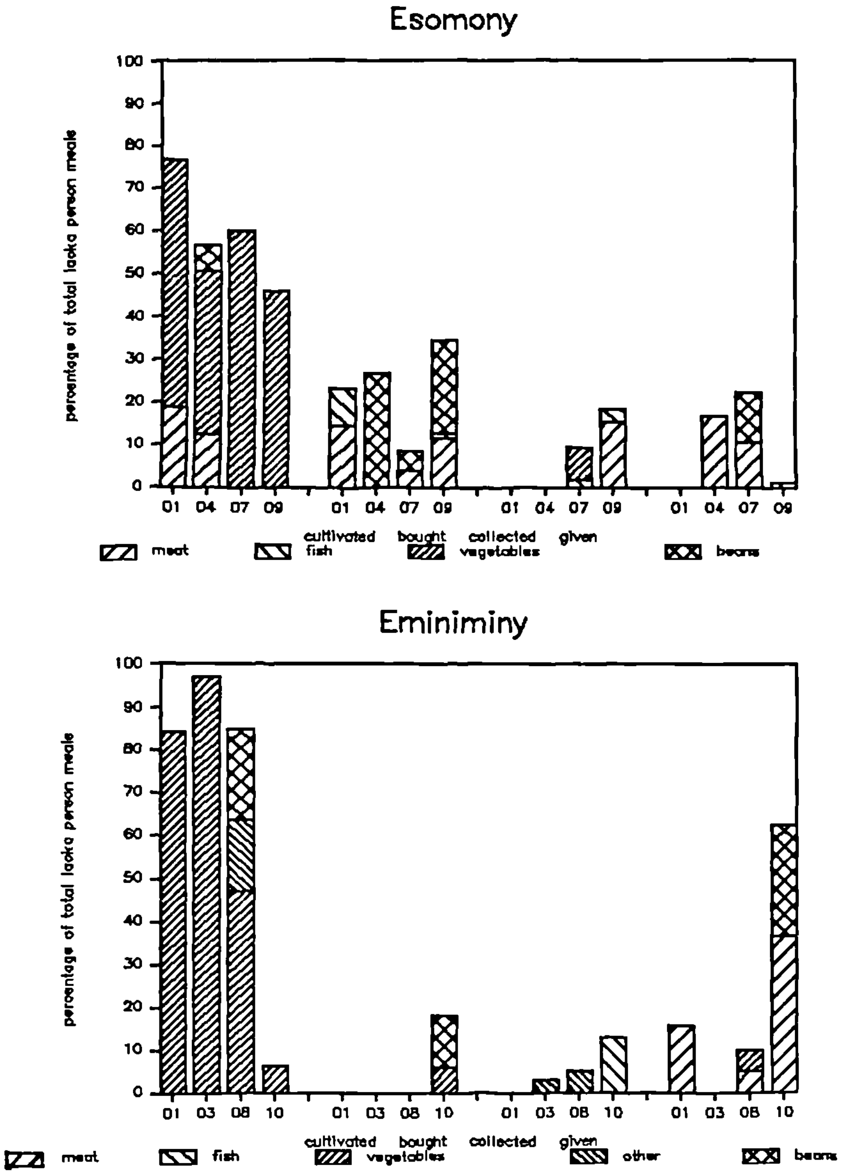


Figure 10. Graphs showing type and source of laoka food in different periods for the Andohahela study villages
01 = Jan, 02 = Feb etc.
1st group `cultivated', 2nd group `bought', 3rd group `collected', 4th group `given'

In Esomony 27% of all meat, and in Eminiminy 100% of meat was given, usually following ritual sacrifices, such as those held at funerals and other cultural events. In Eminiminy in October 1991, 36% of all laoka meals recorded were beef from sacrifices when eight cattle were killed in one week during three funerals, and 25% of laoka was beans from food aid, and very few cultivated vegetables were eaten. Vegetables such as stewed green leaves and pounded manioc leaves are considered the least good of all laoka, and data from this period shows that they are not eaten where alternatives are available. In Esomony all donated laoka was meat from ritual sacrifices of sheep or cattle, except some beans given within a family.

Collected laoka included some fish from July to November, Madagascar sandgrouse (**katrakatraka**, *Pterocles personatus*) shot with a gun, and some water cress-like leaves (**savaha**, *Marsilea* sp.) at Esomony, and locusts and forest nut oil (**hovao**, *Dilobeia thouarsii*) in Eminiminy. Guns are more widespread in Esomony because of fear of cattle thieves, and are sometimes used for hunting, although the cost of cartridges is prohibitive.

4.3 Time allocation: putting different activities in context

Data collection

Energy expenditure is difficult to calculate. Studies that have attempted to calculate energy expended on certain activities have multiplied time spent on those activities by tables of energy expenditure developed by biologists (eg. Ellen 1978). There will be inaccuracies in applying energy expenditure figures across cultures, to similar but not identical types of labour. In addition, there will be differences in energy expended per unit time spent executing a task between individuals. In this study there has been no attempt to calculate energy efficiency, but relative time spent on different tasks was used as a measure of their importance, even though this may not be proportional to energy expenditure. Work activities which require a significant time investment are often those in which a greater energy investment is made.

A random spot-check sampling technique was used to assess time allocation during four periods in different seasons at each study village (for methods see Chapter 3, Section 3.6). Data were collected on between 5 and 11 days (except 18 days in Antsira July 1991) in each period, with an average of between 4.1 and 7.7 household visits per day (Table A4.1, Appendix 4 shows the distribution of data collected). Between 74 and 186 (mean 134.4) person observations, or data points, were collected in each period from seven to 27 households (mean 14.75). The average sample proportions of total village households were 17.7% for Antanandava, 86.1% for Antsira, 15.9% for Esomony and 33.6% Eminiminy. The households with which contact was first made were those which were more open and welcoming, and were often either more highly educated or of higher status within the village, with higher than average land or cattle wealth. This bias was diminished with subsequent visits as an effort was made to visit all households in the villages and include a wider sample in the time allocation study.

The tendency to make fewer visits early, late and during the middle of the day (see Chapter 3, Section 3.6 for an explanation) is well illustrated in Figure A4.2 (Appendix 4), which shows the total numbers of visits in all data collection periods by hour of the day. These are the least active periods of the day for work activities, so non-work activities, such as resting and eating are probably under-represented. I propose that for the types of analyses undertaken here, comparing different types of work activities, the uneven distribution across hours of the day is not important. It does mean, however, that the relationship between work and non-work activities is probably not represented accurately in this study. Data cannot be treated as representative of total daily activities because of the uneven inter-day distribution and the exclusion of early morning, late evening and night-time activities. For example, some sea fishing at Antsira takes place at any time from midnight. Data in different activity categories are therefore described as percentages of person observations, or data points, rather than as percentages of total working time. As the time-sampling bias was fairly consistent throughout data collection it is possible to compare data from different periods. Data collected from four different periods, are well spaced seasonally, so the data for each village have been aggregated (by calculating the means of percentage observations over all sampling periods) to give an approximate mean annual activity pattern, which can be compared between villages.

Activity profiles for each study village

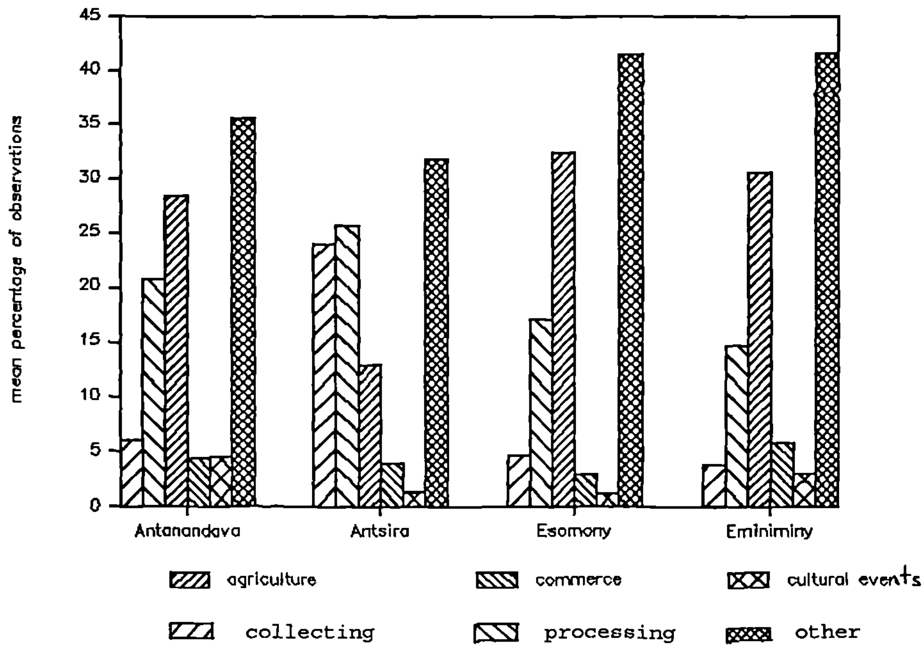


Figure 11. Graph showing means of percentages of observations of main activity types at each village over four periods.

Collecting: collection of non-cultivated resources including fishing, hunting and collecting plants, artefact materials, construction materials, firewood, and water
Processing: production and preparation for consumption, use or sale of food, artefacts (eg. mat weaving), firewood (eg. chopping), traded goods (eg. preparing fishing tackle), and construction (eg. house building, boat repair)
Agriculture: cultivation and harvesting of rice, manioc, and other crops, and caring for cattle and other livestock

Commerce: trading and wage labour including market visits, local trading, paid labour, collecting donated goods (eg. food aid)
Cultural events: attendance at funerals, village meetings, rituals etc.
Other activities: receiving visitors, visiting in the village, visiting further afield, resting or sleeping, being ill, minding children, eating, and hygiene including hair plaiting, washing clothes and washing dishes

The Andohahela villages have remarkably similar activity profiles (Figure 11). Collecting activities were less than 5% of total observations and agricultural work is just over 30%. People in Eminiminy were involved in slightly more commerce and related activities although the difference is only 3%. Antanandava, also a rice cultivating village, has a similar profile, with similar collecting and agricultural work and similarly few commercial activities.

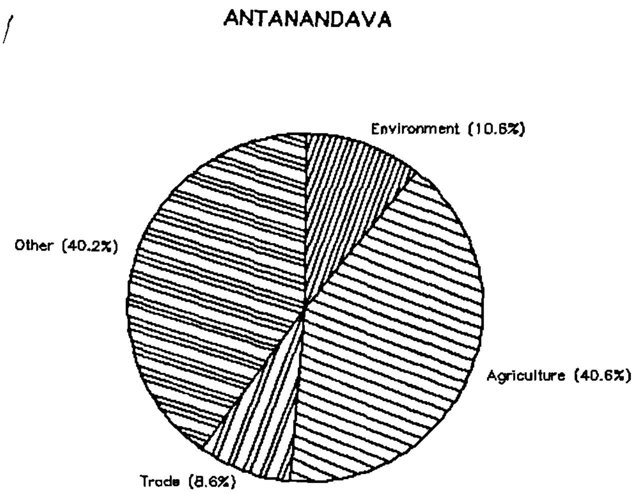
Antsira, a fishing village, has a markedly different profile. Collecting activities are more dominant and more time is spent on processing, due to reliance on fishing and the time needed to process the catch and prepare for fishing. Less time is spent on agriculture, but commercial activities are similar to those in the other villages. People at Antsira spend less time on `other activities'. This is possibly because fishing generally requires less energetic investment, but more time investment, than rice cultivating. As time spent fishing at night is not included, the total time allocated to collecting is probably greater than that recorded here.

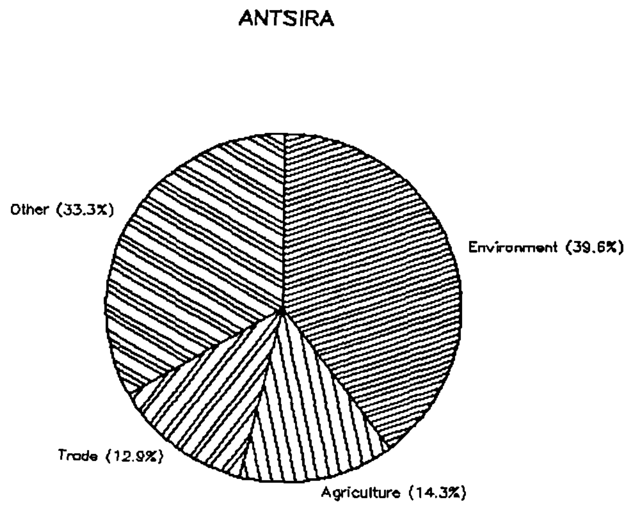
Observations of involvement in cultural events varied greatly. The most time consuming cultural events in all places were funerals, which, for example, accounted for 15% of men's observations in Antanandava in December 1991. A discussion of resources invested in funerals and other cultural events is given in Chapter 6. The time devoted to cultural events is undoubtedly greater than that suggested by these results as I tended to suspend data collection on days of important events, so that I could participate in and observe these events and respect the convention of stopping work while they were in progress.

Time allocated to collecting, producing and processing goods from the environment, agriculture and trade

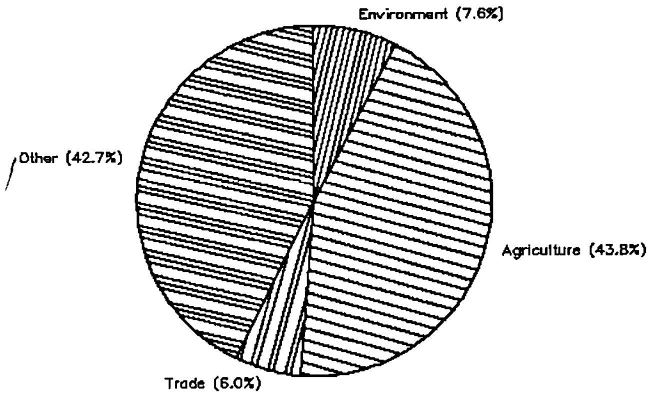
The results are remarkably similar for the three rice cultivating villages (Figure 12), with a greater percentage of activities related to the environment (collecting and processing of non-cultivated resources) at Antsira. Commercial fishing only represents 16% of observations at Antsira, so 24% of observations are other environment related activities. People at Antsira thus spend more time collecting and processing goods from the environment than people in the rice cultivating villages, in addition to commercial fishing.

Figure 12. Pie charts showing means of percentages of time allocation observations at each village over four periods, divided by environment, agriculture and trade.

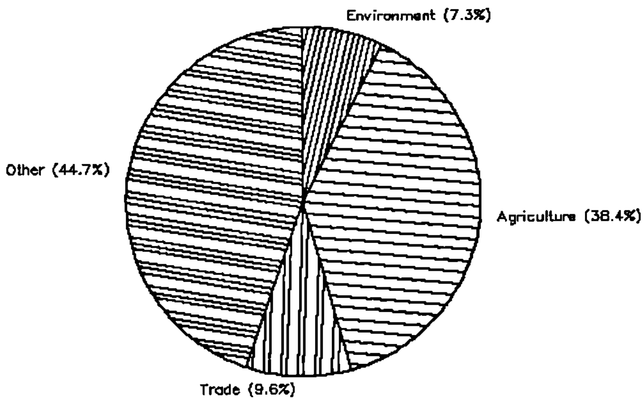




ESOMONY



EMINIMINY



Environment: all collection and processing of wild resources collected from the environment including non-cultivated plants, hunting and fishing, artefacts, house, boat and other construction, firewood and water

Agriculture: all cultivation and harvesting, livestock rearing, preparation and cooking of cultivated foods

Trade: going to market, paid labour, local trading, collecting aid donated food, preparation or cooking of traded goods

Other: all activities not included in the above categories such as hygiene, eating, sleeping, visiting, cultural events etc.

Time allocated to subsistence and commercial activities

Not all rice cultivation is commercial, as a proportion of the harvest provides food for the household. The proportion sold varies widely with the yield of the harvest and the circumstances of the household. For this analysis it has been assumed that on average half the rice harvest is sold, or intended for sale. Half the rice cultivation observations are therefore allocated to subsistence activities and half to commercial activities. Other crops such as manioc may be sold, but the primary motivation for their cultivation is usually home consumption. Similarly cattle may be sold, but the primary motivation for keeping them is for cultural and labour reasons. Tending cattle and cultivation of crops other than rice are therefore classed as subsistence activities. Other livestock, such as poultry and pigs, are usually intended for sale, and have been included as commercial activities, although activities concerning their care were only observed at Antsira, where turkeys require some work. Commercial fishing at Antsira does provide family food, but usually only a small proportion of the total catch is kept for the family, depending greatly on the size of the catch. Occasions where fishing was done only to provide family food are included in the subsistence category. It has been estimated here that one fifth of a commercial catch is retained by the family for food. 80% of commercial fishing observations are therefore allocated to commercial activities. The activities classed here as commercial or subsistence represent those I have chosen to call `work activities'. While activities such as child care, and clothes and dish washing would usually be classed as work activities, only those activities directly related to production and processing of resources are included here. Wage labour and trading are included because they produce financial income.

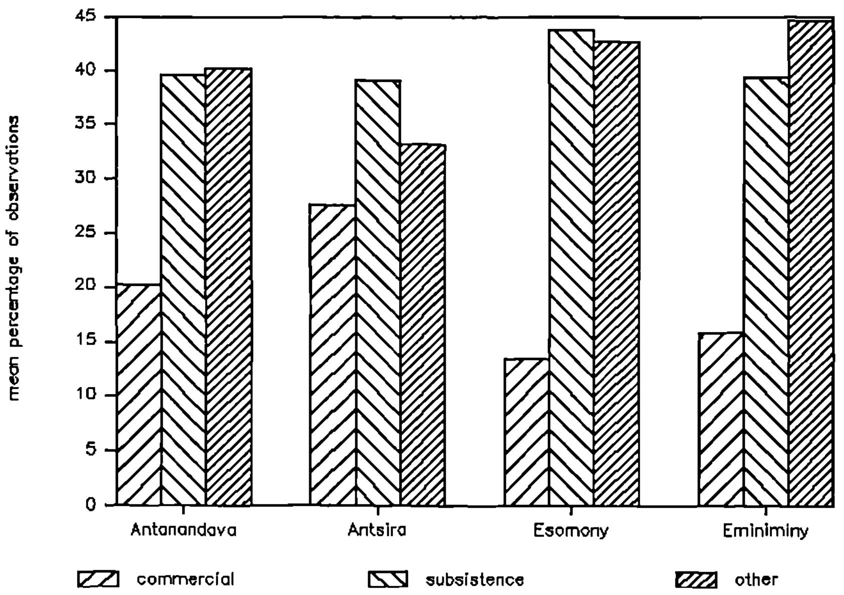


Figure 13. Graph showing means of percentages of time allocation observations, at each village over four periods, divided into commercial and subsistence activities.

Commercial: 50% of rice cultivation at Antanandava, Esomony and Eminiminy, 80% of fishing at Antsira (with non-commercial fishing for family consumption removed), care of livestock other than cattle, collection and preparation of goods for trade (such as making mats for trade, rice pounding for trade, or preparation of fishing tackle for commercial fishing), all trading, and paid labour (aid related activities are excluded).

Subsistence: all collecting, production and preparation (including 20% of commercial fishing but excluding other collection and processing for trade, which are included in commercial activities), 50% of rice cultivation, all cultivation and harvesting of crops other than rice, and cattle rearing (food aid related activities are included)

Other: all activities not defined as commercial or subsistence above.

Esomony and Eminiminy are again similar, with commercial activities representing around a quarter of all work activity observations. The Soalala villages have a greater percentage commercial activities, which suggests that they are more integrated into the market. The coastal fishing communities are more dependent on trade than rice cultivating communities, for example buying most of their staple food. Antanandava specialises more in rice production than the villages around Andohahela, where a wider range of crops are grown and livestock kept, and relies more on trading rice to provide their other subsistence requirements.

There is some seasonal variation in the proportion of commercial activities in the Soalala villages. In Antanandava there was increased commercial activity in August when more agricultural work was observed, and less in February when much less agricultural work was done. In Antsira, commercial activities increased in December and January, at the height of the prawn fishing season, but in July and September more subsistence agriculture was done. The seasonal variations observed in Esomony and Eminiminy are small.

Variation in time allocation with gender

Table 4.2 shows the percentage contribution of men and women to the mean figures for each village. In the Soalala villages men do most collecting and trade, marginally more agriculture and women do most processing. Men contribute more to processing in Antsira where they do tasks associated with fishing, including processing the catch, and preparing fishing tackle and boats. In the Andohahela villages the contributions to collecting are more variable, with women contributing more in Esomony and men contributing more in Eminiminy. As in the Soalala villages men do more agriculture and more trade, and women do most processing. Men were observed to spend more time on cultural events in all four villages although the proportion varies considerably. Apart from women doing most collecting in Esomony the trends are the same in all four villages, and the percentage contributions of women and men in each region are remarkably consistent. The tasks of men and women are often well defined, and that there is much similarity in the division of labour between sexes in the two regions.

Moreover, men always contribute most to commercial activities and women most to subsistence. Women contribute more to commercial activities in the rice cultivating villages. Women are therefore most important commercially to households in the rice cultivating villages.

Table 4.2. Time allocation: contribution by gender to means of percentages over four periods. Activity categories have the same definitions as in Figures 11 and 13.

	Antanandava			Antsira		
	tot	Men	Women	tot	Men	Women
	%	% of total		%	% of total	
Collecting	6.2	62.5	37.5	25.4	66.4	33.6
Processing	20.9	15.3	84.7	25.7	41.2	58.8
Agriculture	28.6	53.9	46.1	11.6	55.1	44.9
Commerce	4.2	73.5	26.5	3.9	83.7	16.3
Cult'l events	4.5	73.1	26.9	1.4	52.9	47.1
Other	35.6	33.6	66.4	32.0	42.1	57.9
Total	100.0	40.8	59.2	100.0	51.3	48.7
Commercial	20.0	56.9	43.1	27.4	70.0	30.0
Subsistence	39.9	35.6	64.4	39.3	45.8	54.2
Other	40.1	38.1	61.9	33.3	42.5	57.5
Total	100.0	40.8	59.2	100.0	51.3	48.7

	Esomony			Eminiminy		
	tot	Men	Women	tot	Men	Women
	%	% of total		%	% of total	
Collecting	4.7	24.6	75.4	3.0	54.0	46.0
Processing	17.0	11.8	88.2	14.8	18.4	81.6
Agriculture	32.6	69.5	30.5	31.7	61.1	38.9
Commerce	2.8	62.2	37.8	5.9	71.4	28.6
Cult'l events	1.2	80.0	20.0	3.0	58.0	42.0
Other	41.7	45.8	54.2	41.6	42.2	57.8
Total	100.0	47.6	52.4	100.0	47.2	52.8
Commercial	13.6	59.1	40.9	15.9	59.5	40.5
Subsistence	43.6	44.9	55.1	39.4	46.7	53.3
Other	42.8	46.8	53.2	44.7	43.2	56.8
Total	100.0	47.6	52.4	100.0	47.2	52.8

4.4 Factors influencing collection and use of wild, non-cultivated resources

Collecting and using non-cultivated resources represent quite a small proportion of activities in rice cultivating villages, with the proportion being slightly greater at Antanandava. There is substantially more use of non-cultivated resources at Antsira, even discounting commercial fishing activities. The variation in non-cultivated resource use at each site, and the influence of energetic and other factors are explored here.

The type of non-cultivated resources used depends foremost on their availability. Other important influences include the relative importance of the resource use, presence of a market for the resource, availability of cultivated alternatives, availability of knowledge and technology to collect, process and use them, and the effort required for their collection and processing. Effort required is primarily determined by the distribution and density of the resource, which affect distance travelled and search time. These constraints can be diminished by knowledge of resource ecology and techniques for collection. The energy or time required is evaluated with the relative usefulness of the resource and the demands of other work. Some examples are given here to show how these influences interact, and particularly how energetic factors can determine type and scale of wild resource use.

Geographical variation in wild resource use activities

Table A5.1 in Appendix 5 lists the different environment-related activities observed in the time allocation study performed by men and women at each village in different seasons. Many resource uses are similar in both regions: water is collected, firewood is used for cooking, mats, baskets and houses are made from local materials, and some food is collected. The main variation here is in species used and scale of use.

Resource use at Antsira reflects its coastal location. Many activities are related to collection and processing of marine resource, for instance catching fish, prawns, crabs and turtles, construction and repair of boats, nets and other fishing equipment, and the manufacture of salt. Salt is used to preserve fish for trade and some is traded with villages inland. Antanandava is only 9 km from the nearest port at Bedory and sea fishing is of some importance, in addition to river and lake fishing. In the Soalala region, particularly at Antsira, there are high densities of bush pigs *(Potamochoerus larvatus)*. Fences, and sometimes evening fires, are built around crop cultivation, greatly increasing wood use.

In Andohahela, there is a variation in species, and to some extent in resource types, used between the two study villages, because of the different habitats on either side of the Andohahela massif. For example, a forest nut (**hovao**, *Dilobeia thouarsii*) used to make oil for food and sale is only available on the eastern moist forest side of Andohahela and is only used at Eminiminy. The different species used for construction of houses and mats, and for firewood, are given in Appendix 10.

Seasonal variation in wild resource use

Some environment-related activities, such as water collection and firewood collection and chopping, have no seasonal variation, but the majority vary seasonally. Appendix 6 includes wild resource use calendars. Non-cultivated resource extraction is limited seasonally by resource availability and by the conditions necessary for harvest. Fruits and nuts are only available seasonally. Fishing is not possible in Andohahela either when rivers are too high and fast flowing in the wet season, from December to April, or when the water is too cold and fish are inactive during colder months, from May to July. People therefore only fish from August to whenever the rivers rise, usually around December.

Collection of weaving materials in Andohahela is best at the end of the wet season (April and May). The stems and leaves have grown well by this time, but may be eaten by cattle later in the dry season when other pasture is in poor condition. In addition, mats are needed for threshing, winnowing and drying rice at harvest, and are sewn into large containers for rice storage. Many women therefore try to finish mats in time for the final, largest rice harvest in May and June. This is also a period when women are relatively free of other duties, after transplanting the final rice and the harvest of the intermediate season rice, but before the final rice harvest (see agricultural calendars, Apendix 6).

Wild yams in Andohahela (such as **vorozy**, *Dioscorea* sp.) are not harvested at the end of the wet, growing season in May and June, but when the leaves regrow in October and November. They are generally not required in April and May when rice is harvested and cultivated food is available, and in the winter months they are difficult to find as all their leaves die back. The type and timing of use of wild resources are thus seen to be primarily influenced by ecological factors, but other factors, such as the availability of cultivated foods, or the labour demands of rice cultivation work, also have influence.

Influence of energetic factors on wild resource use

(a) weaving materials

Mats are made exclusively by women, and are used in all areas as floor coverings in houses, for sleeping on, to eat from and to dry rice prior to pounding, in addition to uses described above at rice harvest. Mats last one to two years depending on use and durability of the material. In Soalala all mats and baskets are made from leaves of fire-resistant palms (**satrabe**, *Bismarckia nobilis* and **satra mira**, *Hyphaene shatan*), which are abundant in the savanna that is the dominant vegetation in the region. Young leaves are sun dried before being split into about 0.5 cm strips for weaving. It is never necessary to go further than 0.5 km to collect young leaves, and they are available all year round, unless there has been a recent fire. The only seasonality occurs because the leaves are less brittle and easier to weave when the air is humid in the wet season, although some women do weave all year round. Mats are traded locally, and are an important source of income for some women.

In Andohahela, weaving materials are the leaves and stems of plants growing in marshy areas. In Esomony, principal materials are **vondro** *(Typha angustifolia),* **vinda** *(Cyperus* sp.) and **boboky** *(Cyperus articulatus*), while in Eminiminy they are **hera** *(Cyperus latifolius*) and **harefo** *(Heliocharis plantaginus)*. Vondro and hera are considered most useful as they are longer than others and thus make larger mats which are particularly useful for rice drying, threshing, and storage. In Esomony, vinda and boboky are found near the village, but vondro is collected from Ankazoabo, about 15 km or 4 to 5 hours walk to the north-west. Women stay overnight and prepare the leaves by rolling them in white earth and drying them, before carrying them back. The number and size of mats each woman makes depends on how much she can carry. Most women questioned only made one collection visit each year. Women in Esomony do not sell mats, probably in large part due to the difficulty of collecting sufficient stems. Women from villages further north and west bring mats to Esomony for sale. Some women cultivate vondro, so do not need to walk long distances for collection, although areas suitable for cultivation are limited as most marshy areas are used for rice cultivation. In Eminiminy, hera is also quite scarce. It grows in disused rice fields which are private land and some owners sell the stems to those who do not have access to such sites. Again, few surplus mats are made for trade, although most households make some mats for their own use, although there is often a shortage at harvest time when mats are borrowed between households.

The environmentally-determined availability of suitable mat weaving materials affects the energy required to collect them, and so limits the scale of the activity. The easy availability of mat materials in Soalala means that surplus mats can be made for trade. Whereas the scarcity and distance of good mat materials at Andohahela means that local demand is scarcely satisfied and some mats are bought from areas with greater availability of materials.

(b) wild tubers

In all areas there are wild tubers which can be used as a staple food. As described above, tubers often grow in the wet season, and are usually collected during the dry season, at times when other food is not available. In Andohahela, the `famine' period (**mosary**) when least cultivated food is available is usually from September to December, and in Soalala from July to October, although food shortages vary annually and between households. Tubers are only collected when other food is unavailable because they are usually time consuming and strenuous to collect, and sometimes time consuming to prepare. Edible tubers are usually found in specialised habitats which are often at some distance from the village. For example, some tubers found near Eminiminy, such as wild yams (**vorozy** and **taretsy**, both *Dioscorea* spp.) are only found in forest at a distance of 4 km or more from the village. These tubers are also rare and require some searching, so collectors sometimes stay one or more nights in the forest until a reasonable load has been collected. For vorozy this entails finding several plants as each provides one tuber of up to 0.5 m long and 0.2 m diameter. Tubers collected in the Soalala region include waterlily roots (**makamba**, *Nymphaea* sp.) which are only found in fresh water lakes at some distance from the villages, the nearest being 8 km north of Antanandava and 11 km east of Antsira. Some tubers, like vorozy and **via** (*Typhonodorum lindleyanum*) near Eminiminy and **masiba** (*Dioscorea* sp.) in Soalala, are large and deeply buried, requiring substantial digging to extract and leaving holes up to 1.5 m deep and 1.5 m diameter. Others, like makamba, **kabija** (*Tacca pinnatifidia*, arrowroot, Soalala) and **lingirotsy** (*Canna indica*, Indian shot, Eminiminy) are small and many must be collected, which can be time consuming. One woman at Antsira collected 11.25 kg of kabija, which are around 5 to 10 cm diameter and only one is found per plant, in four collecting trips to a nearby forest 3 to 4 km distant, spending two to three hours away from the village on each occasion. In Soalala, most tubers are collected by women although men may help if a long expedition from the village is planned. In Andohahela, men collect tubers from the forest, and tubers near the village which require substantial digging like via, although women collect smaller tubers like lingirotsy.

Preparation of tubers (and other food) for consumption is exclusively women's work, and in some cases, such as for kabija, can be very time consuming. The roots, which are very bitter, are grated, then washed in water which is drained through a giant finely woven material seive. The grated root is washed several times and the cloudy effluent is caught in a large bowl. After some time, a fine powder settles in the effluent and the water is poured off. The powder is washed three times, and on each occasion allowed to settle and the water discarded. A bitter flavour, caused by taccalin (Mabberley 1987, p. 567), is washed away by the process described, and the remaining white powder is sun dried and can be stored. For consumption it is boiled briefly in water to make a clear porridge. It takes at least two days to make; one day to grate, wash and allow to settle, and another day to dry. It is only worth making if sufficient tubers have been collected, so several days' collection are required. Wild yams are much easier to prepare, as they are cut into pieces and boiled like manioc, and each tuber can be up to 0.5 m and 0.2 m diameter, but they require more work to collected. Another tuber found in the forest in both regions, **antaly**, is poisonous unless soaked in water for a week, usually left in a basket in a river, before being sun dried, pounded and boiled. People in Andohahela fear that the week old pieces will be swapped with fresh ones and the family will be poisoned. This tuber is rarely collected in either region, except when no other food is found.

The energy required to harvest tubers, as a result of distance, searching, extraction from ground, transporting to village and preparation for consumption, thus influences when tubers are collected, who collects them, and which species are collected. Palatability and personal preference also affect species choice. Although all people preferred rice to wild tubers, many preferred wild yams and kabija to manioc, but most other tubers such as makamba, which are bitter, and via, which are fibrous, are considered famine foods. This suggests that the work involved in collecting wild yams and kabija prevents them being eaten instead of cultivated staple foods.

(c) firewood

The work involved in collecting firewood also influences who collects it. People in both regions said that men usually collect firewood because they are stronger. Large dead boughs and trunks are preferred, rather than bundles of smaller pieces, which women collect if there are no men available. Men collect a large log up to 3 m long and 0.2 to 0.3 m diameter, often at the limit of what they can carry comfortably. Heavier hardwoods are preferred as they burn with a good flame and more slowly. Hardness of wood is indicated by its density, and harder woods give off a higher amount of energy per kilo (NAS 1980 quoted in Maille 1991). They bring wood from around 1 to 3 km distance, but sometimes up to 5 km. Men are responsible for chopping firewood, done with an axe, which is also a task requiring strength, especially if a hardwood has been collected. Men do not collect firewood everywhere in Madagascar, as in the far south of Madagascar, west of Andohahela, in the regions of the Antandroy and Mahafaly ethnic groups, women habitually collect firewood (Maille 1991). The exception among the four study villages was in Antsira where both women and men collected driftwood from the beach, which was not arduous to collect. Here, as in the other villages, women were entitled to ask men to provide more wood as their stocks diminished.

Large logs often lasted many days, which perhaps explains the relatively low number of observations of firewood collection in the villages. In addition, firewood was often collected on returning from work in the fields or other activities away from home, which was be reported as agricultural or other work rather than collection of firewood. It is usually younger men in a household who are responsible for provision of firewood.

(d) construction wood

Men are also responsible for collecting wood for house construction, partly because they are stronger than women. Houses in all villages consist of frames of wooden poles, with harder woods, which are more resistant to termites and rotting, used in the ground, and softer woods above ground. Roof thatch and wall materials vary. Some planks are used, for example for doors, and sometimes for walls in Andohahela. Timber frames are made from poles of up to 0.2 m diameter and 4 m length. They are always collected by the house builder, although not all men build their own houses and some houses are bought. A survey of five houses in each village showed that more than 60 poles are used on average per house in the three rice cultivating villages, while at Antsira on average 36 poles were used per house. In Andohahela, poles are cut in the forest and carried, at least 3 km from the village but reportedly up to four hours walk from villages for the harder woods. With the time taken to select and fell the tree, each pole represents at least half a man-day of work. In Antanandava, ox-carts are often used to collect wood, and in Antsira, canoes are sometimes used to transport wood around the coast. There is a strong incentive to go further to find harder woods as these can last more than 40 years in the ground, where softer woods, which may grow closer to the village, like the introduced *Eucalyptus citriodora* often used in reforestation programmes, may need to be replaced after three to 10 years. Not surprisingly, because of the work involved it takes most people six months to one year, or longer, to complete a house. After houses of 26 households were burned in Eminiminy in August 1991, only one had rebuilt a permanent house while 10 had bought houses from nearby villages by August 1992, and four more had built houses by March 1993. People said that after the men had completed the frame, the walls and roof were relatively fast to complete, usually with help from women and children. The work required to collect and process timber thus appears to limit the speed at which houses can be built.

(e) fishing

In Antsira, fishing (used here to mean all collection of aquatic animals) is the main livelihood activity. There are many different types of fishing, requiring different labour input and different equipment. Table A5.2 (Appendix 5), describes the main techniques used. Of these, women mostly do the types of fishing that do not use canoes, particularly fishing for **tsivakia** (tiny prawns), fishing from the shore with rod and line, and fishing at the shore with a net. The latter two are often done to provide food for family consumption. Fishing for tsivakia was traditionally exclusively women's work but men participate more now. Men build and own the boats which are used for other types of fishing. Some boats, particularly the dhow-rigged type (**lay rakisa**) usually require two crew members (see Figure A12.6, Appendix 12). Other smaller canoes, usually those rigged with square sails suspended between two poles (**lay mizana**), can be managed by one man. Some fishing techniques require two men, even if a smaller boat is used, for example when hunting turtles, where a small boat is used to enable the craft to be paddled fast to the point where the turtle surfaces. Men often have an established partner for a fishing season; they are often related, sometimes by marriage and may be blood-brothers (**mpifatidraha**: see Chapter 6, Section 6.2). The catch is shared equally. On some occasions their wives are fishing partners; most frequently for hook and line fishing at sea, sometimes for prawn fishing, but never for turtle or dugong fishing. Men pride themselves on having the skill to catch turtles and dugongs, which have very highly prized, fatty meat, and build a reputation as good hunters through their success in catching these animals. Skilled hunting is often entirely within the male domain, as with turtle and dugong hunting among the Miskito in Nicaragua (Nietschmann 1973). Once the catch is brought to the village, men and women share the commercial processing and preparation, although women do all preparation destined for home consumption.

In Antanandava and the Andohahela villages, women and children do most rod and line fishing in rivers and lakes. In Antanandava women catch tsivakia in channels near rice fields using a cloth net. In Andohahela women catch fish or prawns with a hand held net (**atsidy**), woven from reeds, and children may use a spear made from a bamboo-like plant (**bararata**, *Phragmites* sp.). Men do fishing which requires greater equipment and catches larger animals. In both regions men set traps (rows of baited hooks) for eels, and catch eels with harpoons. In Antanandava they also cooperate in net fishing in lakes, where a net is dragged across an entire lake. Some own boats on the coast which they use for line and prawn fishing.

For fishing, it is not so clearly the energy or strength required that determines the division of activities but the fact that men control the equipment, and in some cases the knowledge to exploit the resource. The equipment is often specialised and can represent either a large cash or time investment. Canoes, for example, require special woods for different parts, which are often collected from some distance, or purchased. Most men in Antsira made their own canoes, and one specialist boat builder makes boats for people in other villages.

4.5 Agricultural work

Geographical variation in crops grown

Table A7.1 (Appendix 7) lists the different crops grown and livestock reared at each study village. Crops grown are similar, the main variations being that rice is not grown at Antsira, sweet potatoes are not grown in the Soalala region, a greater variety of fruit is grown in the wetter climate at Eminiminy and pigs are not raised in the Soalala region. Differences include the scale at which different crops are grown, in particular, rain-fed field crops are grown in smaller gardens in Soalala, and cattle are kept on the greatest scale at Esomony. The timing of different crop cycles varies greatly, with rice primarily cultivated in the dry season at Antanandava and manioc planted in the wet season, but with rice grown during the wet season in Andohahela, and manioc planted in the dry season (see agricultural calendars, Appendix 6).

Types of crops grown are clearly influenced by climate, particularly rainfall. This is shown most clearly by the variation in fruit trees between Esomony and Eminiminy; in the latter, trees are grown which require higher or more consistent rainfall, such as coffee (*Coffea* sp.), jack fruit, soursop (*Annona muricata*), and lychee (*Litchi chinensis*). They are also influenced by soils; cashew nut trees grow well on sandy soil (Williams *et al.* 1980, p. 122), as found in the Soalala region. Cultural preference and history of cultivation are important, for example, mint, ginger and chillies, used to flavour food and beverages, are only grown in the Soalala region. Pigs and pork are generally taboo in Soalala, much as a result of the strong Muslim influence in the region. Although goats are reared in large numbers by villages surrounding Esomony, there are very few in Esomony itself because the largest clan has a taboo which forbids rearing them.

Influence of labour demands on rice cultivation

(a) factors affecting area under cultivation and labour calendar in Soalala

Although it is the main staple food, rice is not grown in Antsira for several reasons, the most important being that a livelihood can be made from investing time and energy in fishing. Rice is a labour intensive activity, as can be seen from the time allocation observations of the three rice cultivating communities, where rice cultivating and harvest represented around a quarter of all observations in the time allocation study (means of percentages of observations over four periods: 27% at Antanandava, 21% at Esomony and 22% at Eminiminy). There is some marshy land available near Antsira for rain-fed, wet season rice cultivation (**vary asara**), which people say was cultivated over 20 years ago, but since commercial fishing has become more widespread and profitable since the 1960s they have not cultivated rice.

In some other coastal communities, for example at Ambatojoby, 14 km east of Antsira, a proportion of the community moves to the Antanandava region to cultivate irrigated rice in the dry season from May to December (**vary jeby**), and cultivates rain-fed rice, or collects prawns in the wet season. Rain-fed rice, which needs about 1,200 mm rain in the growing season (Williams *et al.* 1980, p. 154), is not always possible due to the variable rainfall. Annual rainfall at Mitsinjo (60 km east of Soalala) varied between 2,000 mm and 706 mm (mean 1,354mm), with four years at less than 1,000 mm, in the 10 years from 1980 to 1989 (see Appendix 3). During the study period, rainfall was low in 1990 and 1991 in the Soalala region and only limited, or no rain-fed rice cultivation was possible in the fields at Ambatojoby. Rain-fed rice is therefore not a reliable activity in this region. In addition people say that bush pigs destroy the rice unless fences are built round the fields, which represents a strong energetic reason for not growing rice.

In Antanandava, rice is mainly grown in the dry season in the flood plains of the Bedango river, where water is too deep for rice cultivation in the wet season (see agricultural calendars, Appendix 6). Rice is not irrigated but grown in slowly receding standing water. Some rice is planted from March to July in receding flood waters (**vary atriatry**) to provide an early harvest if the previous year's harvest was insufficient. However, the majority of rice cultivators pursue other activities during the wettest months from January to March. Many of them consider this time to be a rest from the hard labour of rice cultivation. It is also a time of relative food abundance, and when cash is available to buy new clothes, equipment and luxuries, which people talk of as their reward for the rice work. Many households leave Antanandava to tend their cattle, or fish and cultivate gardens elsewhere. In February 1993, of 75 households normally resident in Antanandava 37 (49%) were temporarily living elsewhere. Although the dry season rice crop is only referred to as one season, people tend to cultivate their fields at different times throughout the season with some transplanted as early as May and others as late as August, in order to spread the work required in different fields over time, particularly for transplanting and harvest. The fields nearest the edge of the plain are cultivated first.

In Antanandava, most agriculture is rice cultivation and minimal time recorded in the time allocation study was spent on other crop cultivation and livestock. This may have been largely because cultivation of other crops and tending to cattle often occurs elsewhere, and was not recorded. Time allocation observations of agricultural work reached a maximium of 50% in August and were 27% and 21% in October and

December respectively. The August figures are probably rather high, although this is a period of intensified work at the end of the transplanting period, when people are racing to complete field preparation and transplanting. Later rice develops better and faster as it is warmer but there is a risk that fields will be flooded by rising water in December and the harvest ruined. Time allocation observations were made by visiting the household base in the village, and many families spent all day at their fields, so it is not certain that each time people were reported to be in the fields they were actually working. Once grains have formed, people tend to camp by their fields, at 1 to 3 km from the village, to guard the rice from birds, or theft once harvested. In October and December many of our time allocation observations were made by visiting the temporary camp areas of each family, so it was clearer who was occupied with which task.

(b) factors affecting areas under cultivation and labour calendar in Andohahela
In Andohahela, rice is cultivated on terraced fields, mostly irrigated from streams which descend from forested mountains in the Andohahela reserve. Different fields with different water availability, are used for three different harvests: first season (**vary aloha**), intermediate season (**vary anivo**), and final season (**vary afara** or **vary tsipala**) (see agricultural calendars, Appendix 6). Successive cultivation is necessary as certain field types are only suitable for cultivation at certain times of the year, and also acts to spread the work required across time. The separation by different field types is clearest in Eminiminy, where the swampy fields at the bottoms of valleys (**mason-drano**), are only suitable for first season rice, as they can be sown in the dry season from July and become too wet and flooded from December. Terraced fields at the tops of valleys (**halitany**) can only be irrigated once streams are full and constant after the wet season commences in December, and must remain well irrigated until rice is harvested in June. In Esomony, there is not usually a problem with drainage, as there are no swampy valley-bottom fields, but the fields cultivated for each harvest are highly dependent on the water available for irrigation. Here, it is possible to cultivate fields used for first season rice with final season rice, although this is only done by households with limited access to land. A large area of rice fields, south and west of the village, were not cultivated from 1989 until 1993 due to insufficient rain.

(c) organisation of labour for field preparation
In all areas, the main work of breaking up soil and making a smooth, soft mud is done by chasing cattle around fields. In Antanandava, trampling with cattle (**mandrevorevo**) is only done once per field, and many fields are not trampled as their cultivators do not have access to sufficient cattle. In February 1993 only 64% of households owned cattle, although close relatives of cattle owners may also have access to cattle. The mud is very

deep, the work is tiring for cattle, and females used for trampling are said to have fewer calves. Owners do not like cattle to be used more than a few times each year and it is rare for cattle to be loaned outside the close famiily. Fifteen to 30 cattle with eight to 10 men may be used at once. The more cattle and men available, the more fields can be done in one day, usually trampling for around 4 to 5 hours. The cultivator of the field provides meals for all participants before and after the work, for which large quantities of rice (around 2 kapoaka, or 0.57 kg, per person) and a sauce with meat or fish are required. Rum is usually provided. There is no payment, either of money or a part of the ultimate harvest. This is the usual way of organising group labour in all regions visited. In return, the cultivator helps with group labour in the fields of other participants.

In Andohahela, field trampling is also done by cattle (**magnosy**), but here it is done three times per field. As in Antanandava it is tiring for cattle, and owners do not like their cattle to do this work very often. It is therefore difficult to borrow cattle, especially for the preparation of fields for the first harvest, when pasture is poor and cattle are weaker. Households with no access to cattle must perform the same work using a spade, which is tiring and time-consuming and often limits the number of fields that can be prepared. Households with less than five cattle may trample the fields on fewer occasions. In Eminiminy only 47% of households have cattle (sample size 15), with a mean of 9.7 per household, although a median of five suggests that a few households have larger numbers (maximum 37) and at least half have five or fewer. In Esomony 86% households have cattle (sample size 22), with a mean of 13.8 per household and median of 11 (maximum 84). The work for cattle is also said to be harder in Eminiminy where the mud is generally deeper, especially in the **mason-drano** fields, and usually only males are used, as opposed to mixed males and females at Esomony.

After trampling, all weeds and grasses not yet broken down are removed from the fields and walls are made. The amount of work depends on the types of vegetation and amount of cattle trampling done. Soil must be turned and broken with a spade if there has been no trampling. In Andohahela irrigation channels and dams must also be built or repaired. This field preparation work represents considerable labour and is done primarily by men. The number of fields that a household can cultivate is often limited by the number that can be prepared for transplanting, and households with no male labour do very few. Group labour is rarely organised for this task, but sometimes labourers are paid, although there are few such labourers available as most people have access to land.

(d) labour involved in planting rice

Transplanting of seedlings and weeding is usually done by women. Transplanting of a particular field is usually done in one day, often with the help of other women, organised in the same way as for trampling. Where people outside the household help, a good meal is provided after the work.

In Antanandava, two to three one-month-old seedlings are placed 40 to 50 cm apart. Usually two to five women worked on a field. It was not unknown for men, particularly younger ones, to help with transplanting.

In Eminiminy, rice is not usually transplanted from a nursery but sown directly onto the main field, where seedlings are redistributed and weeded later. Whereas in Esomony, three week to one month old seedlings are transplanted from a nursery to the main field, as in Antanandava and much of Madagascar (le Bourdiec 1980). Here they are planted singly about 15 cm apart. The main impact for timing is that the full field must be prepared prior to sowing in Eminiminy, where field preparation starts as early as April. In Esomony a small nursery is prepared in advance, and field preparation is started later, in July, while the seedlings are growing. People in Eminiminy know of the transplanting technique, and some people practise it and claim it gives increased yields and uses less seed. The main reason given by people in Eminiminy for not transplanting is that women there do not like to do it. However, the work involved in weeding and redistributing appears similarly strenuous, and occupies women for a similar time at similar periods.

Sowing directly onto the main field is the traditional technique. Flacourt (1661, in Grandidier *et al.* 1913, p. 163) describes rice cultivation in the Anosy region: cattle were used to trample marshy areas, `horracs' (same word is used now for all rice fields, **horaka**), and two types of rice were mixed and sown in winter. One type grew immediately and was harvested in the wet season, the other started to grow in the wet season and was harvested five months later. Although rice is no longer mixed, people do say that if the rice types used for the last harvest are planted earlier they are still not ready to harvest until May or June. People in Eminiminy, all of the Takalilagna clan, have lived in the same place, and cultivated the same fields for many centuries, both according to their oral history and confirmed by Flacourt's account which refers to the region of Eminiminy as `Encalilan' (Flacourt 1661, in Grandidier *et al.* 1913, p. 29, p. 62 and Map of the Province of Anosy). It is possible that they adhere to the old technique for historical reasons. Rice cultivation started at Esomony in the last century, and most families have come from further east within the last few generations. Field preparation and sowing is more limited by water supply for irrigation in this drier region, so they use a technique that allows longer for the rains to supply water for irrigation.

(e) labour required guarding rice from pests

The time spent guarding rice from birds in Antanandava was substantial. Men, women and children stayed beside fields, whistling and throwing mud pellets at flocks of small birds, primarily Madagascar red fodies (**fody**, *Foudia madagascariensis*) and grey-headed lovebirds (**karaoky**, *Agapornis cana*), which threatened to settle in their fields. Attacks were most frequent from sunrise to 10 am and from 4 pm to sunset. People say that if fields are left unattended the harvest is negligible. They do not like to be the first to have rice grains as these are attacked incessantly by birds. Such work often obstructed children from attending school, as they guarded rice while adults did other work. 31% of adults' time observations cultivating rice in October were guarding against birds. People do make scarecrows but no traps were seen, as they said that it would make little difference to trap a few.

Rice in Antanandava is also attacked at night by ducks, notably white-faced whistling ducks and knob-billed ducks. Sometimes men sleep near harvested rice, still in the field, to protect it from ducks. Ducks are trapped, using long nets or lines of nooses, suspended low across rice fields. They are probably trapped because they make a good meal, in addition to their being rice pests. Bush pigs are not a problem in the relatively densely populated area around the dry season rice fields. In the Andohahela region such guarding is currently not necessary, although Flacourt reported in the 17th century that slaves permanently guarded rice and other crops from birds and pigs in the Andohahela region (Flacourt 1661, in Grandidier *et al.* 1913, p. 164).

(f) organisation of labour for harvest

After transplanting or weeding, and guarding from birds, the main work in all areas is the harvest. Men and women have separate but complementary tasks; men cut the rice, women in Antanandava tie sheaves, men make stacks, men and women thresh, women winnow, and men transport the rice to the village for storage. This work is also often done by reciprocal group labour with a large meal provided. Paid labour is sometimes used, particularly in Soalala where there is an urgency to finish final harvest work quickly before water rises in the fields in November and December. In Andohahela, harvesting may be completed over several weeks. Rice is sun-dried and stored as paddy (in the husk), often in raised buildings to protect from damp and rodents. In all areas people said that storage was not a problem, although there may be a small risk of it being stolen or lost through fire or flooding. Rice is pounded to remove husks after drying again in the sun prior to cooking or sale. Women pound rice except when it is for sale, when men may help.

(g) factors affecting yield

In addition to labour and surface cultivated there are further factors affecting the yield in each area. The fields at Antanandava are flooded each year, which maintains a high fertility, and the water level is constant and assured, except at the edges of the plain. Rough local estimates of yields were between 2,000 kg and 3,000 kg rice per hectare, and seed rice multiplied about 80-fold. People say that in the long term yields have reduced due to salination rising up the valley from the river mouth. Floods after cyclones fill fields with sand, and deepen the central channel so that the surface available for cultivation has decreased, also a problem in other parts of western Madagascar (le Bourdiec 1980).

In Andohahela there is much more variability in yield between fields, according to water supply and different soil types, blacker valley-bottom soils being the most fertile. Water supply for irrigation is very variable, depending on rainfall, and is probably the most important factor affecting yield. Moisture stress has devastating effects on the yield of a rice crop (Williams *et al.* 1980, p. 154). In Esomony, where water is less certain than Eminiminy, men spend much time diverting water to their fields, and guarding their supply, sometimes checking several times, day and night. Fragile agreements are sometimes reached between adjacent cultivators, but water supply is a frequent source of conflict. In Andohahela yields were estimated locally to be 1,000 kg to 2,000 kg per hectare, with seed rice producing 20 to 70 times more rice, increasing from the first to final harvest. Yields are significantly greater for the final harvest, probably due to more assured water supply and higher temperatures during the vegetative growth phase when extra stems are produced (Williams *et al.*, p. 154). More fields are cultivated for the final harvest, and although earlier harvests are important for food, the final harvest usually supplies rice for trade. Fertilizer is never used for rice cultivation in either region, and fields are only left fallow in Andohahela when forced through lack of water, although yield is reportedly improved. Rice types are important, and different types are chosen for different types of fields, speed of growth to maturity, tolerance to water variability, and season, and in some cases taste preference. Eight varieties are used at Eminiminy, 12 at Esomony and seven at Antanandava.

Influence of labour demands on cultivation of other crops

Manioc is grown on the greatest scale in Eminiminy, possibly because the most suitable land is available here, and manioc grows better in more humid climates (Williams *et al.*

1980, p. 207). In Esomony, manioc fields are irrigated prior to planting, and most land which can be irrigated has been converted to rice fields, although after several years of rice crop failure some rice fields were being converted to manioc in Esomony. Dry land crops are only grown on a small scale in Soalala, because of the necessity of growing them in pig-proof fenced gardens. Considerable work is involved in collecting wooden poles and setting them about 0.5 m into the ground. Each year the fence must be mended, setting the poles which have decayed further into the ground, and replacing the ones that have become too short and rotten. Gardens at Antsira are a mean size of 880 m^2 (0.088 ha), requiring an average of 100 m outside wall (many are adjoining) using roughly 700 posts each (approximately 7 posts per metre). Usually softer wood is used, which is easier to find, but must be reburied every year and usually replaced after 3 to 5 years, depending on the type of wood and the length of the original pole. Despite this work, bush pigs frequently enter the gardens at Antsira, ruining the root crop. In addition people who are taboo to eat pork cannot eat food touched by pigs, so any disturbed manioc plants are discarded.

In all villages men are often responsible for cultivating crops which serve as a staple, such as manioc, sweet potato and maize, while women cultivate crops which provide laoka. Women cultivate vegetables, beans and groundnuts, often on a smaller scale than the cultivation of staples by men. Most crops are cultivated in the wet season although the timing of manioc cultivation is variable. I propose that manioc is cultivated in the dry season, from June to October, in Andohahela as this is when there is a respite from work in rice fields. This also allows a year, a usual period for development of maximum sized tubers (Williams 1980, p. 206), to the period when rice stocks may be diminishing and an alternative staple is useful. In Soalala, cultivation starts after the first rains in November or December, when the ground is easier to dig. Tubers are usually harvested after eight to 10 months as this is when rice is least available. People say that manioc is planted in mounds to make the tubers easier to harvest, and may also make the soil lighter enabling the tubers to develop (Williams *et al.* 1980, p. 207).

4.6 Conclusions

Collected, non-cultivated food makes a minimal contribution to staple food in both regions. Most households in rice cultivating villages cultivate the majority of their staple food, whereas in the fishing village, Antsira, most staple food is bought. However, non-cultivated staple foods are of great importance for the few households that rely on non-cultivated foods in periods of severe food shortage. Non-cultivated food makes a greater contribution to laoka food, particularly in Soalala where fish is the main laoka.

Although not consumed in great quantities, non-cultivated foods may be perceived as important by local people. Even in Andohahela, where non-cultivated laoka foods represent less than 7% of laoka-meals, they are greatly appreciated. They may be of higher nutritional content than the alternative cultivated vegetable laoka, such as the oil extracted from the forest nut (**hovao**). They may also have a cultural significance, such as turtle and dugong meat in Soalala.

The food consumption study also emphasised the overwhelming reliance on rice as the main staple food. The reasons for the dominance of rice appear not to be strictly due to efficiency of production, but also result from strong cultural preference for rice. As will be shown in Chapter 5, rice also plays an important role in the economy.

In all villages, the majority of time was spent on subsistence activities. The Soalala villages, however, appear to be more integrated into the market than the Andohahela villages, as more time was spent on commercial activities. Relatively little time is spent on extracting and processing non-cultivated resources in rice cultivating villages. The work involved in collection and processing of non-cultivated resources often limits the amounts and types of resources used, and influences the division of labour between sexes. For example, people must go further to collect hard construction wood, and sometimes decide to use lower quality softer woods which are easier to collect. Construction wood and firewood are usually collected by men because they are heavy to transport. There are also cultural influences on division of labour, resulting, for example, in men retaining control of knowledge about coastal fishing and access to tools such as boats and nets.

Labour demands, in addition to climate and other environmental influences, greatly affect the organisation and timing of agricultural production and the area under cultivation. Women appear to be most important commercially to households in rice cultivating villages. Husband and wife (**mpivady**) are an important partnership in rice cultivation; households with either no men or no women available usually complete only a small area. The use of cattle in rice field preparation reduces the manual work required, demonstrating their energetic importance. Their economic and cultural importance will be discussed in following chapters.

Labour and yield, or energy input and output, with respect to collection of wild resources and agriculture, are closely linked to what is environmentally permissable. Environmental factors include climate and terrain, but also biological factors, such as the distribution and growth rate of wild, and cultivated living resources. The impact of use on wild resources is explored in more detail in Chapter 7, but it should be emphasised that it is through energetic influence that there is some feedback between impact on the environment and human behaviour. For example, as timber supplies are depleted people find that they must go further to collect equivalent hardwood, or they collect softer woods which must be replaced more quickly. It is also often through energetic feedback that economic prices are adjusted, as resources, such as sea cucumbers or hawksbill turtles, become scarcer (see Chapter 5).

Chapter 5.

TRADE AND MARKETING: CONTRASTING ROLES OF FISH, RICE AND CATTLE

5.1 Introduction

Although much collection and production in the villages studied is for home use, and many resources used are produced and collected by members of the household, trade plays an important role in the management and distribution of some resources. Trade occurs within villages, between neighbouring villages, and within the wider world through markets and travelling traders. Different commodities are traded at these levels, and the same commodity may have a different value according to where, when and with whom it is traded. In addition to money, rice, cattle and fish are important trading currencies.

This chapter explores different types of markets, conditions for different types of trade, what commodities are traded, who is involved, and the influences affecting trade. In particular, the impact of trade on the use and collection of natural resources is considered.

5.2 Trade in wild, non-cultivated products

Table A8.1 (Appendix 8) lists wild, non-cultivated products and their prices traded in each region within villages, between local villages, at markets and through itinerant traders.

Wood

In Andohahela, wood is only traded when it has been worked. Planks are roughly hewn with axes and knives and have a better finish when trimmed with a plane. People who possess planes (one or two in each village) make planks (for doors and windows) and furniture, such as beds, tables and chairs, to sell. These are often commissioned, and usually the carpenter collects the wood. Not every household possesses furniture, which can last over 40 years, so there is little demand for such goods. Pestles and tool handles which are made from special woods are traded (see Appendix 10 for woods used), as are mortars, which are made from large trees. Access to tools, or the time and skill involved in making wood products makes them a commodity worth trading locally.

Houses may also be bought or commissioned, although the majority are made by members of the household. Nearly all households have the skill and the access to materials to make houses, but, as explained in Chapter 4, there is considerable work involved in collecting wood for houses. Complete houses were bought for between 10,000 and 90,000 FMG[1] when there was an urgent demand for housing after the fire in Eminiminy in August 1991. Houses in the eastern part of Andohahela, such as around Eminiminy, are constructed in such a way that they can be dismantled and moved relatively easily. Houses in Esomony with mud walls are not usually bought and moved, but may be commissioned (see Figures A12.12 and A12.14, Appendix 12). Thatch may be bought to save the effort of collection, especially at Esomony where the best thatch is long grass (**boka**, *Heteropogon contortus*) often collected more than 5 km east of the village.

Sea canoes (**laka**) in the Soalala region are made of hardwood planks attached to a shallow dugout with an outrigger (see Figure A12.6, Appendix 12). They last three to five years, depending on the quality of wood and whether they have been painted regularly. Large households may have several canoes, including smaller ones (4 to 5 m long) for turtle and prawn fishing, when great mobility is useful, and larger ones (up to 15 m long) for transport. Average number of canoes per household at Antsira varied from 1.4 in December 1991 to 0.7 in September 1992. Making canoes requires much time and skill, particularly in shaping and joining pieces so they are watertight. Although most men in fishing communities have the skill to make their own canoes, they may be commissioned from specialists, for between 300,000 and 500,000 FMG depending on the size, quality of wood and craftsmanship. If the commissioner provides the wood, canoes may be completed for 50,000 to 150,000 FMG, although there are many additional costs for tar, paint, sail-cloth and ropes (see Section 5.4 below). Boats require some special woods, for example light strong wood such as **aboringa** (*Sterculia ankaranensis*) for the outrigger, which may be purchased some distance away for 10,000 to 30,000 FMG each. Planks cost 3,000 to 6,000 FMG each. Ox-carts also require planks and are often commissioned from specialists for 100,000 to 200,000 FMG each (including wood), but the iron axle and wheels are the major expenditure, costing from 350,000 to 500,000 FMG.

State authorisation is required for all uses of wood except the collection of dead wood. A request for authorisation must be made to the nearest representative of the Water and Forests Directorate (DEF) for collection of poles and other products for the repair or

---

[1] Exchange rate varied from 2,500 to 3,300 FMG (Malagasy Francs) to 1 GBP (Great Britain Pound) during the study period.

construction of residences, canoes, cattle corrals and coffins. Authorisation is free for local residents where the products are for their own use (`droits d'usage'), but the quantity, species, and sizes of wood must be stated and the requests involve payments to the Fokontany, Firaisana (lowest administrative levels), and for fiscal stamps. Woods are officially classified into five categories, of which the first is most valuable. Woods for the above local uses should be less than 0.6 m circumference of Fourth and Fifth Category wood, or a supplement must be paid for a cutting permit (`permis de coupe'), of for example 1,500 FMG for a Third Category tree greater than 1.3 m circumference, or 2,000 FMG for a Second Category tree greater than 1.5m circumference. Total charges were reported to be 1,200 to 1,900 FMG for a house, 2,400 FMG for a cattle corral, 3,000 FMG for a large tree suitable for mortars (from which up to 10 might be obtained) or a wooden coffin and 3,700 FMG for a canoe. People collecting wood for commercial purposes should apply for a permit for forest exploitation (`exploitation forestier'), but small scale extraction destined for trade in villages was not usually placed in this category. As there are few DEF officials, with few resources to visit outlying areas (for example until 1991 there was one DEF agent with no means of transport for the entire Fivondronona of Soalala [population of 20,000]), there is often a low level of compliance with these regulations.

Sources of income for women

In both regions all collection and processing of wood, including trade, is done by men. Mats are traded in all regions, and these are collected, made and traded by women. Mats, particularly in the Soalala region, are often an important source of income for single women, especially older women who cannot do more active work. Mats are not usually taken to markets but sold locally, and may be commissioned. They are usually priced according to their size, and sometimes according to the durability of the materials, or the fineness and pattern of the weave in the case of decorative sleeping or eating mats. Prices vary from 1,000 to 15,000 FMG each. The influence of scarcity of good weaving materials on quantity of mats made and trading patterns around Andohahela was described in Chapter 4, Section 4.4. In Eminiminy, the materials for larger mats (**hera** *Cyperus latifolius*) which grow in unused swampy rice fields are quite scarce, and are sometimes bought uncut by area in the field (for example 3 m by 2 m for 2,000 FMG). In both regions pairs of identical baskets, often made by women, are traded locally for one basket full of paddy rice. Fresh-water turtle traps (**treko**) and brooms are made for sale on a small scale by older men in the Soalala region, using spines of palm leaves (**satra**, *Bismarckia nobilis*) of which the flat part of the leaf is used by women for mats.

Salt is made in coastal villages around Soalala, and is also a source of income for women. Much salt produced is used to preserve fish for sale but the surplus may be traded in a one to one ratio with rice in villages inland. Smaller quantities (such as **kapoaka**2) are traded equally with white rice, and larger quantities are traded equally with paddy rice. Begot (1900, in Verin 1986, p. 351) described salt as an important aspect of trade in the Bay of Marambintsy, 25 km east of Soalala. He reports that salt and fish were exchanged with rice from the Kinkony and Namakia marshes inland. Wild tubers in the Soalala region, such as **kabija** (*Tacca pinnatifida*), **masiba** and **bemandry** (both *Dioscorea* sp.) are sometimes traded within and between villages, or in the market at Soalala, and are also a source of income for women.

Forest nuts

In Andohahela, nuts of **hovao** *(Dilobeia thouarsii)*, a tree found only in primary moist forest and usually collected from the reserve, are used to make oil in Eminiminy for home consumption, local trade and trade at markets. One basket of nuts (**vaha**, holding about 20 kg of paddy rice), makes eight to 12 litres of oil. Several households make 10 to 20 litres per year of which a part may be sold if cash is needed, although often the majority is consumed by the family. It is eaten with rice, and used by women as hair oil. The price varies from 1,500 to 4,000 FMG/l, or 10 kapoaka of white rice (approximately 2.9 kg) per litre at Eminiminy in April 1993. People in Eminiminy said that some people who live in a hamlet higher up the valley near the forest make more hovao oil to supplement their income as they have fewer productive rice fields.

Honey

Honey, often collected from forest, is also sold locally and at markets in both regions. Some people are have special skills in honey collection, knowing how to locate hives and extract honey, although others collect honey opportunistically when a hive is encountered. A hive may yield up to 10 litres of honey, of which some may be sold (for 1,000 to 1,500 FMG/l) and some kept for home consumption. In Soalala, the wax may be sold at markets for 2,000 FMG/kg or used locally for conditioning women's hair.

Hunting

Some meat from hunting is traded in both regions. Bush pigs *(Potamochoerus larvatus)* are hunted with dogs and spears (**mangorondambo**) in Andohahela. Only a few men hunt, sporadically and not always successfully. When a pig is caught a part is kept for home consumption and the rest may be sold. During my visits to Andohahela, bush pig

---

[2] A **kapoaka** is a condensed milk tin measure, 350 cm^3, which holds approximately 0.285 kg of white rice

meat was only sold once in Esomony. Some people trap and hunt bush pigs in Soalala but the meat is never traded, and is sometimes just fed to dogs, as there is a widespread taboo on eating pork due to Muslim influence.

Brown lemurs *(Lemur fulvus collaris)* are trapped by specialists on the east side of the Andohahela massif, around Eminiminy, and sold locally for 1,500 FMG each. This practice appears to have stopped in Eminiminy due to the employment of local people as forest guards ('Agents pour la Protection de la Nature', APNs), but lemurs were reportedly traded previously and this probably still occurs in surrounding villages.

In Soalala, meat and oil from a dugong (**trozo**, *Dugong dugon*), were traded locally when one was caught near Antsira in July 1991. It was the first to have been caught in that village for over 10 years, although one or two are usually caught within 30 km of Soalala each year. Even though most families received a small portion of dugong meat as a gift, there was such demand for the dried meat and oil that most surplus was sold very locally, for 1,000 FMG per packet (**kipasa**, approximately 0.25 to 0.50 kg) and 5,000 FMG/l of oil. Some remaining meat was sold in the market at Soalala for only 500 FMG per packet.

Sea turtles (**fano**) are caught much more regularly; usually green turtles (*Chelonia mydas*), but some olive ridley (*Tortuga olivacea*), loggerhead (*Caretta caretta*) and, rarely, hawksbill (*Eretmochelys imbricata*) or leatherback (*Dermochelys coriacea*). Turtle meat is rarely traded within villages, but is distributed widely to kin and friends. Dried and fried turtle meat is traded with surrounding villages, particularly with villages inland, in exchange for rice, but is not exported from the region.

Eels are caught in Andohahela in streams, often in forest in the reserve, and are sometimes dried and sold locally. Eels are caught inland near Soalala, for example in a river at Antanandava, but not traded locally. They are sometimes dried and taken to Mahajanga for trade at 3,000 to 10,000 FMG per kilo, depending on the size and species.

Rarity and perceived quality of different types of meat thus determine whether it is traded locally, or whether gifts saturate demand. The fatty dugong meat was in great demand in villages, where it is considered to be a traditional part of the diet for the Kajemby group living on the coast. It was less valued in Soalala where other meat such as beef is more regularly available, and people are of different ethnic groups, mostly Antalaotsy Muslims (see Chapter 3, Section 3.4).

Small fish and prawns caught in rivers were often traded in Esomony by people from other villages, but were never traded within the village by people from Esomony, nor were they traded in Eminiminy. Locusts were similarly traded in Esomony. People from both villages said that they considered it dishonourable to sell such small goods. The reasons for the intervillage trade in Esomony are discussed below in the section on rice trade. People in Eminiminy also said that it is taboo for them to sell tenrecs (*Tenrec ecaudatus*, order: Insectivora).

Seafood trade in Soalala

Fish and other resources from the sea are important elements of trade in the Soalala region. Seafood is not traded within fishing villages, as it is usually given to households with no **laoka** (sauce of fish, meat or vegetables eaten with rice) on that day. Fish, crabs and dried prawns are traded for rice with villages inland. Most coastal people grow little or no rice, and buy rice or other staple carbohyrate either at markets or from rice cultivating villages. Fish are either grilled (**saly**) or lightly salted and dried (**kelisira**), which preserves them for four to seven days. Seafood produce is carried inland and traded directly for rice, which is carried back. The amount traded per trip is therefore limited by the fish and rice that can be carried. This type of trade tends to be sporadic, practised mostly after the rice harvest (October to December) when rice is plentiful, or when fishermen have to make a journey inland for another reason. There is nearly always a greater demand for laoka in the rice growing villages than can be satisfied by the amounts of fish and seafood brought for trade.

People in fishing villages usually prefer to sell fish for cash in markets, or in towns. Antsira is only one to two hours sailing time from Soalala (depending on winds) and fresh fish can usually be sold for 500 to 1000 FMG/kg by patrolling the streets and calling that fish is available. Rice is then bought in the market and transported to the village by canoe. Such trade saves time and effort in transporting goods, as the markets are more accessible than the rice cultivating villages, even if the amount of rice gained per kilo of fish may be lower.

Excess fish is more heavily salted and dried (**madray**) for sale for 900 to 1300 FMG/kg in the larger town of Mahajanga (120 km north west). Dried fish is stored for several months until there is sufficient to justify a visit to Mahajanga. Transport is arranged with a larger sail-boat (**botry**) or a large canoe (**lakabe**). Cargo is usually charged at 100 FMG per kilo, and accompanying passengers go free. Many goods, such as sugar, cooking oil, paraffin, batteries, and clothes, are cheaper in Mahajanga than Soalala, so such visits are economically advantageous although time consuming, as journeys to and from Mahajanga may take one to three days depending on wind. In the dry season, when rice is scarce in the Soalala region, rice is also often cheaper in Mahajanga. Salted dried fish may be sold to local traders, at a much lower price (500 to 700 FMG/kg), for example when the seller needs immediate cash because the household's rice stores are depleted.

Dried prawns may be taken to Mahajanga for sale, but it is most profitable to sell them fresh to collecting boats when these are present. Only excess prawns are dried, and many are spoiled as prawns are caught in the wet season (October to April), and must be dried quickly for one to two days in hot sun. An overcast or rainy period can ruin them. Collection is made by motorised boats ('vedettes') owned by export companies (such as Martin Pêcheur, Refrigé-pêche, Sojedis, Somapêche) from Mahajanga. There is particular demand in December when industrial fishing is banned during the spawning season but local fishing ('pêche artisanale') is allowed. They load prawns into iceboxes, paying extra for larger prawns, during three to five days, and may collect up to one tonne before returning to Mahajanga. A pair of prawn fishers can collect up to 50 kg per day (worth 75,000 to 100,000 FMG), although catches are very variable. During three days at the end of January 1993 the net daily income per pair for two pairs varied from zero to 16,500 FMG (mean 5,300 FMG). The best catches are at high tides for two to three days before and after new and full moons when many people from surrounding villages take part. Prawns are caught in mangroves within the bay, such as near Marotia, and there are relatively few suitable sites in the region. These prawn fishing centres become unusual local markets during this period as people spend much of their money immediately. Others come to the village to sell food, alcohol, cassettes, and clothes at higher prices, up to twice those in towns.

Older people in Antsira described the rising scale of commercial fishing during the last 30 years. In the 1940s and 1950s fish were only caught for subsistence and local trade. Coastal people grew wet season rice and kept large cattle herds. Fish were caught with traps made of fences of bamboo (**kira**), set in channels in mangroves to catch fish on the ebbing tide. Prawns were caught using nets made of raffia (**sihitry**). They started to sell salted dried fish and dried prawns in Mahajanga from around 1960. As this trade developed, rice and other cultivation and size of cattle herds diminished. Rice fields near Antsira were last cultivated around 1970. Equipment became more sophisticated with fish caught using hooks and strong nylon thread, or nets made of nylon thread. Prawns are now caught with funnel nets (**kopiko**) made of strong synthetic thread. Motor boats started to buy fresh prawns from 1983.

Coastal people now rely heavily on trade in seafood exported from the region for their livelihood, and can make impressive profits in comparison with rice cultivators, or government employees. Many are concerned, however, about the future of the trade as increasing numbers of large boats with sophisticated equipment fish offshore. These boats use nets with fine mesh to catch prawns. Many unwanted fish and turtles are caught in the nets, including young fish needed to maintain future fish stocks. In addition they fish within the bay, which is reportedly not permitted. Nietschmann (1973, p. 177) refers to similar problems caused by commercial shrimp boats operating close to the shore of the Nicaraguan coast, jeopardizing local fisheries and turtle poulations.

People in Soalala remark that the quantity of prawns they catch has reduced, and say that previously two men could catch 100 kg per day, whereas now 50 kg is a maximum and 20 kg or less is expected. They also say that the commercial fishing organisations export a small number of species, the remainder being sold in Mahajanga. This undermines the market for their dried salted fish, prices for which dropped from 1,200 FMG/kg in 1991 to 900 FMG/kg in 1992.

Resources purchased by itinerant collectors

Collectors also visit the Soalala region to buy shark fins (**mapeza** [fin], **ankio** [shark], order: Pleutotremi) and sea cucumbers (**dingadinga**, class: Holuthuroidea), both for export to Chinese communities, where they are considered delicacies. A shark fin collector from Mali, based in Hong Kong, was encountered in Soalala in February 1993. He visited remote settlements to buy dried fins for 25,000 to 40,000 FMG/kg, and had been in Madagascar for four months. The fins were exported by air, to Antananarivo and thence to Hong Kong. There must be a substantial profit in this trade to justify such expensive freight and travel expenses. Seven fins can be obtained from large sharks, as ventral, lateral and tail fins are used in addition to dorsal fins (see Figure A12.7, Appendix 12). Larger fins are worth more per kilo. A 1.5 to 2.0 m shark may give 1 kg dried of fins (worth 25,000 FMG) and 20 kg of dried flesh (worth 20,000 FMG). Some people now specialise in shark catching, using baited rows of hooks (**palanky**) or large nets (**jarifa**). Shark fin collectors visit rarely, but fins can also be sold in Mahajanga for 20,000 to 35,000 FMG/kilo.

Sea cucumbers are bought by similar collectors, who bring motor boats from Mahajanga. They are usually only collected when traders are present, who buy them fresh for 75 to 100 FMG each. They may also be sold dried in Mahajanga, for 5,000 to 20,000

FMG/kg, depending on size and species. It is a long process to dry them, involving boiling in sea water, baking in hot sand, trampling to soften and further drying. In 1992 no traders visited the region and no collecting occurred. Sea cucumbers have reportedly diminished in numbers .

Traders buy cashew nuts in the Soalala region in October and November. In Soalala, many cashew nut trees grow around existing and disused settlements and although some were originally planted, many may have seeded naturally. They are now not owned and are treated as wild resources. When traders do not visit they are sold to traders based in Soalala. I am not aware of local people taking cashew nuts to Mahajanga for sale. Other specialised products sold in Mahajanga are crocodile (*Crocodilus niloticus*) skins (500 to 1,000 FMG/cm width of skin) and tortoise shell (carapace of hawksbill turtle, *Eretmochelys imbricata*). Both animals are rare locally, and are reportedly rarer than previously so their decline may be due to over-hunting. One crocodile of about a metre long (worth about 35,000 FMG) was caught in the river near Antanandava on a hook set for eels in September 1990. These resources are probably sufficiently valuable to justify visits by traders, but are too rare for reliable collection. Hawksbill turtles are on Appendix I of CITES (Convention on the International Trade in Endangered Species[3]) and Nile crocodiles on Appendix II (Rakotomanana *et al.* 1989, p. 87) which makes unauthorised collection risky.

The only wild product that I heard of being bought by traders visiting villages around Andohahela was seeds of a pachypodium, **votasitry** (*Pachypodium geayi*), an ornamental plant. Collection was very irregular in the Esomony region, never occurring during the two years I visited the area. In the southern region of Andohahela similar collection was made more regularly of seeds of the locally endemic triangular palm (**lafo**, *Neodypsis decaryi*). Such collection is not a dependable source of income for local people due to the difficulties traders have in obtaining export permits.

Impact of trade on wild resource populations

The majority of wild resources are collected to provide for the subsistence needs of the collectors. Surpluses may be sold or traded locally for a supplementary income. In some cases they may provide an important income, particularly for those who are unable to provide sufficient food and money from agriculture or commercial fishing, such as single women and the elderly, who may rely on selling mats, baskets or turtle traps.

---

[3] Trade in CITES Appendix I species, or their products, is subject to strict regulation by ratifying nations, with trade for primarily commercial purposes banned; trade in CITES Appendix II species is subject to monitoring by ratifying nations (Jenkins 1987, p. 168).

Local trade has limits as local demand can reach saturation, whereas longer distance trade has a greater potential market and less probability of saturation. Trade for export seems more likely to affect local distribution and availability of resources, leading to a decline and possible collapse of populations. Resources are only worth the transport and transaction costs of longer distance trade if they are of relatively high value to the consumer, which means that the income for the collector is relatively high in comparison with income from local trade or subsistence occupations. Markets often exist because the resources are rare elsewhere, and prices rise as they become rarer, so increasing collecting pressure on a dwindling population.

There are many examples of selective pressure on rare species due to long distance trade, for example the species of sandalwood found on the Juan Fernandez Islands, *Santalum fernandezianum*, was rare through over exploitation of timber by 1740, and extinct by 1916 (Mabberley 1987, p. 519). Nietschmann (1973) working on the Miskito coast described hawksbill turtles collected for shell, crocodiles, caimans, freshwater otters, jaguars, ocelots and margays collected for skins and lobster collected for food as all very depleted or exterminated over much of eastern Nicaragua due to pressure from external trade.

Severe population depletion may already have occurred for hawksbill turtle and crocodile in the Soalala region, sea cucumber and prawn populations appear to be declining, and sharks are collected in very large numbers. Although large numbers of green turtles are caught along the Soalala coast, and green turtle populations appear to be reducing in other parts of Madagascar (Rakotonirina and Cooke 1994), the meat is only traded very locally for rice, and local people do not report dramatic changes in green turtle availability. In contrast, exploitation at breeding grounds in Costa Rica and along the Nicaraguan coast has severely depleted green turtle populations there (Nietschmann 1973). Tortoise shell (from hawksbill turtle) was exported from the Soalala area during the 19th century, as were ebony (*Diospyros* sp.), palissander (*Dalbergia* sp.), sandalwood (possibly **morasiny**, *Hernandia voyroni* and/or **masonjoany**, *Santalina madagascariensis*), honey and wax (Samat 1852, in Boudou 1932). Mangrove wood was exported to the Persian gulf as a source of tannin in the early 20th century (Verin 1986, p. 356). There is now little export of these resources from the region. Ebony, palissander and sandalwood are now rare in the Soalala region, especially trees of large size near the coast, and their decline may be attributable to this earlier trade.

5.3 Trade in cultivated products

Table A8.2 (Appendix 8) lists cultivated products and their prices traded in different markets.

Rice trade

Rice is the most important commodity for rice cultivating communities. It is both the most important cash crop and the most important staple food, accounting for from 60 to 90% of staple food eaten at meals (Table 4.1). There is therefore a conflict between how much is kept for family consumption and how much is traded.

Rice production is seasonal, and in both regions there is a staggered harvest over several months with the final harvest being the largest. Most households in the three rice cultivating villages finished their rice, and often alternative staple food supplies, prior to the first rice harvest (Table 5.1). In most cases a significant proportion of the rice harvest had been traded. Although these were years of low harvest due to low rainfall, the fact that rice trade continued in successive poor harvest years suggests that there are strong incentives to trade rice, even when there is insufficient food to sustain the family until the next rice harvest.

Table 5.1 Availability of rice and other staples in rice cultivating villages

	ESOMONY			EMINIMINY				ANTANANDAVA		
Month	Sept 91	Jan 92	July 92	Aug 91	Oct 91	Jan 92	Aug 92	June 92	Oct 92	Jan 92
households sampled	19	20	17	16	20	17	13	20	10	8
with rice (%)	57.9	60.0	64.7	43.8	20.0	58.8	61.5	55.0	60.0	100.0
with manioc (%)	78.9		47.1	75.0	55.0		84.6	55.0	0.0	0.0
with sw. potato (%)	68.4		70.6							
with staple (%)	89.4		94.1	75.0	95.0		84.6	80.0	60.0	100.0
with no staple at 1st rice harvest		65.0				69.2		at least 45%		
avge no. months with no staple		4.9				3.1		at least 2 months		

Rice is traded in several different ways. In order to obtain money, rice is usually pounded to remove the husk and transported to the nearest market for sale by the kapoaka. In Andohahela the nearest markets are 17 km (Ihazoambo from Eminiminy) and 25 km (Tranomaro from Esomony), over steep terrain. The only transport is by foot, so all rice for sale must be carried. Men may carry up to 140 kapoaka (40 kg) in two baskets strapped to a pole carried across the shoulder. Women carry up to 100 kapoaka (29 kg) on their heads. In wet weather there is a risk that the rice, or the goods bought with the proceeds such as salt and sugar, will get wet. From Eminiminy, the steep path through the rainforest has a high density of leeches, which are less active in dry weather. As a result some market visits are postponed in wet weather. Households require strong, able-bodied members in order to obtain cash from rice.

Rice is bought at the weekly markets by traders from larger towns such as Amboasary-sud (50 km south of Tranomaro) and Tolagnaro (30 km south-east of Ihazoambo). Due to the size of the nearby towns there is always a demand for rice, although the price varies greatly according to supply (500 to 1,400 FMG/kg).

In Antanandava, white rice may be transported to the market in Soalala (16 km distant) by ox-cart or by foot. Not all households have access to ox-carts (55% owned or shared ox-carts within their family from a survey of 22 households in June 1992) and many prefer to carry the goods rather than pay a charge to hire a cart. In Soalala there is no set market day, and the town is considerably smaller (less than 2,000 inhabitants), so there is a less demand for rice. People from fishing villages and areas where wet season rice is cultivated provide a market for dry season rice cultivated at Antanandava, but do not necessarily go to Soalala to buy rice or have cash for payment. People in Antanandava complain that if they take rice to Soalala it is not certain that they can sell it in one day and they are forced to stay longer or accept low prices (price range 350 to 1,000 FMG/kg).

The fertile flood plains probably produce sufficient rice for a surplus to be exported. This occurred previously, when government collectors (SINPA, Societé d'Interêt National pour la Production Agricole, or FIFABE, Fikarakarana ny Fambolena Manamorona Betsiboka) used to visit villages like Antanandava regularly after the main harvest to buy paddy rice. FIFABE stopped visiting the region in 1990 and there is now only small-scale export via traders based in Soalala. The disintegration of roads since 1975 deters trade and transport of rice. Local people consider coastal transport by canoe or other sailing vessels, used for export of dried fish and marine produce to Mahajanga, too expensive, as freight is charged at 100 FMG/kg. People in Antanandava thus rely heavily on the visits of occasional buyers to obtain cash for rice. They complain that in such cases they do not control sale of their rice, but must await opportunities, and it is difficult to plan for a major cash expenditure, such as ox-cart wheels and axle (350,000 to 500,000 FMG).

In practice, much rice in all regions is bartered in villages for other goods. People from surrounding areas, or within the village, exchange goods of value to rice cultivators. In Soalala, people from coastal villages bring grilled or salted fish, turtle meat, crabs, dried prawns, salt, coconuts, or manioc. People from further inland may trade cattle.

In Andohahela barter for rice was most frequent at Esomony. Rice cultivation is possible on the west flank of the Andohahela massif because water is supplied by rivers descending from the forested, mountainous region in the reserve. Most villages further west have no irrigated fields and rely primarily on maize, manioc and sweet potatoes. There was particular demand for rice grown at Esomony during the two years covered by this research due to partial or complete failure of rain-fed crop harvests in the region. People brought a wide variety of goods, including pestles, tool handles, mats, fish, tomatoes, onions, goat meat, milk (often curdled, **habobo**), and locusts, which they exchanged for rice.

People in villages in Andohahela sometimes butchered a goat (often bought at a market), a pig or, rarely, a head of cattle to obtain rice when their food supplies were depleted. Portions of meat (around 1 kg) were traded for a number of kapoaka of white rice, or larger quantities were traded for baskets of paddy rice (**vaha**, equivalent to about 50 kapoaka of white rice).

When rice was greatly depleted in the Andohahela region in October 1991, manioc was traded in a similar way. People to the north of the reserve who grow manioc in forest clearings had a better harvest than those at villages like Esomony and Eminiminy. People from the surrounding regions brought goats, beef, chickens and money to buy manioc in these remote villages. People said that this trade was unusual and only occurred in times of exceptional regional food shortage.

Another type of rice trade in villages is for goods that rice cultivators would otherwise purchase at market towns with cash. People bring sugar, paraffin, soap, salt, coffee and other goods to the village to exchange for rice. Such trade is usually very disadvantageous for the rice producer in comparison with the amount of the same commodity that could be bought for cash, if the same quantity of rice were sold at a market (Table 5.2). This difference reflects the convenience of having the goods brought to the village, and is thus an example of financial valuation of the energy and time expenditure involved in pounding rice, taking it to market, buying goods from a shop and carrying them back to a village. This cash difference is exploited by traders, from the village or elsewhere, for whom the increased cash or rice obtained is worth the energy required to complete the transaction. Some people in villages even pay porters to bring goods from market towns which they then trade in the village; for example 1,500 FMG for transport of 10 l of paraffin from Ihazoambo to Eminiminy. The profits in Table 5.2 have been calculated per kilo to reflect the work involved in transporting a load by foot. Nivaquine (and other drugs such as antibiotics not shown in this table) give a large profit and some people specialise in selling drugs, travelling widely and often selling old stock. It is possible that the greater profits at Antanandava reflect the difficulties rice cultivators have there in obtaining cash for rice.

Table 5.2 Examples of differences between barter and market prices

date place	commodity	unit	market price (FMG)	in village (no. kap rice)	equivalent in cash (FMG)	profit (FMG)	profit/ unit (FMG)	approx. profit/kg (FMG)
-	-	-	-	-	-	-	-	-
ES,7/92	salt	1 kap.	75	1	200	125	167	313
ES,7/92	soap	1 piece	250	1.5	300	50	20	400
ES,7/92	paraffin	0.25 l	125	1.5	300	175	140	700
ES,7/92	nivaquine	1 tablet	50	1	200	150	300	150,000
EM,8/92	coffee	1 kap.	250	2	440	190	76	570
EM,8/92	salt	1 kap.	100	1	220	120	120	300
EM,8/92	paraffin	1 l	500	4	880	380	76	380
EM,8/92	sugar	1 kg	1,600	9	1,980	380	24	380
AD,12/91	soap	1 piece	500	6	900	400	80	3,200
AD,12/91	material	1 lamba	7,000	4 daba	10,000	3,000	43	6,000
AD,7/91	tobacco	1 packet	70	1.5	225	155	221	7,750

1 daba paddy rice = 12 kg
ES = Esomony, EM = Eminiminy, AD = Antanandava

A further example of work done in order to gain rice is making rice cakes (**mokary**). These are made from pounded rice powder mixed to a batter with sugar and water and left to ferment overnight, before being cooked on a oiled, cup-shaped griddle. These cakes are traded for kapoaka of rice, and a profit can be made of the equivalent amount of rice used in preparation. This work is done exclusively by women and can be an important source of income for them. Finally, rice is also used purely as a trading commodity within villages, where cash is scarce. If a household needs a chicken for a ceremony or a visitor they may trade rice to obtain one.

Other cash crops

Other than rice, the only crops taken to markets to obtain money are coffee in Eminiminy, dried manioc in Esomony and cashew nuts in Soalala. Coffee, which generally requires an annual rainfall of 1,800 to 3,000 mm (Williams *et al.* 1980, p. 63), is not grown on the dry western side of Andohahela around Esomony but is grown on a small scale on the eastern side, such as around Eminiminy. Coffee trees are grown immediately around the village and most production is kept for home use, but some is sold if cash is required. Coffee producers said that the price paid by collectors had reduced in recent years (possibly due to global depression in coffee prices) and now most trade is local.

In Esomony, dried manioc could be sold for cash in the markets further west (Tranomaro and Besakoa) when those drier areas had had crop failures (such as in 1991 and 1992). Some cashew nut trees in Soalala have been planted, often in or near private gardens, and these are harvested for sale.

Rum is made for sale in the Andohahela region. Sugar cane is grown, or bought in the village by the plant. It is mixed with banana in Eminiminy or tamarind (*Tamarindus indica*) in Esomony, ferments for five to seven days in a sealed container (usually half an oil drum) prior to distillation. Such locally produced rum (known locally in Andohahela as **katratro**) is illegal to make or sell, but is made throughout Madagascar. Not all distillations are successful. The equipment is usually borrowed in exchange for several litres of the product. Rum is a source of income for men, and around 7 l (worth 7,000 to 10,500 FMG) can be made from each half oil drum distillation. Sugar cane is most available after the wet season, that is from April, but some is saved for rum for celebrations at New Year. Rum is provided at the expense of the host family at all funerals, and at most rituals. In addition, rum is usually provided at field trampling with cattle (**magnosy**), and other group work days. When there is no local rum available it is bought in the nearest markets.

Soalala is only 60 km from Namakia where there is a large sugar factory. Most rum in the region is supplied from there, bought for 1,000 FMG/l or less, and sold in villages for 2,500/l to 3,000/l. Palm wine (**sora**) and honey beer (**drodromena**) are sometimes made locally but rarely sold.

Tobacco (**paraky,** *Nicotiana* sp.) is grown in some areas around Andohahela, particularly in remote parts north of the reserve, such as the villages of Vohibaka and Marovato. Although some plants are permitted for home consumption, any trade except through authorised government agents is illegal. There is, however, a widespread trade throughout Madagascar. Most men and a few women in all villages visited smoke tobacco rolled in paper (often from school exercise books) or dried banana leaves. Men and women in the Soalala region grind dried tobacco with ash, which they put under their bottom lip, although some sniff up the nose. Tobacco is traded locally in Andohahela for rice, as the villages which grow tobacco have little irrigated land for rice cultivation. It is distributed more widely by itinerant traders who buy at a low price from the producers, and sell elsewhere for a profit. Tobacco is not grown in Soalala, and traders come from several hundred kilometres distant. They usually travel on foot as vehicles may be searched, and all tobacco or rum would be confiscated. People in villages may buy in bulk to sell at a profit to other people locally.

In addition to tobacco the villages north of Andohahela, particularly around Vohibaka, grow marijuana (**rongony**, *Cannabis sativa*) for sale to specialist traders. It is grown in clearings in the forest, often several kilometres into the reserve in order to hide the illegal cultivation from outsiders. It is sold for around 25,000 FMG per 50 kg rice sack. Rural police (gendarmes) visit the area periodically and exact large fines (for example 150,000 FMG was paid to gendarmes during our visit in May 1991).

Cattle trade

Cattle are important in both regions, for ritual sacrifices and food at funerals and other ceremonies, in ritual exchange such as for bridewealth, and for rice cultivating communities they are important for trampling fields in preparation for planting. Social prestige is gained by having a large herd which ensures that cattle are available for rituals, gifts and hospitality, so enhancing the family's local political position. Cattle also enable the accumulation of wealth, as more rice fields can be bought and cultivated, and the surplus production can be invested in more cattle. Fauroux (1989) make similar observations of the role of cattle among the Sakalava of the Maharivo Valley, west Madagascar. Wealth in cattle was also described as a means to maintain political power for the Zafindraminia rulers in the 17th century Antanosy kingdom (Flacourt 1661 in Kent 1979, pp. 83-84). In surveys in March and April 1993, 19 cattle owners in Esomony and seven in Eminiminy gave the following reasons for keeping cattle:

to trample rice fields (100%),
for customs and rituals (**fomban-drazana**, ancestral customs) (85%),
to sell (81%),
for milk (15%),
to pull ox-carts (4%), as one household in Esomony has an ox-cart).

In Soalala they are often used to pull ox-carts. Due to their high value (up to 250,000 FMG for a large bullock), they represent an investment which can be realised in times of need. Cattle are traded within villages or at markets, and are bought from visiting cattle traders.

As reproduction is often insufficient to replenish cattle lost through rituals and illness, there is a tendency to try to maintain or increase the size of herds with purchases. In surveys of cattle owners at Esomony and Eminiminy, the total number of cattle had been depleted for cultural reasons by an equivalent of 15% to 35% in the previous year, with 3% sold and 7% to 28% dead from illness, and the herd had been maintained with 14% to 18% born and 8% to 24% bought (Table 5.3). These data for 1992/3 show net herd reductions, of as much as 24% in Esomony, probably in large part due to the small harvests of 1989 to 1992 as a result of inadequate rainfall, which meant more cattle were sold and fewer bought. Even the large loss due to illness in Esomony can be attributed to successive years of poor pasture because of the drought (74% of those dead from illness in Esomony were described as **maty boroka**, dead from famine).

In both villages there was a net flow of cattle into the area, as more cattle were bought than sold (see Table 5.3). Several households bought cattle through the sale of rice after harvest, and later had to sell cattle to buy rice to feed the family. For example, one family in Eminiminy bought 10 cattle after the rice harvest in May 1991, when the price of rice was low (150 FMG/kapoaka) and cattle were relatively expensive. They ran out of rice in June and manioc in July, and by October had been forced to sell two cattle to buy rice to eat, when cattle were cheaper and rice had become expensive (330 FMG/kapoaka). They lost the equivalent of 142 kg rice per head of cattle sold. One person in Eminiminy explained that when cattle traders from further west brought herds to the village after the harvest, it was important to be seen to buy cattle, although some were later returned when the traders came to collect their debts.

Table 5.3 Flow of cattle into and from herds in Andohahela

	ESOMONY 1991	ESOMONY 1992	EMINIMINY 1991	EMINIMINY 1992
No. surveyed	19	19	14	7
Total owners	72	72	29	29
% surveyed	26.4	26.4	48.3	24.1
% bought cattle	57.9	44.4	85.7	71.4
total bought	74	22	44	16
avge/buyer	6.7	2.8	3.7	3.2
max	20	6	10	5
median	4	1	3	4
% sold cattle	73.7	31.6	28.6	28.6
total sold	35	10	5	2
avge/seller	2.5	1.7	1.3	1.0
max	7	3	2	1
median	2	1.5	1	1
% who bought and sold	22.2	10.5	14.3	28.6
total bought - total sold	39	12	39	14
average net increase/owner	2.05	0.63	2.79	2.00

Results of surveys in March/April 1993

	ESOMONY total	ESOMONY avge per owner	ESOMONY % of total herd	EMINIMINY total	EMINIMINY avge per owner	EMINIMINY % of total herd
No. surveyed	18			7		
Total owners	72			29		
% surveyed	25.0			24.1		
no.cattle	262	14.6	100.0	68	9.71	100.0
increase	62	3.4	23.7	28	4.0	41.2
born	37	2.0	14.1	12	1.7	17.6
bought	22	1.2	8.4	16	2.3	23.5
other	3	0.2	1.1	0	0.0	0.0
decrease	126	7.0	48.1	33	4.6	48.5
sold	8	0.4	3.1	2	0.3	2.9
illness	74	4.1	28.2	5	0.7	7.4
cultural	38	2.1	14.5	24	3.4	35.3
butcher	1	0.1	0.4	1	0.1	1.5
other	5	0.3	1.9	1	0.1	1.5
net increase	-64	-3.6	-24.4	-5	-0.6	-7.4

People in Andohahela also explained that cattle are rarely sold to raise money for medical treatment or education, but are traded for land, houses, or food, and to pay for treatments administered by traditional healers (**ombiasy**), which often involve protection against sorcery. They tend to be sold for traditional rather than modern expenses. The circumstances under which cattle are traded also vary according to the number of cattle owned. Families with larger numbers of cattle are more willing to sell cattle to provide food. However, those with one or two cattle often want to save these in case of an important event, such as a death in the family, which would necessitate sacrificing at least one head of cattle. Some people preferred to sell smaller items, such as smaller livestock or household equipment which they felt would be easier to replace. Some even preferred to sell land than their last cattle. The drought placed much greater stress on households with fewer or no cattle, as they reduced their food consumption dramatically (to as little as 0.18 kg rice/person/day for one household in Esomony in January 1992) in order to save their few remaining possessions. When they had been forced to sell land and cattle, people were in a very poor position to provide food for the family, even if rainfall improved, as having fewer than around five cattle limits the area of rice fields that can be prepared.

The cultural and ritual importance of cattle affects cattle trade, causing seemingly irrational economic behaviour. Exchanging cattle for cash or rice occurs only under extreme circumstances, often when their financial value is low. In addition there is such pressure to accumulate cattle that people are willing to buy at inflated prices as soon as they have the means to do so, even if they are allocating more than the household can afford. Similar aversion to selling cattle was remarked in the Maharivo valley by Fauroux (1989), where sale only occurs to provide for unexpected expenses, often in periods of food shortage, when thin and unhealthy cattle are sold at low prices. Fauroux also describes that people prefer to keep cattle of special or unusual colours that might be needed for sacrifices, or cattle particularly respected because of their behaviour, so limiting the choice of cattle for trade beyond economic or practical livestock management considerations.

There are similarities with the economic spheres described for the Fur people in Sudan by Barth (1967). Fur institutions governing labour and land use determined that some aspects of the economy, in particular millet production, were separate from cash and market trading. Some millet produced was used to make beer for work parties in order to cultivate more millet, other crops or build houses, and the remainder was used for food but never sold. Labour organised through such work parties was very cheap (if valued by the amount of millet required to make the beer). Entrepreneurs exploited the system by importing millet and using these work parties to cultivate cash crops, such as tomatoes, for export. The cultural barriers to cattle trade in these Malagasy villages are similarly exploited by entrepreneurs. Rice traders, for example from nearby towns, buy rice cheaply when people want to sell it in order to buy cattle. Cattle traders, for example from Antandroy or Bara regions further west, sell cattle for inflated prices after the rice harvest, sometimes buying them back later at a much lower price.

Beyond immediate influences affecting individual decision-making about trade in cattle, there are political and environmental factors which influence trade regionally. In Andohahela there are strong differences in cattle management between the east and west of the massif. The pasture and climate are reportedly better for cattle on the drier western side, where the predominant grass is **boka** (*Heteropogon contortus*). Cows are said to produce calves most years, and the climate is better for the health of calves. The predominant grass in the east is **tegny** (*Imperata cylindrica*), which is not said to be as good for cattle, and cows are said to reproduce less frequently with greater calf mortality, due to the cooler wetter conditions. People in Esomony, most of whom came from further east during the last few generations, quote better conditions for cattle as the main reason for their migration. The first settlers, the Tesomony, came from near Manantenina (75 km north east) probably around 150 to 200 years ago, and the largest clan, the Temahangaza, came from Mahangaza, Ambolo, (35 km south east) since 1900. The cold and wet conditions that foster respiratory and hoof infections, in addition to higher levels of parasites, are also given as important reasons for moving cattle to lowland pastures in the wet season in Maasailand in Tanzania (Homewood and Rodgers 1991).

People from eastern Andohahela, such as at Eminiminy, used to take their cattle west for pasture, returning to the village for the main rice field preparation season from October to December. This practice continued until cattle thieving increased in the western area from 1975. Relatively small scale cattle theft between lineages was a traditional way of maintaining herds, an expression of local rivalries, and sometimes a way that young men proved their virility (Flacourt 1661 and Nacquart 1651 in Kent 1979, and Fauroux 1989). From 1975 a different type of theft escalated, in which whole villages were attacked by armed gangs of bandits (**malaso**), who stole entire herds, sometimes burning homes and raping and killing victims (Fauroux 1989). This is said to have been associated with the loosened control of crime and increasing corruption during the Second Republic (1975-1993). As a result, people in Eminiminy now keep their cattle around the village, as the cattle thieves rarely penetrate the area east of Andohahela and are most active further west where more cattle are found. People in Eminiminy say that their herds used to be much larger, frequently up to a hundred, whereas now the average size is 9.7 (Table 5.3), and the largest herd is 37. There are larger herds in Esomony with an average of 14.6 and a maximum of 84. They say that they grow rice in greater quantities now so that they can sell rice to maintain their cattle herds, which are smaller, reproduce less and are less healthy than previously. Although they may have increased effort in rice production recently for this reason, rice has been grown in the Andohahela area since the 17th century, and even then rice production was used by the ruling class (**roandriana**) to obtain cattle (Flacourt 1661 in Kent 1979, p. 84).

Rice was cultivated in western, Sakalava areas in the 17th and 18th centuries, although principally in areas controlled by royal clans for trade with Europeans for arms and ammunition, but was not described as an important food (Le Bourdiec 1980, p. 134-135). Intensive rice production began with immigration of rice cultivators, many from the central highlands, with the Merina expansion in the 19th century (*ibid.* p. 135). Rice was not grown in large quantities around Soalala in 1852;

> "This country does not provide enought to feed its inhabitants. The natives plant manioc, sweet potatoes, pineapples and a little rice, which last them only for a little time." (Samat in Boudou 1932, p. 58).

Guillain (1845 in Verin 1986, p. 353) also mentioned that rice was not at all plentiful in Baly (5 km west of Soalala). Some Sakalava explain their relatively recent adoption of rice cultivation as a strategy to increase their cattle herds, both so it is not necessary to sell cattle in order to obtain cash for commercial goods, and in order to purchase cattle (Fauroux 1989, p. 105). This perception of rice primarily as a means to obtain cattle, starts to explain why, in both study regions, rice is sold immediately after the harvest, to buy cattle, as people worry that if it remains in the store it might be used for other purposes.

The results of the 1993 cattle survey in Andohahela (Table 5.3) suggest that there was greater illness and less reproduction in Esomony than Eminiminy. This may well have been because of the stresses put on cattle by the drought in the drier western area, showing that in some environmental conditions the cattle may be better off on the wetter eastern side. The cattle thieving around Esomony has also affected how and where cattle are pastured. They are usually kept near to the village and are brought to corrals in the village at night. They are guarded all day by a young man (**mpiarakandro**, `one who accompanies the day'), either paid one calf per year, or an unpaid member of the family. In the dry season, cattle are taken higher up the valley into the reserve for better pasture, sometimes into the forest. They are also taken to these areas for safety when cattle thieving is particularly bad, as they are among the Sakalava (Fauroux 1989, p. 51).

The Sakalava people were traditionally primarily cattle raisers (Le Bourdiec 1980, Fauroux 1989). Cattle were raised in large numbers in the Soalala region in the 19th century, when live cattle and skins were the main exports at the port of Baly. They were traded with Arabs and Europeans for slaves, fabrics, guns and ammunition until the early

20th century (Verin 1986, pp. 353-357). The rice growers in Antanandava still keep cattle, with herds up to 80. In February 1993, 62% of households in Antanandava possessed cattle. However, fishing people, like those at Antsira, have many fewer cattle than previously (20% have cattle and largest herd is eight). They no longer require them for rice production, which the majority have abandoned in favour of commercial fishing. They say that their herds were greatly reduced during the colonial era (1896-1960) when cattle were taxed. In addition to cattle tax there were head tax (**latety**), house, land, goat, dog and gun taxes, imposed with the aim of inciting people to produce cash crops or seek paid labour by creating a need for money (Covell 1987, p. 20 and Feeley Harnik 1991, pp. 244-245). The policies encouraged increased rice production and reduction of cattle herds. Cattle tax continued during the First Republic (1960-1972), and people say that when local leaders took over the administration they ensured that true numbers were declared, considerably increasing the taxes paid. Although the cattle tax is no longer levied, many people hide the true size of their herd as they worry that the information may be used for future taxation.

Other livestock

Most smaller livestock play a very different role from cattle, except for sheep in the Esomony region which may be used for ceremonial and ritual purposes. Sheep and goats are only kept on the drier western side of the massif at Andohahela, while goats are kept in Soalala. Six households in Esomony gave the following reasons for keeping sheep:

sacrifices (83%),
credit to exchange for cattle (50%),
large meals for group agricultural work (33%),
meals (33%),
to sell (33%), and
meals for visitors (17%).

Sheep were never butchered for sale, although they did play an important part in trade. A credit system (**trosa**) is operated, in which sheep are loaned to people in difficulty, either to sell or for an important sacrifice, who pay back a head of cattle after an agreed period of time. There was high mortality from illness in 1992, which may mean that sheep are a risky investment. From a survey of 22 households in April 1993, only 27% of households in Esomony raise sheep, with an average of 10 per owner (maximum 32, median 4.5). For the 6 owners surveyed, currently possessing 60 sheep, 57 sheep had died of illness in the previous 12 months.

Goats are not used ritually, but are important in trade. Only 6% of households in Esomony keep goats. It is taboo (**fady**) for people of the most populous clan, Temahangaza, to raise goats, although they can eat them. They are often butchered for profit. Goats are bought further west, where they are numerous, and cheap in times of food shortage (as little as 3,500 FMG each in October 1991), and butchered in the village, the meat being traded for cash or rice. For example, five were bought at the market in Tranomaro (35 km west) and butchered in Eminiminy for sale and family meals at New Year 1991. Goats were also used for large meals, such as for a large field trampling day (**osybe**) at Eminiminy in August 1992. Goats are raised in Soalala town, but rarely in villages (no goats were raised in Antsira or Antanandava).

Men care for cattle, sheep and goats, which roam outside the village, but women care for other small livestock which usually remain within the village. In Andohahela pigs are important economically. When asked why they kept pigs 10 households in Eminiminy and 13 in Esomony said:

to sell (96%), and
for family consumption (13%).

They range freely around villages and are fed once or twice daily with rice or bran, food remains, and sometimes specially cooked or dried manioc. They are butchered in the village once they are large, at around one year old. The best profits are made at New Year, when meat is sold for 2,000 FMG/kg. Five were slaughtered at New Year 1992 in Eminiminy. One family traded meat for paddy rice, making 6 vaha (equivalent of around 85 kg white rice). In Eminiminy they are sometimes sold live to visiting traders from Ranomafana (25 km east), for 100,000 to 150,000 FMG for a large hog. If animals are butchered in the village there is pressure to sell meat on credit, and many such debts are never repaid, so cash income is more certain when the animals are sold live (however, the family misses many good meals of the offal and other meat). Piglets are also sold, at two months old for 12,500 FMG for a male and 10,000 FMG for a female. This presumably reflects the greater possibility of profit from sale of meat from males, but does not reflect the reproductive value of sows. Pigs do not always realise their full cash potential, not through death from illness, but because they attack crops in fields around villages. There is a convention that any pig found in a field may be killed by the cultivator, and the pig owner then sells the meat. In Esomony, pigs are penned when rice is ripening in fields near the village but they are almost never penned in Eminiminy. There are no pigs in Soalala where the meat is taboo for the majority of the population due to Muslim influence.

Men and women usually decide together when to slaughter pigs, but women are often entirely responsible for poultry, often even keeping the proceeds of a sale for their own use. In surveys in Esomony and Eminiminy, 24 households gave the following reasons for keeping poultry:

for family consumption (88%),
to sell (66%),

for eggs to eat (54%),
and for meals for visitors (13%).

Chickens are rarely eaten at family meals. They may be used for special meals, such as after circumcision (only red cocks) or for large meals for group agricultural work. In Antsira, different members of the household (men, women and children) owned their own hens which they could decide whether to eat or sell. Other poultry, such as ducks, turkeys and geese are also kept, and may be sold for greater prices: for example at New Year geese in Eminiminy are traded for a vaha of rice (equivalent to 14,500 FMG), and turkeys are traded at Antsira for up to 10,000 FMG each. While hens are usually not fed, other poultry are fed rice bran or food remains, and in Soalala termites are collected to feed young turkeys. Quite large numbers of poultry die from diseases (particularly **barika**), and in Esomony large numbers of chickens are lost to birds of prey, particularly to a resident pair of peregrine falcons (**tsipara**, *Falco peregrinus radama*).

5.4 Trade in commodities not produced locally

These are often goods for which cash is required, as they are imported from outside the region. Table A8.3 (Appendix 8) lists the types of such resources and their prices traded in villages, at markets and with itinerant traders, although these lists are not exhaustive. Goods traded in villages are those which are bought regularly, whereas the long list of goods bought at markets (often from shops) are those that are required infrequently. Those traded by intinerant salesmen are often those of good profit margin for which trade is restricted or illegal (medicines, tobacco and rum).

Main household necessities are considered to be, in approximate order of increasing luxury, salt, paraffin, soap, tobacco, sugar, coffee, tea (only Soalala), and hair oil (usually coconut). Cooking oil is rarely bought in Andohahela, except for making rice cakes to sell, and is more common in Soalala. Type and quantities of goods purchased regularly vary greatly with season, and between households. Many households buy almost nothing when rice and cash are scarce, but buy many more goods, including non-consumables such as clothes and kitchen utensils, after the rice harvest. Appendix 8 gives examples of expenditure on household consumer goods for six households in Eminiminy in March, when rice was available for trade.

The main equipment required by rice cultivators are spades, picks, sickle shaped and other knives, which last many years, and cost 1,000 to 2,000 FMG. Of six households surveyed in Eminiminy, four bought one to four new spades or similar equipment in 1992. In Soalala, rice cultivators may buy ox-carts. These are a major expenditure, particularly for the iron axle and wheels which cost 350,000 to 500,000 FMG. In addition the bolts required may cost around 30,000 FMG and the carpenter may charge around 100,000 FMG to collect wood and make the cart. A carpenter in Antanandava had made 10 ox-carts in 1992. The wood lasts five to 10 years depending on its hardness and function, although some parts may need replacing every year. Trained cattle (**sovaly**) are traded for more than untrained cattle, reflecting the work required to train them, which may take several weeks.

The greatest outlay is required for fishing equipment. Canoes are expensive, even if made by the owner. The following expenses were listed by a boat owner in Antsira:

cotton to pack between planks	1 kg	3,000	FMG
nails (galvanised)	2 kg	20,000	FMG
nails (ordinary)	1 kg	5,000	FMG
sail cloth, drill	21 m @ 4,500 FMG/m	94,500	FMG
paint	4 l @ 12,000 FMG/l	48,000	FMG
tar to cover cotton filled gaps	1 bucket	2,500	FMG
permit to build boat		3,800	FMG
		-------	
	total	176,800	FMG.

In addition, this builder had bought eight good quality planks of **vory** (*Alleanthus greveanus*) from Mahajanga at 6,000 FMG each (48,000 FMG), and an outrigger balance of **aboringa** (*Sterculia anakaranensis*) from inland for 30,000 FMG. The boat was about five metres long and he expected it to last five to seven years if he repainted it every year, and refilled gaps with cotton and tar (53,500 FMG/year).

Nets are also expensive, even if home-made. A 100 m net costs 75,000 FMG for the nylon thread, and requires several months of intermittent work to make. These nets may last four years. Funnel-shaped nets (**kopiko**), used to catch prawns, are not made locally, and may cost 150,000 to 200,000 FMG and last around 10 years.

5.5 Financial influences on labour arrangements

Much agricultural and other labour is provided either by the extended family or through reciprocal group work, where the cultivators provide a large meal and later participate in group work for their helpers. However, sometimes work is paid, usually at a set price for completion of a certain task. Work for payment is often done by young and strong people who are unable to provide sufficient for their household through their own production, usually due to lack of access to land. For example, a woman weeded and transplanted rice in Eminiminy for 15,000 FMG, which took her three weeks. A man in Antanandava prepared rice fields, removing weeds (**mikaoky**) for 20,000 FMG for three weeks.

In some cases people debated whether it was more cost-effective to organise a group work day, or pay an individual to complete a task. For example, a household in Antanandava prepared a large meal for group work to cut rice in a large field. They made cakes and coffee for before the work (using 20 kapoaka rice, five coconuts, 5 kg sugar, 0.25 l oil, coffee and tea) and a large meal for after the work (one turkey, three coconuts, 40 kapoaka rice, onions, tomatoes and greens). The meals cost them at least 27,850 FMG and 60 kapoaka rice, which translates to a total cost of around 10 **daba**[4] of rice in addition to the work required to cook the meal. People estimated that the same work could have been commissioned for around eight or nine daba of rice, but would not have been completed as quickly. The group work day was more expensive and more work, but the cultivators could well have provided a less rich and generous meal. Such events are also seen as important participation in the traditional life of the community, and a means of maintaining the family's honour by providing a generous meal. Decisions on the best way to complete agricultural work are thus not all made on narrow economic grounds.

A different type of employment occurred in Esomony in August 1992, when Antandroy people from further west had left their villages in search of food. They were employed to do tasks normally done by members of the household, in exchange for food. For example they pounded rice, receiving one kapoaka white rice for every 10 pounded, collected firewood, built cattle corrals and reapplied mud to the walls of houses. People in Esomony said that this influx of cheap labour was unusual, and must have been the result of the third year of food shortage.

5.6 Changing financial position of rice cultivators and fishers

People in all regions remarked on their diminished buying power in relation to imported goods. This was particularly true for rice cultivators, and some examples from Antanandava provide a good illustration.

> In 1970, 100 daba of rice were worth 15,000 FMG which was sufficient to buy axle and wheels for an ox-cart. In 1991, 100 daba of rice were worth 250,000 FMG, but the axle and wheels for an ox-cart cost 400,000 to 500,000 FMG.
>
> In 1970 a polyester lambahoany (printed cloth worn by men) cost 300 FMG, equivalent to two daba of rice, but now they cost 10,000 FMG equivalent to three to four daba of rice. Similarly cattle could be bought for 5,000 FMG in 1970, equivalent to 33 daba of rice, whereas now cattle are worth 200,000 FMG or 80 daba of rice.

---

[4] A **daba** is a petrol can measure, equivalent to 12 kg of paddy rice.

> In 1979 a battery cost 80 FMG, and now costs 800 FMG, representing a 1000% increase, but a daba of rice then worth 400 FMG is now worth 2,500 FMG, only a 625% increase.

Rice cultivating people have a strong sense of decreasing wealth, particularly with diminishing size of cattle herds, but also because of their reduced ability to buy imported goods. Goods like radios and cassette players are perceived as symbols of wealth, and one teacher in Eminiminy had bought a large cassette radio for 500,000 FMG, even though he rarely bought the 12 batteries required to use it. Several people in Soalala showed me old radio sets which they said they could no longer afford to use.

In contrast, fishing people have experienced increased cash incomes as commercial fishing has grown since the 1960s, and particularly since the early 1980s when prawns have been bought fresh by traders. They have mostly abandoned cattle raising, rice cultivation and in some cases all crop cultivation (particularly people living at Marotia, 4 km south of Antsira).

The relative isolation of the villages studied, especially in Andohahela, increases the real cost of goods and services. Treatment at hospitals and medical centres is free, although the costs and effort of visiting are often prohibitive. Medical centres (`Poste d'Infirmerie', `Poste Sanitaire', or `Centre de Soins et de Santé Primaire') are five to 27 km walk from the villages studied and only have basic drugs which are often in short supply so people are forced to buy from drug peddlars. Visits to larger hospitals often entail the sick person and a carer taking a `taxi-brousse' and then paying for food in the town during the visit. Visits take many days, keeping the carer from productive activities in the village. One man in Esomony calculated that it would cost 28,000 FMG for his daughter and a carer to visit Ambovombe hospital for three days treatment for bilharzia. Similarly, children do not pursue education in secondary schools in towns because of the expense of paying for their upkeep, unless they have a relative in the town, because of the expense of buying exercise books and compulsory sandals and clothes, and because their work is valuable for household production.

5.7 Conclusions

Most non-cultivated resources are extracted for subsistence uses, but some are traded. Understanding why different types of trade occur, and the conditions that affect the volume of trade, gives a clearer view of the likely impact on availability of the resource. Trade within villages is often opportunistic and on a small scale; products involved are often those which require skill or are time consuming to collect or make, such as canoes. Trade between villages often reflects varying local availability of resources, such as mats traded in Esomony, and salt in Soalala. Goods sold at markets, such as fish in Soalala, are usually sold to buyers for export from the region, and are those for which there is demand outside the local area. Some high value products which can be found predictably in relatively high density, such as shark fins and sea cucumbers in Soalala, are bought by visiting collectors.

Products which are exported from the region are most likely to be over-exploited, as demand from external markets usually reflects the relatively high value of the product. Hawksbill turtle, crocodile, sea cucumber, prawn and shark populations in the Soalala area are vulnerable to, or showing signs of, reduction due to collection for export. The clearance of forest in Andohahela reserve for cultivation of marijuana and tobacco for sale is also motivated by external demand and large profits. Resource extraction motivated by demand from external markets will be difficult to curb to keep within the limits of sustainability.

Rice is both the main cash crop and the main staple food in both regions, so there is often a conflict between raising money and ensuring that the household has sufficient to eat. The difficulties of carrying rice to markets by foot in Andohahela, and the lack of means at Antanandava to reach a larger market than the limited demand in Soalala, limit the trade in rice. Goods imported to the region are therefore traded for rice in villages at inflated prices in comparison with the amounts that the same quantity of rice could buy in a market town. Some traders exploit this difference.

Cultural influences can sometimes have a strong impact on trade and economic decisions. This is illustrated where people appear to make irrational economic decisions, as in cattle trading. Cattle are of great social importance for rituals and prestige. People tend to buy cattle as soon as they have the means after the main rice harvest, when the price of rice is low and that of cattle is high. In some cases, they sell cattle later at low prices in order to buy rice for food at high prices. It appears that, in these regions, rice is viewed primarily as a cash crop to obtain cattle rather than as a means to achieve food security. However, the motivation for buying cattle is not only driven culturally; they also provide a means to accumulate wealth, as they enable greater areas of rice to be cultivated, the surplus from which can invested in more cattle. Having several cattle also provides greater security against crop failure. Cultural influences also inflated the price of duging meat among the Kajemby in Soalala, who attach great importance to this traditional food.

The commercial fishing trade in Soalala has changed the lives of coastal people, but there are concerns about its continuing stability. The growing cash economy, with increasing rice production and reduction in cattle, has wide social implications which are explored in Chapter 6.

Chapter 6.

THE SOCIAL RELATIONS OF RESOURCE USE

6.1 Introduction

As previous chapters have demonstrated, decisions concerning use and management of resources are often not made solely to maximise economic and energetic efficiency, but are greatly influenced by pressures to conform to socially expected behaviour. Access to items of wealth such as land for cultivation may be controlled through socially recognised rules and procedures for transfer of rights, for example those governing inheritance. Production may be shared, for example between kin, enabling resources to support a wider set of individuals, or given to a leader, in recognition and support of their authority. Certain rituals and prohibitions are observed which may serve to consolidate membership, define hierarchy between members and perpetuate the cultural identity of a group. These social and cultural influences are explored here.

6.2 Social organisation

The family

In both Soalala and Andohahela regions there is a strong sense of loyalty to and identity with kin, which is organised in a series of hierarchies of association. The nuclear family (father, mother and children) is often the basic unit of production, but may be complicated with repeated, sometimes multiple marriages, and the strength of ties with parents, siblings and other kin. Societies in both regions are predominantly patrilineal and wives move to the husband's family domain on marriage. The woman may retain allegiance to her father's family, returning to them on separation from her husband and being buried in their tomb, but the children belong to the father's family.

While children are respectful and obedient to their parents, working for and supporting them, there is often a less formal relationship between children and grand-parents; in Soalala, grand-child and grand-parent relations of opposite sex treat each other jokingly as husband and wife (**mpivady**). In Soalala, there is similar camaraderie between someone and their spouse's siblings and their siblings' spouses (**ragnao**). In Andohahela, such relations exist between men (**valilahy**), that is between someone and their wife's brothers and sister's husbands. Children-in-law (**vinanto**) are respectful and obedient to their parents-in-law (**rafoza**), which usually include spouses elder siblings.

Clans, lineages and local history in Andohahela

People in the two villages studied in Andohahela are almost exclusively of the Antanosy ethnic group. Within larger Antanosy regional groups (such as the Tavaratra north of Manantenina, Tatsimo around Ranopiso, Tambolo from the valley of the Manampanihy, and the Tanosy from the region around Fanjahira) there are groups of related descent called **razana**, referred to here as clans. The people of Eminiminy are of the same clan, Takalilagna, whereas people at Esomony are of many clans which migrated from different places further east.

The Takalilagna have been in the Eminiminy region for many centuries, both according to oral history and supported by Flacourt (1661) who refers to the Eminiminy area as `Encalilan' (p. 29, p. 62 and Map of the Province of Anosy, in Grandidier *et al.* 1913). They won rights to the upper Manampanihy valley by defeating two other groups, the Tehela and Mitavagna, later being defeated by and becoming subjects of the Zafiraminia (Tanosy).

There are six main clans in Esomony (in order of arrival): Tesomony, Temarokahita, Tamboasary, Temantaroho, Tehosoky, and Temahangaza. Oral hitory recounts that the Tesomony, originally from north of Manantenina (75 km north east of Esomony), were invited by the previous occupants of the region, the Zafindravola, to help repulse an attack by the Temaroasara. After victory, the Tesomony were given the valley of the Sakamalio, where they founded the village of Esomony (named after their country of origin) and started irrigated rice cultivation. This occurred before the colonial period, probably around 150 to 200 years ago. The final large group to arrive, the Temahangaza, came from Mahangaza in Ambolo, east of Eminiminy, in the early 20th century. Esomony is on the eastern Antanosy limit with Antandroy groups further west and Bara groups further north, and a few of these people have settled in Esomony.

Within each clan there are one or more extended families, or lineages, called **hazomanga**, under the moral authority of a **lonaka** (or **mpitohazomanga** or **mpisorona**). The lonaka leads ceremonies within the lineage, receives some of the first harvest and is given the rump of any animals killed. The position is inherited patrilineally, passing to brothers in order of age seniority before reverting to the eldest son of the eldest brother. Lonaka are thus usually older men. Members of a hazomanga usually live in the same area of the village, with houses of more senior members to the east, although placement is flexible. Each hazomanga has its own tomb and a different identifying pattern of cuts to cattle ears (**sofinagnomby**). Cattle belonging to members of the hazomanga may be kept in one or several herds, depending on the size of the lineage. Fathers and sons, or groups of brothers tend to keep their cattle together. Cattle, other livestock and land are owned by individuals (usually men). Produce is primarily used to sustain the close family, although some of the first harvest is given to the lonaka, some is given to their kin who do not produce sufficient, such as the elderly, and contributions are made to family rituals and events.

Clans, lineages and local history: Soalala

There are quite strong cultural differences between the predominantly Muslim, Antalaotsy (Chapter 3, Section 3.4), town of Soalala and surrounding villages such as Antsira and Antanandava. Most people at Antsira are Kajemby (a clan conquered by the Sakalava; see Chapter 3), subjects of a king at Amparafaka (west of the mouth of Baly Bay: Figure 6). There are several kings (**mpanjaka**) in the area; others are based at Antamboho, Kasany and Ankoro. People at Antsira and Marotia visited the royal site, **doany**, at Amparafaka on irregular occasions to participate in rituals and work (**famompoa**) associated with the maintenance of the royal tomb. In December 1991 they visited at new moon (**fanjava tondroy**) to clear grass from inside the enclosure (ceremony called **mangala kongo**). In February 1993 people were engaged in collecting timber to repair the fence around the tomb, **valamena**. This took several months, as work could only be done on certain days, depending on the moon and other prescriptions. Most people from Antsira only visited for a few days during the event.

Sacrifices and benedictions performed to the east of the bay are performed by a **mpijoro**, or **mpangataka** living at Mangabe (see Figure 6). He has inherited the position from his mother's mother. People said that when a mpanjaka dies, the successor is chosen by the elders of the clan from among the close relatives of the deceased. Several local mpanjaka were women, which seems an important contrast with the Andohahela region where women appeared to have little possibility of holding a position of political authority. Most Kajemby at Marotia and Antsira are buried at Amparafaka. In addition to the Kajemby at Antsira, there are some Vezo from coastal areas further south.

People were much more mixed at Antanandava than at Antsira. Many people migrate there seasonally to cultivate dry season rice, **vary jeby**, returning to ancestral homes to guard cattle, fish and cultivate gardens in the wet season. These included Kajemby, Antalaotsy, Betsirebaka (generic term for people from southern central to south east Madagascar, mostly Betsileo or Antesaka) and other Sakalava. The people renting land changed each year.

In both Antsira and Antanandava, as at Andohahela, the household is the focus of production. At Antsira, part of the fishing catch is given to kin or other people in the village, although bought food, like rice, is rarely given except to close dependent kin. Rice fields at Antanandava are owned by individuals, who may decide to lend or rent them to others. Rice is given to parents and siblings, and sometimes to more distant kin. Cattle belonging to father and sons, or brothers are often kept in joint herds, although each head of cattle is owned individually, as in Andohahela.

Relations between clans

In both regions, different clans residing in a village cooperate, for example over use of pasture, or collection rights from forest or marine areas. The longer established residents dominate negotiations over access. The people recognised as the first residents are called the **tompon-tany** (masters of the land), or **tompon-tana** (masters of the village). They often own greater areas of land, or better quality land, for example nearer to water sources, which they claimed when they first arrived. Longer established families may have status because of greater wealth, in terms of cattle and rice production. However, they maintain a respected position even if they are less wealthy. The Zafindravola pastoralists gave the Sakamalio valley, the best cultivating land in their territory, to the rice cultivating Tesomony, and are now markedly less wealthy in terms of both cattle and crop production. However, their ancestors are still invoked in recitations at rituals. Similarly, the Tesomony retain a respected position at village meetings, despite their smaller numbers, than more recent arrivals such as the Temahangaza. In Soalala, new arrivals must ask permission of the **tompon-tana**, often making a gift of rum, before settling in the area and clearing a garden, although access to rice fields or previously cleared areas usually only involves a rent agreement with an individual owner.

Artificial kinship

In both areas there is also a widely used system of artificial kinship formed by a blood-brother ceremony (**fatidraha** in most of Madagascar and Soalala, or **atihena** in Andohahela). It can be performed between men, men and women, or women. The pair treat each other like siblings, with equivalent reciprocal obligations. Seniority in the relationship follows age, the older being **zoky**, and the younger **zandry**, as with real siblings. They assist each other in production; loaning land and cattle, and giving labour. They provide each other with unlimited hospitality, and with support in negotiations with others, particularly with their own family.

This artificial kinship is a means of ensuring reliable cooperators, especially for immigrants to a region (Bloch 1973). For example, in Eminiminy, a schoolteacher from Ranomafana became the atihena of a local man, who loaned him a house and fields, and they worked together on each other's land. A man from Marotia had become the fatidraha of the tompon-tana of Antsira, giving him the right to settle there with his wife's relations, all of whom were now considered kin of the resident family.

People in Andohahela said that they can only do business with kin as others cannot be trusted. For example, in Andohahela a female atihena from Marovato brought tobacco to her `brother' in Eminiminy who traded the tobacco for rice which the atihena collected later. Travellers, such as traders, tend to have large numbers of blood brothers throughout the areas through which they travel regularly. Other people said that it was useful to have blood brothers in towns so they could stay with them when visiting markets, or send their children to stay with them to attend school.

6.3 The role of ritual

Rituals and ceremonies, and observance of customs and prohibitions are guiding influences of Malagasy life. In both regions visited, these cultural influences dominate not only life events such as birth, marriage and death, but also daily work, social relations and resource use.

Divination and astrology

In both regions there are men with special knowledge of how to control and alleviate unwelcome events, known as **ombiasy** in Andohahela and **moasy** in Soalala. These men have special knowledge of plants used in sorcery and counter-sorcery, and are consulted when people need help to control their destiny. They often use a divinatory practice called **sikidy** or **sikily**, employing seeds from the **fany** (or **fanina**, possibly *Entada abyssinica*) tree and beads. For example, the practice was seen used in Andohahela to try to locate a cow that had gone missing, and in Soalala to decide where to hunt for turtle the following day.

Astrology is important in both areas, but particularly in Andohahela. **Mpanandro** are consulted who understand the meanings of days **(mahay andro)**. A propitious day, **andro soa**, must be chosen for any important event, for example for ceremonies, and even for making a journey or starting the rice harvest. Births may fall on a bad day, **andro mahery** (strong day) in which case rituals, and often a sacrifice, must be done to remove the bad luck from the child and the family.

Charms are worn which protect against bad consequences, or evil spirits, often prescribed by ombiasy. In Andohahela some people wear a black disk on a string around the neck (which used to be made from black hardwood, **hazo-taha**, and are now often made from gramophone records) described as **fanafody lolo**, or **fanafody angatsy** (**fanafody** means `medecine'), which protects against the evil spirits of the dead. Charms in Soalala are known as **aoly**. Some people wear small batons of wood on a string round their neck to protect against **tolaky** (evil spirits or sorcery).

Fady

Fady are prohibitions, usually translated as `taboo', which govern diverse activities in Malagasy life. There are many types of fady, including **fadin-drazana** (fady of the ancestors), **fadin-tany** (fady of the land) and **fadin-tromba** (fady of the **tromba** spirit [only in Soalala]). Fady may refer to food, to places, to relations with other clans or lineages and to all manner of practices. The consequences following the transgression of a fady also vary and may include death, deaths in the family, ill health such as contraction of leprosy, having no more children, losing wealth, bringing a cyclone, and other ill fortune. Transgressions often can be anulled, after advice from an ombiasy, often involving a sacrifice. Some fady may be negated, as, for example for the Temahangaza in Esomony who may now eat goat, although they may not raise them. Fadin-drazana are inherited from both mother and father. It is said in Soalala that people inherit fady and clan affiliation from eight of their immediate ancestors (also mentioned by Feeley Harnik 1991, p. 25). There were large numbers of fady in the Soalala region, varying between clans, and between individuals. Lists of food fady for some individuals are given in Appendix 9.

Some clans maintain fady in relations with other clans as a result of historic conflict. For example the Zafiraminia from Anosy, the region around Fanjahira, are said to have conquered the Takalilagna (before Flacourt's visit in 1656-1660) using the sorcery of an ombiasy. From that time it was fady for a Takalilagna to marry a Zafiraminia, which is still effective today. Transgression of this fady was believed to be the cause of death of a woman at Eminiminy during my visit.

Fadin-tany are specific to a place or region. At Antanandava the **andro-fady** (**andro** means `day') are Tuesday and Sunday, but only Tuesday in Antsira, and Thursday in Esomony and Eminiminy. The ground must not be dug or disturbed on these days. No work may be done in rice fields, although rice brought to the village may be threshed.

People may thatch houses but not put posts into the ground. They may pull up root crops, but not plant them. Some people in Soalala also have personal andro-fady.

Fadin-tromba (which only occur in Soalala) either belong to the spirit of a royal ancestor **(tromba)** which possesses a person, or have been prescribed by a tromba. The full possession may only be manifested on special occasions (also **tromba)**, but the mediums must respect the fady of their tromba at all times. The tromba sometimes impose fady when they give advice to cure an illness, as in the case of one woman's fady of tinned milk and coffee at Antsira. Sometimes these fady are linked to certain days, for example some people are fady to eat rice or to handle money on certain days of the week.

Sacrifices

Many rituals seem very expensive in terms of animals sacrificed, food (such as rice) provided to participants and time allocated. Many events involve a sacrifice, of which a head of cattle is the most honourable, but sheep or even chickens are sometimes used. Blood must run. The animal is tied and faced east, before the throat is slit with a knife. The **lonaka** (Andohahela) or **mpijoro** (Soalala) recites an invocation **(sodrano)** to God **(zanahary)** and the ancestors **(razana)**, requesting their blessing. The meat is eaten, with the most respected elders (lonaka, mpanjaka etc.) receiving the rump. The marked ears of sacrficed cattle are often kept as proof of the cattle's origin, in case of accusation of theft. Sacrifices are done on many occasions, some of which are described below.

Birth

After birth, the mother remains indoors, often drinking infusions made with wild plants for protection from illness. New mothers apply face packs, often of special powdered woods, to maintain a clear complexion. In Soalala, women habitually apply facepacks, made of wood such as **masonjoany** (*Santalina madagascariensis*), both against the sun and as decoration on special occasions, but in Andohahela it is only done by new mothers in confinement. In Andohahela, women said that confinement traditionally lasted six months, but usually only lasts one or two months now, and in Soalala, confinement usually lasts for one week.

In Andohahela, the umbilical cord **(foitra)**, often with the first hair cut after one week **(volobody)**, is buried in a special place **(fagnaria-poitsy)**; each clan having a separate place. The Tesomony clan keep umbilical cords for several years until a member of the family returns to their ancestral home, **tanin-drazana**, north of Manantenina, where they are buried. This helps to maintain the clan's links with their ancestral land.

In addition to bridewealth at marriage, men in Soalala traditionally give a head of cattle to their wife's family when the first child is born. This head of cattle, referred to as the **vily** or `price', is sacrificed, and the man returns with a part of the thigh as proof. This establishes the father's rights to this and following children. In Andohahela, no gift or sacrifice is required but prior to birth a father may make a pledge, **voady** or **firavoravoa**, that if the child is born safely, they will make a sacrifice of a head of cattle or a sheep. The children become the father's responsibility, and are buried in his family tomb. Children born out of marriage, or where the father is not deemed to have fulfilled his contractual obligations, remain within the mother's family, and are the responsibility of her father and brothers.

In Andohahela, the maternal grandfather traditionally gave his daughter one head of cattle, called **loloharakitsy**, on the birth of her first child. This was her inheritance, given so that her brothers did not feel obliged to give her other goods when her father died. These cattle gifts have become rarer as fewer cattle are kept.

Circumcision

All boys are circumcised, which may be done at any time until they are around 10 years old. In both areas, people talked of circumcisions (**savatsy** in Andohahela and **mijavatsy** in Soalala) being a great event in the past. In Andohahela, each lineage held a circumcision every few years, usually in the cooler, drier season (June to August) when the wounds heal more quickly. Traditionally, a bull was tied by the horns to a decorated wooden stake in the village (called **hazomanga**, or **tsitsiboto** at a circumcision), and each boy was placed on the bull's back by their maternal uncle (**renilahy**). If they did not fall during a prescribed period (several minutes) the circumcision was carried out, otherwise, they had to wait until the next occasion. Cattle were sacrificed, large quantities of food were prepared for great numbers of invited guests, and gifts of cattle (called **fenakoho**) were made to the boys, often from their maternal father and uncles. One house at Esomony had the ears of the four cattle killed at the father's circumcision hanging above the hearth. A man in Eminiminy aged around 60 said that six cattle had been killed at his circumcision, as his father owned 200 cattle, but none were killed at his sons' circumcisions as he only owns nine cattle. Many circumcisions are still done in the village by specialist men with a special knife (**bevoho**), although increasing numbers are done at medical centres. Nowadays, cattle are rarely killed at circumcisions and a meal is only prepared for close family. The last circumcision with cattle sacrificed at Eminiminy was in 1980. In Soalala, similar large events, **mijavatsy**, were described but again, most are done now without sacrifice of cattle or large meals. Traditions are changing as people have smaller cattle herds and fewer means to sustain the expenses.

Marriage

In both areas, marriages involve the groom's family giving bridewealth (**miletry** in Andohahela and **mahary** in Soalala) to the bride's family. In both regions, men usually build houses near their father, and on marriage the wife goes to live with her husband's family. In Soalala, men who go to live with their wife's family are mocked, and called **jaloko**.

In Andohahela, bridewealth usually comprises two cattle (**omby roa be tsy teraka**, literally `two grown cattle which have not yet given birth' which can be of either sex), some money, and a shawl or blanket for the bride's mother (**bodon-drakemba**). One head of cattle must be given immediately, and if the marriage is within the extended family this is sacrificed prior to the wedding to ward off any ill-consequences. The second may be given up to two years later. These cattle belong to the bride, although they are kept by her father, and if he dies she can decide if she wants the cattle to join the herd of her husband or her brothers (the most usual).

Marriage is prohibited between siblings or children of sisters (**zanaka mprahavavy**) or any of their descendants, but is allowed between children of brothers (**zanaka mprahalahy**) or of sister and brother (**zanaka mpianadahy**). Marriages within the lineage, **fanambalihamitroky**, were common in Eminiminy (90% of 10 couples questioned). Parents prefer such marriages so that inheritance remains within the family, saying **ny lova tsy mifindra** (literally `inheritance does not change place'). Endogamous marriages are preferred for the same reason among the Merina of central Madagascar (Bloch 1986). Marriages used to be arranged from early infancy (**sazon-jaza**) and although this is now rare, parents sometimes find brides for sons residing at home, and must give their consent to a marriage.

In Soalala, cattle are also traditionally the main constituent of bridewealth, but equivalent sums of money are sometimes given now. If two cattle are given they should be a cow and her own calf, but additional cattle can be of any type. Cash replacements were 150,000 to 200,000 FMG. One recently married woman at Antanandava said that her family had received three cattle for her latest marriage, but that money had been given at her previous marriage, which had been used to buy her a sewing machine. Waast (1980) reports that, from the 1950s, bridewealth in the Soalala region increased in value as there was competition for brides from increasing numbers of immigrants (Betsileo, Antesaka and Tsimihety) who wanted access to land.

The cattle belong to the woman, but are kept in her father or brother's herd. If the couple separate within a year the bridewealth is returned to the husband's family (also reported by Feeley Harnik (1991, p. 286) in Analalava, a Sakalava area 300 km north east of Soalala). Marriages appeared to be made and broken easily in Soalala, also reported by Feeley Harnik (1991). Waast (1980) proposes that divorces increased in the Soalala area as a means for women and their families to benefit from multiple gifts of bridewealth from immigrants. He also proposes that this became a means for women to accumulate wealth and become independent from their families.

First marriages are sometimes arranged by parents, when their grown children still live at home. Girls in both regions usually marry at from 15 to 19 years and men in their early twenties. One mother in Antsira explained that they had found a wife for their 20 year old son to keep him at home. Marriages are generally more permanent in Andohahela, however, the break up of one marriage in Esomony gives a good example of each partner's rights to household goods. The man had taken a new, younger wife and the former wife demanded her sewing machine and other household goods which the husband had bought for her. A meeting (**kabary**) was held in the village, at which the former wife's family requested a judgement from the village elders. It was agreed that the man should have bought new equipment for his new wife, so he was forced to give up the sewing machine and make a sacrifice of a head of cattle.

Polygamy (**mampirafy**) occurs in both regions, but is rare (one man in Antsira, one in Esomony, and none in Antanandava or Eminiminy). Both men in Esomony and Antsira had taken a second wife with their first wife's consent because she had not had children. Each wife has their own house and cooks meals for their husband who eats at both houses. Land is divided between the wives, with a greater share for the first wife, and the husband works on both. The production from their land goes to their respective stores for management of their household. The man maintains control of cattle and may ask his wives for rice, or other wealth, to buy cattle or for other requirements. Polygamy is considered only to be possible for wealthy men, and is a sign of wealth to which men aspire. Men and women recognise that jealousy and conflict are almost inevitable between the wives.

Funerals
Cattle play a very important part at funerals. Funerals without cattle killed, called **faty kaboky** at Andohahela, are considered very shameful for the family and for the deceased. Traditionally, young children are not given full funerals, but this appeared to be changing with burial in the family tomb, sacrifices and a wake increasingly occuring for children of young ages (as young as three months at Eminiminy during fieldwork). The scale of the event increased with increasing age and social postion of the deceased. In order to appreciate the time and goods invested in funerals I give here some examples from each region.

The funeral of an elderly woman occurred in Antanandava in December 1991. Her body was taken to a place outside the village. Members of the family set up shelters there, brought cooking utensils and mosquito nets. and a wake continued for 18 days. Distant members of the family were summoned. The site of the body was always active, and each night there was singing, dancing, and plenty of rum. Cattle were killed, and meat was distributed raw, or cooked in large meals at the funeral camp. Sweetened coffee was given to all participants every night.

The closest members of the family (in this case her nephews) were responsible for providing the hospitality (referred to as **tompon-paty**, `masters of the corpse'). Members of the family contributed cattle, rice and money to the expenses, while other visitors brought drapes for the body, and money (500 or 1,000 FMG notes) which were pinned to the cloth covering the body. For this funeral, the tompon-paty provided six cattle, two barrels of rum, 24 kg coffee, 36 kg of sugar, and large unmeasured quantities of rice to feed the guests. Members of the family and other villagers helped with the work, which involved cooking, finding firewood, pounding rice and collecting stones for the tomb.

On the day of the funeral the entire group, around 150 people, went to the tomb, where a new grave was dug just east of previous ones, lined with stones. The body, by now greatly decomposed, was wrapped in fresh cloths (I counted eight special **sobahia** worth 30,000 FMG each and several more **lambahoany** worth 6,000 to 7,000 FMG) and buried with rum, a glass tumbler, a comb, tobacco, matches and more lambahoany.

The time available for agricultural work was severely reduced, particularly for the family of the deceased, but effectively for most villagers, during the three week period. This death occurred at the final intensive harvest period as people were trying to complete their harvest before the rains caused the water to rise. In addition, those who came from long distances abandoned their own productive work completely. Such funerals are therefore a vast drain on resources, in terms of cattle, rice, cash and time. People said that deaths of royalty may involve wakes for two or three months, and the minimum for an adult is eight days. The Antalaotsy Muslims bury their dead the same day, but maintain open house and revelry for many days after the burial (43 days for an elderly man at Ambarinanahary, 4 km east of Antanandava).

It is interesting to remark what occurred when an old deaf man died at Antanandava. He had no kin there, and had never married. He was an ex-prisoner who had worked in rice fields for payment until he became too old. He survived on charity from villagers. There was a debate about whether to bury him immediately. It was decided to have one night's wake, and one kapoaka of rice was collected from all families in the village to buy some rum, coffee and sugar and provide a meal after the burial. They felt that even this old man deserved a wake, and were willing to share the expense.

People say that the coastal Kajemby were traditionally buried at sea in coffins made of two hollowed trunks. This practice was banned during the colonial period, and most are now buried in tombs near the shore, in the same type of coffins. Several years after the death there is a celebration in honour of the dead (**rangandolo**). If the body had been properly buried in the family tomb there is no disturbance to the tomb but stones may be added. Bodies which for some reason were not buried in the right place are exhumed for a proper burial. In Antsira, a boy had died during very windy weather in the wet season. It was too dangerous to take the body to Amparafaka in boats, so he was buried on the east of the bay, and his bones were exhumed two years later for burial on the west side.

In Andohahela, wakes may continue for up to four nights, but are often only two nights. It is considered shameful for the body to decompose before burial, and many families cannot afford the expense of continuing wakes over many days. The body is usually kept in a house and is continuously accompanied by older women of the village, called **beranomaso** (many tears), or **mavokasoatry**. Older men stay outside or in another house. The younger family members do most of the work, particularly those married into the family (**vinanto**), and descendants of female members (**zanakapela**), that is those of other lineages who are related by marriage to the family. People said that when the family is rich enough they call upon a group called the **tsimahaivelo** to manage and cook the funeral feasts. These are a band of vinanto and zanakapela from many lineages. They have the right to steal or demand any animal in the village (cow, sheep or goat) which the family must later pay for. They take a cloth from the body and a cow which they sell after the funeral, the proceeds being divided between them.

Cattle were nearly always killed, and when the family had none they would trade land and get into debt to obtain one. When larger numbers of cattle were killed, some were sacrificed, called **fapindray**, and distributed raw to distant relatives and other villagers, but were not eaten by the close family. Other cattle, called **akoho** (literally `chicken'), were killed to feed people assembled for the funeral, including the family. Distant members of the family were collected by messengers. Most people in the village did no work as a sign of respect, and spent long periods at the funeral site, particularly at night. The wakes here also had a wild, party atmosphere with continuous music and dancing at night, encouraged by rum and sweetened coffee.

Again, some donations are made by visitors, but the major expenses are covered by the close family. The majority of funerals occurring during my visit involved one to three cattle, killed over three days and two night. The largest funeral in Esomony occurred when an aged Temahangaza lonaka died. At least 100 people came from surrounding villages. Twenty cattle were killed in total. Five were sacrificed on the first day, the **fapindray**, and eight were sacrificed after the burial, called **fasangatobe or taom-bato,** which the close family did not eat. The other seven cattle killed during the five days of the wake were the **akoho**. They consumed 2,000 kapoaka of rice (570 kg). The sons bought 200 l of rum (350,000 FMG), eight vakilandy (cloth, 80,000 FMG), one **anaketsy mena** (loin-cloth, 15,000 FMG) and three cotton lamba (cloth, 15,000 FMG). Fifteen cattle were brought by others to the funeral, of which seven were killed, and six were kept alive (**natsanga**).

One reason given for delaying a burial as long as possible was to enable all members of the family to assemble. However, it is also clear that the nightly revelry, the sacrifices made and the aggregation of people, fed at large communal meals, were a way of honouring the dead. People in both regions said that it would be dishonourable to their lineage (including their ancestors) if the funeral was not completed with these great expenditures of money, time and work.

In Andohahela, there is also a commemoration to honour the deceased, often several years after death, but maybe after only a few days (as during my visit). A large, flat stone is dragged to a special family site and set upright, called **orom-bato, or vato-tsanga.** The largest stones, **vato lahy**, literally `male stone' which may be up to 3 m by 1 m, are erected for older men, while women and younger people have smaller stones depending on their social position when they died. The event (**mitarim-bato** or **tokam-bato**) involves several days dragging of the stone, bound with lianes onto hardwood runners. Men pull in unison, encouraged by women chanting, or a single man singing in a characteristic wailing voice **misarandra** (also done at funerals, sometimes narrating events from the deceased's life). Much rum is drunk, and after the stone has been raised a head of cattle is sacrificed and meat distributed raw throughout the village. People in Esomony are buried in family tombs near the village, but their commemorative stones are raised in their **tanin-drazana** to the east.

Spirit Possession

Other events when large numbers of people gather and cattle may be sacrificed are on occasions of spirit possession. In Soalala, people are possessed by spirits of royalty (**tromba**), often from other parts of western Madagascar. Their mediums must always be careful not to anger the tromba observing prohibitions associated with the spirit. People can possess several tromba, which often dominate their lives. The tromba are only fully manifested on special occasions (also called **tromba**). I only attended one entire tromba during my fieldwork, which lasted two days, continuing through the night. The event was being held to inform the tromba of an old woman that the hamlet (Soanavia, near Ambatojoby) had been moved to a new site during the previous year (500 m from previous site) after a fire. Tromba are also held when people are ill (sometimes they are ill because their tromba is angry), and Feeley Harnik (1991, p. 266) adds that they are held when tromba want to get together with their friends, or make an announcement to their followers.

People in Esomony in Andohahela described healing ceremonies, **bilo**, which are held after people have been ill for some time and are believed to be possessed. Although none occurred during my two years of fieldwork, they were mentioned as one of the occasions on which cattle are killed. Huntington (1988, p. 113) described bilo ceremonies as being "with the exception of certain funeral rites, the most frequent, elaborate and costly social event in Bara village life" (from fieldwork about 200 km north of Andohahela in 1970-71).

6.4 Ownership and control of resources

Land

In Andohahela, rice paddies are the most valuable land, in terms of economic productivity, in terms of the labour invested in their creation, and because suitable land is limited (also remarked by Bloch [1975] among the Merina). In Esomony and

Eminiminy the terraced fields and irrigation canals were rarely built by the current user, most having been created over 50 years ago. In some areas, such as at Vohibaka in the north of Andohahela, rice fields are still being created. The task is often too great for a household, so owners usually pay labourers. The creation of rice fields, a route to greater wealth, is thus limited to those who are already wealthy (also true among the Zafimaniry of central south east Madagascar: M. Bloch, pers. comm., October 1993). Rice fields are individually owned and may be rented, inherited and traded.

In Andohahela, there is more land suitable for rain-fed cultivation of manioc, maize, sweet potatoes and other vegetables than for rice paddies. Some new land is cleared for these crops, although much cultivation is on permanent fields. Different areas around the village are often owned by different clans or lineages, usually land allocated when they first settled in the area. For example, when the Tehosoky came to Esomony, invited because of their reputation as hunters to control wild pigs which attacked crops, they were given land in the Vavara valley. Clan or lineage members may clear new fields on their clan's land with the agreement of family leaders (for example the lonaka in consultation with other elders, **ray aman-dreny**). Clearance and cultivation of land establishes the individual's rights to use, rent, bequeath to their children, and sometimes to sell the land. There was quite a substantial trade in all types of fields, and although I know that the individual often discussed the sale with other members of the family I am unsure what influence family leaders have over decisions about sale outside the family. Beaujard (1983, p. 520) reports that among the Tanala of Ikongo (300 km north of Andohahela) the approval of the family and other members of the village (the **fokonolona**, see Section 6.6) are required for sale of rice fields.

In Soalala, there are different types of rice field: in flood plains used for dry season rice (**vary jeby**) and in marshy areas used for wet season rice (**vary asara**). Dry season fields (such as at Antanandava) are mostly owned collectively by Sakalava families, which are considered to be the longest inhabitants of the area (**tompon-tana**). They may be rented or loaned to others but are never traded, as it is believed that they must remain within the family (see section on inheritance, below).

Wet season fields in Soalala are not necessarily cultivated every year, either because of insufficient rain or lack of cultivators (see Chapter 4, Section 4.5). Usufruct rights to land unused for many seasons may be established by asking permission of the tompon-tana (there may be a group of elders or an individual), and of the previous user if they are known and available. The use of land may be requested by anyone accepted within the local community, which requires being vouched for by an existing member. If they have no kin relations locally, an immigrant usually forms bonds with a local family by taking a local wife or through fictive kinship (blood-brothers) (see Section 6.2). The request is usually made with a gift of rum. After cultivation, the usufruct rights of the cultivator are established for successive years. However, if land is unused, the use rights may be transferred, by the tompon-tana, to another cultivator. The same procedure applies to clearing and cultivating a garden for manioc and other crops. I am not aware of unused gardens or wet season rice fields being rented in Soalala, and they are certainly never sold. In most areas there is sufficient suitable land for all who wish to cultivate, as the region is sparsely populated and many prefer to fish commercially, cultivating only small gardens, or none at all. Much of the land suitable for wet season rice, for example near Antsira, is no longer cultivated. Also, in contrast with Andohahela, large amounts of labour are not required to establish rice fields.

Cattle

The resources which determine productive wealth in rice cultivating villages are rice fields and cattle. Cattle also determine social prestige. Wealth in cattle enables realisation of full productivity from the land, and, in Andohahela, also enables appropriation of rice fields. Increased rice production is invested in cattle, which can be used to buy fields. Just as cattle are the means by which wealth may spiral upward, they may also be the means through which wealth is lost. Families with around five or fewer cattle are in a precarious situation. They can probably cultivate sufficient land, as long as they have access to sufficient labour, but if those cattle are lost, through theft, multiple deaths in the family or prolonged food shortage from failed harvests, they fall into a poverty trap. They usually cannot cultivate such a large area, as the work in each field is greatly increased without sufficient cattle for trampling. In Andohahela they may be forced to sell land. They must await a good year climatically which may enable them to produce a surplus of rice from which they can acquire cattle. However, on such occasions others have plenty of rice and the price of cattle increases dramatically.

Cattle are individually owned, mostly by men, who also take decisions about management. They may be kept in joint herds, often with those of father, sons or brothers. All cattle should be registered in the owner's herd book, with the official stamp of the President of the Fokontany. Any cattle acquired should be accompanied by their papers, and appropriate tax paid where necessary. These measures are supposed to help control thieving. However, in practice not all cattle are registered and verifications are rarely made.

Cattle may be bought, or earned through some service, like the calf earned annually by cattle herders, or in exchange for building a house. Alternatively they may be acquired through ritual exchange such as for bridewealth, or through inheritance (**lova**). As described in Chapter 5, cattle were often acquired traditionally through theft, however, this is now considered an improper means of appropriation.

Inheritance

Older men in several families were asked how goods are inherited. There was some variation in Andohahela, but the majority described the following scenario. A father's rice fields, dry fields and cattle are divided between his sons. The eldest son gets a quantity of land and cattle called the **voli-hena** (literally `rump of the meat', the part of meat traditionally given to the lonaka or leader of the family). Remaining land is divided equally among all sons, including the eldest, who thus gets a larger (up to double) share. Brothers choose land and animals in decreasing age order, so although they get roughly similar quantities, older brothers get a better quality inheritance. The final division of land is usually decided before the father dies, and is distributed to sons as they marry, the father usually retaining the **voli-hena** portion until death. Sons assure their father's upkeep. Cattle are not usually inherited until the father's death. Any decisions or dispute about division of property after the father's death are presided over by the **ray aman-dreny** (elders) of the village, including those of other families.

Women in Andohahela do not usually inherit land or cattle from their father, although unmarried women may request a small area of land from their brothers, who retain ownership. One man said that daughters inherit a small quantity. Others said that daughters are given some household utensils when they marry. If they are not married, they receive some utensils on their father's death, although not all utensils are given to the daughters. The father's jewellery (such as silver bracelets, **vangovango**) are inherited by sons. Daughters inherit their mother's jewellery and sewing machine. Women retain control of cattle given by their husband's family as bridewealth. In addition any cattle or land that a daughter has bought or earned, called **mitalia,** remain hers on her father's death.

Rarely, women in Andohahela inherit more significant portions, in special cases of polygamy where one wife has only daughters. Land and cattle are divided between the wives; the first wife (**vadibe**, the mother of the first son) receiving a larger portion than junior wives (**vadimasay**). Their land is cultivated by the wives during their lives and inherited by their children. If, for example, the first wife has many more sons, they inherit much smaller portions than their half brothers. If one wife has only daughters they inherit her portion. However, some interviwees said that these daughters still only receive a small portion. Sons born with unknown fathers inherit only small quantities of land and cattle, at the discretion of their maternal uncles (**renilahy**).

In Soalala, ownership of dry season rice fields is usually more collectively, by lineage, than in Andohahela. When someone dies their estate reverts to the family. It may be managed by their brothers and sisters, who give some to the deceased's children for cultivation. The eldest, male or female, manages the inheritance and portions out the fields. If some children are too young, or leave the region, their land is farmed by their siblings or rented out. The rent belongs to the true owner but may be ceded to the eldest. Cattle are owned individually and are inherited by sons and daughters, who receive a smaller share. Some people said that because children inherit from their father, the mother's possessions may be inherited by her brothers' children.

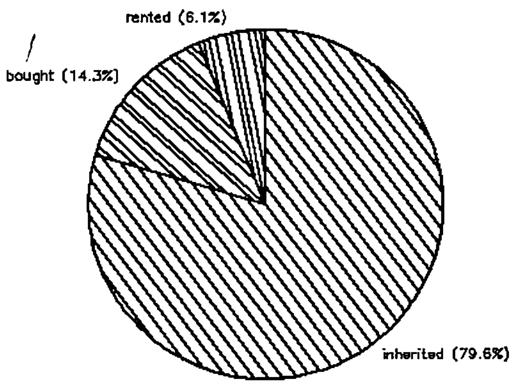
Rental agreements

In both regions rice fields may be rented, either for a proportion of the harvest or for an agreed quantity of the production. In Andohahela, the standard system is called **telo-mizara** (literally `divided in three'), in which one third of the harvest is given to the owner. However, if the owner provides the seed rice (**doria**), or the owner provides the cattle for trampling the rice field (in each case the cultivator providing all other work and resources), half of the harvest is paid to the owner. Some people in Esomony said that they had, in the past, rented fields for money, but that there had later been a dispute when the tenants claimed that they had bought ownership of the land rather than rights to one year's cultivation. For this reason, they prefer to rent fields to people they know well, rather than immigrants. Dry land fields are not usually rented in Andohahela, but loaned free of charge, often between relatives.

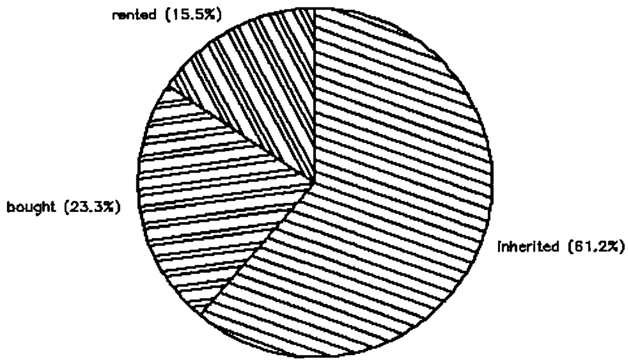
A survey of 1992/93 cultivation for 15 households in Eminiminy and 22 households in Esomony in March and April 1993 gave the proportions of rice fields and dry fields that had been rented (or borrowed), inherited, cleared or bought (see Figure 14). More fields were inherited and fewer rented (or borrowed) at Eminiminy, where there are almost no recent immigrants and therefore more households own inherited fields.

The **telo-mizara** system is also used for pigs. Sows are loaned to another family, who feed them while they are pregnant. Some piglets are retained, and the sow and the rest of the piglets are returned to the owner. For example, in one case, four piglets were kept by the household which fed the sow and three piglets and the sow were returned to the owner.

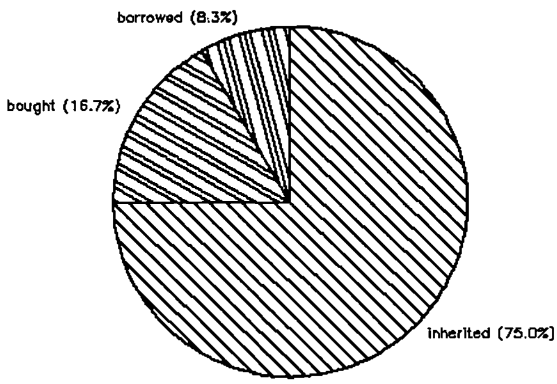
Eminiminy: rice fields



Esomony: rice fields



Eminiminy: dry fields



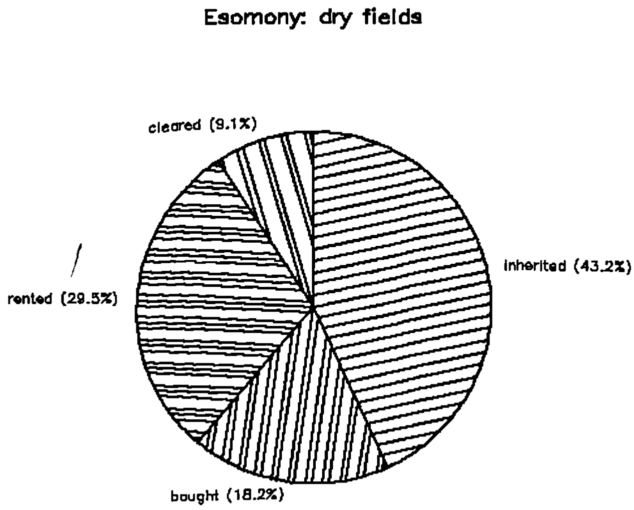


Figure 14. Pie charts showing the percentage of fields inherited, bought, rented (includes free loan) and cleared for rice and dry cultivation in Andohahela villages, March/April 1993.

At Antanandava, many of the irrigated rice fields, which are owned by a limited number of families, are rented by a diverse range of people each year. A quantity of rice for the rent is usually agreed in advance, varying from 10 to 50% of the expected harvest. Owners gave preferential access and better rates to members of their family, or longstanding members of the community (the highest rent encountered was 50% of the harvest, charged to an immigrant Antandroy couple in October 1990).

Pasture

In Soalala, pasture areas (**kija**) are owned by clans and lineages. Newcomers must negotiate access to pasture with an existing family. At Esomony, in Andohahela, people said that pasture areas (**tanin-aomby**) up the valley, particularly used in the dry season when lower pasture areas are dry, used to be partitioned by clan and lineage. Some areas are still owned; for example, one of the Tesomony lineages have exclusive pasture rights in the Vavara pass area. Now, anyone in the village can send cattle to other areas up the valley, but herds must be kept separate in the relatively small area to avoid fights between bulls. Land below the village is open access (**mandeha doara**). In Eminiminy, people said that their village has exclusive rights to pasture south, east and west of the village, and there is equal access for all village members. People from other villages, further down the valley, must not bring their cattle into this territory.

Wild, non-cultivated resources

Most non-cultivated resources, such as wood, tubers and fruit, and medicinal plants are open access. I was not aware of villages having territories in which people from other areas are excluded from using certain resources. I think that such territories do not exist, as I know that many resources, such as reeds for mats in Esomony, and ravenala (*Ravenala madagascariensis*) leaves for salt-making in Antsira, are collected at some distance from the village from areas shared with people from other villages. Access to **hovao** trees (*Dilobeia thouarsii*) is not restricted, even though they are quite rare. Nuts for edible oil are collected annually from the same hovao trees ~~and they~~ which are protected by a locally respected convention (sacrifice of a head of cattle for any damage).

I am only aware of one non-cultivated tree being owned. This was a **mafotra** tree (?*Brochoneura frencei*: identification from notes by editors p. 194 in Grandidier *et al.* 1913) of which only one specimen is known near Eminiminy. Oil from the nuts is used to cure infected wounds. The tree, found in forest in the reserve, is owned by a man living in Andonabe (1 km south of Eminiminy), and was inherited from his father. Others are excluded, by a locally respected convention, from collecting the nuts or from damaging the tree in any way, on penalty of sacrifice of a head of cattle. The oil is used locally and can be sold at markets in Andohahela for 6,000 FMG/l.

Other non-cultivated resources which are owned and may be sold are reeds growing in disused rice paddies near Eminiminy. They are owned because they grow on private land, and they are bought because there are few remaining marshy areas not used for rice.

In Soalala, people must be accepted into the local community in order to be able to fish. The procedure is the same as that described above to gain rights to clear a garden. They often ask for a benediction (**joro**) from the local ruler. A man from inland came to ask the royal family at Antamboho for a benediction for a fish trap (**vala kira**) which he intended to install in a gulley entering mangroves (see Chapter 4, Section 4.4). **Joro,** requesting the benediction of god (**zanahary**) and royal ancestors (**razana**) with the sacrifice of a head of cattle in royal places near angonoka sites, were recommended for the success of the Angonoka Project. Local people sometimes perform similar joro to ensure a good fishing season, or good rice harvest. Fishermen said that good fishing spots over rocks were open to the first comer, and later arrivals must install themselves elsewhere. The same system was described for good places to set nets for prawns in gulleys entering mangroves (**kinga**) near Marotia. The lucrative prawn harvest appeared to be open to all comers. People arrived in Marotia from dispersed areas and did not request permission from locals.

6.5 Traditional cooperative arrangements regulating use and management of resources

There are some traditional, locally respected arrangements which regulate people's use and management of resources. These conventions are either long-standing, such as taboos (**fady**), or are openly debated and agreed by the **community (fokonolona**, see Section 6.6). Examples are the conventions mentioned above that protect valuable trees such as mafotra and hovao. Also in Andohahela, cultivated areas are protected from damage by cattle and other livestock by a stake with grass tied to the top (**vorovoro**). Sometimes a more sinister totem (**kialo**) is used, with red cloth, bones, and special herbs attached to a stake, which employs sorcery to protect the field. In this case it is believed that anyone responsible for damage to the crop in the field will suffer ill-health or death. If domesticated pigs damage crops the cultivator kills them, and the pig-owner may sell or use the meat, giving some to the cultivator. In Soalala, at Antsira, there is a convention that if cattle can be proved to have damaged crops in a garden, the cultivator can demand a fine of 3,000 FMG per plant destroyed (for example each manioc mound, or sugar cane plant) from the cattle-owner.

Dina are local conventions which are discussed and adopted by the community concerned. For example, there is a **dina-mpihary** (literally a `charter or convention of those who accumulate possessions') currently effective in parts of south east Madagascar. This is an agreement, enforced by the community (represented by the **fokonolona** of each village) that any proven cattle thief must return the stolen cattle and three times the number stolen, or four times the number stolen if they have been killed or sold. The cattle are taken from the individual and then from the herds of his closest relatives. One man in Esomony had his entire herd of 53 cattle seized after his wife's brother had stolen cattle. People attributed the recent reduction in cattle theft to this convention. Most believed that it is just, and an important measure to control the thieving which escalated from the mid 1970s. If it is not within their means to pay back the cattle the thief is sent to the courts and goes to prison. In one case the son of an Esomony family was found guilty of cattle theft by courts in Amboasary Sud. His father killed a head of cattle to atone for his son's guilt and exonerate the family from giving the cattle required by the **dina**.

People in Esomony said that in other cases of theft, for example if rice, manioc, chickens or money are stolen, thieves are required to return the stolen goods and may be made to dance in the village (**mandrombo**), publicising their shame. Such cases were never taken to court during my visit, because of the time, expense, and potential social disunity involved, although thieving was quite widespread. In Soalala, a dina had been agreed by people at Kasany (8 km south west of Soalala) to control bush fires. They agreed that all members of the community should be responsible for putting out fires that were uncontrolled and unattended, and any that did not help would be charged a fine.

6.6 Integration of traditional systems with state administration and Government (fanjakana)

The colonial Government (1896-1960), and the regime of the First Republic (1960-1972), used a system of `notables' to govern rural areas (Covell 1987. p. 85). They identified nobles and local traditional leaders whose cooperation was rewarded with privileges, for example "being appointed to organise rather than participate in a forced labour group" (Covell 1987, p. 21). During the colonial era the State imposed itself in isolated rural areas primarily through three functions: the collection of taxes, the organisation of forced labour and the maintenance of law and order (Fauroux 1989, p. 185). The military style `gendarmerie' (rural police) ensured that tax defaulters were punished with forced labour (until the 1970s, Fauroux 1989, p. 193-4) and maintained some control of activities declared illegal, such as cattle thieving, and rum and tobacco production and trade. Repression following the nationalist revolt in 1947 accentuated a relationship of fear between the authorities and rural villages, particularly on the east coast where the uprising was centred. People in the Andohahela region remember whole villages fleeing into the forest on the arrival of representatives of the authorities. When administrative officials visited villages they were treated with polite subservience, for example, they were automatically given one of the best houses in the village with the services of a young woman for the night, and a meal of rice and chicken (Fauroux 1989, p. 194). People in Antamboho (18 km east of Antsira, Soalala) remember killing a head of cattle in honour of visiting officials, which also served to gather people from the surrounding area, both for a feast and to listen to official messages.

Following the overthrow of the First Republic in 1972, the `reform of the **fokonolona**' aimed to transform relations with the state at the base of society, making villages the "dynamic motors of development" (Covell 1987, p. 86). The **fokonolona** (literally `a group of people') originally united in one place (**fokontany**) the descendants of one ancestor (**razana**), but now means the group of people who have a permanent residence in a village, including people of different families and different ethnic backgrounds (Beaujard 1983, p. 143). The fokonolona was a basic unit of Merina society, which owned land communally, and had extensive powers of social control. Fokonolona decisions were made by **ray aman'dreny** (literally `fathers and mothers', in practice a group of male elders). The transfer of the fokonolona's control over land and people to the monarch enabled the Merina to create a centralised state. Although the fokonolona model applied well in much of Madagascar, for example among the Tanala of the central south east (Beaujard 1983), some societies, such as the Sakalava (Fauroux 1989, p. 235) had little precedent for such community organisation.

The 1976 `Charter of Decentralised Collectivities' established the current system where members of the geographical village (**fokontany**, lowest administrative unit) elect a committee and president, who participate in election of representatives to higher levels (**firaisampokontany** or `district', **fivondronampokontany** or `region', and **faritany** or `province'). The collectivities duties include the maintenance of local peace and security, enforcement of health measures, provision of social assistance, and the conciliation of quarrels in the community. Their activities have generally been closely supervised by the state administration. Although they have never functioned as autonomous self-taxing, self-policing social units, there has been considerable loosening of state-village ties, both as a result of these reforms, and in some degree due to enforced isolation from collapse of the road system and the near disappearance of transistor radios following the national economic collapse from 1980 (Covell 1987).

Fokonolona were traditionally dominated by a group of elders, whose status was determined by age, sex, relative prosperity and position in the overlying class system (often comprising nobles, commoners, and slaves). Fokontany committees and presidents are elected by all citizens over 18 years old, including young people, immigrants and women who would not traditionally be represented. I noticed tensions in Esomony between the president of the fokontany, a member of the largest, most recently arrived clan, and the leaders of the Tesomony clan, the founders of the village, who felt they should have greater influence in the government of the village. Despite these tensions, fokonolona decision making is usually dominated by traditional social organisation. In the Andohahela region this means that women are rarely present at fokonolona meetings, and that youth and immigrants rarely express their opinions.

Most disagreements over land or other property are solved locally by the fokonolona. I only heard of one case when a local disagreement was taken to court. This was in Eminiminy where some rice fields bought by a woman had been given to her eldest brother to cultivate. On his death he left them to his daughter who had cultivated them for 10 years. The first owner claimed that the fields should have reverted to her after her brother's death. The affair was settled in favour of the niece by the fokontany, and subsequently by the court in Tolagnaro. The defendant complained that all official correspondence had been in French, which caused great difficulty as she is illiterate and understands no French, although the hearing had been in Malagasy. She had also had to pay the travel and lodging expenses for herself and her witnesses and some tax and duties. Another disagreement taken to the fokonolona in Esomony was about the division of possessions on divorce, when the husband was required to give up some goods and sacrifice a head of cattle (see Section 6.3). On another occasion in Eminiminy a woman accused a man of using sorcery to harm her family. The fokonolona mediated a ceremony of reconciliation, called **sangy**, after which it was believed that if the accused continued to harm the other family he would die or there would be deaths in the family. The two were also forced to become blood brothers to ensure future harmony between the families.

6.7 Conclusions

This chapter has demonstrated the strength of traditional modes of organisation and traditional practices in rural life in Madagascar. The family plays an important role in social organisation in both regions, with children usually joining their father's family. In Andohahela, land and cattle are almost exclusively owned by men, and are inherited patrilineally. In Soalala, rice fields are owned more collectively by a family, and women play a greater role in their use and management; however, cattle are also owned individually by men. Pasture areas may be controlled by extended families, as around Soalala and east of Esomony, or be controlled more collectively by a village, as at Eminiminy. Most non-cultivated resources can be used by anyone living locally, with access only restricted to strangers from much further away. One exception is a mafotra tree near Eminiminy, the nuts of which provide a medicinal oil, which is owned individually and others are denied access. Trees of another valuable species, hovao, the nuts of which provide an edible oil, are protected from cutting damage by a local convention, but nut collection is not restricted.

Ritual plays an important role in people's lives. Fady (taboos) and superstitions may determine, for example, what resources people collect, which days they work and what food they eat. The importance attached to cattle is emphasised by their role in rituals associated with circumcision, marriage and death. People believe that cattle must be killed at funerals in order to maintain family honour. The costs of funerals in terms of cattle, rice, rum, coffee, and valuable work time are substantial. Extravagant funerals even occurred in the periods of drought experienced during this fieldwork, when host families often had few resources available.

There have been changes in rural social organisation as a result of national political and economic changes. Perhaps starting with the liberation of slaves, followed by the increasing mobility of different groups around the island, regional groups have become more mixed. The colonial Government used taxes to create a need for money, to encourage production of cash crops (like rice, coffee, cape peas and cotton) for export, and to liberate a work-force for commercial companies and settlers. The result has been a progression away from collective control of resources by tightly knit family groups to more individual control with less collective cooperation. In addition, the reform of local government has somewhat broadened the constituency of local decision making, although traditional modes of organisation are still dominant. Interestingly, traditional methods of influence and control, such as **dina**, are becoming more widespread and instutionalised, particularly where state methods of control have been inadequate, such as in the control of cattle thieving. The challenge for external groups interested in local sustainable management of resources, including national government authorities, conservation organisations and development agencies, will be to strengthen and not undermine effective traditional practices and to collaborate effectively with local people within existing social organisation.

Chapter 7.

THE ENVIRONMENTAL IMPACT OF RESOURCE USE

7.1 Introduction

This chapter examines a fundamental issue concerning conservation of natural resources: the impact of resource use by local people on the environment. Information was gathered on this subject by observing and questioning people about the types and estimated quantities of resources collected from different habitat types and areas around their settlements. Pressure on the various resources, and the likely impact on their future availability, is mainly inferred from the collectors' knowledge of changing availability, with some auxiliary evidence from observation of collection areas. History of use and resource availability is difficult to reconstruct, but some information is available from memories of older people and from oral history.

The complementary information on environmental impact of resource use which would be provided by observation and measurement of the habitats themselves, was not collected. Such data would be very relevant to environmental management for sustainable use, but their collection requires long term and controlled monitoring, and is confounded by the complexity of ecosystem dynamics. I hope that such work will be undertaken in these study areas, focussing on the resources and areas that are highlighted here as both vulnerable, and important for people in the area.

A further important focus of this chapter is to examine local resource management practices. Local explanations of their importance and efficacity for resource maintenance are an important source of ecological knowledge. Conservation projects must work with these practices, strengthening and improving them, rather than attempting to undermine or replace them.

The following sections consider the uses made of different habitat types, or zones, at different distances from settlements, reviewing factors affecting use of the area, the resources used and collected, and which of these show signs of changing availability due to high levels of extraction. The description starts with settlement patterns, as an important element of resource use patterns, followed by cultivated areas, savanna areas, forested areas, and wetlands, marine, and coastal areas. Sketchmaps of the zones around each study village, and transects summarising the dominant vegetation and uses of each zone are given in Appendix 11.

7.2 Factors influencing settlement patterns

Although the placement of villages is determined by local environmental factors, the relative importance of different environmental features depends not only on practical (or energetic) considerations, minimising distances between residences and resources, but also on a variety of cultural, historical and political considerations (Ellen 1978). All permanent settlements must have a permanent supply of water and not be at risk from flooding. They are usually near to areas in which the inhabitants perform their main livelihood activities. At Antanandava, the main village is on higher ground at the edge of the Bedango valley as lower areas flood in the wet season. However, the village is almost deserted in the dry season when most people erect temporary houses near to their fields, reducing the time taken to get to fields and, particularly once grains have formed from August, enabling constant surveillance against birds and theft.

Although scattered, small settlements are usually the best settlement pattern to minimise distance from fields, there are other reasons why people congregate in larger villages, for example for security. In the past, when there were wars with neighbouring ethnic groups, villages were often placed in isolated and easily defensible places. The Takalilagna of Eminiminy recount that their ancestors originally lived higher up the Manambolo valley. They later migrated down the valley and lived on an easily defended spur at the current site of Andonabe. It was not until they won the local wars that they moved down to the flatter, and less easily defensible, current site, nearer to the river and their fields.

In some cases, aggression from conquering powers caused people to scatter or relocate to forests and hills to try to evade domination. This was a frequent reaction to French forces during their military campaigns to conquer the entire country between 1895 and 1904 (Deschamps 1972). Later, the colonial administration, in an effort to control the rural population. forced people to move to, or create, larger central villages in relatively accessible places (Beaujard 1983, Oxby 1985, Fauroux 1989). With the imposition of other rules restricting traditional practices, such as slash-and-burn cultivation, people began to hide such cultivation deep within forests. Officials and outsiders only saw the official village and a few show fields near a oad (Oxby 1985). Although restrictions on slash-and-burn cultivation are not enforced now to the same degree, some villages still conform to this model. At Vohibaka, north of Andohahela, the few manioc fields beside the village are insufficient to support the population and the majority of food and other crops are grown in cleared fields hidden within the forest, several kilometres within the reserve. These fields are hidden from outsiders both because they occur within the reserve, which is illegal, and particularly because drugs are cultivated illegally for trade (tobacco, *Nicotiana* sp. and marijuana, *Cannabis sativa*).

Since the relaxation of control by central government, particularly since 1975, larger villages have started to disintegrate and smaller settlements are reappearing. A good example is provided by people in the Antsira area, who lived in a large village at Andanivato until around 1979. Now they are scattered between Marotia, Antsira, Antranolava, Mangabe and Andanivato (Figure 6), but they continue to function ceremonially as a single unit. People at Isaka Ivondro in Andohahela also said that more people are moving from the main village to smaller hamlets, while maintaining strong links with the main village, and said that this was more like settlement patterns before the colonial era.

Social relations and cultural beliefs also affect settlement patterns. People immigrating into an area must be accommodated by existing inhabitants. At Eminiminy, the Takalilagna beat the other claimants to the area in battle. At Esomony, the Tesomony were invited to help the previous inhabitants, the Zafindravola, to repulse attacks by another group. Although they were offered cattle as a reward, the Tesomony requested the land of the Sakamalio valley. This land was suitable for irrigated rice cultivation, the traditional livelihood of the Tesomony from the east, and, at the time, not of interest to the Zafindravola pastoralists. Their descendants now regret the decision as the inhabitants of Esomony have become economically powerful, using rice to accumulate cattle. Another group at Esomony, the Tehosoky, were given land in exchange for reducing the bush pig (*Potamochoerus larvatus*) population. New arrivals no longer establish themselves by force but must ensure the support of a member of the local community, often through blood-brother fictive kinship or through marriage, and slowly build up their entitlement to land and pasture rights (see Chapter 6, Section 6.4). A lineage is fully established in an area (no longer `outsiders', **vahiny**) once they create a tomb, although they often maintain strong links with their larger clan (**razana**) and their clan's place of origin (**tanin-drazana**).

Fathers and sons of one lineage tend to live together, as the sons inherit land from the father and have obligations to work for and support him in old age, while women move to their husband's settlement. In Andohahela, smaller hamlets usually comprise one lineage, while larger villages include several lineages, sometimes of the same clan, as at Eminiminy, or of different clans, as at Esomony, each lineage maintaining their own space within the village. Settlement populations in Soalala tend to be more mixed as there are many more immigrants. Some villages largely maintain their traditional structure, dominated by the original families, with the addition of (male) immigrants integrated by marriage. In other cases, immigrants have created separate villages (also observed by Waast [1980] in the Soalala region).

Sometimes, whole villages move to new locations after multiple deaths, because people believe that the location is unlucky or cursed. A village west of Esomony had moved after 72 people died in two months. One family in Eminiminy had moved to a new location, 200 m from the main village, because seven of their 14 children had died.

Non-cultivated resources in villages

Villages often contain fruit trees, such as tamarinds (*Tamarindus indica*) and mangoes (*Mangifera indica)*, which provide both fruit and shade. Abandoned sites of villages are evident in both areas from the presence of mature fruit trees, such as mango and cashew (*Anacardium occidentale*) at the abandoned village of Sada. Most of these fruit trees, although introduced species, are treated as common property resources as their ownership history is no longer known and they may have propagated naturally. At Esomony, there are numerous fences of prickly pears *Opuntia* sp in and around the village. Fruit and other food growing wild in villages mainly provide snacks, particularly for children, but some provide famine food on which poorer families rely. These include tubers of **lingirotsy** (*Canna indica*), and fruits and seeds of jack fruit (*Artocarpus heterophyllus*), both in Eminiminy, and prickly pears in Esomony.

7.3 Factors influencing location of cultivated land

Cultivated land in Andohahela

The availability of land suitable for cultivation has a strong impact on settlement patterns and landscapes. In Andohahela, the main types of cultivated land are irrigated rice fields **horaka**, and fields for dry land cultivation of crops such as manioc, sweet potatoes, beans and maize. Rice fields are in valleys, irrigated from rivers descending from the forested catchment area in the reserve. They are either terraced and well drained (**halitany**), or in valley bottoms with poor drainage (**masondrano**).

Although some rice fields have been built recently, the majority of land suitable for irrigated rice cultivation with existing technology has already been converted into fields. Some cement dams exist, but are mostly in disrepair, and most irrigation relies on channels built with stones and mud. Larger areas of cultivation, extending into existing dryland fields and savanna areas, and improved irrigation of existing fields, would be possible with improved structures for water diversion and control (Barbour 1988).

The increasing importance of cash crops, following the promotion of a cash economy by the colonial Government, has had a big impact on land use and land tenure in much of Madagascar (Beaujard 1983, Oxby 1985). In Andohahela there has been an increase in rice production, bringing as much suitable land under cultivation as possible, and possibly forcing other subsistence agriculture into more marginal areas. In other parts of eastern Madagascar, coffee, cloves and vanilla were promoted, and were often planted on previously forested hillsides. These perennial crops became a means to establish individual permanent land tenure, replacing more flexible tenurial systems, often involving collective ownership (Beaujard 1983, Oxby 1985). Although coffee is now only grown on a small scale immediately around villages in eastern Andohahela, there are some areas east of Eminiminy where coffee trees were planted in the reserve. These areas are now abandoned, possibly as a result of recent stricter enforcement of reserve regulations and the global slump in coffee prices, but the coffee trees remain in the forest and these areas would belong to the planters' families if rules were again relaxed.

Dry field crops are mostly grown in permanent fields in savanna areas that are not too steep. Some, such as manioc, can withstand drier fields up valley sides, whereas others, particularly taro (*Colocasia* sp.) and to some extent yams (*Dioscorea* spp.), require damper ground nearer valley bottoms. Taro and yams (with rice) were the traditional main staple foods (Flacourt 1661, in Grandidier *et al.* 1913) but are no longer grown on a large scale, possibly because much of the moister land has been made into rice fields. Dry crop production is limited by labour requirements, rather than availability of suitable land, except in dry years in Esomony when some fields are unproductive unless they can be irrigated.

The distribution of land among lineages at Esomony demonstrates that those which arrived earliest possess land close to the village, while more recent arrivals possess land higher up the valley, towards the reserve. If more immigrants arrive, as a result of population pressure in other regions (particularly to the north east, the provenance of many groups in the Andohahela area) they may claim land closer to or within the forest.

Some cultivation occurs in forest around Andohahela, where forest is partially cleared then burned prior to cultivation (locally called **tetiky**, although called **tavy** in other parts of eastern Madagascar). Slash-and-burn cultivation in forested areas is described by Flacourt (1661, in Grandidier *et al.* 1913) as the main way of preparing land for yams and other crops, except rice which was grown on marshy land. **Tavy**, practised throughout eastern Madagascar, was traditionally a form of shifting cultivation where plots were left fallow for six to 10 years, however, fallow periods are sometimes being reduced to as little as two years, greatly reducing potential future productivity of the plot (Oxby 1985). Land in forest is both more fertile and less affected by drought than fields in savanna areas. The main crops are manioc, sweet potato, maize and beans, and there is almost no hill rice (locally called **vary tomboky**), although this is a major crop in other parts of eastern Madagascar (Oxby 1985).

There are only isolated areas around Andohahela where such forest cultivation is occurring, most notably in the northern Vohibaka area where crops such as tobacco and marijuana are also grown commercially. There is also some cultivation in forest in the reserve at Marovato, with some cultivation of tobacco for sale, and an area of around 10 ha, 0.5 km inside the reserve at Baketra (both in the north east corner of the reserve). Slash-and-burn cultivation is more widespread in Tsitongambarika Classified Forest east of Andohahela, where it poses a severe threat to the future existence of the forest (Hagen 1991).

There are several factors contributing to the clearance of forest for cultivation in the northern area of the reserve. Most of the residents are immigrants who have arrived in the region during the last few generations. These groups came from the higher populated areas further north around Manantenina (the Zafimahazo at Vohibaka came from Ankaria, north of Manantenina, about 70 km north east of Vohibaka, around 1900). They originally settled further down the valleys away from the reserve but were forced to move on by competition for land with existing residents. They say that their current site was forested when they arrived, and they primarily grew beans for export in cleared forest. Now the main village of Vohibaka is surrounded by savanna for about 1 km, and satellite hamlets have been created nearer to the forest boundary. Much of their current income comes from sale of tobacco and marijuana, although they still grow some beans commercially, and, in periods of food shortage as a result of drought in surrounding areas, they sell considerable quantities of manioc (observed from September to December 1991). The large profits made from sale of drugs encourage continuation and expansion of forest cultivation, often several kilometres into the reserve in order to hide the extent and location of the cultivated area. People at Marovato and north of Baketra are also relatively recent immigrants. Although forest clearance for cultivation is not presently practised on a large scale in Andohahela, new fields have been created during recent years in savanna higher up valleys towards the reserve. If production became insufficient on existing cultivated land, through declining yields and increased population, or with the arrival of immigrants, more land in the reserve may be threatened.

Factors influencing location of cultivated land in Soalala

Although in other areas Sakalava still practise slash-and-burn shifting cultivation of maize, peanuts, beans and manioc in forested areas (Fauroux 1989, Feeley Harnik 1991), this does not now occur in the Soalala study area. All cultivation is either in permanent fenced gardens, wet season rice cultivation in marshy areas, or dry season rice cultivation in alluvial plains.

Not all flood plain rice fields were cultivated during the period of this study, although many were rented from landowners by other locals and immigrants, suggesting that production is limited more by the availability of labour than land. People say that yields are diminishing, particularly in areas nearer the sea, as a result of salination. Ten years ago, rice was cultivated at the penal camp of Ankijinjaly, 8 km west of Antanandava towards the river mouth at Soalala, but can no longer be cultivated there. Plants which grow in brackish water, such as **matsia** (a perennial herb), are becoming increasingly common at Antanandava.

Salination may occur as a result of increased irrigation and inadequate drainage in areas of low rainfall and high evaporation (Vermeer 1977), however, it is most likely that the salination occurring here is linked to the proximity of the sea. Such areas may suffer salt water penetration into groundwater and surface water, particularly during pulses from high tides; cultivators rely on rainwater and drainage to flush out salt (Vermeer 1977). It is likely that increased salination is occurring because of reduced river flow in the dry season, allowing saline groundwater to rise nearer the surface. Reduced flow may be caused by increased use of water upstream for rice cultivation, or increased runoff in the wet season with less flow in the dry season as a result of vegetation loss in the water catchment area, and as a result of the low rainfall from 1988 to 1992. Salination is a widespread problem in coastal plains and downstream areas of deltas in north western and western Madagascar, with an estimated 200,000 ha of rice fields affected (Le Bourdiec 1974).

Some local people also claim that the sea level is rising. They say that the town of Soalala, now on a sandy promontory a few metres above sea-level, used to be situated in the area now under water to the west of its current site, which was then forested. Although sea levels are starting to rise more rapidly as a result of global warming, there has only been an average total rise of 14.3 $\pm$ 1.4 cm in global sea levels from 1890 to

1980 (Dugdale 1989, p. 41), which is probably insufficient to force relocation of the settlement. However, rising sea level may already be affecting saline encroachment in the low lying flood plains, a process that will probably accelerate as a result of global warning, with predictions of a 28 cm to 96 cm rise in sea levels by 2090 (Intergovernmental Panel on Climate Change, quoted in Parry 1990, p. 57).

People also say that the cultivable area of the flood plain is significantly smaller than before the cyclone of December 1983 (one man said half the area). The say that the lower part of the valley has become softer, with deeper mud that is difficult to cultivate, and that fields at the sides of the valley have lost soil.

The expansion of rice cultivation in much of Madagascar has led to increasing conversion of wetlands into rice fields. Some wildlife species, such as the Madagascar teal *(Anas bernieri)*, which requires open, nutrient-rich mud with shallow water, are becoming increasingly rare, mainly due to loss of habitat to rice fields. Hunting (especially in the past) and disruption of habitats by the introduction of tilapia and black bass (*Micropterus salmoides*) may also have contributed (Jenkins 1987, Young *et al.* 1993). It is probable that the extensive area of flood plain rice fields around Soalala once supported a more diverse wildlife.

Marshes used for wet season rice cultivation appear to be less intensively used than 10 to 20 years ago, as a result of recent low rainfall and greater specialisation on fishing (see Chapter 4, Section 4.5).

Dry fields, or gardens, for cultivation of manioc, maize, beans, squashes, and other vegetables, are severely limited by the work required to build strong fences against bush pigs. Average garden size at Antsira was 660 m^2. Only 50% of households at Antsira and 48% of households at Antanandava have gardens. These are usually near to villages, although the few cultivators at Marotia have gardens at Amborobo, 5 km north of Marotia, as land is too salty nearer Marotia. Some people said that it helps to keep pigs away if a 20 m area is cleared around the garden. Others said that a reason for burning scrub areas was to reduce the undergrowth available for pigs to hide.

The areas of land used for cultivation do not appear to be changing in the Soalala area, although, in the past, forested areas may have been used for slash-and-burn agriculture. Evidence of old manioc enclosures were found in areas of regenerated forest 7 km north west of Baly (see Figure 6) (Hawkins and de Valois 1993).

Non-cultivated resources collected from cultivated land
In the Andohahela region, some reeds and grasses used for mats and baskets grow in marshy areas, which have mostly been converted into rice fields. In Eminiminy, **hera** (*Cyperus latifolius*) only grows in unused valley bottom rice fields.

In Soalala, irrigated rice fields and the channels surrounding them are used for the collection of small prawns (**tsivakia**), small fish (such as *Tilapia*), and eels (**amalo**). Fresh water turtles (**kapiky**, ?*Pelusios castanoides*) are caught in rice fields, sometimes in special traps (**treko**). Ducks (mainly **vivihy**, white-faced whistling duck, *Dendrocygna viduata*) are caught by lines of noose traps hung between two posts above rice crops. Bush pigs are sometimes caught with snares or baited trap-door cage traps, often incorporated into a garden fence.

7.4 Savanna

Madagascar was believed to have been mostly covered with forest before the arrival of man (Paulian 1981, Olson 1984) although recent stratigraphic analysis of pollen and charcoal of the Holocene indicate that the central highlands, at least, were subject to climatic variation and underwent dynamic fluctuations between forest and savanna vegetation types (Langrand 1990). Native forest formations are all vulnerable, variably, to degradation to grassland after repeated burning, which is often combined with clearance for cultivation (Jenkins 1987). Recent estimates suggest that as much as 75% of the island no longer has significant native woody plant cover (Jenkins 1987). The central highlands are now almost entirely covered by savanna, and large tracts of coastal areas are similarly degraded.

The grasslands, which increasingly cover most of the island, have low species diversity. Their primary use is as pasture for cattle, with sheep and goats in the south and west, although the grasslands vary considerably in their ability to support livestock. Much of the highland savanna (**tanety**), between 1,200 and 1,500 m, has widely spaced tufts of one species, *Aristida rufescens*, which has hard, dry stems and is unpalatable to cattle, with hard infertile soil in between (Jenkins 1987). Most savanna is burned annually to provide a flush of new growth for cattle, which tends to prevent recolonisation by forest.

Use of savanna in Soalala
Savanna covers the majority of the Soalala region. This is typical of the western Malagasy region, of which more than 80% is grassland (Jenkins 1987). The dominant species are taller than those of the eastern Malagasy grassland and there are more trees

and bushes (Jenkins 1987). In the Soalala region, savanna is dominated by *Aristida rufescens, Heteropogon contortus* and *Hyparrhenia rufa* grasses, *Bismarckia nobilis* and *Hyphaene shatan* palms, and *Acridocarpus excelsus* trees. Savanna is locally called **alan-satra** (forest of satra palms [*H. shatan* and *B. nobilis*]) referring to the high density of fire-resistant satra palms (see Figure A12.1, Appendix 12).

Cattle are primarily pastured on savanna around the villages, although forest areas are sometimes used to hide cattle when cattle thieves are reported to be in the region. Cattle which are not visited regularly become wild. Wild cattle hide in dense vegetation, such as at Cape Sada and Beheta (angonoka sites, see Figure 6). One man of Antanandava said that it would be helpful for them if a cattle-proof fence was put around Beheta as it would prevent cattle from hiding in the dense vegetation, from which they are hard to remove.

A technique for gathering wild cattle is **donaky**. This is performed by specialists, who use smoke from special plants (including **satra** and **mavoravy**, *Acridocarpus excelsus*), and divination using seeds (**sikidy**), to make cattle docile. It involves setting fires upwind of the cattle; several small burned patches seen on Cape Sada in October 1990 were attributed to this. These fires sometimes become uncontrolled and burn larger areas. Fauroux (1989) describes **donaky** being used to catch wild cattle for sacrifice at special ceremonies: the strong odour from burning fat and special talismans attract cattle into a corral, where they are starved for several days until sufficiently weak to be led safely to the village for sacrifice.

The main reasons for burning savanna areas are to remove dry, old stems, to stimulate the growth of new, green shoots, and to kill cattle parasites, in particular preventing a cattle disease called **malasia** (like tuberculosis). Pasture burning is widely practiced among pastoralists in Africa, and is often important to maintain grassland, especially where woody forest or thicket is the natural climax vegetation (Tainton and Mentis 1984, Homewood and Rodgers 1991). Fire-climax species, such as *Heteropogon contortus*, tend to be palatable to livestock, and are favoured by burning just before the start of active spring growth (Tainton & Mentis 1984). Destruction of livestock parasites is also recognised as an important role of pasture burning in the Ngorongoro/Serengeti region of Tanzania (Homewood and Rodgers 1991).

People in Soalala disagreed about the most effective frequency of burning. Some said that it is necessary at least every five years to control parasites. Others said that pasture should be burned every two to three years to remove old stems. Some said that damp areas where the grass grows fast should be burned every year, but drier areas only every other year. There was universal agreement that burning should be done just after the first rains in November and December, so that fires do not rage out of control and the following rains quickly stimulate new growth. Traditionally, strips were burned as firebreaks to control the area burned. Skill is required to control burning, in choosing the right time of day and wind conditions.

The better grasses for cattle are **ahidambo** (*Heteropogon contortus*) and **sy** (*Hyparrhenia rufa*). Local people say that **paipaiky** (*Aristida rufescens*), which is tough and unpalatable to cattle, becomes dominant after repeated burning. Research in southern Africa has shown that annual burning ensures dense grass cover where rainfall is moderately high (*ca.* 650 mm annually). However, where rainfall is low, or during a cycle of dry years, annual burning may lead to reduction in the quality of grassland (for cattle), if frequent enough to promote die-out of perennial climax species and invasion by pioneers. In such arid areas, occasional fire may improve quality if instrumental in maintaining grassland climax, for example during a cycle of above average rainfall (Tainton & Mentis 1984). The local information that different frequencies of burning are suitable in different areas, according to moisture content of the soil, appears consistent with this research. Rainfall in the Soalala region has been very variable over the last 10 years. Data from Mitsinjo (60 km east of Soalala) show that, although the average annual rainfall was 1,345 mm from 1983 to 1992 (range 293.0-1,831.6 mm), it was only an average of 573.9 mm from 1987 to 1992 (range 293.0-872.6 mm, see Appendix 3 for more complete weather data). Annual burning may be inappropriate in periods of successive dry years or on well drained soils, when it may encourage succession to *A. rufescens*. Other disadvantages of burning, particularly where fires become uncontrolled, are: (i) that it may destroy forested areas used for collection of timber, firewood, medicinal plants and tubers for food; (ii) sometimes houses may be burned (people at Mangabe lost all their possessions when their house was burned down in September 1992); and (iii) loss of vegetation causes erosion, silting up rice fields and lakes, and causing more flooding, fewer permanent rivers, and possibly disrupting the local climate.

During the colonial period, strict laws were enforced to control bush fires. Pasture burning was restricted to a short period at the start of the wet season, from 25th November to 25th December, and required a permit from the local Water and Forests Directorate (DEF) official. He had to visit the area, make a map and agree the area to be burned with the **fokonolona** (village community: see Chapter 6, Section 6.6), who were responsible for cutting 20 m firebreaks around the perimeter. The burning took place in the presence of the DEF official and members of the fokonolona, who ensured that only the agreed area was burned (Rakotomanana *et al.* 1989). People in the Soalala area said that they used to be allowed to burn pasture every five years. They burned a different area every year in rotation. Any fires for which there was no permit were investigated, and those guilty of starting them were punished with a fine or forced labour. People said that sometimes several men were chosen randomly for punishment where no particular culprits were found.

These regulations remain, but, with increasing liberalisation and reduction of central control over rural areas from 1975, there has been widespread burning without permits. As a result of earlier restrictions, fires are often started as a rebellion against authority. During my fieldwork, uncontrolled bush fires occurred regularly throughout the dry season (from May to November). It was not unusual to see smoke rising from several distant fires, some of which burned for several weeks. Most savanna areas were burned annually, and some forest areas were destroyed each year. People are reluctant to report fires to the authorities as they say that the informant becomes the prime suspect. The local DEF official found it impossible to control the setting of fires and gave no pasture-burning permits.

Although cattle raising may not occur on such a large scale in the Soalala region as in the past (see Chapters 5 and 6), it is still very important both economically and culturally. The management of savanna for cattle pasture will remain a very important issue in the Soalala region.

In addition to pasture for cattle, savanna areas provide satra palms which are used for many purposes. **Satrabe** (*Bismarckia nobilis*) leaves are used universally for thatch. All mats and baskets are made from satra palm leaves: **satrabe** for most mats and **satramira** (*Hyphaene shatan*) for stronger mats and baskets. Satra palm trunks (**banty**) are used for garden fences. Fresh-water turtle traps (**treko**) and brooms are made from spines of satra palm leaves. Palm hearts (**potaka**) may be collected from satra palms. Large grubs (**lafa**) are reportedly collected from decaying satra palm trunks, sometimes felled and covered with leaves specifically for this purpose. Satra, which survive burning, are said to have become more abundant in the region as a result of repeated burning. Some firewood and construction wood are collected from the scattered trees found in savanna, although the majority of construction wood comes from forested areas. Some animals are hunted on savanna areas, notably helmeted guineafowl (***akanga***, *Numida meleagris*) and Madagascar sandgrouse (***katrakatraka***, *Pterocles personatus*). Cicadas and grasshoppers are collected as snacks by children.

Use of savanna at Andohahela

Villages around the Andohahela forest reserve area are typically surrounded by savanna (locally called **roanga**) for at least 0.5 km beyond cultivated areas. There are many factors contributing to the conversion of forest to savanna around villages. Some forest would have been cleared for cultivation, but the presence of savanna beyond cultivated fields suggests that this was not the only factor. In Isaka Ivondro, elders said that they prefer to have an expanse of savanna between forest and their fields to limit depredation by bush pigs, which shelter in forest and tend not to cross open areas. Bush pigs were a major pest in this region in the 17th century, particularly for fields close to forest (Flacourt 1661, in Grandidier *et al.* 1913).

Savanna may also be promoted to provide pasture for cattle, although cattle are frequently pastured in forest, particularly in the dry season when much savanna grass is dry and unpalatable. Savanna pasture is comparatively more productive for cattle in the wet season, after the growth of new leaves. The abundant leeches in forest are also more active in wet conditions, which could be a health risk for cattle. People prefer cattle to remain in savanna to aid surveillance, as they are sometimes difficult to find and may become wild in forest. Conversely, cattle are hidden in forest when cattle thieves are rumoured to be active in the region. Adjacent areas of savanna and forest thus provide complementary habitat types, suitable for cattle under different conditions. In addition, savanna around villages helps in monitoring the arrival of visitors. Although there are no longer armed conflicts with neighbouring groups, many villagers are suspicious of visitors, and have been known to flee to the forest on the arrival of police. Environmental and social factors thus affect management of cattle and influence savanna ecology.

Dominant grassland species vary on each side of the Andohahela massif, with **boka** (*Heteropogon contortus*) predominant in the west and **tegny** (*Imperata cylindrica*) predominant in the east. People at Eminiminy say that boka has become more widespread in the east in the last 10 years. Boka is said to be one of the best local grasses for cattle. Other locally preferred species are **vero** (*Hyparrhenia cymbaria*), and **ahibe** (*Panicum maximum*). Tegny is much less palatable to cattle. The area to the west of Andohahela is said to be much better for cattle, both because the drier climate is better for the health of calves, and because there are better grasses for pasture. Many people at Esomony gave this as a reason for having migrated from further east. People at Eminiminy said that until about 1975, their herds were larger, and were usually pastured west of the reserve, only being brought to the village for rice field preparation. Since 1975, cattle theft had greatly increased in the western pasture areas, and they now keep smaller herds near Eminiminy throughout the year. They believe that the cattle brought boka seed with them from the east, and this, in conjunction with increased grazing pressure has favoured its local increase.

Most people believe that pasture should be burned every year for similar reasons as in Soalala: to remove old, dry stalks, to stimulate new, green shoots, and to kill cattle ticks (**kongo**). However, some people said that around Esomony there are no cattle ticks and where pasture has been well grazed it is not necessary to burn it to remove old stems, and suggested that burning every five years is suitable. They say that the annual burning habit was brought from the east where tegny grasslands do require annual burning. People were willing to cut firebreaks around pasture areas in exchange for a permit to burn pasture when this system was promoted in 1991, but when the provincial DEF banned all fires and permits in 1992, pasture was still burned illegally and people refused to cut firebreaks.

In addition to pasture, savanna grasses are used for thatch. At Esomony, the longest grass, which is best for thatching, is found at higher altitudes, and is collected up to 5 km within the reserve. Boka lasts for around 10 years, while rice straw lasts only three to five years. In Eminiminy ravenala leaves (***raty***, *Ravenala madagascariensis*), which last four to six years, may be used as an alternative to tegny, which lasts around 15 years. Some trees and shrubs are found in savanna areas, particularly in damper places along valley bottoms. These are used for firewood and some construction, particularly **voandelaky** (*Melia azedarach*) for planks. Savanna areas may be sites for reafforestation.

7.5 Forests

Forest use in Andohahela

Forest is believed to have been the climax vegetation over most of Madagascar, with different forest types in different climatic zones, ranging from evergreen rainforest in the east, to dry deciduous forest in the west, and spiny deciduous thicket in the south (Jenkins 1987). An estimated 17.7% of the national land area is covered by closed broadleaved forest, with an annual deforestation rate of 1,500 km^2 from 1981 to 1985 (FAO 1988 quoted in Sayer *et al.* 1992). Less than 34% of the original eastern rainforest remains (Green & Sussman 1990). The majority of Madagascar's endemic flora and fauna is confined to primary forest (Jenkins 1987, Langrand 1990). With increasing degradation of primary forest to secondary formations, and ultimately to the sterile savanna which now covers much of the island, primary forest is confined to dwindling, isolated patches. The Andohahela reserve covers one such patch of primary forest, in a unique position spanning the southernmost extension of sub-montane and montane moist forest and the transition to spiny thorn forest on the drier western side of the Andohahela massif. The transitional area has unique vegetation, with a high density of the endemic triangular palm, *Neodypsis decaryi.*

This section considers the uses people make of forest, particularly primary forest, making comments on the possible impact of current collection levels and collection practices on the forest ecosystem. It is possible that some uses are sustainable and could be continued in limited areas without threatening the biodiversity that the reserve aims to protect. In this way, the maintenance of the reserve could become more beneficial to local people. All use of the Andohahela reserve is prohibited, although enforcement of the regulations has been quite relaxed, particularly from 1975 until the WWF/DEF project started in 1989. The forest in the reserve is now used relatively freely and it has largely been possible to observe current forest use in order to get an indication of the impact on local people of more rigorous enforcement of the regulations.

People at Eminiminy, in their long residence surrounded by forest, have traditionally made extensive use of forest products. Although oral history, and reports by Flacourt (1661, in Grandidier *et al.* 1913), suggest that their forefathers cleared forest in order to grow food crops, they no longer practise forest clearance. Their earliest settlement is believed locally to have been 8 km south of Eminiminy, in an area now covered by tall forest. They insist that they lived in a substantial cleared area. They say that, after they descended the valley to the better area for rice cultivation, their cattle were kept in better pasture west of the massif. The savanna in the east, not being required for pasture, was not regularly burned, and the forest, undisturbed by fire, regenerated.

The drier forest on the western slopes of the massif has probably been much more susceptible to fire. Savanna now extends about 10 km east of Esomony, into the reserve and to the crest of the ridge at 1,600 m where moist forest starts. This area has never been cultivated, but was almost certainly created by anthropogenic fires. It is used as pasture for cattle. West of Esomony, there are tracts of spiny thorn forest, which people claim have become significantly denser and more species rich during their lifetimes. People at Emitray (2.5 km west of Esomony) say that they used to collect wood for houses near Behara, 50 km south west, but now there is ample wood locally. They say that lemurs (*Propithecus verreauxi* and *Lemur catta*) have recently started to be found about 3 km west of the village. People at Esira, 20 km north east of Esomony used to have to use manioc stalks for fuel, but firewood is now abundant. From this information, it seems that in some areas forest is regenerating, possibly due to suspension of fire in those areas.

Some tubers, particularly wild yams (*Dioscorea* spp.) are collected from forest (see Appendix 10). People say that vorozy (*Dioscorea* sp.) has two tubers, one of which is called the **razana**, or ancestor, which does not have a good flavour and is left behind for regeneration of the plant. However, extraction of most tubers involves complete destruction of the plant and high collection levels could cause certain species to become locally scarce, as with **madaribo** (wild taro) near Esomony (see Section 7.6), depending on reproductive cycles. Although some forest tubers, such as vorozy, are highly appreciated, their collection requires considerable work (see Chapter 4, Section 4.4). People generally collect staple food only when cultivated supplies are exhausted and they have no means to buy food, principally from September to December before the first rice harvest of the season. In the food consumption study (see Chapter 4, Section 4.2) non-cultivated staple food contributed to on average only 2.5% of meals at Eminiminy and 0.5% at Esomony (average over 4 periods during different seasons). Of these non-cultivated staple meals the majority were tubers and other food found nearer to villages (such as **lingirotsy**, **via** and jack fruit seeds), which are more easily obtained than forest tubers. Forest tubers probably formed a much more substantial part of the diet in earlier times; vorozy (`ouvirouzes') and others are mentioned by Flacourt (1661, in Grandidier *et al.* 1913).

Of **laoka** (sauce of meat, fish or vegetables eaten with the staple) plant foods, **hovao** (*Dilobeia thouarsii*), a nut which provides oil for food and hair conditioning, and palm hearts **boaka** (from a number of a Palmae) are collected from forest. Collection of **boaka** destroys the palm, and occurs up to 0.5 km into the reserve. Hovao nuts, which come from a large primary forest tree, are collected from the ground up to 5 km into the reserve. Hovao trees are traditionally protected: it is prohibited to fell or cut boughs from the trees, on penalty of sacrifice of a head of cattle. Although boaka are collected rarely, and were never recorded in the food consumption survey, hovao oil is made on a moderate scale (10-20 l/year) by many households and is highly appreciated. Non-cultivated food represented only 5.3% of laoka eaten at meals at Eminiminy and 7.0% at Esomony. Flacourt (1661, in Grandidier *et al.* 1913) mentions hovao (`ovivau'). Most fruits are collected outside the reserve, except **rotsy** (*Eugenia jambolana*), **raotsy** (*Neophloga* sp.) and **vorotsaka** (*Rubus rosaemifolius*). Fruit collection does not generally disturb the habitat, although it could hinder propagation of particular species if a limited number of individual plants exist, and almost all fruits are collected. This could be the case for hovao, and requires further investigation.

Bush pigs, brown lemurs (**varika**, *Lemur fulvus collaris*) and tenrecs (**tandraka**, *Tenrec ecaudatus*) are hunted in forest, and there is some eel and crayfish collection from forest streams. Honey is also collected in the reserve. Lemur trapping and honey collection cause most habitat disturbance. Lemur traps (**tandraho**) consist of several nooses set on a branch across a cleared strip in the forest (for example 100 m by 3 m), which catch lemurs when they use the branch as a bridge across the clearing. Hunting of larger social species like lemurs can cause local changes in their behaviour and distribution (Hawkins *et al.* 1990), and may severely reduce their numbers. Bush pigs and tenrecs are hunted with dogs. Honey collection often involves felling a large tree containing the nest, which creates a clearing as it falls. Bees are kept in hollow logs near villages by one or two households in most villages, although the practice is not widepread, possibly because it is easier to collect wild honey from the forest.

Forests also supply construction wood. Houses are constructed around a wooden frame with thatched roofs and walls made from planks or ravenala leaf stems in Eminiminy and planks or mud walls in Esomony (see Chapter 4, Section 4.4, and Appendix 12, Figures A12.12 and A12.14 for photographs). Appendix 10 contains lists of most commonly used woods. A survey of numbers of poles of different woods used in the construction of 11 houses in Eminiminy and 10 houses in Esomony shows that the majority of wood used comes from primary and degraded primary forest (57.53% at Eminiminy and 60.49% at Esomony: see Table 7.1). Depending on the quality of wood used, and hence the frequency of replacement, an estimated 116 to 929 new poles are required per year at Eminiminy and from 280 to 2,242 poles per year at Esomony (see Table 7.2). People report that the following construction woods at Eminiminy are collected from primary forest in the reserve:

ombitavy *Bridelia pervilleana* (used in ground)
foto *Leptolaena panciflora* (used in ground)
vatoa *Brachylaena ramiflora* (used in ground)
halapo *Dombeya* sp. (for frames/planks)
varongy (used above ground)
hazon-domohy (used above ground)
menahihy *Erythroxylum* sp. (used above ground, particularly for door and window frames)
nato *Capurodendron* sp. (for pestles, tool handles)
ampoly *Vepris* sp. (for pestles, medicinal plant)

Nato and ampoly are the rarest and people may go up to 2 km within the reserve to collect them, while the others are collected up to 1 km within the reserve.

Table 7.1 **CONSTRUCTION WOOD FROM DIFFERENT ZONES**
from a survey of 11 houses in Eminiminy, 10 in Esomony, 6 in Antsira and 5 in Antanandava

Percentages of wood poles from different zones

Zones	Eminiminy	Esomony	Anstira	Antanandava
primary/degraded forest	57.5	60.5	17.0	46.9
secondary forest	29.7	-	25.6	9.0
savanna	4.4	39.5	10.2	2.8
coast	-	-	43.2	37.2
unknown	8.4	-	4.0	4.1
	100.0	100.0	100.0	100.0

Table 7.1 continued

CONSTRUCTION WOOD FROM DIFFERENT ZONES
from a survey of 11 houses in Eminiminy, 10 in Esomony, 6 in Antsira and 5 in Antanandava

EMINIMINY		ESOMONY		ANTSIRA		ANTANANDAVA	
PRIMARY FOREST		PRIMARY/DEGRADED FOREST			FOREST		FOREST
Leptolaena	37	Indigofera	133	Dalbergia1	2	Dalbergia1	3
Bridelia	96	Cedrelopsis	53	Dichrostachys	6	Bridelia	28
Dombeya	2	Tarenna	21	Cedrelopsis	1	Dichrostachys	32
Brachylaena	2	Phyllarthron	2	Terminalia1	15	Cedrelopsis	1
	---	Mendoravia	33	`sofinankomba'	1	Terminalia1	3
	137	Tetrapterocarpon	7	Dalbergia2	4	Zanthoxylum	1
		Dalbergia	5	Caesaria	1		
		Filicium	9		---		---
		Alluaudia	51		30		68
PRIMARY/DEGRADED FOREST							
Dalbergia	16	Schismatoclada	3				
Uapaca	73	`lalipito'	6	FOREST/SCRUB		FOREST/SCRUB	
Erythroxylum	27		---	Genipa	6	Grewia1	1
Canthium	21		323	Foetidia	5	Pittosporum	2
`varogny'	1			Grewia1	2	Ouratea	3
	---			Terminalia2	22	Grewia2	2
	138			Securinega	9	Breonadia	2
				Pittosporum	1	Eugenia	2
SECONDARY FOREST						Gardenia	1
Eugenia1	32				---		---
Eliea	55				45		13
Macaragna	17			COAST		COAST	
Eugenia2	32			Ceriops	76	Ceriops	48
Harungana	6					Ixorca	1
	---					Hibiscus	5
	142				---		---
					76		54
SAVANNA/INTRODUCED		SAVANNA/INTRODUCED			SAVANNA		SAVANNA
Melia	1	Adina	164	Stereospermum	18	Ziziphus	4
Eucalyptus	20	Eugenia	18	Strychnos	1		---
	---	Melia	29		---		4
	21		---		19	UNIDENTIFIED	
			211	UNIDENTIFIED		`tapianakanga'	1
UNIDENTIFIED				`voalitsaka'	4	`maivalafoky'	1
`voatsila'	20			`fitindry'	2	`hazoambo'	1
`andragnohy'	20					`mamalofolahy'	1
	---					`varogny'	2
	40				---		---
					6		6
	---		---		---		---
TOTAL	478	TOTAL	534	TOTAL	176	TOTAL	145
	===		===		===		===

Genus is given, where no identification is available local name is given in inverted commas
Andohahela: Eugenia, 1=`rotsy', 2=`fatsikaitsy'
Soalala: Dalbergia, 1=`magnary',2=`tainkindambo'; Terminalia, 1=`amaninomby', 2=`taly';
Grewia, 1=`tokampototsy', 2=`sely'.

Table 7.2

Estimated quantity of wood required annually for construction

n=sample size mn = mean ma = max mi= min

	ANTSIRA				ANTANANADAVA				ESOMONY				EMINIMINY			
WOOD FOR HOUSES	n	mn	ma	mi	n	mn	ma	mi	n	mn	ma	mi	n	mn	ma	mi
poles 10-20cm diameter																
hardwood poles/house	5	29	45	18	3	42	58	27	5	33	50	24	5	22	28	18
softer wood poles/house	5	8	13	4	3	34	38	4	5	31	38	21	5	40	55	29
houses/household	10	2.2	4	1	77	1.8	4	1	116	1.5	4	1	58	1.3	4	1
TOTAL																
no. houses in village	20				131				173				74			
hardwood poles		572				5,449				5,778				1657		
softer wood poles		152				4,506				5,432				2989		
all types poles		724				9,956				11,210				4647		
estimated annual requirement (trees 10-20 cm diameter)																
replacement every 5 years		144				1,991				2,242				929		
replacement every 10 years		72				995				1,121				464		
replacement every 20 years		36				497				560				232		
replacement every 40 years		18				248				280				116		

	ANTSIRA			
WOOD FOR CANOES	n	mn	ma	mi
trees 30-50 cm diameter				
trees/canoe	5	10.4	13	9
canoes/household	10	0.6	2	0
TOTAL				
canoes in village	6			
trees used		62	78	54
estimated annual requirement (trees 30-50 cm diameter)				
replacement every 3 years		21		
replacement every 5 years		12		

	ANTSIRA			
WOOD FOR FENCES	n	mn	ma	mi
posts 15-25 cm diameter				
posts/metre	3	7.7	8.4	7.0
area of gardens (ha)	11	662	1,596	229
fence length/garden	11	81	142	33
no posts/garden				
no. gardens/household			0	2
no. gardens in village		11		
total fence length		892		
no. posts in village		6,866		
estimated annual requirement (trees 15-25 cm diameter)				
replacement every 3 years		2,288		
replacement every 5 years		1,373		

In Esomony, wood is available in spiny forest to the west of the village, away from the reserve, and, although wood may be collected from savanna areas in the reserve, it is not collected from the nearest moist forest (10 km east). Woods which are locally scarce in the western spiny forest but are still widely used are:

mendoravy, *Mendoravia* sp. (for door frames),
katrafa, *Cedrelopsis grevei* (used in ground and medicinally)
raotsy, *Alluaudia procera* (for planks; this wood is called **fantsiolotse** elsewhere and is also bought from further west and south where it is common).

Hardwoods are also used for handles of spades, axes, and spears, using poles of 3 to 7 cm diameter. Larger trees, up to 15 cm diameter, are used for pestles, which require heavy woods that do not split when used for pounding, such as *Capurodendron* sp., *Vepris* sp. and *Tetrapterocarpon geyai*, which are rare locally. Wood used for pestles and good quality tool handles may be collected from the reserve, particularly in Eminiminy.

In Eminiminy, planks for floors and some walls are made from split, hollowed and flattened palm trunks (**vakaka**). **Vakak-anivy, vaka-kony** and **vakambe** (Palmae) are used for floors, whereas **vaka-potsy** (planks from **ravinala**, *Ravenala madagascariensis*) are used only for walls. These palms, which are often collected from the reserve, were described as of medium availability (except **ravinala** which is more common), and the level of use may be affecting local availability and distribution. Madagascar has an unusual diversity of palms and many are moist forest species. Palms are one of Madagascar's most highly threatened plant groups and are vulnerable both to forest destruction and selective destruction (Jenkins 1987). Although palm leaves may be collected sustainably, the destruction of trees for planks or their edible terminal bud may threaten some species.

The giant leaf bract from an endemic palm, **tavilo** (*Neodypsis* sp., not yet described), is used in Eminiminy to drag soil when levelling terraced rice fields (see Figure A12.13, Appendix 12). The palm is not killed as only outer leaves are removed. Each household may use one to three per year. It is probable that this is a localised practice, as in Isaka Ivondro, 20 km south of Eminiminy, people used a piece of beef hide to perform the same job. **Tavilo** leaves are collected from the reserve and their collection is probably sustainable as it does not kill the tree.

Vaha, the main type of transport basket in the whole region, are made from a liana, **hovavy** or **vahipiky** (*Flagellaria indica*), found in moist forest, but most baskets in the study villages are bought from specialist makers or at markets. Although not collected in large quantities near the study villages the liana populations used for the baskets traded throughout the region should be investigated for sustainability. Other lianas, and bark strips, are collected as cord to tie house frames.

The use of medicinal plants is widespread and, although some are collected from savanna or secondary forest outside the reserve, many exist only in primary forest, where there is greater plant diversity, and are collected from the reserve. Information was collected about 110 medicinal plants, of which 105 were identified (see Appendix 10). We collected information about the main illnesses occurring in each village, and how they were usually treated (with natural medicines, by a visit to a medical centre or to an **ombiasa** [traditional healer]). Of 17 illnesses described at Esomony, 13 (76%) would usually be treated with natural medicines, 15 (88%) would be taken to hospital, and 8 (47%) to the ombiasa. Of 19 illnesses described at Eminiminy, 14 (74%) would usually be treated with natural medicines, 14 (74%) would be taken to hospital, and 9 (47%) to the ombiasa.

Most traditional remedies use only small quantities of leaves, bark, or wood to make infusions or powders and do not generally kill the plant or disturb vegetation in a significant way. Some medicinal plants are locally rare, such as **ampoly** (*Vepris* sp.), **malainarety** (*Caesarea* sp.) and **komboy** (*Senecio fanjasoides*). Others, such as **katrafa** (*Cedrelopsis grevei*) have a market value. Seeds of **mafotra** (*?Brochoneura frencei*: identification from notes by editors p. 194 in Grandidier *et al.* 1913) are used to make an oil to treat abcesses and infected wounds an only one tree is known in the Eminiminy region and this is owned by a local family. Others may not collect the seeds, or harm the tree in any way, on penalty of sacrifice of a head of cattle. Private ownership appears to conserve the resource.

Some plants are used for rituals and for cultural purposes. These are often used in a similar way to medicinal plants and leaves, bark or wood are used in small quantities. Some of these are locally rare and collected from within the reserve, such as **fanola**, **akalavelo**, and the tree at the top of Trafonaomby mountain (name not specified), which are all used for healing and spirit possession rites at Esomony.

Forest use in Soalala

Around Soalala, the once predominant, dry deciduous forest now covers small areas which are becoming increasingly degraded from the concentration of forest resource extraction. In the area east of Baly Bay, where the study villages are situated, there are only a few isolated forest patches ranging up to about 1,000 ha. There is a more extensive area of forest to the west of Baly Bay, of around 10,000 ha. Several forest patches have been destroyed by fire in the last 10 years, including the area just inland of Antsira in 1985 (see Figure A12.2, Appendix 12). Although around 34,000 ha (of an area of 25 km by 60 km around Soalala representing the limits of angonoka distribution) are marked as forest on a 1958 map (SGM 1958), only approximately 10,000 ha of primary forest, in four patches west of Baly Bay, are shown on a map created from satellite images in 1988 (Faramalala 1988) (see Figure 6). All forest patches east of Soalala are marked as secondary formations in the 1988 map, and from personal observation are mostly degraded with an open canopy, although some primary forest trees remain. Juvik *et al.* (1992) report that a preliminary comparison of forest boundary congruence between 1949 aerial photography and 1990 digital satellite image of the area east of Baly Bay suggest a general trend in dry forest conversion to savanna. Local people claim that forest areas burned as a result of cyclone Andry (12 December 1983), which passed through Soalala and caused many trees to fall. Although primary forests of even the drier types do not normally burn (Murphy and Lugo 1986), forests disturbed by storm damage or selective logging are more fire-prone because of the accumulation of ground debris and disturbance to the canopy (Woods 1989). They are also less likely to recover, and are susceptible to conversion to grassland if there are subsequent fires (Woods 1989).

Forest tubers are collected for food. These are mainly **kabija** (*Tacca pinnatifida*; small tubers from which a fine starch powder is extracted), **masiba** (large tubers which are boiled), and **bemandry** (large tubers eaten raw) (both yams, *Dioscorea* spp.). They are collected from the few small areas of remaining forest such as north of Marotia (except bemandry), Alanjiadala (3 km north of Antanandava, although now very degraded) and Beheta (angonoka site 15 km north of Antanandava). However, non-cultivated staple food only contributed to an average of less than 4% of meals in the food consumption survey (see Chapter 4, Section 4.2), and not all of these are forest tubers, which make a very minor contribution to the diet.

Brown lemurs (**gidro**, *Lemur fulvus rufus*) are reportedly caught for food, although Decken's sifaka (**tsibahaka**, *Propithecus verreauxi deckeni*) are not, as they are often taboo. Decken's sifaka live safely in towns and villages (including Soalala). Tenrecs (**tandraka**, *Tenrec ecaudatus*) are caught in the wet season. Some birds (such as: Madagascar crested ibis, *Lophotibis cristata*; giant coua, *Coua gigas*; crested coua, *C. cristata*; red-capped coua, *C. ruficeps*; and Coquerel's coua, *C. coquereli* etc.) are caught in forest with snares and slingshots, mostly by young boys. Honey is collected in forested areas by lighting a fire to make smoke to drive off the bees, which sometimes spreads and becomes a bush fire, and sometimes felling the large trees in which the bees' nest is found. Honey is reportedly becoming more difficult to find. It is possible to keep bees but we only found one household with one hive (in Antamboho). These types of non-cultivated laoka also make a very minor contribution to the diet.

Forests are used most heavily for construction wood. Houses are constructed, as in Andohahela, around a wooden frame with thatched roofs and walls, using similar sizes of poles and harder woods to go in the ground (see Figure A12.3, Appendix 12). Appendix 10 contains lists of most commonly used woods. A survey of wood used for poles for six houses in Antsira and five in Antanandava (Table 7.1) shows that 46.9% of wood used at Antanandava comes from forest and only 9.0% from forest/scrub (predominantly secondary forest species), while 17.1% of wood used at Antsira comes from forest and 25.6% from forest/scrub. Mangrove (**honko)** represented 43.2% of all wood used at Antsira and 33.1%, at Antanandava. People said that they use more lower quality woods than previously, such as mangrove[1] (particularly **honko**, Rhizophoraceae), as hardwoods are becoming scarcer. People in Antsira collect wood for houses in the forest or mangroves north of Marotia, or from Cape Sada, although some longer poles are collected from Bemosary (12 km west across the Bay). People in Antanandava collect mangrove from Bedory, and other timber from degraded forests north of Antanandava.

The greatest quantity of construction wood is used for fences around gardens. Adjacent wooden posts are dug at least 0.5 m into the ground to form a pig-proof fence. Gardens, particularly where manioc and other root crops are grown, are constantly attacked by bush pigs. Pigs regularly broke into gardens in Antsira when some of the fence posts were weak and rotten. This is the only area of Madagascar in which I am aware of such sturdy fences being required to protect crops from bush pigs.

The fences are often made of softer woods, like palm trunks, (**banty** from **satra** palms), which are most easily available. Each year the fence must be mended, setting the poles which have decayed further into the ground, and replacing the ones that have become too short and rotten. The wood must usually be replaced after three to five years, depending on the type of wood and the length of the original pole. Table 7.2 gives estimated quantities of wood required annually for houses, fences and boats. It is clear that in Soalala by far the greatest consumption of wood is for fences, the hamlet of Antsira

[1] Mangrove wood was described locally in Soalala as a lower quality, softer wood, which does not last long in the ground, however, *Rhizophora* spp. are described as "very strong, hard and durable" by Corkhill (1979).

requiring from 1,373 to 2,288 new posts annually, in comparison with from 18 to 145 poles annually for house maintenance (depending on the quality of wood used). Antanandava requires an estimated 249 to 1,991 poles for houses each year. Fences are also built around wet season rice, grown in marshy areas, although these do not use as much wood as garden fences as they are primarily to keep out cattle. Fences are not usually needed around the dry season rice fields in the alluvial flood plain as these are mostly surrounded by habitation.

Woods required for different parts of boats are usually of a special quality and some are collected or bought from some distance away. A list of the main woods used for different parts of boats is given in Appendix 10. Woods collected from the greatest distance, or bought, include: light, resistant wood used for the outrigger (particularly **aboringa**, *Sterculia ankaranensis*), and resistant wood, that is soft enough to make planks, for the walls of the canoe (particularly **morasiny**, *?Hernandia voyroni*, **vory**, *Alleanthus grevei* and **arofy**, *Commiphora* sp.). Many of these special woods are forest trees. Trees of west Malagasy deciduous forest grow very slowly, and research in Morondava has proposed growth rates of 250 to 300 years for *Commiphora grandifolia* to attain 40 cm diameter, and 170 years for *Hazomalania voyroni* to reach 40 cm diameter (CFPF 1991). The Centre de Formation Professionelle Forestière (CFPF) has determined that sustainable production is only 15 m3/ha with a yield of 0.05 m^3/ha/year (Cuvelier 1992).

Canoes last three to five years, depending on the quality of the wood and whether it is painted regularly. Some parts may need replacement, for example the internal hull supports are usually replaced annually. Some parts of canoes, notably the wood for the outrigger, dugout hull, planks, hull supports, bow, and stern, require much larger trees than houses and fences (up to 50 cm diameter). Canoes of 4 to 8 m length require nine to 13 large trees. Large households may have several canoes, including smaller ones (4 to 5 m long) for turtle and prawn fishing, when great mobility is useful, and larger ones (up to 15 m long) for transport. The estimated annual timber requirement for canoes at Antsira is from 12 to 21 trees of 30 to 50 cm diameter (Table 7.2).

People in Antsira collect large trees, such as **arofy** and **maignaty** *(Hibiscus* sp.), from Bemosary which they say is the nearest tall forest but complain that there are few large trees left. Trees such as **morasiny**, **aboringa** and **monongo** *(Zanthoxylum* sp.) are collected from locations up to 20 km south and west of Soalala. People from Ambatojoby collect wood like **arofy**, **monongo** and **morasiny** from Analamahavelo (just east of Beheta) and from Ambodimagnary (20 km south east of Ambatojoby).

Large trees are also used for some coffins, particularly by the coastal Kajemby sect who were traditionally buried in a canoe at sea until this practice was banned by the colonial administration. They are now buried in coffins made of two dugouts. Large trees are also used for mortars. Often no special quality other than size is required and large trees in villages are used, such as mango and **sakoa** (*Poupartia caffra*). See Appendix 10 for a list of woods used. Other special quality woods are used for pestles, tool handles and paddles, which must be strong and not split. At Antsira, these woods are often collected from Cape Sada.

The use of medicinal plants is also widespread here, and, as in Andohahela, many exist only in primary forest or in specialist habitat types like Cape Sada. Twenty-five medicinal plants were identified (see Appendix 10), but this is a small proportion of the range of natural remedies and treatments known to and used by local people. Specialists, known as **moasy**, may treat recognised illnesses or treat sorcery or poisoning, which are believed to be very widespread. A moasy may prescribe charms (**aoly**), such as small batons of wood worn around the neck, as protection against **tolaky** (evil spirits or sorcery). In addition some special plants are associated with **tromba** spirit possession. See the list of ritual uses in Appendix 10 for some of the plants used. Most natural remedies use only small quantities of leaves, bark or wood to make infusions or powders and do not kill the plant or significantly disturb vegetation. Some plants used for medicinal and ritual purposes are locally rare and have a market value, such as **masonjoany**, **tsakafara** (*Mundulea* sp.), and **vavaloza**.

7.6 Inland wetlands

Water courses, marsh land and lakes originally supported a variety of endemic fauna, including fishes, amphibia, turtles, plants and birds. However, many such habitats have been modified by the introduction of alien species, such as tilapia and black bass (which have been important for inland fisheries throughout Madagascar since 1950); by transformation into rice fields and fish farms; and as a result of less water in rivers and lakes and lowering of the water table in some areas over the last 50 years (Jenkins 1987). All these types of modification are illustrated in the study areas. These modified habitats are still productive areas for collection of useful resources, as described below. However, in some areas endemic wildlife is threatened.

At Andohahela, rivers are used to collect fish, eels and prawns. Fish caught are mainly tilapia of relatively small size; for example, fish from the Manambolo river traded in

Esomony were usually 10 to 15 cm long. Some people at Esomony and Vohibaka have experimented with fish farming, but have been largely unsuccessful due to difficulties controlling water supply in drought and flood conditions.

Some tubers are collected from riverine areas, including **madaribo** (wild taro) at Esomony and **via** at Eminiminy. Madaribo was over-collected during the food shortages in 1990 and none was available for collection during the period of this study. Via is widespread near Eminiminy, as throughout eastern Madagascar, but is less appreciated as it is both fibrous and difficult to collect.

Marsh growing plants are used to weave mats and baskets, although in both Esomony and Eminiminy the best mat materials are locally rare (**vondro** *Typha angustifolia* in Esomony and **hera** *Cyperus latifolius* in Eminiminy), probably due to use of their natural habitat for rice cultivation. They are either collected at some distance (15 km for *vondro* at Esomony), or cultivated, or bought (as mats or as uncut stems). Cultivation is difficult, both because suitable land is scarce, and because the stems are eaten by cattle.

Non-cultivated resources collected from irrigated rice fields have been described above. There are numerous freshwater lakes in the Soalala area, used for collection of fish (also mostly tilapia), often of much larger size than at Andohahela. During food shortages, the lakes provide waterlily tubers (**makamba**). Some lakes suffer from siltation as a result of erosion due to loss of vegetative cover on surrounding hills, which is also a threat to rice fields. People at Antamboho said that a local lake is now only marsh land in the dry season and no longer provides fish, whereas many years ago it was permanent and had crocodile. They also say that there are fewer permanent rivers in the area. It is possible that there has been a lowering of the water table.

Crocodiles (*Crocodylus nilotica*) were abundant in much of Madagascar until at least the mid 1950s, and are now rare due to intensive hide-hunting (Jenkins 1987). A crocodile approximately 1m long was caught in the Bedango river, near Antanandava, on a baited hook set for eels in 1990. This was a rare occurence. The endemic Madagascar sideneck turtle (**rere**, *Erymnochelys madagascariensis*) (which can reach 0.5 m length and 15 kg [Jenkins 1987]) are reportedly caught in rivers like Bedango, although these are also rare. It is widely considered to be rare, and reported to be declining, as a result of collection for food and from habitat modification, notably transformation of river banks into rice fields (Jenkins 1987), as has occurred around Soalala.

Raffia palms (*Raphia ruffia*) grow in marshy areas and are widely used locally. The leaf stems are very strong and light and are used to support house roofs, for doors and walls and for decks of canoes. Fibres of young leaves are used to sew mats and to make cord. Before the introduction of commercial cotton cloth, and as recently as the 1940s, cloth woven from raffia fibres, sometimes combined with fibres from the trunk of **vontaky** (*Pachypodium rutenbergianum*) was used for clothing and sails. The fruits (**maragnambo**) are also eaten. None of these uses destroys the tree.

7.7 Marine and coastal ecosystems

Madagascar possesses the largest areas of mangrove in the western Indian ocean, the majority being concentrated along the west coast. Their composition is typical of Indian Ocean mangrove systems, with six widespread plant genera. They are of great importance for inshore fisheries, serving as nursery areas for many species of fish and crustacea (Jenkins 1987, Sayer *et al.* 1992). Mangroves constitute a highly productive estuarine ecosystem of vital importance in animal food webs, through production of organic plant debris (around 10 tonnes of organic plant material/ha/year) and re-oxygenating waters during the ebb and flood of tides. They also protect shorelines from the erosive forces of wave action (Dingwall 1984).

Mangroves mostly occur in sheltered areas in bays in the Soalala area and covered approximately 9,800 ha within 30 km of Soalala in 1958 (SGM 1958). Prawns and crabs are caught amongst them, providing an important income to large numbers of local fishermen. The increasing use of mangrove wood, particularly for garden fences, but also for house construction, may be having some effect on mangrove habitat. In many parts of the world, mangrove is managed as a forest resource. For example, mixed Rhizophora forest in Malaysia can yield around 200 to 230 m^3/ha with a rotation of 25 to 30 years. In some cases it is most effective to replant; plantations of *Brugueria gymnorhiza* in Andaman and Nicobar Islands attain a height of 9 to 12 m and a girth of 23 to 30 cm in 15 years, yielding approximately 185 poles per ha (Walsh 1977). Mangroves were exploited commercially in the Soalala area in the early 20th century when they were exported to the Persian Gulf as a source of tannin (Verin 1986), although it is not known how this affected the mangrove stands. Siltation from inland erosion is seen as the greatest threat to mangroves in Madagascar (Sayer *et al.* 1992), and is probably occurring in the Soalala area.

There are extensive coral reefs around much of the Malagasy coastline, and small isolated reefs are located on either side of Baly Bay (Jenkins 1987). Reef areas, cays and lagoons are important habitats for many groups of animals that are exploited locally, or in some cases for national or international markets, including marine turtles, the dugong (*Dugong dugon*), molluscs, crustaceans and fishes. Sediment accumulation, as a result of inland soil erosion, is again seen as a major threat, and overfishing is reportedly becoming a problem in some areas (Jenkins 1987). The increasing collection and export of marine animals was described in Chapter 5 (Section 5.2) with some discussion of the perceived impact on availability.

Dugongs (**trozo**) are caught rarely, using harpoons from canoes. A pregnant female caught in June 1991 in Antranolava was reportedly the first to have been caught by people from that village in more than 10 years. Three more were caught there in 1991 and one had been caught at Anky (8 km east of Antranolava) in 1990, but none was caught at Antranolava in 1992. People say that dugongs are scarcer because they are scared by the noise of commercial motor boats. Nietschman (1973) suggests that the presence of commercial fishing boats is linked to increased rarity of manatees (closely related to the dugong) in Nicaragua, which may get caught in nets and propellors, and local people there also say that they are disturbed by the noise and pollution caused by such boats. In Soalala, people are also worried that the fine meshed nets used to catch prawns by the increasing numbers of commercial fishing boats are destroying young fish and having an impact on the availability of fish and prawns. In particular, they have noticed that prawn catches are declining.

Sea turtles, **fano**, (usually green turtle [*Chelonia mydas*], but some olive ridley [*Tortuga olivacea*], loggerhead [*Caretta caretta*], and, rarely, hawksbill [*Eretmochelys imbricata*] or leatherback [*Dermochelys coriacea*]) are caught quite regularly during the dry season, also using harpoons from canoes. Sucker fish (**hamby**, *Remora* sp.) are caught, and a light line tied through the dorsal fin. They are released near a turtle and attach to the turtle with their sucker. They enable the pursuers, via the line, to follow and harpoon the turtle when it surfaces to breathe. Sucker fish are used for three days, then released, and are never eaten. Nesting turtles (olive ridley, loggerhead and hawksbill turtles nest locally on beaches) and eggs are taken, although there is a convention to leave some of the 100 to 150 eggs in the nest and young turtles leaving the nest are not taken. However, not everyone leaves eggs and sometimes only one is left. The conservation value of leaving even up to 10 eggs is dubious, given the low probability of a hatchling reaching maturity. People do not report a reduction in green turtle availability or in average size of animal, although reduction or cessation of nesting, reduced numbers and size of animal caught have been reported in other parts of Madagascar (Rakotonirina and Cooke 1994). Despite legal protection of marine turtles from all exploitation since 1988 there is almost no enforcement. Turtle meat is very popular in fishing communities where the fatty meat provides a welcome change from fish, and turtle hunting is a traditional activity.

Green turtle meat is only traded locally, and it is possible that the offtake is sustainable, but several commodities traded for export appear to be less available. Of these, tortoiseshell (from hawksbill turtle) and crocodile skin are no longer exported from the region due to low availability. Sea cucumbers collected from beaches and mud flats were collected intensively until the last few years, but are now much scarcer. Sharks of many species are caught primarily for their fins, which are exported, as are sea cucumbers, to Chinese communities in Madagascar and abroad. Sharks are still caught in large numbers but fishermen report that they are more difficult to catch, possibly due to a reduction in numbers.

Loss of vegetation inland may be having an impact on the diversity and productivity of wetlands, coastal and marine ecosystems through siltation from soil erosion. Loss of forest inland also diverts direct pressure to mangrove areas for wood collection. The impacts may be far-reaching, reducing the productivity of fisheries on which many local people increasingly rely for a livelihood. This may make fish and prawn populations more vulnerable to offshore commercial fishing operations, which are increasing in scale and coming closer to the shore, often within the bay. Collection for export puts the greatest pressure on resources and some species may be vulnerable to population collapses.

7.8 Implications of local resource use for the management of Andohahela Strict Nature Reserve

Andohahela Strict Nature Reserve was originally created in 1939 as an addition to the 10 strict nature reserves created in 1927 which aimed to protect the flora and fauna of representative native ecosystems from exploitation or disturbance. The 1939 presidential decree states that the reserve comprised an area of approximately 30,000 ha, covering the forested mountain ranges (`massif forestier') of the three current parcels of the reserve and the boundaries mostly followed the forest edge (`la lisière de la forêt') (JOMD 1939). Boundaries were not officially marked until cement boundary markers were put in place in 1966. The re-defined reserve, although largely covering the same region, now covered 76,020 ha in three parcels, and the boundary followed roads, paths and rivers, some running through established villages and rice fields (JORM 1966). It appears that from this period the official boundary of the reserve included savanna areas

Box 1

SUMMARY OF THE RELATIONS BETWEEN LOCAL RESOURCE USE AND THE ANDOHAHELA RESERVE

Costs to local people of enforcing reserve regulations

food	hovao nuts for oil wild yams (September to December, poorer families) lemurs, bush pigs, tenrecs crustaceans, eels honey palm hearts
construction	some special woods for houses and pestles planks from palms for floors in east *Neodypsis* leaf bracts to level rice terraces
medicinal	some medicinal plants (Western medicines are expensive and it is difficult to visit clinics)
plants	some plants used for ritual and cultural purposes
cultivation	entire livelihood for some villages (cultivating marijuana and tobacco for export)
cattle	forest pasture in dry season forest used as refuge from cattle thieves
access	use of paths cross the reserve (used for trade and to visit relations)

Potential benefits of the reserve to local people
- water: provision of a continued and relatively constant supply for rice cultivation
- local employment: on a small-scale eg. cutting firebreaks, forest guards, village development agents etc.
- improved education facilities: teacher training, teaching materials, materials for school building maintenance
- wood for fuel and construction from tree planting programmes
- village shade and embellishment from tree planting programmes
- fruit trees: training in grafting, improved strains
- increased surface of irrigated land: so far only one dam

Threats to the reserve (in approximate descending level of impact)
- slash-and-burn cultivation in north of the reserve
- burning of savanna pasture, threatening forest edges
- clearings for lemur traps
- honey collection with destruction of large trees
- palms for planks and palm hearts
- extraction of specialist construction wood
- hunting, eg. pigs and tenrecs with dogs
- collection of wild tubers
- cattle pastured in forest

Proposed for customary use (potentially allowed to permanent residents of named villages near the reserve, with research and monitoring of impact)
- collection of plant products (leaves, bark etc.) for medicinal and cultural purposes (on a small scale only with no felling of trees)
- collection of fruit and nuts (eg. hovao)
- collection of long grass for thatch (protected by firebreak adjacent to the forest)
- collection of wild tubers

(some extensive, as in the Esomony area) and cultivated areas. It has been recommended that the reserve boundaries be altered to include only forested areas (O'Connor *et al.* 1985). In view of the stated aims of the reserve, to protect the flora and fauna of the forested ecosystem, it seems appropriate to consider only the forested area in analysis of reserve impact.

Box 1 summarises the impact of the reserve on local people, in terms of access to natural resources. In evaluating the costs to local people of enforcing the regulations associated with the reserve it should be noted that other than **hovao** nuts, most resources are extracted on a small scale. Although, numerically, uses may be small scale, in some cases they may be of great importance, such as tubers for poorer families during food shortages, although there are often alternative wild foods growing nearer villages. Probably of greater weight is the fact that many forest uses, such as for the collection of food, wood and medicinal plants, are traditional parts of cultural life. Most long term residents, particularly at Eminiminy where their ancestors have lived adjacent to the same forest for several centuries, feel that they have a right to continue to use the forest. It would therefore be very helpful politically if uses that are probably sustainable are allowed to continue. Ideally, their sustainability would be ensured through careful monitoring and protection from outsiders, by the user community. It may be suitable to designate certain areas as customary use zones for certain communities, protecting a central core area from all disturbance. Greater exploration will be made of different approaches to managing the balance between costs and benefits to local people, and threats to maintaining the reserve, in the following chapter.

This chapter has also helped to identify a number of resources which are becoming less available, or suffering reduction in quality, and could benefit from management or provision of alternatives.

(a) Wood poles for construction

It should be noted that trees of large diameter are not felled for houses, and some consideration should be given to the effect of selective extraction of trees of 10 to 20 cm diameter. Table 7.2 gives estimates of the annual number of poles required to maintain houses in each village. Some species coppice (grow back after felling), usually with several stems growing from one original trunk, including *Eliea articulata* (hardwood used in ground) and *Harungana madagascariensis* (used above ground), both secondary forest trees, and *Eucalyptus citriodora* (used above ground) and *Melia azedarach* (used above ground and for planks), both introduced species. The height at which they are cut may be important, and it may help to get a good straight pole if the regrowth is cut so that only one or two stems remain (G. Davies, pers. comm. June 1992). Hagen (1991) also noted natural regeneration of stumps on a site logged three years previously at Tsitongambarika classified forest, east of Andohahela, and recommended further investigation and research.

Although harder woods may take longer to grow, consideration should be given to the provision of harder woods which can be used in the ground when planning tree planting programmes. Local people said that *Eucalyptus rostrata* was more durable than the more widely planted *Eucalyptus citriodora.* It should also be noted that hardwood is generally preferred for firewood. Although *E. citriodora* is quite widely available around Eminiminy from earlier tree planting programmes (before 1975) it only provided 4.2% of the wood used in the survey (Table 7.1). In contrast, introduced and savanna species (which grow along water courses) provided 39.5% of wood used for houses in the survey at Esomony.

(b) Planks

Planks are used for doors, windows and furniture, but are particularly important in villages to the east of the reserve to make raised floors. An alternative to the ubiquitous planks made from palm trunks should be investigated. One possibility is to make planks from large *Eucalyptus citriodora*, currently underused at Eminiminy, by making appropriate tools available. In western villages, plantations of *Alluaudia procera*, which grow well from cuttings (S. O'Connor pers. comm. July 1992), could be investigated.

(c) Firewood

Firewood is not usually collected from within the reserve, but is needed daily and takes time to collect. Plantations of suitable firewood near villages would probably save time and energy. Harder woods are generally preferred.

(d) Weaving materials

Some weaving materials are locally scarce and are collected from some distance (**vondro** at Esomony and **hera** at Eminiminy). Investigations could be made of possibilities for their cultivation, bearing in mind that they might compete with food and cash crops for moist land and are vulnerable to cattle.

(e) Fish

Fish are only available seasonally and are usually small. Possibilities for fish farming should be investigated, particularly as some people have already experimented with fish farming in Esomony and Vohibaka.

(f) Other protein

If hunting within the reserve is prohibited it would be advisable for the project to consider ways of providing alternative sources of protein, for example through improved poultry rearing.

(g) Honey

A small number of people in each village already keep bees in hollow trunks (two in Esomony, one in Eminiminy), and this could be considered for expansion.

(h) Pasture

A measure of control of pasture burning was obtained when permits for burning were given for well defined areas in 1991, on condition that firebreaks were cut and burning was carefully supervised to remain within the authorised boundaries. This progress was completely undermined when all pasture burning permits were suspended in 1992, as people continued to burn without controlling the area. The authorities should be prepared to be sufficiently flexible in order to control burning, for example the official regulations stipulate that a 20 m firebreak should be cut around all areas authorised for fires, which is widely considered (including by many DEF officials; V. Rasolonirina pers. comm. July 1992) to be much too large. If pasture in the reserve is prohibited, measures to improve fodder available to cattle in the dry season would probably alleviate some conflict.

7.9 Implications of local resource use for management of a protected area in Soalala

The angonoka tortoise (*Geochelone yniphora*) is restricted in the wild to small patches of suitable habitat (totalling less than 10,000 ha) in an area of about 60 by 25 km around Soalala (Durrell *et al.* 1989). There are thought to be only a few hundred individuals left in the wild, and the species has long been considered to be in danger of extinction (Decary 1950, Juvik *et al.* 1981, Jenkins 1987). Known angonoka sites include Cape Sada (approximately 150 ha) and Beheta (approximately 600 ha) in the mainly savanna area east of Baly Bay, and several patches totalling around 3,500 ha among the Belambo forest west of Baly Bay (Durrell *et al.* 1993).

Angonoka occur in secondary scrub `islands' found in xeric sites (porous, rocky substrates and/or exposed coastal sites on rising, well drained land) often forming a mosaic with areas of palm savanna and dry deciduous forest (Juvik et al. 1981, Reid 1991). Cape Sada, the best known angonoka site, comprises dense thickets of *Terminalia mantaly* and *Terminalia bovinii*, with a *Nastus* sp. (bamboo) understory on elevated areas, and more open communities of scattered trees (including *Acridocarpus excelsus* and *Hyphaene shatan*), with a variety of herbaceous and shrubby species on rocky slopes. Such areas provide an open herbaceous foraging zone and adjacent thickets for protection. Known food plants include a leguminous shrub (*Bauhinia cf. pervellei*), a grass (*Heteropogon contortus*), a locally endemic tree (*Erythrophleum couminga*), *Foetidia retusa* and *Pycreus mundtii* (Juvik *et al.* 1981). Local people suggest that angonoka disperse, sometimes long distances, into savanna and forested areas when active in the wet season but return to dense bamboo thickets for aestivation in the dry season. A research project is currently underway to elucidate such aspects of angonoka ecology (Smith 1993).

The angonoka is thought to be primarily threatened by loss of habitat and habitat modification, although collection of adult tortoises by people and predation on eggs and young by bush pigs (*Potamochoerus larvatus*) may have contributed to their decline (Durrell *et al.* 1993). Predation by bush pigs on young tortoises and eggs has not been proved, but feral pig populations have had a significant effect on tortoise populations (*Geochelone elephantopus*) in the Galapagos Islands (Macfarland *et al.* 1974). The particularly high density of bush pigs in areas like Cape Sada makes such predation seem likely. Other possible predators (mostly on juvenile tortoises) include the boa, *Acrantophis madagascariensis*, yellow-billed kite, *Milvus migrans*, and the carnivorous viverrid, *Cryptoprocta ferox*.

Trade may have had a big impact on angonoka populations in the past. The Portuguese Jesuit priest, Luis Mariano, wrote in his early 17th century navigational description of the coast of Madagascar, that many tortoises were available for trade in the Bay of Boina (Mariano 1614 in Grandidier *et al.* 1905). Records from maritime archives indicate that in the 17th century Arab traders collected large numbers of tortoises at Soalala for export as food to the Comoro Islands (Vaillant and Grandidier 1910, in Juvik *et al.* 1981). Decary (1954) reported from maritime archives that "in the 18th century Arabs bought many tortoises in the Bay of Boina, and that one saw on the banks, stalls were full of these animals". Decary implies that these tortoises were angonoka, although Boina is 75 km north east of Soalala, probably because no other land tortoises occur in the north west of Madagascar. Perhaps their range extended to this region, or they were exported from Soalala, or other kinds of tortoises or turtles were traded.

Angonoka are not generally eaten locally, although most people said that this was not because of fady (taboo). Tortoises are, however, consumed in other parts of Madagascar and some people said that immigrants (such as Vezo and Antaisaka) eat angonoka (also remarked by Curl *et al.* 1985). Decary (1954) noted that local people in Soalala, although not the Sakalava, never missed an opportunity to collect tortoises to sell to Europeans, who appreciate the meat. People at Antsira say that a man from Réunion (a French dependency, 680 km east of Madagascar) lived for many years on the north coast of Cape Sada and ate angonoka. There was, historically, a substantial trade in tortoises for meat. Decary (1954) also reported that tortoise meat was particularly appreciated by people from Réunion, inhabitants of the central highlands of Madagascar, Hindus and Chinese. Records exist of the export of several thousand radiated tortoises (*Geochelone radiata*) annually from southern Madagascar to Réunion from the early 19th century until 1950 when all collection and trade were banned (Decary 1954). The angonoka was protected by a decree in 1931 although Decary (1954) was clearly not convinced of the effectiveness of the ban.

There is now very little trade. Angonoka are, however, collected opportunistically from the wild and kept locally in courtyards (see Figure A12.8, Appendix 12). It is believed that they prevent chickens from catching a disease called **koropoky**. They also keep them as pets and for children to play with. Although such collection currently appears to be on a small scale it could affect the very small remaining wild populations of these long-lived animals.

Although no protected area currently exists in the Soalala region, there have been repeated recommendations for the creation of a reserve specifically to maintain remaining wild populations of the angonoka (Blanc 1974, Juvik *et al.* 1981, Curl *et al.* 1985, Durrell *et al.* 1989). `Project Angonoka', an angonoka conservation programme, jointly managed from its initiation in 1986 by Jersey Wildlife Preservation Trust and DEF, has undertaken research in preparation for the creation of a protected area (Curl 1986, Durrell *et al.* 1993). The creation of a protected area for the angonoka in the Baly Bay area is planned as part of the first five year phase of the Environmental Action Plan (`Projet Environnement - 1', initiated in 1989) (DEF/ANGAP 1992) although formal proceedings have not yet been initiated. Although the specific areas for protection have not yet been designated, it is likely that Cape Sada will be developed as a `small management unit' for the study and protection of wild angonoka and as a site for the introduction of captive-bred animals. Research and monitoring will continue in all other sites (Durrell *et al.* 1993).

The uses made of Cape Sada and Beheta, and possible implications for local people of their formal protection, are summarised in Box 2. Many of the forest resource uses described above for the Soalala region occur in angonoka sites. In addition bamboo (*Nastus* sp.) is used to support thatch on walls and roofs of houses. Although saplings can also be used, the harvesting of bamboo is probably sustainable. Bamboo occurs as secondary vegetation and grows back vigorously even after fire (from personal observation of a site at Cape Sada burned two years previously).

Beheta is a source of ravenala leaves (*Ravenala madagascariensis*) which are used to line evaporation pools in salt making (see Figure A12.5, Appendix 12), an important economic activity, particularly for women in coastal villages. Ravenala are locally rare and becoming rarer as a result of frequent burning. Women collect ravenala leaves at Beheta from as far away as Ambatojoby (7 km).

The following woods used by people in Antsira had been collected from Cape Sada:

atikonjo, *Poupartia silvatica* (canoe outriggers)
beholy, *?Hymenodictyon decaryi* (house thatch supports, bark for twine)
boramena, *Erythroxylum*sp. (houses, garden fences)
jobifototsy, *Diospyros* sp. (pestles)
katrafay, *Cedrelopsis grevei* (houses)
kitata, *Bridelia pervilleana* (houses, garden fences)
kolohoto (canoe planks)
magnary, *Dalbergia* sp. (paddles, houses)
mangarahara, *Stereospermum* sp. (houses, garden fences)
namologna, *Foetidia* sp. (houses, garden fences)
nato, *Sideroxylon* sp. (houses, garden fences, pestles)
rogno, *Sonneratia alba*, (canoe bows and sterns)
tala (canoe planks)
taly, *Terminalia mantaly* (houses, garden fences, pestles)

Similar wood is also collected from Cape Sada by people in Antranolava, Mangabe and Andanivato. If this collection area became unavailable, people would probably use more local mangrove wood for houses and fences, and would have to travel longer distances, for example to Bemosary (north of Baly and west of the Bay), where some wood is already collected, for stronger and larger wood.

Box 2

SUMMARY OF RELATIONS BETWEEN LOCAL RESOURCE USE
AND A POTENTIAL ANGONOKA RESERVE
(for example at Cape Sada and Beheta)

Costs to local people of banning all use of potential reserve areas

food	honey tenrecs wild yams (Beheta) ravinala leaves (for salt making: Beheta)
construction	some special woods for boats and pestles some wood for houses and garden fences bamboo for thatch supports in houses
medicinal plants	some medicinal plants some plants for ritual and cultural purposes
cattle	water holes, important in the dry season
access	summer fishing camps on Cape Sada coast royal tomb at Cape Sada

Potential benefits of reserves to local people

- fencing of the dense vegetation of Cape Sada and Beheta may:
  limit areas for wild cattle
  limit areas for bush pigs
- small-scale local employment, eg. cutting firebreaks
- improved education facilities
- support for community development associations
- income from preserved pig products, eg. dried meat and skins

Threats to the reserve areas (in approximate descending level of impact)

- uncontrolled bush fires
- donaky, fires used in traditional method to calm wild cattle, if allowed to spread
- honey collection, often by starting a fire or destroying a large tree
- extraction of construction wood
- hunting of bush pigs, tenrecs, brown lemurs, couas etc.
- collection of bamboo for houses

Proposed for customary use (potentially allowed to permanent residents of named villages near the reserves, with research and monitoring of impact)

- access to royal tomb on Cape Sada
- collection of plant products for medicinal and cultural purposes (small scale only, no felling of trees)
- bush pig trapping or hunting with dogs
- collection of young ravinala leaves at Beheta, with trees maintained for future leaf collection
- collection of wild yams at Beheta
- collection of bamboo for houses

The following woods used by people in Ambatojoby had been collected at Analamahavelo, just east of Beheta:

arofy, *Commiphora* sp. (canoe dugout hulls, planks)
monongo, *Zanthoxylum* sp. (canoe planks)
morasiny, *?Hernqndia voyroni* (canoe planks)

This area is 8 km from Ambatojoby so only special large trees which cannot be found closer are collected there. People from villages like Jejema and Bedory, and the wet season cattle herding camps of Andranomatavy and Ambolimanga, probably collect a greater amount and variety of construction woods at Beheta. People in Antanandava do not collect wood in the Beheta area. If this area became unavailable for collection, people would probably use more mangrove for house and fence construction, and go to forests east of the Bay of Marambintsy or much further south, such as Ambodimagnary (10km south east of Antanandava), to collect special large woods for boats.

Both Cape Sada and Beheta contain important water holes which are used by cattle throughout the dry season. A man from Antanandava (who no longer has cattle) built a concrete dam at Beheta to ensure permanent water for his cattle.

There is a royal tomb (**doany**), within a sacred enclosure, at Ampasiloaka, on the north side of Cape Sada, which is the tomb of an Antankarana royal family. The master of the doany (**tompon'ny doany**) lives in Mahajanga, but the master of ceremonies (**mpangataka** or **mpijoro**) lives at Mangabe. The Antsira-Andanivato-Marotia community guard the tomb and sometimes make sacrifices (**joro**) there, for example to request a good fishing season. It is important to them that they should retain their right to visit and maintain the tomb, which should not be disturbed.

The dense vegetation on Cape Sada and at Beheta is a refuge for wild cattle. If it was fenced, cattle might have to stay in more open areas where they are easier to survey and control. This was mentioned by local people as a possible advantage of fencing the area and requires further investigation. Bush pigs also take refuge in dense vegetation, such as that found on Cape Sada and at Beheta, during the day. If pig-proof fences surrounded the regions, pigs would not be able to take refuge in these areas. This may make a difference to cultivation near Cape Sada, which is the only area of dense vegetation in the vicinity. Beheta is much more distant from village gardens and would probably have little effect. The likely effect on pig populations in garden areas as a result of fencing potential reserve areas needs more research before this can be confidently quoted as an advantage to local people.

A number of resources have been identified as becoming degraded in the Soalala region, and could benefit from management or provision of alternatives.

(a) Pasture

People in the Soalala region believe that it is necessary to burn pasture to maintain its quality for cattle. It is likely that burning maintains fire-climax vegetation (eg. *Heteropogon contortus*) that is good for cattle, but that the optimal burning regime is sensitive to local physical and climatic factors. It is probable that a much more controlled burning regime would promote better pasture quality. Investigation should be made of research done in other parts of Madagascar, and discussions should be held with groups of men (who are responsible for cattle) in rural areas in the Soalala region both to discover traditional knowledge, and to promote a more controlled approach to pasture burning. Local DEF officials and Nature Protection Agents (APNs) should be involved in this work. They must work with people to try to control pasture fires, rather than trying to eliminate pasture fires through punishment, as these fires will always occur.

(b) Remaining areas of forest and mangrove

It is widely believed locally that the large scale of uncontrolled burning that currently occurs in the Soalala region is damaging. In particular, small areas of forest are lost which are useful for wood, for food and for plants used for medicinal and cultural purposes. The loss of woody vegetation has caused erosion which silts up rice fields and freshwater lakes, causes floods and reduces surface water available throughout the year, and affects local climate. Uncontrolled fires also represent a risk to habitation and possessions. Most people would welcome stricter control of fires. The advantages of planting (and protecting from fire) stabilising vegetation on hillsides should also be investigated.

People are aware that the forest areas provide them with many useful products, and that mangroves provide nursery areas for prawns and fish. The forested areas are threatened by fire, and some communities may decide that it is worthwhile to clear firebreaks around forested areas. People would probably be interested in growing trees that can be used for houses and garden fences, in order to protect mangrove areas. Coppicing is probably also worth investigating in Soalala; it is more common in dry forests as it represents an adaptation to periodic loss of above ground biomass, for example through drought or fire (Nyerges 1989). In addition, more controlled management of mangroves, perhaps with rotation cropping and replanting, would probably improve their productivity and aid their conservation.

(c) Bush pigs

Nearly all rural people were enthusiastic about participating in programmes to hunt or trap bush pigs, even if they are Muslim, because of the difficulties that pigs create for cultivation of crops. They are particularly keen on the idea of exporting pig products for financial profit. There would be a very limited demand for pork in Soalala, mostly from government officials from other parts of Madagascar, but some Muslims object to pig meat being brought into the town. Some Muslims in villages would not be able to cut up and prepare pig meat, but the majority of Sakalava who are **fady lambo** (taboo to eat pig) can prepare the meat. There would probably be a market for dried pig meat in Mahajanga, and certainly in the central highlands of Madagascar, where pork is very popular.

(d) Fisheries

Coastal people now rely heavily on trade in seafood exported from the region for their livelihood. Many are concerned, however, about the increasing numbers of large boats with sophisticated equipment fishing offshore. These boats use nets with fine mesh to catch prawns, many unwanted fish and turtles are caught in the nets, including small young fish needed to maintain future fish stocks. In addition they fish within the bay, which is not permitted. Local people feel very strongly that the regulations should be enforced and that commercial fishing boats should remain outside the bay, and ideally at some distance out to sea.

(e) Honey

A small number of people in villages keep bees in hollow trunks, and this could be considered for expansion.

(f) Turtles

Although people do not report reductions in green turtle populations, they have noted that hawksbill turtles are rarer than before. The traditional practice of leaving at least one egg in nests when taking eggs probably has very little conservation value, but I believe that people might agree to leave more eggs, for example one third or one half of the eggs in the nest (typically 100 to 150). They may also agree not to take nesting females. It would be very unpopular to ban all hunting of turtles (although turtles are internationally protected). They are a traditional and highly popular food, and such a ban might undermine all positive conservation action (including activities affecting the angonoka).

(g) Sharks

There has been increasing pressure on the shark population with the high price paid for dried fins. People say that sharks are getting harder to catch. It would be very hard to impose restrictions on numbers or size of sharks fished, but perhaps greater control of trade for example through tax on export of sharks fins, would be appropriate. This requires investigation.

7.10 Conclusions

Investigation of the importance of resources from different ecological zones, and local perceptions of changing availability and quality of resources, has been very helpful in highlighting important conservation issues from local people's perspective. It assists with identification of resources and collection areas most under pressure, so that further research and management can be designed to conserve them for future sustainable use. It helps to analyse the impact for local people of the restrictions on resource use imposed by the presence of a reserve. It enables identification of the types of resources collected from the reserve area (or which would be collected with no enforcement of reserve regulations) and alternative collection areas. Finally, it helps to prioritise the impact of different resource uses on the reserve area, in terms of the level of threat to the reserve ecosystem, and thus which types of uses must be controlled or influenced in order to maintain the reserve.

Settlements and cultivation certainly have had a big impact on native ecosystems in the regions studied in the past, but now there are only relatively small areas, such as in the north of Andohahela, where slash-and-burn cultivation is destroying forest in the reserve. Uncontrolled fires, often started for regeneration of pasture, are the greatest threat to forests in both regions. People believe passionately that pasture burning is necessary to maintain the quality of their pasture, the strength of the belief being connected with the great importance attached to cattle. Traditional burning regimes were undermined by the strict measures to control burning imposed by the colonial authorities. With the loosening of central control since 1975, burning has become a means of expressing defiance of authority and political discontent, and is currently widespread and frequently uncontrolled. Some promising attempts made by DEF agents around Andohahela to apply the pasture burning rules more flexibly were stopped by their superiors. Controlling burning will require a much more flexible approach on the part of the authorities, and would probably be most effective if traditional systems of controlled burning were promoted.

Many extractive uses of forests in both regions are relatively small scale, but nevertheless important for local people. For example, traditional medicines are widely used, and may make a significant contribution to health, especially when Western medicines and visits to health centres are relatively expensive. Often only small quantities of leaves or bark are used, and collection probably has an almost negligible impact on the forest ecosystem. Other uses, such as for timber, may have a greater environmental impact, but could possibly be harvested sustainably. Little research has been conducted in Madagascar of native forest management; some suggestions are made here for further investigation. For example some useful native trees are known to coppice. Management of mangroves could help to solve wood supply problems in Soalala, and help to safeguard mangrove ecosystems which play an important role in maintaining productivity of fisheries.

Past approaches to nature conservation were to mark a boundary around a reserve and declare all entry illegal, such as at Andohahela. If some areas are managed for local sustainable use, maintenance of special habitats and resources within the reserve could become a benefit to local people. It may be that some resources that are of value to local people could continue to be extracted at low levels, but most would require more research and monitoring to determine sustainable levels of offtake.

The social institutions through which management is effected will be of great importance. The cultural and political implications of different approaches to management also influence the success of conservation measures. Some such influences have been mentioned, such as the setting of fires as a statement against authority. I have stressed that this chapter has considered the impact of the protected areas in terms of access to natural resources, which is a necessary part of the analysis required for effective management. The importance of taking account of the political and social influences, and the importance of different approaches to the management of relations between local people and a protected area, are explored in Chapter 8.

Chapter 8.

MANAGEMENT OF RELATIONS BETWEEN LOCAL PEOPLE AND PROTECTED AREAS

8.1 Introduction

It has been proposed that conservation of biodiversity can be achieved through the implementation of development initiatives among rural people surrounding protected areas (see Chapter 1). The principles of this approach are to alleviate pressure on the protected area by reducing the need for resources found in the area, and to improve benefits to local people associated with the protected area, in order to promote their support for its maintenance. There is a wide range of potential development activities at each site. Development activities as part of integrated conservation and development projects often attempt to encourage improved natural resource management, to improve access to social services and to improve income generation. While some projects have brought benefits to local people, these are rarely linked to long-term sustainable resource use, let alone the maintenance of the reserve (Wells *et al.* 1992). Funds for management of a protected area are limited, and careful planning is required to ensure that activities promote long-term maintenance of the reserve. In addition to careful planning of development objectives, the way in which activities are implemented is of great importance to their success.

I have proposed a framework for the analysis of factors affecting local people's behaviour in relation to natural resources which considers resource use from four different perspectives: energetic, economic, cultural and ecological (see Chapter 2). I advocate analysis of protected area management with respect to local people from these four perspectives. Project goals should address each aspect, for example:

ecological goals

- maintain the protected area such that biodiversity is conserved
- ensure sustainable use of resources outside the protected area
- maintain and improve productivity of resources outside the protected area

energetic goals

- satisfy basic human needs; for example food security and adequate shelter

- minimise effort required in satisfying basic needs

economic goals

- increase opportunities for income generation, and ability to respond to such opportunities
- target income at those bearing cost of protected area maintenance

cultural goals

- promote cultural and social acceptance of, and support for, the protected area
- promote institutional stability
- ensure participation

The primary goals of such a project are ecological, but the other goals have an important impact on possibilities for achieving the ecological goals. Ecological goals may vary in their specificity. For example, the maintenance of angonoka populations is the primary objective of the proposed protected area in Soalala, with the maintenance of regional biodiversity, the general objective of most protected area projects (including Andohahela), as an additional objective. The success of protected area maintenance rests on the ability to design activities that integrate these varying goals. Having reported on energetic, economic, cultural and ecological influences on the use of natural resources at the study sites (Chapters 4 to 7), and the environmental impact of local people's activities (Chapter 7), I consider here the implications of such analysis for the design and implementation of development activities at each site.

8.2 The ecological basis for development activities

The obstacles to achieving primary ecological goals must be the starting point for a project which aims to maintain a protected area. It is necessary to investigate the impact of current human activities on resources in the protected area and on the availability of useful resources in the surrounding area. Summaries of this information were given for the study sites in Chapter 7 (Boxes 1 and 2).

At each site the level and type of use of resources in the protected area varied between villages. My research was based at only two villages in each region, but a plan for reserve maintenance should involve similar investigations all round the reserve. This is especially the case at Andohahela where the reserve is large (72,060 ha), is split into three parcels, and covers varied ecological zones and terrain. Some threats to the reserve are widespread, such as uncontrolled burning, whereas others are localised, such as slash-and-burn cultivation in the north of Andohahela, and clearings for lemur traps and the use of palms for planks and food in the east of Andohahela. The threats should be prioritised depending on their level of disturbance to the protected ecosystem. Slash-and-burn cultivation is clearly a greater threat than collection of wild tubers. Investigation may be necessary to determine whether some species are being threatened by selective use, such as certain palm species, or certain trees which provide special construction wood.

Depending on the scope of the protected area project, attention should be given to the degradation of natural resources in surrounding land which could benefit from management or provision of alternatives. It is in this way that a protected area can become a focus for regional sustainable development and for regional ecological stability. Such resources identified at the two study sites are given in Chapter 7 (Sections 7.8-9).

Protected area projects will have most success in maintaining the protected area in the long term if they are based on the natural resource issues proposed by such ecological analysis. Integrated conservation and development projects sometimes become a vehicle for more general development initiatives, at the expense of the goal of maintaining the protected area. Activities which divert pressure from the reserve would not necessarily be the priority of a rural development project, so decisions must be made at the outset about whether the priority will be development for conservation of natural resources and protection of the protected area, or development for most effective improvement in rural livelihood. Although these aims are not mutually exclusive, clear priorities must be set to achieve primary project objectives most effectively.

8.3 Energetic influences on resource use: providing alternatives to reduce pressure on the protected area

Influences affecting local people's use of resources should be considered before deciding the best approach to their management. The local communities described at the two study sites are primarily subsistence populations where many resources are extracted for personal use with only small scale trade of surpluses. It made little sense to attempt to convert costs and benefits of subsistence resource extraction to financial units, and consideration of the energetic cost, or effort, of collecting different resources was more appropriate. Decisions about which resources to collect, and which alternatives are suitable, are often made on the effort involved in collecting them and the relative importance of the use made of them. Some examples are given here of resources extracted from the protected areas to satisfy subsistence needs, and how these uses could be reduced, often by provision of alternatives.

Some resources are required to satisfy basic subsistence needs of people living around the protected area, such as food, fuel and shelter. For example, non-cultivated tubers are used when cultivated staple foods have run out, particularly by households with less productive land or limited labour, and in years of crop failure. However, non-cultivated tubers and other staples found close to villages are usually collected in preference to those in the forest. Non-cultivated staple foods contributed to less than 5.1% of person-meals in the food consumption survey in the two study villages at Andohahela during any data collection period and less than 10.6% in Soalala. All non-cultivated staples recorded in the survey at Andohahela were collected from near the village and only 1% of person-meals during one data collection period in Soalala came from forest. The lack of records of forest tuber consumption in the survey does not mean that it does not occur, but that it is a rare occurrence. Improving the yield of cultivated staples, particularly those which are less likely to be converted to cash or cattle, such as manioc and maize, directed at households with a history of running out of cultivated staple food, would probably alleviate almost all demand for forest tubers.

Hovao nuts (from the tree *Dilobeia thouarsii*) are collected from the eastern Andohahela reserve and are pressed for their oil which is used for food. The alternative, peanut oil, is only available at distant markets and requires cash (or barter with a cash crop such as rice). In addition, other fatty foods are rarely available and the particular flavour of hovao, which is a traditional food, is greatly appreciated. It also does not make a substantial dietary contribution, as it was only recorded contributing to 3% of laoka meals during one data period at Eminiminy in the food consumption survey. Other foods collected from the reserve at Andohahela, such as honey, eels, crustaceans, lemurs (*Lemur fulvus collaris*), tenrecs (*Tenrec ecaudatus*), bush pigs (*Potamochoerus larvatus*) and palm hearts, are similarly greatly appreciated without being important for survival, and are collected less often than hovao. They were not recorded in the food consumption survey, perhaps partly because food such as crustaceans and honey may be eaten as snacks, which were not sampled. Equivalent resources collected from angonoka areas in Soalala are honey and tenrecs, which were also not recorded in the food consumption survey.

Cultural preference and economic factors probably have greater influence on the collection of these food resources than the satisfaction of basic needs, although protein is scarce, particularly at Andohahela. The percentage of person meals with laoka averaged 53.3% at Esomony and 36.6% at Eminiminy for the four data collection periods (Table A4.2, Appendix 4). Of laoka meals, the percentage with meat, fish, or beans averaged 44.5% at Esomony and 32.5% at Eminiminy for the four data collection periods (Table 4.1), the remainder being boiled greens and other vegetables. Although demand for these forest foods may be reduced by improving access to a better diet, with greater availability of cultivated protein, the cultural preference for these foods may result in some continuing demand.

Returning to the ecological objectives of management, those which have greatest impact on habitat integrity and biodiversity should be targetted for reduction. These include lemur trapping at Andohahela, which involves forest strip clearance, and honey collection at both sites, which involves tree burning and felling. All hunting and detention in captivity of lemurs is illegal in Madagascar (Rakotomanana *et al.* 1989), so encouraging their breeding for food or sale, in order to alleviate pressure on the wild populations, is not possible. As a result of the high profile of lemurs with international conservation organisations, lemur trapping was one of the first activities to be actively discouraged by new forest guards (APNs) around Andohahela, and it appears that the presence of these guards and threats of prosecution has almost eliminated lemur trapping at Eminiminy. Bees are kept on a small scale in many villages and this could be expanded.

Perhaps the most important use of the Andohahela reserve to satisfy basic needs is the slash-and-burn cultivation of crops for subsistence and sale in the north of the reserve, providing a substantial portion of the livelihood for populations of several villages. Ideally, the project should cooperate with the relevant government authorities to eliminate the drug trade, and work closely with those villages to find alternative sources of livelihood. This will be the most difficult aspect of the Andohahela project and will require considerable effort in research and implementation. Relocation of the villages was proposed by some conservationists, but is very unpopular both locally and with central government and is unlikely to be pursued (S. O'Connor pers. comm. August 1992).

Another widespread subsistence use of the protected areas in each region is for construction wood. In a survey of wood used for 11 houses in Eminiminy and 10 in Esomony, 57.5% of poles in Eminiminy and 60.5% of poles in Esomony were primary forest species. It is known that some wood is collected from the reserve, although both villages also have access to forest outside the reserve. In order to reduce pressure on the reserve for construction wood, tree planting has been promoted at several villages around

Andohahela reserve. The project provides seedlings which people can collect free-of-charge and plant for later personal use.

The aim of the tree planting programme is to use energetic incentives to influence behaviour, although some analysis reveals that identification of real incentives is difficult. Alternative construction wood and firewood will be provided so that it will no longer be energetically worthwhile to remove wood from the reserve. This will only be an effective incentive if the types of wood being grown are suitable alternatives to the durable hardwoods from the forest which are preferred for construction. There will be an energetic incentive in harvesting wood close to the village, as currently people at Eminiminy often walk up to four hours from the village to find suitable hard construction wood. However, if the poles must be replaced much more frequently this may not constitute a real incentive. Local people say that *Eucalyptus citriodora*, one of the main fast-growing woods used for tree planting around Andohahela, must be replaced after three to 10 years if used in the ground, whereas forest hardwoods can last 30 to 40 years. It should be noted that some *E. citriodora* plantations already exist close to Eminiminy, planted more than 20 years ago, which are rarely used for house construction. Only 4.4% of poles used for houses in the wood survey in Eminiminy were from introduced species growing in savanna near villages. This may be because access to the plantations is restricted to a few tree owners, and requires further investigation. There could be a financial incentive not to collect wood from the reserve, if offenders are fined, but there is a low risk of being discovered and local forest agents have little history of enforcement of such fines. Perhaps the most potent influence in the short term is a cultural influence; by participating with tree planting, or with other project activities, people feel a social pressure not to use the reserve and to respect the rules associated with the project. However, it should also be noted that tree planting was introduced by the colonial administration and may be associated with other repressive colonial measures, so that its current promotion could lead to conflict and misunderstanding between local people and protected area management.

There has so far been little research on sustainable timber extraction and forest management in eastern Malagasy rainforest. It may be possible to harvest some common forest species sustainably. See Chapter 7, Sections 7.8-9, for some suggestions for investigation.

Other building materials for which there is particular demand in eastern Andohahela (and throughout eastern Madagascar) are planks for raised floors and sometimes for walls, which are mostly made from split palm trunks. In a survey of 71 houses in Eminiminy in May 1991, 84.5% had raised palm plank floors, and 19.7% had palm plank walls. Palms are particularly diverse in Eastern Malagasy forest (Jenkins 1987), and at least two species are endemic to the Andohahela region (S. Malcomber pers. comm. April 1992). Some palm species may be at risk from selective extraction. A forester visiting the Eminiminy region suggested that mature *Eucalyptus citriodora*, which are currently unused, could be made into planks with the use of appropriate equipment (M. Fenn pers. comm. April 1993). It should be investigated whether planks of *Eucalyptus* or other savanna or secondary forest trees would be a suitable alternative.

Wood collected for boat building in Soalala will be harder to provide alternatives for than wood for houses and fences, because of the special qualities required for boats. Some canoe wood comes from larger trees (up to 50 cm diameter) which are collected or bought from further inland because they have been eliminated locally. Canoes only last three to five years so quite large numbers of trees are required; an estimated 12 to 21 large trees are required annually by a small settlement like Antsira (Table 7.2). As many species in western Malagasy deciduous forest grow slowly (for example 170 to 350 years to reach 40 cm diameter [CFPF 1991]), it will be difficult for sufficient wood to be provided sustainably. This will be a difficult problem to solve, but as it does not directly impinge on angonoka areas, where most such trees have already been removed, it seems more important to concentrate on provision of wood for houses, and particularly garden fences. These consume by far the greatest quantity of construction wood; an estimated 1,400 to 2,300 posts required annually for fences at Antsira. This wood is collected from angonoka areas, from remaining forest patches and, increasingly, from mangrove. Possibilities which could be investigated are plantations of fast growing varieties, management of secondary woodland, for example by coppicing or replanting, and mangrove management.

It seems probable that bamboo (*Nastus* sp.) which is used for thatch supports in houses, can be harvested sustainably, as the plant is a secondary species, is not killed by even complete removal of above-ground vegetation and grows back quickly. However, care should be taken that tortoises are not disturbed if bamboo cutting continues in tortoise areas (which are often the main source of bamboo in the region).

8.4 Commercial incentives: adding value to maintenance of the protected area

Where collection of resources is influenced by possibilities for trade it will be harder to reduce or deflect demand. However, it is also possible for commercial exploitation to provide an incentive to maintain the resource and its habitat. This is the method employed by CAMPFIRE in Zimbabwe, and other wildlife management projects. The financial benefits of wildlife management, for example from sale of permits for trophy hunting or tourism, are paid back to the `producer community', or those living with wildlife, either through investment in development projects or through cash payments. These communities are then motivated to promote wildlife, accepting competition from wildlife with their own livestock for grazing, and depredations by wildlife on their crops. This approach has been effective in southern Africa where wildlife has a high financial value (Murphree 1991).

A similar tactic is being employed at Manongarivo Special Reserve by a WWF ethnobotany programme in north western Madagascar, where medicinal plants are being used to demonstrate the value of the forest to local people. After substantial research on the medicinal use and effectiveness of forest plants, an integrated healthcare programme has been set up where trained doctors and local healers work together. Western medicines are only provided where there are no local alternatives. Local people receive no financial benefit, but local knowledge and medicinal plant use are promoted, enabling healthcare to be made available at a much reduced cost. In rural Madagascar, where government health services are understaffed and underfunded, and intinerant traders profit by selling out-of-date medicines giving unreliable medical advice on their use, this healthcare programme has been very popular. WWF are investigating the possibility of getting financial backing from pharmaceutical companies in return for access to local medicinal plant knowledge, in order to finance the healthcare programme, and possibly provide other benefits to local people (Quansah 1993). Such a project might also be effective in Andohahela or Soalala, where large numbers of forest plants are used medicinally.

Current legislation concerning Andohahela reserve prohibits entry into the reserve or any extraction of resources. Perhaps certain uses should be considered for small-scale, non-destructive use by recognised members of named villages in easily patrolled areas. These might constitute buffer zones for the rest of the reserve. Unless local people assist with enforcement of these rules it would probably be difficult to ensure they were respected. In Zimbabwe the high value of wildlife in CAMPFIRE schemes has ensured that communities effectively prevent poaching. Poaching is condemmed locally as it now represents stealing from the community, where it was previously condoned locally because it represented stealing from the state, or an absentee landlord (Murphree 1991). This demonstrates how effective popular enforcement can be.

In order for commercial incentives to be used to promote conservation, suitable commercial products must exist. The most valuable commercial product collected from forest at Andohahela is **mafotra** (?*Brochoneura frencei*: identification from notes by editors p. 194 in Grandidier *et al.* 1913). The disadvantage of using this to promote forest conservation is that only one tree is known near Eminiminy, which is owned privately, and therefore does not provide much incentive for maintenance of a wide area of forest by others. A better candidate is hovao. It was reported at Eminiminy that people living in hamlets near the forest rely on the sale of hovao oil for some of their livelihood, because they have fewer rice fields. Before action is taken to reduce collection of hovao more research should be done of its sustainability, for example mapping distribution of hovao trees, nut collection methods, quantities collected and provenance of collectors. Hovao may be a good candidate for controlled sustainable use, where access to collection areas could be limited to certain communities which become custodians of the forest. This could help to increase the value of the forest to those living adjacent to it, and thus provide an incentive for maintaining it.

At Soalala there are no commercialised resources collected from angonoka areas, except reports of a very low level of trade in the angonoka itself. The extreme rarity of angonoka has given them a high value in international markets, and theoretically this value could be used to help ensure their conservation. However, angonoka are strictly protected in Madagascar and all international trade in angonoka is banned by CITES (Convention on the International Trade in Endangered Species[1]), to which Madagascar is a signatory. Some conservation organisations believe that all trade in endangered species or their products (such as rhinoceros horn) should be banned, as authorised limited trade may stimulate the market and increase illegal trade (Pellew 1994). The angonoka occurs at such low numbers and recruitment is slow (they may take 15 years to reach sexual maturity [Reid 1990]), so all wild individuals should be retained in the wild population. Captive-bred tortoises will either be destined for reintroduction, once they are large enough not to be vulnerable to predators (perhaps 10 years old [J. Juvik *in litt.* Sept. 1990]) and an area of suitable habitat is adequately protected, or required to maintain a healthy captive-breeding stock. Controlling poaching may become an important aspect of angonoka conservation, as there have already been reports that the increased profile of the angonoka in recent years as a result of the activities of Project Angonoka has created a regional demand for the tortoises from people who hope to sell them in the future (L.J. Rakotoniaina *in litt.* March 1994). It will become increasingly important to get local people's support for angonoka conservation, so they will help to control poaching.

[1] Angonoka appear on Appendix I of CITES, for which trade in the species, or their products, is subject to strict regulation by ratifying nations, with trade for primarily commercial purposes banned (Jenkins 1987, p. 168).

Tourism is a real possibility for Andohahela, as the nearest town, Tolagnaro, is already well established on the tourist circuit, has frequent air services and several good hotels and restaurants. Proposals have been made for part of the reserve to be redesignated as a National Park to legalise tourism (O'Connor 1988). Soalala, in contrast, can only be reached by very poor roads or by limited and often unreliable air services, has no hotels and has one very basic restaurant. Tortoises are very hard to find in the dry season, when they are mostly dormant, which is the easiest time to visit because the roads are passable and there is less risk of cyclones. Although the proposed development of an angonoka breeding station at Soalala (Durrell *et al.* 1993) may provide an incentive for some visits by tourists, it seems unlikely that tourism could provide significant funds towards angonoka conservation in the forseeable future.

8.5 Using incentives to control indirect threats to the protected area

While the section above on energetic incentives, described their use in attempts to control resource use in protected areas, the incentives described here aim to control indirect threats, which originate from use of resources outside the protected area. For example, in the Soalala region, remaining angonoka habitat is threatened by uncontrolled bush fires, often originating from fires started for pasture regeneration. One villager suggested that if the threat of fires was reduced he would like to start cultivating cashew nut trees (*Anacardium occidentale*). There are some cashew nut trees in the region which were planted during the colonial era before 1960. Although some have reproduced naturally, there has been almost no planting, and many trees are becoming old and unproductive. Cashew nuts can be sold commercially for a relatively high price (see Table A8.2, Appendix 8). The project could encourage people to grow cashew and other useful trees, especially in areas near angonoka locations. In this way, it would be in people's interests to help control the fires and limit them to defined pasture areas by cutting firebreaks. There would be a financial incentive from cash earned from cashew nuts. However, the ability to control access to the nut crop may limit the effectiveness of private ownership. Most trees are currently treated as open access resources and there is competition for nuts, often resulting in the collection of immature nuts. Unless trees were planted very close to homes, where they could be surveyed, it is likely that nuts would be stolen. This is an example where communal ownership and communal harvesting may be most effective (see Section 8.8 on institutions below). The plantations may provide fuelwood. However, collection of fuelwood is not particularly time consuming in most villages, and unless cashew plantations are very close to villages (and therefore far from angonoka locations), this would not be a very effective energetic incentive.

In Andohahela, the control of bush fires was attempted through agreement with local people about the application of laws regarding pasture burning. All pasture burning requires a permit, which is awarded to a fokontany, or village community, after a visit by the Waters and Forest Directorate (DEF) official to agree the area to be burned, and later to check that a firebreak has been completed (Rakotomanana *et al.* 1989). This system worked well in several areas around Andohahela in 1991, where villagers were willing to cut firebreaks, particularly to protect forest, in order to receive the permit. Unfortunately, the regional DEF authority banned all burning in the region in 1992, which provoked villagers to burn areas without cutting firebreaks. This shows that people are willing to contribute some effort to control fires and obey the law, but their compliance depends on the ability of the local DEF official to gain their agreement, and on the regional DEF authorities to continue their support for such actions. The local DEF official in Soalala believes that he should not accept firebreaks less than the 20 m width specified in the regulations, and is unwilling to attempt negotiations with villagers over use of permits to control burning.

Bush pigs occur in high densities in the Soalala region, particularly among the dense undergrowth present in angonoka areas. They are believed to predate angonoka nests and young and are a serious pest for the cultivation of root crops, necessitating the construction of sturdy fences around gardens. Most local people do not eat pork, and pigs are only hunted sporadically. However, in many other parts of Madagascar, pork is highly prized and is more expensive than beef and goat. A programme to market pig products might provide an incentive to control pig numbers. The meat could be cut into strips, lightly salted and sun-dried (**kitoza**), a traditional way of conserving meat throughout Madagascar. In addition, hides could be preserved, perhaps using tannin from local mangroves. Boats with cold stores, which currently collect prawns, could collect fresh meat for sale in Mahajanga (the nearest large town, 120 km north east). The possibilities for establishing this trade require further investigation. Initial discussions with local people reflect considerable enthusiasm for such a scheme.

A programme for the conservation of natural resources in the Morondava region of western Madagascar (`Programme d'Appui à la Sauvegarde des Ressources Naturelles du Menabe') employs incentives to reduce threats to forest conservation. This programme is the result of collaboration between the Swiss Government international aid organisation (`Intercoopération') and the Malagasy Government. It includes a professional forestry research and training centre ('Centre de Formation Professionelle Forestière', CFPF) and an agricultural development operation ('Sauvegarde et Aménagement des Forêts - Côte Ouest', SAF-CO). The programme has been operating in the Morondava region for 12 years (Randrianasolo *et al.* 1992).

SAF-CO spent three years on research before they formulated a very precisely targetted programme to reduce deforestation in a delimited region of 230,000 ha north of Morondava, of which 130,000 ha is primary forest. They identified slash-and-burn cultivation as the most important cause of deforestation. This involves the clearance of forest for maize cultivation for two to three seasons, before being permanently abandoned due to the invasion of weeds. The aim is to make this abandoned land productive by growing peanuts for sale, reducing the extra work involved in clearing weeds and land preparation with improved techniques and equipment, with the high value of the crop providing an incentive for the extra investment. Groups of cultivators who enrol in the scheme are loaned seeds and are given financial loans to hire equipment. Cultivators must pay back the quantity of seed that they have borrowed after the harvest, which is then used for loan to other groups. After one year of pilot implementation, the programme has been extended, and 60% of the target population is participating in only the second year of implementation (Genini 1992). The programme is very clearly identified, with all pressures on forest described in terms of causes, consequences and solutions. They emphasise that they are not just working to maintain a protected area, but addressing the pressing conservation problems in the region as a whole. They are concentrating on one action, with a clear and measurable target of reducing deforestation, and have not diverted resources to a more wide ranging package of agricultural, education or health activities (G. Cabalzar pers. comm., October 1992).

A similar objective was behind the construction of small dams to rehabilitate or create irrigated rice fields at Andohahela. The intention was to improve yields from valley fields to reduce the need to practise slash-and-burn cultivation of forested slopes. However, most valley land is already owned, even if not cultivated, and only a few households benefitted in each locality. O'Connor (1990) reported that 10 small irrigation projects resulted in the improvement or creation of 40 ha of rice fields, benefitting only 23 households. In most cases, households which own valley fields are not those practising slash-and-burn cultivation. There were also considerable problems with implementation. Dams were built with inadequate research into hydrology and construction was of poor quality. Moreover, beneficiaries were not sufficiently involved in construction of the dams, so they did not take responsibility for maintenance and expected further outside assistance (O'Connor 1990). All of these dams were discovered to be either not functional, or only partly so, during an informal investigation in 1991 (R. Hagen pers. comm. April 1991). A much more carefully constructed dam and irrigation system was built in 1992, but cost much more, again benefitted a small number of households, and has experienced continuing problems over maintenance (J. Ralambo pers. comm. March 1993). This is an example of an attempt at targetting development to assist conservation where inadequate research and insufficient participation by beneficiaries resulted in the activity being poorly planned and ineffective.

8.6 Providing benefits to offset costs: difficulties of maintaining links with conservation

Many conservation and development projects employ development activities not directly targetted at maintaining a protected area or improved natural resource management, such as improving household income and improving access to social services, such as education and healthcare. Although the Andohahela project aimed to pursue only development activities clearly targetted at improving resource management, some, such as market gardening, became a means of improving income. Most cultivation of vegetables such as onions, greens and tomatoes is done by women. Seeds for new varieties of locally grown vegetables, and some new vegetables such as carrots and courgettes, were distributed in villages and some training given. Some vegetables proved very popular, particularly improved varieties of locally known types. For example, new large, round tomatoes were considered a great improvement over previous small varieties, and became an important trade commodity, particularly around Esomony. Women in other villages have obtained seed, and these tomatoes are now used and traded over quite a wide area. The vegetable seeds were also distributed to schools, which were encouraged to start their own vegetable gardens. In Esomony, the enthusiasm of the teacher ensured a good crop, which was sold. The funds were used to pay the school insurance fee for new pupils, to encourage more households to send children to school.

The distribution of vegetable seed was very popular. It created a lot of interest, especially among women. It improved income generating opportunities for women, which is particularly helpful for some one-parent households, and provided a way of generating income for schools. Costs were low for villagers and for the project. People knew that the new varieties came from the project, and it helped to promote good relations between local people and the project. However, it is unclear whether the activity helped to conserve the reserve.

In Soalala, the largest development activity that has been undertaken is the rehabilitation of a well in Marotia, a village near to Cape Sada angonoka area. The project provided financial assistance to buy concrete and employ a mason. Although this activity has little direct impact on angonoka conservation, the general mobilisation of this village community, and the interest from other villages in similar small scale projects, has had a very good impact on relations between local people and the project (L.J. Rakotoniaina *in litt.* March 1994).

These small scale projects provide tangible examples of how conservation projects can provide development benefits. A similar example is provided by a health team supported by Ranomafana National Park Project in central south east Madagascar. They have worked to improve healthcare in villages near to the national park, for example by providing vaccinations for children, education on first aid, and training on management of village pharmacies (Fenn 1992). The health team quickly earned the trust and support of local people and helped to promote acceptance of, and interest in, other project activities, which were often conducted during visits by the health team (Ferraro 1991).

The advantages of these projects are that they have been perceived as beneficial by local people, and have therefore improved relations and made them more receptive to other project activities. The particular activities described here have also not been particularly expensive to run. The disadvantage of development activities not clearly targetted at rational resource use and reduction of pressure on the reserve may be that such activities require a substantial input of financial and human resources, at the expense of activities which have a clearer impact on maintenance of the protected area. Interaction between local people and a project may become dominated by discussions about when a new road or school will be delivered, or disagreements about who will benefit from an irrigation system, rather than rational resource management. In addition, unsuccessful development activities, poorly conceived and implemented, may create a negative impression and injure relations with local people.

Many integrated conservation and development projects aim to increase household income, for example by improving access to markets and by stimulating employment opportunities (Wells *et al.* 1992). The impact of increasing local incomes must be understood within the cultural context, and within the political economy of each region. The management of cattle provides a good example. Cattle are very important in both regions for cultural events, such as funerals, and for bridewealth. Cattle are also important for the preparation of rice fields; access to cattle limits the surface of fields that can be cultivated by each household as the equivalent work done by men with spades is very time consuming. Cattle are tired by trampling fields and owners do not readily lend cattle to others for trampling; in particular, cows used regularly provide fewer calves. The health and size of herds are extremely important to people in both regions, particularly the rice cultivators. Rice and other sources of cash income are considered a means to buy more cattle. Rice is traded for cattle, sometimes leaving insufficient for family consumption until the next harvest. These households often rely on non-cultivated tubers for several months. Without a change in priorities, improving rice production might increase the number of cattle, putting pressure on pasture, and possibly on the protected areas, without solving the problem of food security or of slash-and-burn cultivation. Similarly, improving cash income from other means might have the same effect. Improving cash incomes thus should not be seen as the most important measure of the success of development activities, although this has been advocated in some reports (Brusberg 1992), as how people spend money and the longer term implications for the maintenance of the reserve must be considered.

8.7 Difficulties with implementation of development projects: cultural influences

Even if development activities are well targetted, ensuring that initiatives are adopted and effective is equally difficult. In ideal conditions, any activity intended to benefit a local community would be adopted automatically. However, cultural influences, social organisation, historical associations, and aversion to the risk of trying a new technique may all present obstacles to a good idea.

Some difficulties are posed by the nature of environmental projects. These often require a long term perspective, but life in subsistence communities may be dominated by short term considerations, such as ensuring the family has sufficient to eat. One difficulty with tree planting is that the benefits are long term, but energy is required for planting in the short term. Incentives can be used to overcome this, as at Andohahela where a young coconut tree was donated for every 100 trees planted. Interestingly, the benefits of this incentive are also long term, as the coconut trees will not fruit for five or more years, but they were still very popular as they are rare in the region and provide much appreciated fatty food.

After the coconut trees were distributed, a cultural obstacle was encountered; some people believed that some disaster would befall them or their families if their shadow fell across the hole dug for the young coconut. After much discussion, it was agreed that it would be safe to plant them after sunset. Similarly, a taboo prevented the use of manure as fertiliser in some villages at Andohahela (J. Ralambo pers. comm. October 1991).

This illustrates the importance of comprehension of people's beliefs and cultural influences, both to discover effective incentives, and to overcome potential cultural obstacles.

Using incentives in order to encourage implementation may be counter-productive in the long-term, if people come to expect perpetual incentives prior to action. An activity will only be sustained if it is demonstrably beneficial. Even if outside planners are convinced that an activity is worthwhile, they must succeed in persuading the potential beneficiaries before they are willing to invest time, energy or land. The lack of uptake of a project may result from local people's superior knowledge from their long association with the area. Projects must find a way to access local knowledge and overcome scepticism of local people, which can often be addressed by their greater participation.

It is now widely recognised that participation of local people in research, design and planning of development activities greatly improves the likelihood of success. The advantages of participation are manifold. Projects are most likely to be locally appropriate and locally acceptable if local people have participated in their planning. People are most likely to cooperate with decisions in which they have been involved, especially if their ideas and concerns are incorporated from the beginning. Research by observation is slow, but if local people participate, much more information can be gathered more quickly. Initiatives which aim to alter people's behaviour in relation to resources will clearly only be assured with their participation.

The traditional `top-down' style of development planning and implementation, where target beneficiaries are educated through the transfer of technology by outside experts, has been widely criticised and many projects aspire to a `bottom-up' approach (Hough and Sherpa 1989, Chambers 1991, Murphree 1991). The aim is for local people to define the problems and develop solutions, with projects acting as catalysts and providing support. While project documents espouse the theory of such an approach, few achieve more than token participation by local people (Murphree 1991, Wells and Brandon 1993). It is difficult for existing aid and development structures to accommodate, as it requires donors and educators to relinquish power.

Participation is not only necessary for local people, but for all parties with a stake in the outcome of a protected area project. Management structures should be planned to enable representatives from interested groups, including government agencies, international agencies (funders or project implementors), local government, and village representatives to give their input in the planning of a project. The management of a project must be recognised by all as a partnership between these different groups. Certainly, a project would not succeed without funding, or government support, or technical expertise. It is often not sufficiently recognised by these parties that it will also not succeed without the support and participation of local residents.

8.8 The importance of appropriate social institutions for resource management

Another important characteristic of conservation and sustainable resource use projects is that they often require concerted action by all members of a community, or user group. It is not effective for some people to abstain from harvesting a resource in order to let it regenerate, if others continue extraction. Some resources are privatised, like rice fields, and each owning group, perhaps a family, is responsible for managing their patch and defending it from others. However, many non-cultivated resources such as forest fruit, tubers, construction wood and fuel wood, are not currently owned privately. Another option is for an authorised body, like a government department, to impose rules about resource use. The difficulty with this scheme is that they are distanced from the resource and may make ill-informed decisions about resource management, and they must police and enforce the regulations. This is often expensive and ineffective. In many situations a common property regime is more appropriate (see Chapter 2, Section 2.4).

Where resources are owned communally, the group members assume responsibility for regulating resource use, monitoring use by members of the group, and defending the resource from outsiders. The responsibility for managing the resource may be vested in a leader, or a group of leaders, or may be taken by the entire group. Leaders must be accountable to the group so that if members are not getting the best return they can force changes in management or leadership. In this way the resource is managed for the benefit of all members of the group. Such resource management systems require the existence of appropriate social institutions, defining membership of the group, the role of members and interactions between members (Ostrom 1990).

Common property regimes have been identified as a good model for sustainable development, as they provide access to resources equitably, sustainably and at reasonable cost. It has also been recognised that where they do not exist already they are difficult to create (Berkes 1989). Many natural resources in both study regions are common property. However, the extent to which access rights are controlled and non-owners are excluded is very variable. Pasture rights in the areas studied were usually either privately owned by an extended family, as in some areas around Soalala or in the more heavily used pasture areas up the valley east of Esomony, or controlled by a village, as at Eminiminy. The fact that access is restricted to a defined group suggests that it should be in the interests of that group to manage the pasture. People in both regions say that pasture was managed more carefully in the past, and, in particular, burning was more controlled. It would probably be effective for the project to work with and encourage user groups to control and monitor pasture and fire management to improve pasture productivity and protect other areas from fire. Where common property conventions and institutions already exist it is likely that users will perceive that it is worth their while to improve management.

The majority of natural resources, such as forest products including wood, honey and fruit, are usually open to unrestricted use by people from a much wider area. For example coastal people in Soalala go to forested areas inland to collect wood for boats. However, people coming from further outside the local region, must usually request the permission of local residents (**tompon-tany**). Newcomers are usually vouched for by a local family before they may settle in the area and use local resources. Although there is some control of access by outsiders, it is less carefully controlled and the user community is much larger. Under such circumstances it may be harder to organise management, but worth trying to implement.

The difficulties of controlling cashew nut collection in the Soalala area demonstrate some of the problems in getting people to respect rules designed to improve resource yield. Each fokontany attempted to restrict collection to certain days in the season to ensure that nuts grew to maturity between each collection, and to give equal collecting opportunities to each household. Even though a certain day had been declared for the opening of the season in October 1992, many people collected several days earlier when they heard that shops in Soalala had started buying cashew nuts and that other people were collecting. There were few nuts left for people who waited until the official collection day. People complained that others did not respect the official collecting days, but recognised that once some had disregarded the rules, it was in their best interest to defect, even though it resulted in lower total yield. Some people even requested that the assistance DEF agents to help enforce the collection rules by policing the area. The difficulties were that resource collection behaviour was difficult to monitor, and not enough members of the community were willing to respect the rules and ensure others did likewise. This shows that even if people agree in principle to resource management, implementation may depend on the nature of the resource, whether resource use is easy to monitor, and the degree of cooperation among the community.

Social relations within communities, and cultural influences on behaviour and resource use, are very important in determining the success of local resource management. Although under the right conditions (where a resource has high value, the user community is well defined, and others can be excluded, as with the CAMPFIRE programme), institutions for local management can be developed, it is often easier to work within existing social and cultural controls. Traditional cooperative systems regulating use and management of resources can be very effective. A type of local convention which controls certain types of behaviour (**dina**), could be employed to influence resource use in the regions studied (see Chapter 6, Section 6.4). For example, in the south east of Madagascar a **dina-mpihary** has helped to reduce cattle theft. In Soalala, a dina agreed by people at Kasany (8 km south west of Soalala) aimed to control bush fires. Investigations should be made into the wider use of such social mechanisms for controlling resource use.

Traditional cultural controls in the Soalala region regulate the number of eggs taken from sea turtle nests. There is a custom to leave some sea turtle eggs in a nest when they are raided. The custom is to leave up to twenty eggs, but sometimes only one is left (see Chapter 7, Section 7.2). This custom may have evolved as a practice to ensure the continuation of the species for future exploitation. People feel very strongly that it would be wrong to take all the eggs, but the ecological advantage of leaving only one is doubtful due to the low probability of one egg reaching adult maturity.

In these cases, feedback from the ecological system could be reinforced by environmental education to make the cultural practice more effective. Often people are aware of environmental problems which affect them, and know that they are a result of human activity, but find it difficult to change their behaviour as they see no point in just one person changing. There is a clear role for environmental education programmes which promote local discussion of environmental issues. They can help to demonstrate the relation between people's actions and their effect on the environment, and encourage people throughout the community to take collective responsibility for their actions, perhaps by stimulating community discussion and action groups.

8.9 The implementation of development activities at Andohahela

The Andohahela project has encountered difficulties promoting participation. The reserve, created in 1939, allows no use or entry and was imposed with no consultation. Colonial authorities strictly enforced reserve regulations and there has been a history of conflict between local people and DEF agents who guarded the reserve. The current integrated conservation and development project has worked very closely with DEF personnel, and has therefore been treated with the same mistrust. Formal meetings are held with local people, which usually involve presentations by project staff, and speeches of thanks by village officials. Although project staff say that they want to hear people's suggestions and to work together, these formal occasions are not an ideal occasion to promote participation. Although several members of the project team have built good relations with some people in some villages, they rarely meet the more sceptical or poorer people, as they do not stay more than a few days in each village. The project, with its four four-wheel drive vehicles and other signs of relative wealth, is viewed by local people as a source of development gifts, and not as a team with which they could work to improve their long-term livelihoods. The emphasis on tree planting results from the policies and expertise of DEF. The project was given a two year grant by USAID and the number of trees planted, people employed, and training courses given, were seen as a good way to evaluate progress (Brandsetter and Gilruth 1992). In such circumstances it has been difficult for innovative participative approaches to be adopted.

An evaluation in 1992 highlighted many of these difficulties (Brandsetter and Gilruth 1992) and much of 1993 was spent reformulating the project. A much more participatory approach has been employed. For example, during research on local knowledge and resource use some of the techniques and methods of `Participatory Rural Appraisal' (PRA: see Chapter 3, Section 3.6) were employed (see Figure A12.15, Appendix 12). These methods were very effective in getting local information and local perceptions quickly, although maps and other physical diagrams were not always spatially accurate. They were also very effective in promoting participation, as once a few people had started, others quickly gathered and gave their opinions. It was clear that such activities raised interest in and enthusiasm for the project.

There has also been much greater participation in planning, both with informal discussions in villages and conducting workshops over several days with four representatives (two male and two female) from 20 villages. The project plan for the next three years emphasises reinforcing existing NGOs, government extension services, and an institution which can represent the local population as a partner to the project (M. Fenn *in litt.* March 1994). It seems likely that the balance of local participation will be much greater in the future. However, possible activities are hampered by the inflexible legislation concerning the reserve. While proposals have been made to adjust boundaries of the reserve to include only forested areas, to reclassify parts of the reserve as a national park to enable tourism, and to legalise some subsistence use of peripheral forest areas (O'Connor 1988), there is no precedent for such legislative changes in

Madagascar. The slow administrative processes required for such changes may obstruct the immediate adoption of more radical management reforms.

8.10 The implementation of development activities in Soalala

Project Angonoka, in contrast, has not had to work with an existing unpopular protected area. As a result of government policy it has, however, been necessary to work closely with DEF agents, who are similarly mistrusted in this region. Relations with local people have been built slowly throughout this three year research project. Prior to this research, periodic visits had been made to the area by conservation workers interested in the angonoka, but with very limited contact with local people. Although this research was based in only two villages, other villages were visited and news spread of the presence of visitors interested in conserving the angonoka, in natural resource management and in local people. I think that the frequent visits of a small team of researchers (usually just me and one assistant) helped greatly to gain local acceptance. The people with whom we worked closely vouched that we were trustworthy and accompanied us on visits to other villages.

More formal local involvement in Project Angonoka started with an environmental awareness and training session in the town of Soalala in May 1991 led by WWF-Education with assistance from JWPT. WWF-Education is a WWF funded project with Malagasy staff that has been working to promote environmental education in schools throughout Madagascar. They have worked with education planners to include environmental concerns in the national curriculum, produced educational materials, and trained teachers and others involved with education. The training session in Soalala was part of a national training programme but differed from other sessions as, in addition to school teachers and local officials, community and religious leaders, medical staff and DEF agents participated. Collaboration with JWPT enabled local conservation issues, particularly the plight of the angonoka, to be highlighted. During five days of discussion, training and activities focussed on the impact of degradation of the environment and the importance of conservation. As a result, participants created an association (Association de la Sauvegarde de l'Environnement, ASE). These have been formed at all WWF-Education training sessions and so form a national network. The aim of this association was to start small scale conservation activities in the town and to visit surrounding villages to raise environmental awareness. The ASEs also provide the vehicle for dissemination of the WWF-Education quarterly publication, Vintsy. This is sold for 100 FMG (less than 0.04 GBP) of which 50 FMG is retained by the ASE and the remainder returned to WWF-Education to help cover production costs. The aim is for the ASE to use Vintsy sales, membership fees (which each group sets themselves), and other means to raise funds to be used for small development activities and for administrative expenses.

Villagers living close to angonoka areas felt strongly that they should be involved with conservation and development activities related to the Angonoka, so in October 1991 and October 1992, WWF-Education, JWPT and the Soalala ASE collaborated to hold three day events in villages near angonoka areas (two villages on each occasion). It was the first time that WWF-Education or JWPT had held such events for a largely illiterate population, trying to reach all members of society. Local people from these and surrounding villages participated in debates, handicraft workshops, songs and dances, and a large communal meal supplied from a cow provided by the project and killed in honour of the occasion. For much of the time people separated into groups of men, women and children (see Figure A12.9, Appendix 12). Wildlife films were shown in the evening, which caused a great impression in these areas far from electricity. The events had a festival atmosphere (they were known locally as **fety Angonoky**) and helped greatly to raise awareness and interest in the conservation of the environment and Project Angonoka.

People in these villages also had the idea of creating their own ASEs as they felt that the Soalala ASE would not represent their interests. This was a new departure for the ASE network, as even the Soalala association was the smallest existing ASE. Soalala ASE committee members visited the villages to give advice on the creation of committees and the functions of members. A visit by Malagasy rural development workers (`animateurs') to all ASEs, organised by the Project Angonoka, helped them to draw up action plans. The Soalala ASE originally envisaged running the accounts for village ASEs and distributing funds and materials as required. For example, 1992 funds were used to buy stationery for the committees and to buy cashew nuts for planting. These were distributed equally to each village ASE. However, the village ASEs demanded autonomy, and are now in charge of their own accounts. This gives them more incentive to encourage membership, to ensure payment of membership fees and to decide and spend their money on their own activities. We remarked that the village ASEs and the Soalala ASE became competitive, which acted to motivate each group to be more active than the others.

In addition to planting cashew nuts, the most ambitious ASE activity to date has been the rebuilding of the well at Marotia. The Marotia ASE, with the help of the Soalala ASE committee, drew up a quote for purchase of cement and employment of a mason. They were given the money (480,000 FMG, approximately 170 GBP) and organised the purchase and transport of the cement and hiring the mason. People of Marotia collected the sand and gravel required, made the cement bricks and helped the mason. The well was completed in the 1993 dry season, elicited the widespread participation of villagers, and has promoted a sense of pride in this achievement and in the angonoka (L.J. Rakotoniaina *in litt.* March 1994).

Project Angonoka has started a very interesting initiative in the Soalala region, with the creation of the ASEs in villages. These will need encouragement and support, probably with some training, certainly in the initial stages. Ideally they will build the capacity to mobilise members to act together, investing time, energy, and some of their own money in environmental activities. Communication procedures must be established through which the different ASEs can communicate with each other and with external organisations. The ASEs should ultimately function as autonomous associations, which have the capacity to tap into the rural development and conservation funding that is increasingly becoming available in Madagascar. Donor organisations often wish to help community groups directly, but lack the means to contact them, while most rural communities lack the capacity to request assistance and organise their own development programmes. Although a protected area has not yet been declared in the Soalala region, local people are already involved in conservation activities. Local institutions which can represent local interests, either in the town or in villages, are being developed. This is a very important achievement for a conservation project, demonstrating that the way in which development is implemented is as important as the actual activities realised.

8.11 Conclusions

These case studies in Madagascar illustrate that, as argued in Chapter 1, there are two important dimensions to projects aimed at protected area maintenance through integrated conservation and development: projects must address natural resource issues, and cultural or political issues. A conservation project which aims to effectively protect a protected area must address which resource uses affect the maintenance of the protected area, which resources are not being used sustainably and what are suitable alternatives or effective forms of management. In order to understand the causes of various use patterns, and how to influence them, energetic and economic influences on local resource use must be considered. But even when the natural resource issues are carefully researched, cultural or political issues can have an overriding influence. Activities which aim to influence resource use must be appropriate and effective within cultural and political constraints. It is therefore equally important to research and understand the social relations of resource use. All these various aspects lie within the broad sphere of the human ecology of a protected area, and must be integrated to approach a practical and enduring solution to its maintenance.

Activities which clearly target the natural resource issue might seem to be most effective, but they must be implemented carefully so as not to upset cultural dynamics. For example, the peanut cultivation programme implemented by SAF-CO near Morondava worked with small groups of cultivators, making no gifts, but providing loans of seed and equipment. The project successfully created the conditions under which target beneficiaries were willing and able to adopt the proposed activity and be responsible for its success. Other projects, such as Project Angonoka, put even greater emphasis on the cultural aspects of development. Project Angonoka is helping to create the conditions under which community associations can independently organise a wide range of sustainable development activities.

The advantage of working through community empowerment is that any development or conservation activities that are adopted are most likely to continue in the long term without outside support. A major problem with many externally instigated projects is that they do not endure once the outside support and pressure is removed. Building and reinforcing local institutions is thus a way to promote sustainable conservation.

A potential criticism of such an approach is that it requires considerable time to implement. I would argue that it would, in any case, usually take a long time (in the order of decades rather than years) to effectively alter resource use patterns. Projects that terminate after two or three years are much less likely to have a long term impact. There has been widespread recognition that integrated conservation and development projects must plan for longer periods (such as 10 to 15 years), and donors should be prepared to provide secure funding for these longer periods (Wells *et al.* 1992, Hannah 1992, UNESCO 1992).

A more worthwhile criticism is that communities, once empowered, may not choose to invest time and energy in activities which are important for protected area maintenance, or even for sustainable use of natural resources. This is why it should always be recognised that protected area maintenance must be a partnership between the interested parties. In the largest sense, projects which aim to maintain a protected area should represent a partnership between the international community and the country in which they exist. If members of the international public, represented by international governments and conservation organisations, are interested in the maintenance of a protected area, they must be represented in its management. In particular, there should be mechanisms for them to help support the maintenance of the area, for example through donations and through paying for tourism. At a national level, local interests are often not adequately considered by the national government, although the goverment does have an important role to play in the management partnership. Local concerns over the maintenance of the protected area, which have been the focus of this thesis, are just one important part in the successful maintenance of a protected area. Development activities which help to mobilise local community action, can help to provide a means by which local interests can be represented. An appropriate management structure must be developed to enable representation of all these different interested groups, not least local people.

APPENDIX 1

IUCN CATEGORIES AND MANAGEMENT OBJECTIVES OF PROTECTED AREAS

Source: Mackinnon *et al.* 1986

1. STRICT NATURE RESERVE
   Kept undisturbed to maintain natural processes
   Used for scientific research and environmental monitoring
   eg. Andohahela Strict Nature Reserve in Madagascar

2. NATIONAL PARK
   To protect outstanding natural and scenic areas
   Used for scientific, educational and recreational use
   eg. Royal Chitwan National Park in Nepal, Etosha National Park in Namibia

3. NATURAL MONUMENT/ NATURAL LANDMARK
   To protect and preserve nationally significant natural features
   eg. Petrified Forests Nature Monument in Argentina

4. MANAGED NATURE RESERVE/ WILDLIFE SANCTUARY
   To protect significant species
   Sometimes allow controlled harvesting of resources/ tourism etc.
   eg. Manas Wildlife Sanctuary in India

5. PROTECTED LANDSCAPES
   To maintain landscapes characteristic of harmonious interaction of man and land
   Enables maintenance of traditional lifestyles
   Used for recreation and tourism.
   eg. Dales and Peak District National Parks in England

6. RESOURCE RESERVE
   To protect natural resources for future use
   Prevents development activities that could affect the resources
   eg. Brazil's Forest Reserves

7. ANTHROPOLOGICAL RESERVE
   To allow the life of societies living in harmony with the environment to continue undisturbed
   eg. Central Kalahari Game Reserve in Botswana

8. MULTIPLE USE MANAGEMENT AREA
   To provide sustained production of water, timber, wildlife, pasture and tourism
   eg. Ngorongoro Conservation Area of Tanzania

9. BIOSPHERE RESERVE
   To conserve for present and future use the diversity and integrity of biotic communities of plants and animals within natural ecosystems
   For research, education and training
   eg. Rio Platano Reserve of Honduras

10. WORLD HERITAGE SITE
    To protect natural features of outstanding universal significance: either natural or cultural
    eg. Great Barrier Reef in Australia

APPENDIX 2

SUMMARY OF PROTECTED AREA CATEGORIES IN MADAGASCAR

Protected areas covering a range of habitats have been created in Madagascar with status varying between six categories (Jenkins 1987, Nicoll and Langrand 1989).

1. 'Réserves Naturelles Intégrales', Strict Nature Reserves

These reserves were created to protect flora and fauna. Access is strictly forbidden other than for authorised scientific research purposes.

There are 11 such reserves in total (10 established in 1927, one in 1939, one in 1952 and one de-gazetted to a Classified Forest in 1964), covering 569,542 ha.

2. 'Parcs Nationaux', National Parks

Their aim is to protect and conserve native fauna and flora and to provide educational and recreational opportunities. Neighbouring villagers are allowed access for subsistence exploitation of certain natural products and tourism is allowed with permits.

The first two National Parks were created in 1958 and 1962 covering 99,740 ha, and three others have been added in the last few years.

3. 'Réserves Spéciales', Special Reserves

These were usually created to protect threatened animal or plant species. Access is available by permit but hunting, fishing, pasturing of livestock, collection of natural products are forbidden.

There are 23 Special Reserves in total, covering 376,580 ha; 14 were created before 1960, and seven more recently.

4. 'Forêts Classées', Classified Forests

These are the subjects of individual ministerial decrees with the following points in common: all commercial forest exploitation is forbidden but local inhabitants can exercise certain traditional use of minor forest products. Protection is not necessarily permanent.

There are 158 classified forests covering approximately 2,671,000 ha.

5. 'Zones de Reboisement', Reafforestation Zones

These are created for the stabilisation and protection of watersheds and for the prevention of erosion. Land-use is regulated and the region benefits from management practices such as reafforestation, pasture management and use of anti-erosion measures.

There are 77 such areas covering approximately 823,978 ha.

6. 'Réserves de Chasses', No-Hunting Reserves

Hunting is prohibited in an approximately defined area. Hunting is allowed by permit in other regions of the country except for species protected by special legislation.

There are four no-hunting reserves, created in 1972, covering an undefined area.

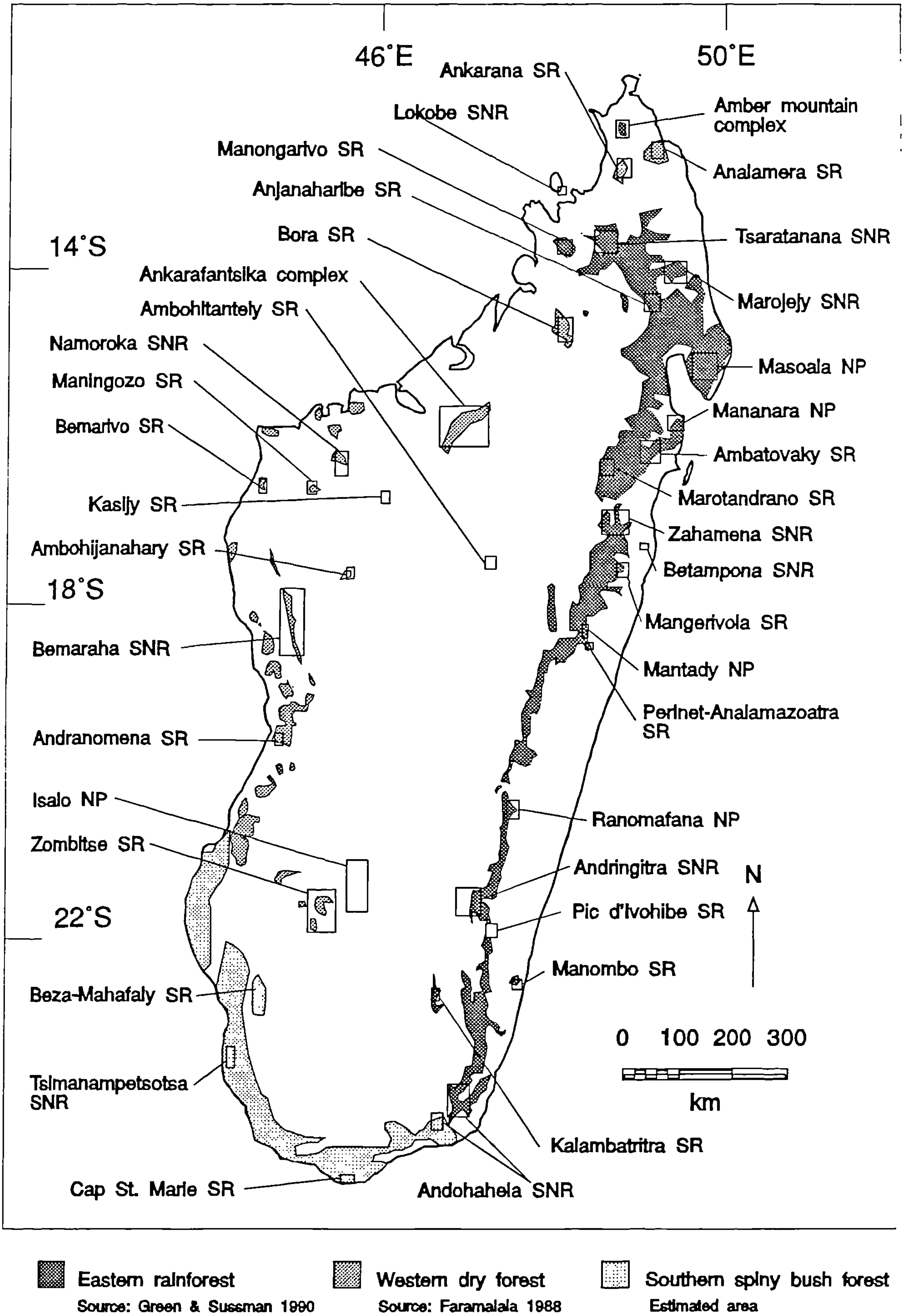


Figure A2.1 Current forest cover and protected areas

SNR = Strict Nature Reserve, SR = Special Reserve, NP = National Park

APPENDIX 3

WEATHER DATA

All data are from the National Meteorological Service at Ampandrianomby, Antananarivo, Madagascar.

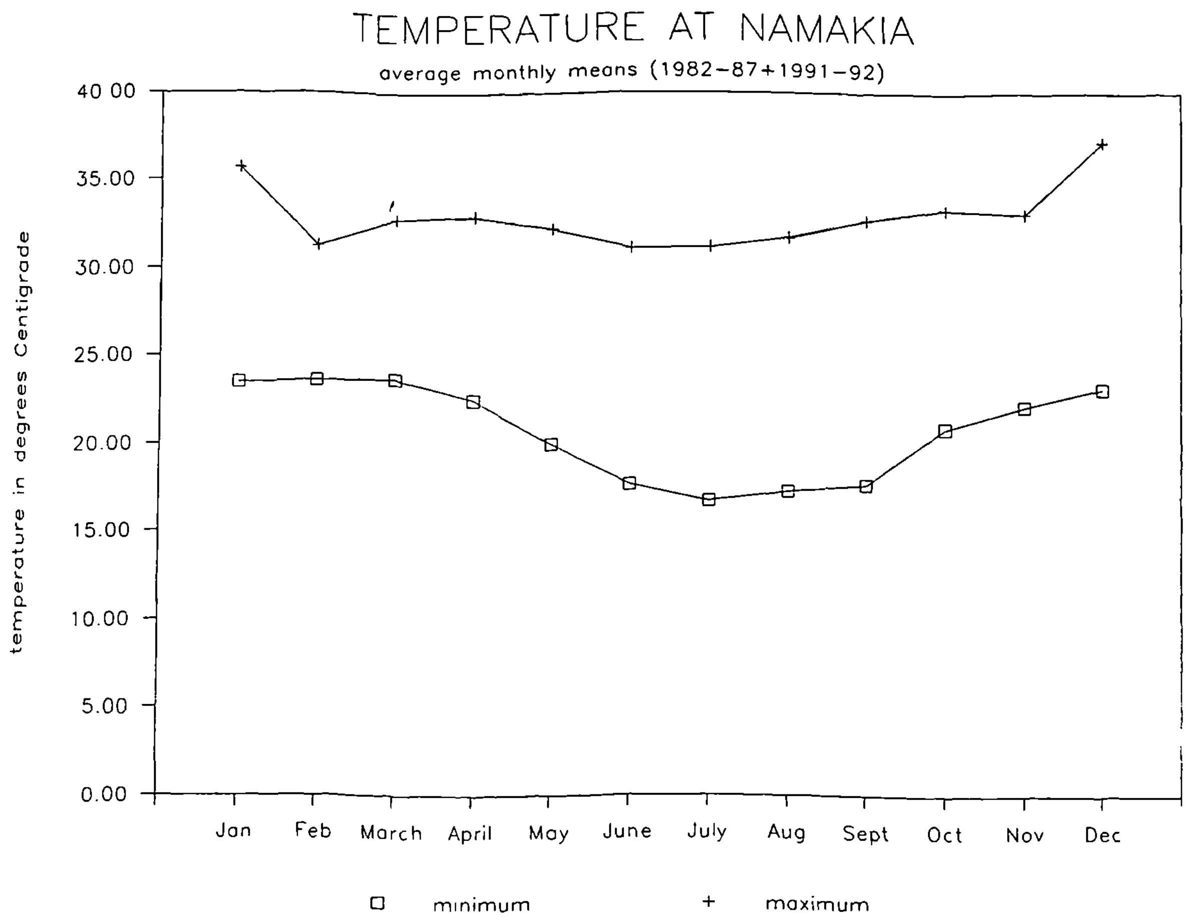
Graphs of rainfall and temperature are given for the following four weather stations near to the study sites:

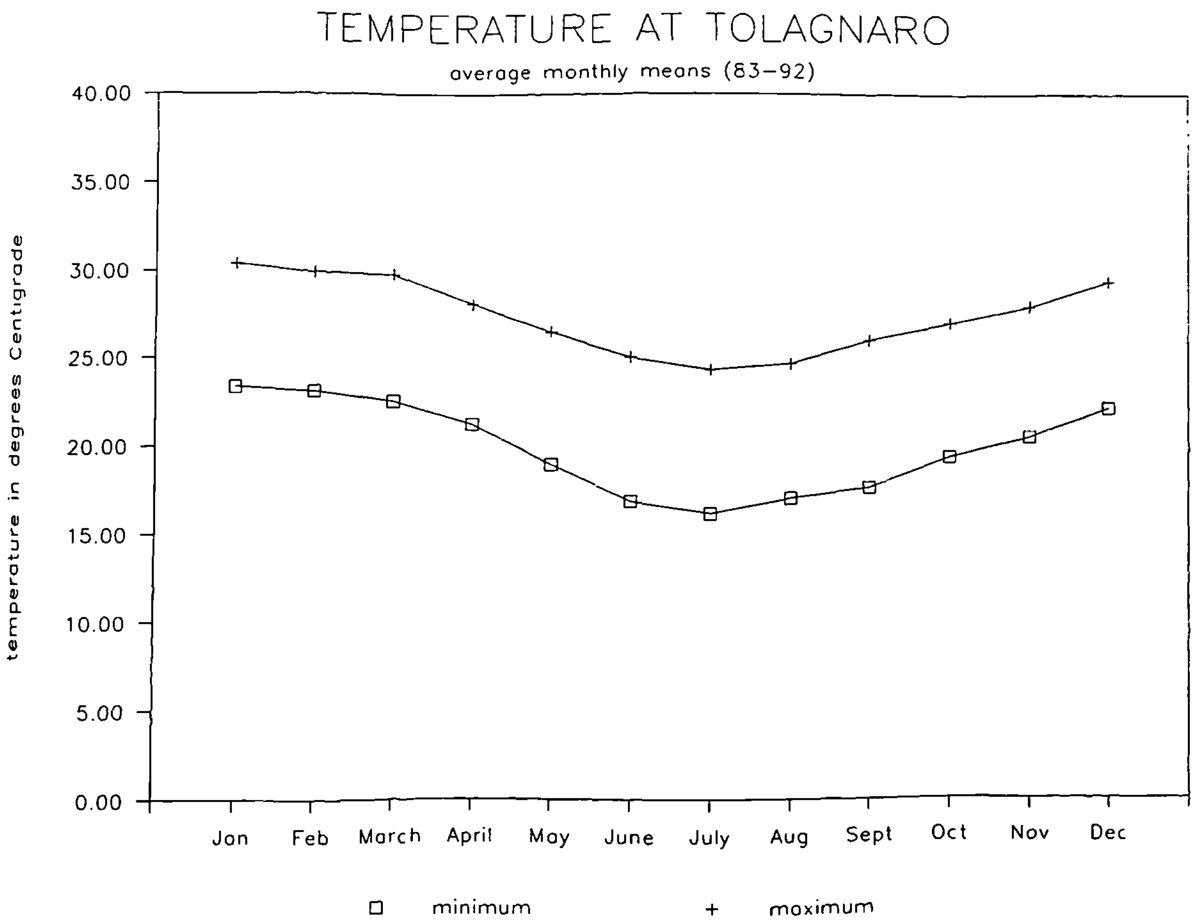
NAMAKIA: 60 km east north east of Soalala

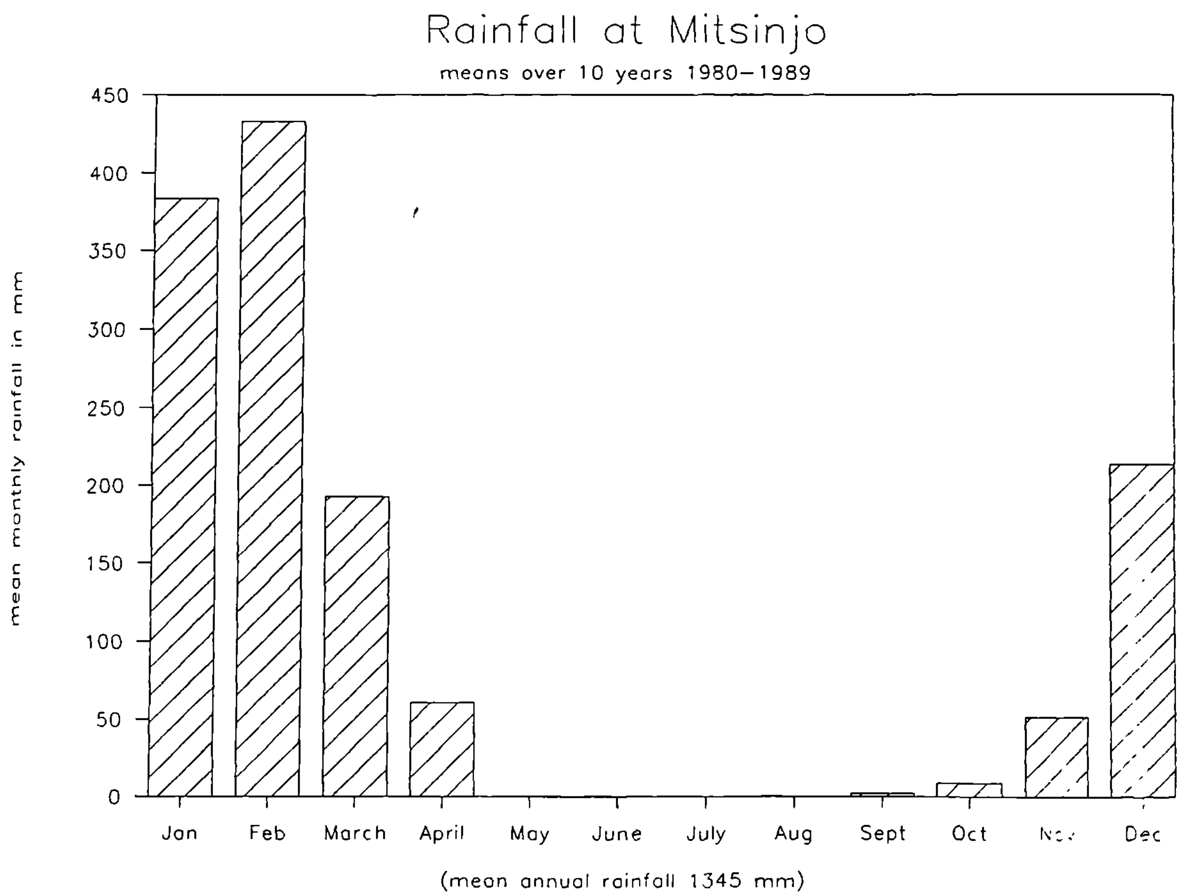
MITSINJO: 60 km east of Soalala

TOLAGNARO: 25 km south east of Parcel 1 of the Andohahela Reserve

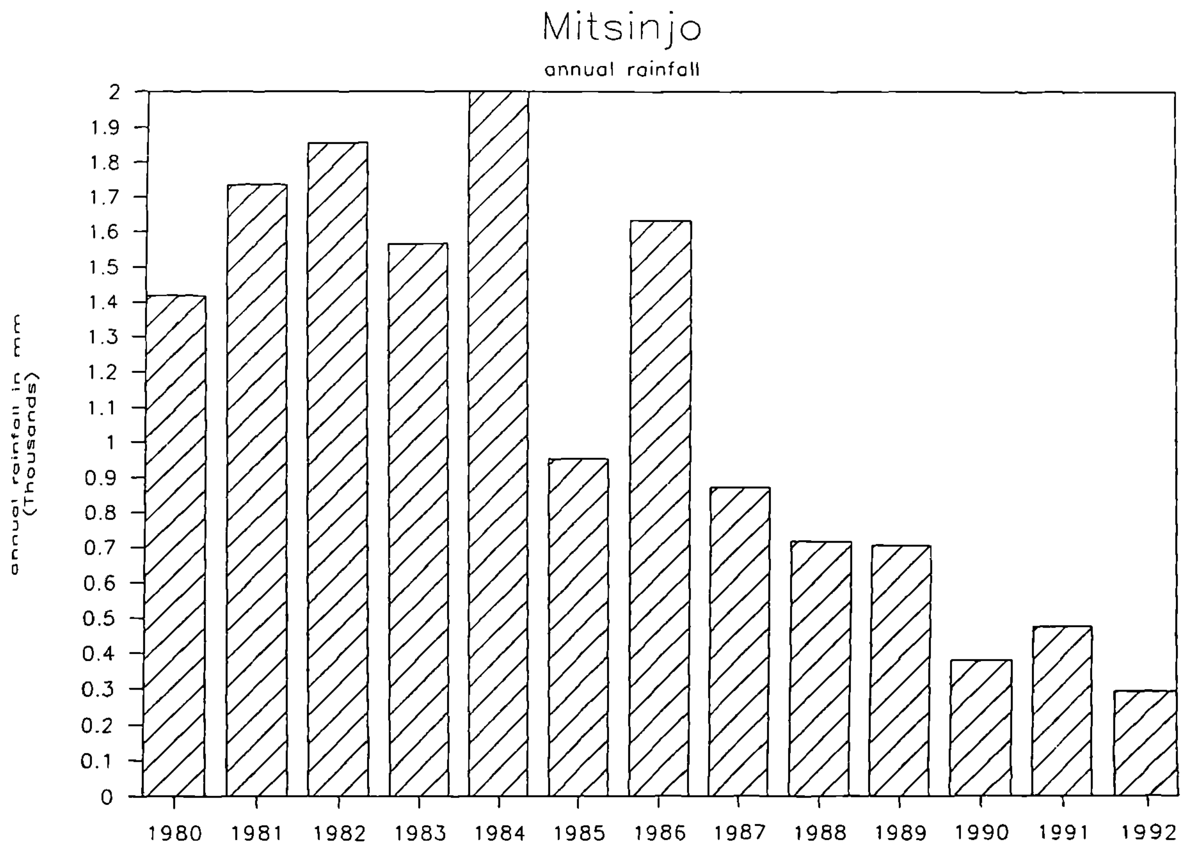
BEHARA: 15 km west of Parcel 2 of the Andohahela Reserve


TEMPERATURE AT NAMAKIA
average monthly means (1982-87+1991-92)
temperature in degrees Centigrade
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Jan
Feb
March
April
May
June
July
Aug
Sept
Oct
Nov
Dec
minimum
maximum

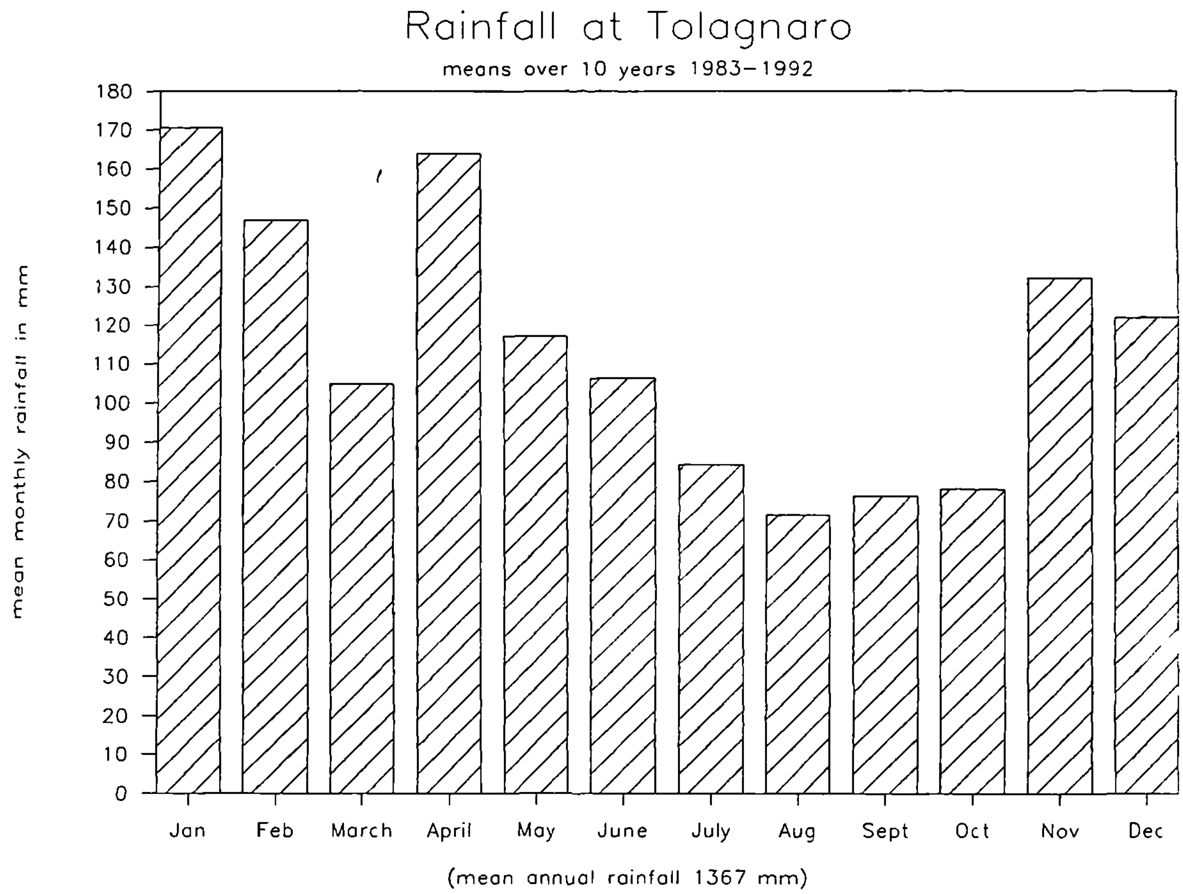

TEMPERATURE AT TOLAGNARO
average monthly means (83-92)
temperature in degrees Centigrade
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Jan
Feb
March
April
May
June
July
Aug
Sept
Oct
Nov
Dec
minimum
maximum



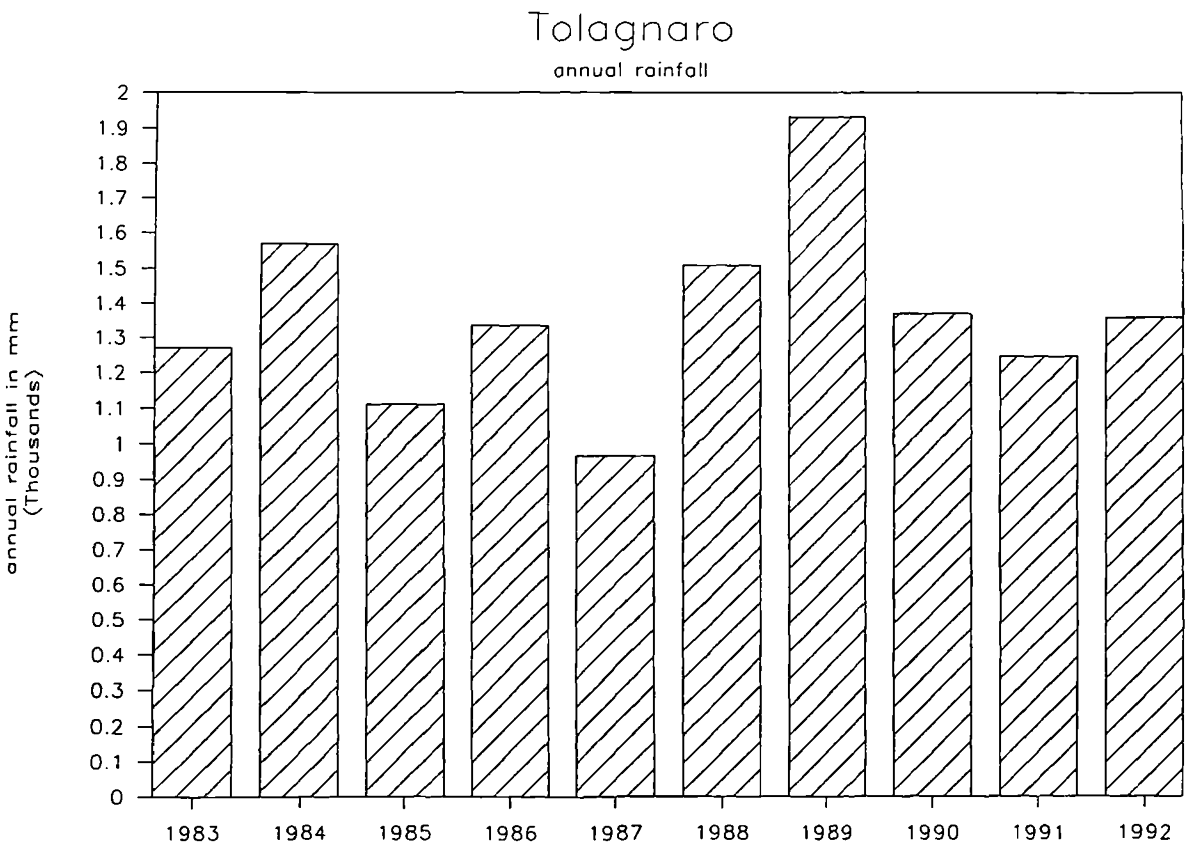
Rainfall at Mitsinjo
means over 10 years 1980–1989
mean monthly rainfall in mm
450
400
350
300
250
200
150
100
50
0
Jan
Feb
March
April
May
June
July
Aug
Sept
Oct
Dec
(mean annual rainfall 1345 mm)



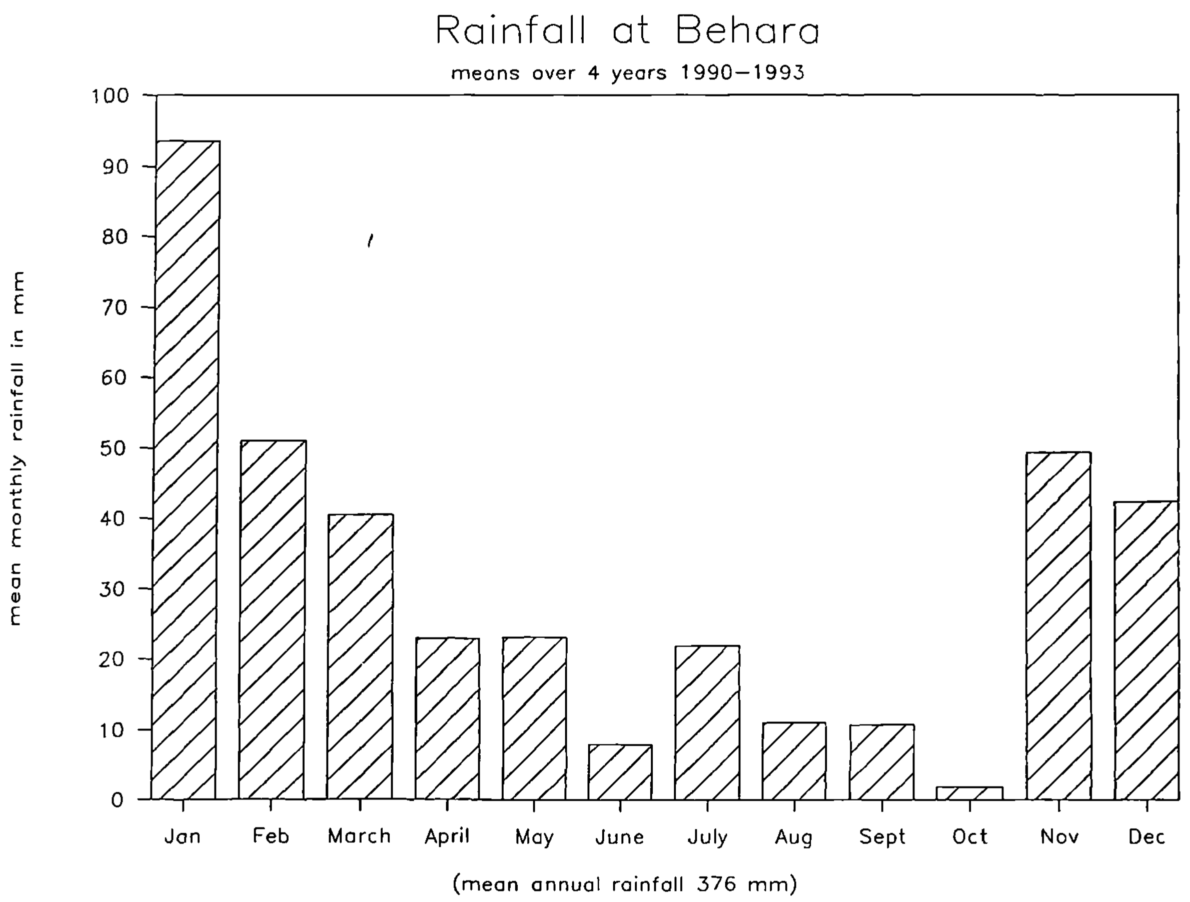
Mitsinjo
annual rainfall
annual rainfall in mm
(Thousands)
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

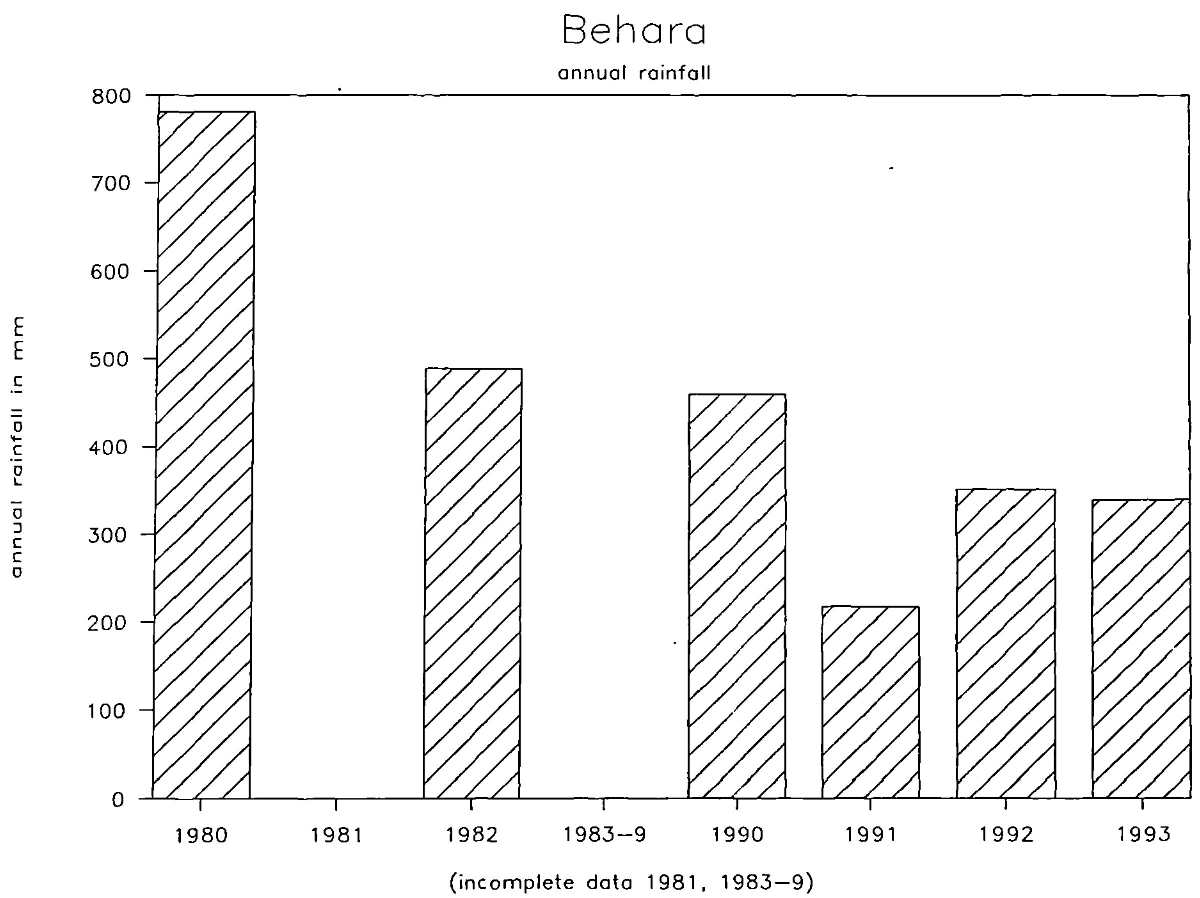


Rainfall at Tolagnaro
means over 10 years 1983–1992
mean monthly rainfall in mm
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
March
April
May
June
July
Aug
Sept
Oct
Nov
Dec
(mean annual rainfall 1367 mm)



Tolagnaro
annual rainfall
annual rainfall in mm
(Thousands)
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992


Rainfall at Behara
means over 4 years 1990–1993
mean monthly rainfall in mm
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
March
April
May
June
July
Aug
Sept
Oct
Nov
Dec
(mean annual rainfall 376 mm)


Behara
annual rainfall
annual rainfall in mm
0
100
200
300
400
500
600
700
800
1980
1981
1982
1983–9
1990
1991
1992
1993
(incomplete data 1981, 1983–9)

Appendix 4. Figure A4.1

SEASONAL DISTRIBUTION of DATA COLLECTION
for TIME ALLOCATION (TA) and FOOD CONSUMPTION (FC) studies

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Soalala Seasons	ASARA			:		FAOSA				:	ASARA	
ANTANANDAVA		93				92 (FC only)		91 (TA only)		92		91 (TA only)
ANTSIRA	93						91		92			91
Andohahela Seasons	PAHAVARATRA			:	ASOTRY			:	LOHATAONA		:	
ESOMONY	92			93			92		91			
EMINIMINY	92		93					92		91		

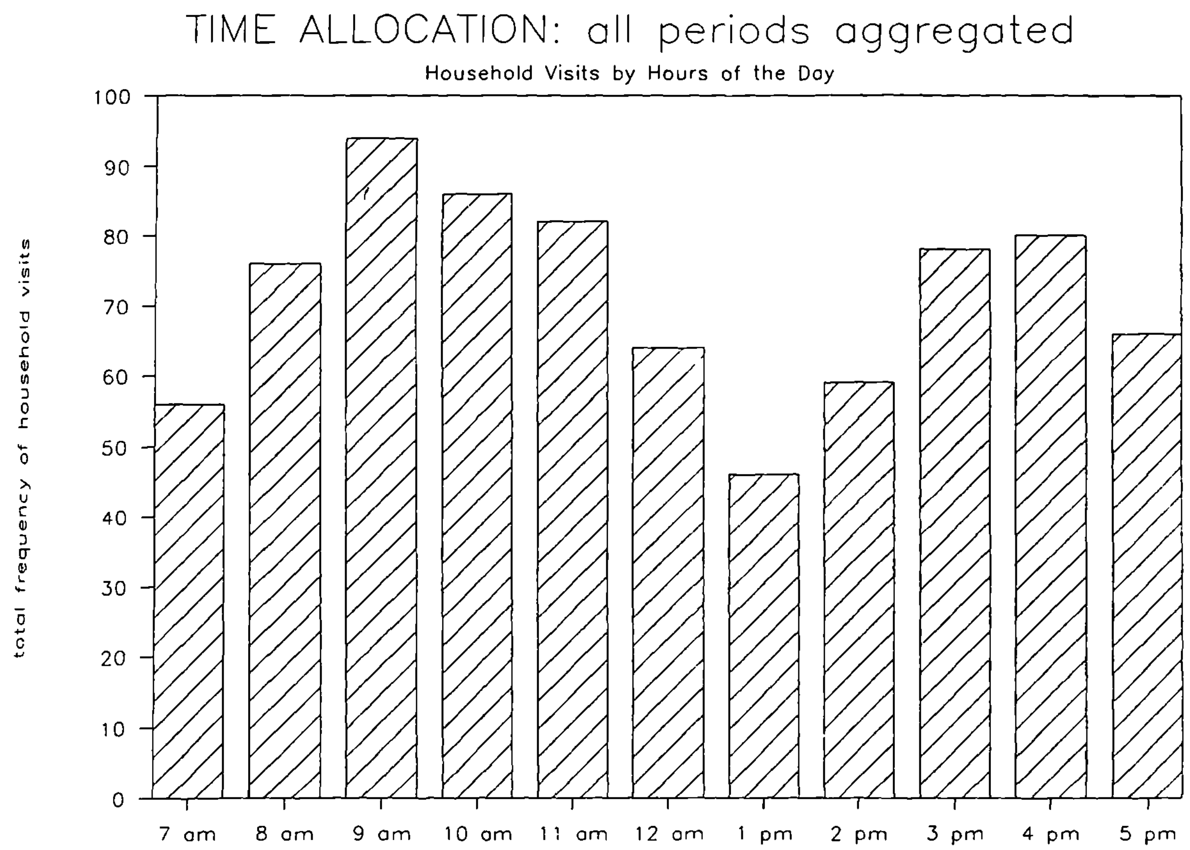
Appendix 4. Table A4.1

TIME ALLOCATION DATA

Frequency of household visits by hours of the day

	ANTANANDAVA				ANTSIRA			
	08/91	12/91	10/92	02/93	07/91	12/91	09/92	01/93
7 am	6	0	2	1	8	4	4	3
8 am	8	1	5	2	6	5	8	4
9 am	11	4	7	3	11	3	7	3
10 am	7	4	8	3	10	3	2	3
11 am	9	5	7	4	5	4	2	4
12 am	5	3	7	3	3	5	6	2
1 pm	3	1	0	3	3	4	3	3
2 pm	3	1	5	4	5	2	2	3
3 pm	7	4	8	3	7	5	4	4
4 pm	6	4	5	4	10	6	6	2
5 pm	7	5	4	3	5	5	6	1
total visits	70	32	58	33	73	46	50	32
no. days	11	6	10	5	18	6	10	5
mean visits/day	6.4	5.3	5.8	6.6	4.1	7.7	5.0	6.4
no. data points	171	85	133	74	178	109	132	84
mean data points/day	15.5	14.2	13.3	14.8	9.9	18.2	13.2	16.8
mean data points/visit	2.4	2.7	2.3	2.2	2.4	2.4	2.6	2.6
no. male data points	70	33	54	32	89	57	67	46
no. female data points	110	52	79	42	89	52	65	40
total households in village		75				9		
no. households	8	13	16	16	7	8	7	9
% of total households	10.67	17.33	21.33	21.33	77.78	88.89	77.78	100.00

	ESOMONY				EMINIMINY			
	09/91	01/92	07/92	04/93	10/91	01/92	08/92	03/93
7 am	7	3	2	1	6	4	2	3
8 am	3	5	7	3	5	5	7	4
9 am	2	4	8	3	9	4	9	6
10 am	7	3	8	2	8	4	9	5
11 am	7	4	7	3	5	1	9	6
12 am	6	2	8	2	2	2	4	4
1 pm	4	4	4	4	2	1	4	3
2 pm	7	2	7	5	3	4	4	2
3 pm	6	1	7	5	3	2	7	5
4 pm	8	2	7	6	3	3	4	4
5 pm	6	2	2	5	3	3	6	3
total visits	63	32	67	39	49	33	65	45
no. days	11	5	10	7	10	5	11	7
mean visits/day	5.7	6.4	6.7	5.6	4.9	6.6	5.9	6.4
no. data points	167	89	163	100	186	127	214	136
mean data points/day	15.2	17.8	16.3	14.3	18.6	25.4	19.5	19.4
mean data points/visit	2.7	2.8	2.4	2.6	3.8	3.8	3.3	3.0
no. male data points	75	41	86	45	89	59	98	67
no. female data points	92	48	77	55	97	68	116	69
total households in village		116				58		
no. households	11	22	25	16	14	16	27	21
% of total households	9.48	18.97	21.55	13.79	24.14	27.59	46.55	36.21



Appendix 4. Figure A4.2

Appendix 4. Table A4.2

FOOD CONSUMPTION DATA

	ANTANANDAVA			ANTSIRA			
total households in village	75			9			
	06/92	10/92	02/93	07/91	12/91	09/92	01/93
total household-days	14	11	9	23	9	6	8
no. households	10	10	8	4	4	5	6
% of total households	13.33	13.33	10.67	44.44	44.44	55.56	66.67
no. person-meals							
-staple	86.5	127.0	85.0	35.6	42.8	30.5	37.0
-laoka	51.5	36.8	54.1	33.9	26.5	23.5	31.0
% meals with laoka	59.5	28.9	63.6	95.2	62.0	77.0	83.8
mean no. meals/day	2.40	2.30	2.13	2.25	2.75	2.20	2.17
mean kapoaka rice/meal			1.02	0.90	0.93	0.96	1.04
mean kg rice/meal			0.29	0.26	0.27	0.27	0.30

	ESOMONY				EMINIMINY			
total households in village	116				58			
	09/91	01/92	07/92	04/93	10/91	01/92	08/92	03/93
total household-days	12	9	15	9	24	13	11	8
no. households	10	9	15	9	15	11	10	8
% of total households	8.62	7.76	12.93	7.76	25.86	18.97	17.24	13.79
no. person-meals								
-staple	138.0	124.0	221.0	123.0	270.6	278.0	197.5	168
-laoka	91.5	69.0	114.0	48.5	63.9	101.5	70	99
% meals with laoka	66.3	55.6	51.6	39.4	23.6	36.5	35.4	58.9
mean no. meals/day	2.56	2.61	2.73	3.00	2.97	2.84	2.90	3.00
mean kapoaka rice/meal	0.59	0.54	0.56		0.67	0.52	0.91	0.73
mean kg rice/meal	0.17	0.16	0.16		0.19	0.15	0.26	0.21

APPENDIX 5. Table A5.1. COLLECTING AND PROCESSING NON-CULTIVATED RESOURCES: ACTIVITIES OBSERVED IN TIME ALLOCATION STUDY

f = female, m = male   figures are numbers of observations during period

ESOMONY

January		April		July		September	
f collecting fruit	1	f collecting water	1	f collecting water	5	f collecting water	5
f collecting reeds,mats	1	f collecting fruit	1	f fishing & leaves, food	1	f chopping firewood	1
f weaving basket	1	f collecting locusts	2	f collecting firewood	2		
		f weaving mats	5				
m chopping firewood	1	m collecting firewood	1	m hunting game birds	1	m collecting firewood	3
				m collecting firewood	2	m chopping firewood	2
				m chopping firewood	1		
				m building fence/house	3		

EMINIMINY

January		March		August		October	
f collecting water	3	f weaving mats	4	f collecting water	1	f collecting tubers	1
f collecting fruit	3			f pounding locusts	1	f fishing for prawns	1
f cooking jack fruit	1			f weaving mats	3	f collecting reeds,mats	1
f cooking fern	1				2	f collecting water	2
f weaving mats	3						
m collecting firewood	2	m preparing nut oil,	1	m collecting leaf bract			
m collecting fruit	1	m collecting firewood	2	m collecting firewood	1	m collecting thatch	1
m chopping firewood	1	m chopping firewood	1	m chopping firewood	2	m collecting firewood	1
		m making trough	1	m building house	1	m building house	1
						m chopping firewood	1

ANTANANDAVA

February		August		October		December	
f fishing	2	f fishing	1	f collecting firewood	1	f collecting water	1
f cooking fish	1	f collecting for mats	1	f preparing tubers	3		
f collecting water	2	f collecting water	1	f cooking cashew nuts	1		
		f weaving mat	1	f weaving mats	4		
				f preparing mango chutney	2		
m fishing	1	m fishing	3	m fishing	5	m collecting firewood	1
m collecting wood,house	1	m collecting thatch	1	m collecting cashews	1	m building houses	4
m repairing house	1	m collecting firewood	3	m collecting wood,house	2		
				m collecting thatch	1		
				m collecting bamboo,hse	1		
				m building house	1		
				m making trap for ducks	1		

ANTSIRA

January		July		September		December	
f collecting water	2	f collecting for mats	3	f collecting tubers	1	f fishing, home food	1
f fishing, home food	2	f collecting thatch	2	f collecting cashews	1	f fishing, commercial	1
f prawn fishing	2	f collecting firewood	1	f collecting for mats	1	f prawn fishing	8
f preparing palm fruit	1	f collecting water	1	f collecting wood, fence	1	f collecting water	3
f weaving mats	3	f fishing, home food	3	f collecting water	2	f weaving mats	4
		f fishing, commercial	2	f preparing tubers	1	f preparing fish, comm.	3
		f preparing tuber	1	f cooking crab	1	f repairing fence	1
		f preparing turtle meat	2	f weaving mat/basket	4		
		f preparing fish, comm.	5	f making salt	7		
		f preparing bark, mats	1	f preparing fish, comm.	2		
		f weaving mats	7				
m collecting crabs	1	m collecting wood, fence	2	m collecting tubers	3	m collecting wood, house	1
m building boat	1	m collecting wood, table	1	m collecting cashews	2	m fishing, commercial	4
m building garden fence	1	m collecting thatch	3	m fishing, commercial	4	m prawn fishing	16
m prawn fishing	14	m collecting firewood	2	m collecting wood, fence	4	m collecting salt	1
		m fishing, home food	2	m collecting thatch	1	m preparing fish, comm.	1
		m fishing, commercial	26	m building boat	5	m building boat	3
		m preparing turtle meat	2	m building house	1	m building house	1
		m preparing fish, comm.	2	m chopping firewood	1	m building fence	1
		m making fire, pigs	3	m collecting salt	2	m making axe handle	1
		m making blowpipe	1	m preparing fish, commercial	3		
		m building boat	3				
		m mending fence	2				
		m making [illegible]	[illegible]				

Appendix 5, Table A5.2 FISHING TECHNIQUES: ANTSIRA, SOALALA

type	location	equipment	labour	technique	duration	season	produce	destination
maminta an-driaka = to fish with hook at sea	at sea or in deep bay over rocks	canoe hook and line	1 or 2 people (depends on size of canoe)	fish caught with baited hooks	3-8 hours, often early am eg 2am-8am	May to Nov	fish 0.5-10kg each including tuna, small shark,	salted and dried for sale
manao jarifa = to use shark net	at sea or in deep bay	canoe shark net (jarifa) buoys	1 person	large meshed net left permanently	check each am 1-2 hours	May to Nov	large sharks (to 3m) barracuda large rays	fins dried for sale to dealers flesh salted and dried for sale
manao palanky = to use shark trap	at sea	canoe 5-10 large hooks on rods attached to chains and rope, buoys	1 or 2 people	baited hooks left on sea floor and suspended from rope (palanky)	check each am 1-2 hours	May to Nov	large sharks (3m+) barracuda	"
manharato = to fish with net	at shore	50-100m net 1.5-2cm mesh	1 person (sometimes 2)	set one end of net with buoy & weight, hold other end	< 1 hour	all year	smaller fish (< 1kg) different types from line fishing	often just home consumption, or salted and grilled for local sale inland
manihitsy akamba = to trap prawns	in bay in mangroves	cone shaped net (kopiko), canoe	2 people	hold mouth of net open in channel, as high tide turns to ebb prawns flow into net	1-2 hours, twice daily, especially for days either side of full and new moon	Oct to May	prawns, 5-50kg per catch, and larger variety, like Dublin Bay prawn	sold fresh to collecting boats or sun dried for sale
manihitsy tsivakia = to trap tiny prawns	at shore in bay	loose weave material as net (toaly ie toile)	2 people	use fine net to trap tiny prawns occcurring in large shoals at high tide	1-2 hours, twice daily,	Feb to April	tiny prawns (tsivakia=unable to split open)	dried for sale
maminta haranta = to fish with hook from shore	at shore on rocks	rod and line with hook	1 person	baited hook from shore line rocks at high tide	1-2 hours	all year	small to medium fish (<1.5kg)	mostly for home consumption

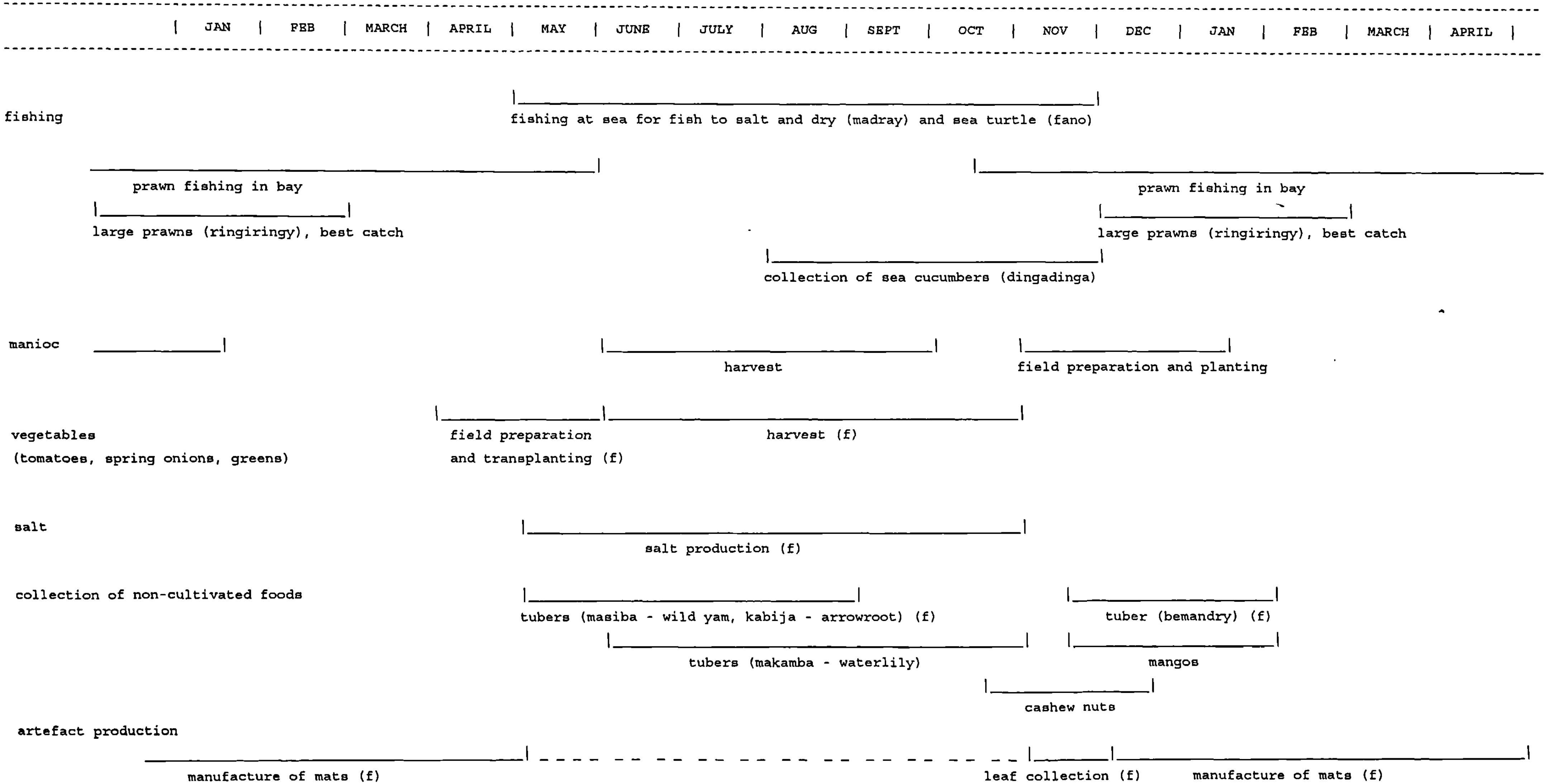
Table A5.2 cont.

type	location	equipment	labour	technique	duration	season	produce	destination
mihaza fano = to hunt turtle (similar for dugong, but no remora)	at sea	small canoe harpoons remora fish	2 people	remora (sucker fish) attached to line, attaches to turtle and enables pursuit of turtle, harpooned when near surface	4-8 hours	May to Nov	mostly green turtles some loggerhead and olive ridley hawksbill rare	home consumption, some meat traded locally
	in bay in mangroves	small canoe scoop net harpoon	1 person	paddle canoe in shallow water, scoop crabs with net in frame (like tennis racket) harpoon rays, high tide	2-4 hours	all year	crabs and ray	ray dried, both home consumption and local sale some crab sale to collecting boats

Appendix 6

ACTIVITY CALENDAR - ANTSIRA

(m = predominantly male activity, f = predominantly female activity, no qualifier means done by men and women)



Appendix 6

ACTIVITY CALENDAR - ANTANANDAVA

(m = predominantly male activity, f = predominantly female activity, no qualifier means done by men and women)

| JAN | FEB | MARCH | APRIL | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC | JAN | FEB | MARCH | APRIL |

flood plain rice
(vary jeby)

field preparation, trampling and sowing in nursery (m)

transplanting (f)

harvest

rain-fed rice
(vary asara)

field preparation, trampling (m)

transplanting (f)

harvest

field preparation, trampling and sowing in nursery (m)

transplanting (f)

manioc

field preparation and planting

harvest

field preparation and planting

vegetables
(tomatoes, spring onions, greens)

field preparation
and transplanting (f)

harvest (f)

collection of non-cultivated foods

waterlily tubers (makamba) (f)

tuber (bemandry) (f)

wild yams (masiba), arrowroot (kabija) (f)

mangos

duck trapping (m)

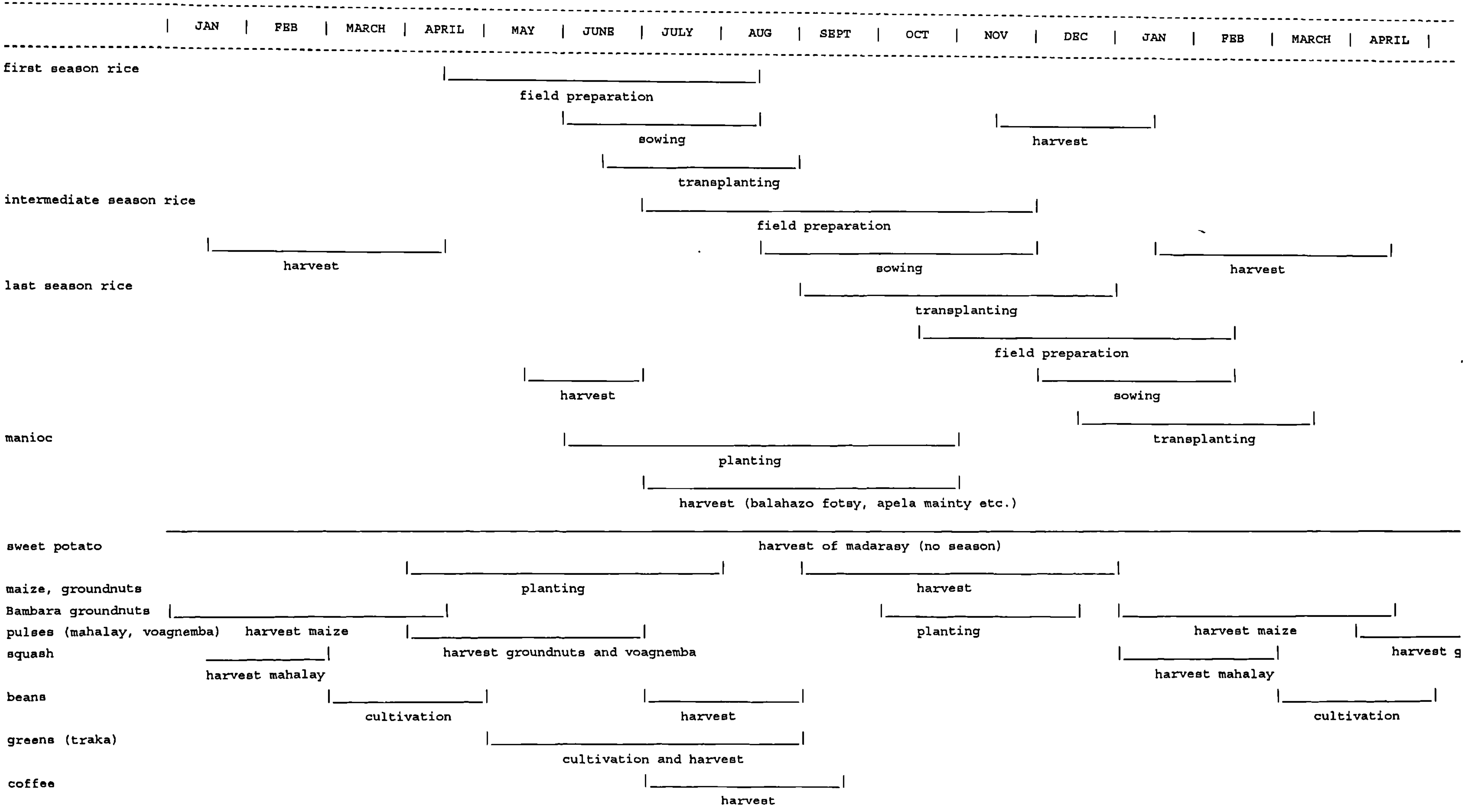
artefact production

manufacture of mats (f)

manufacture of mats (f)

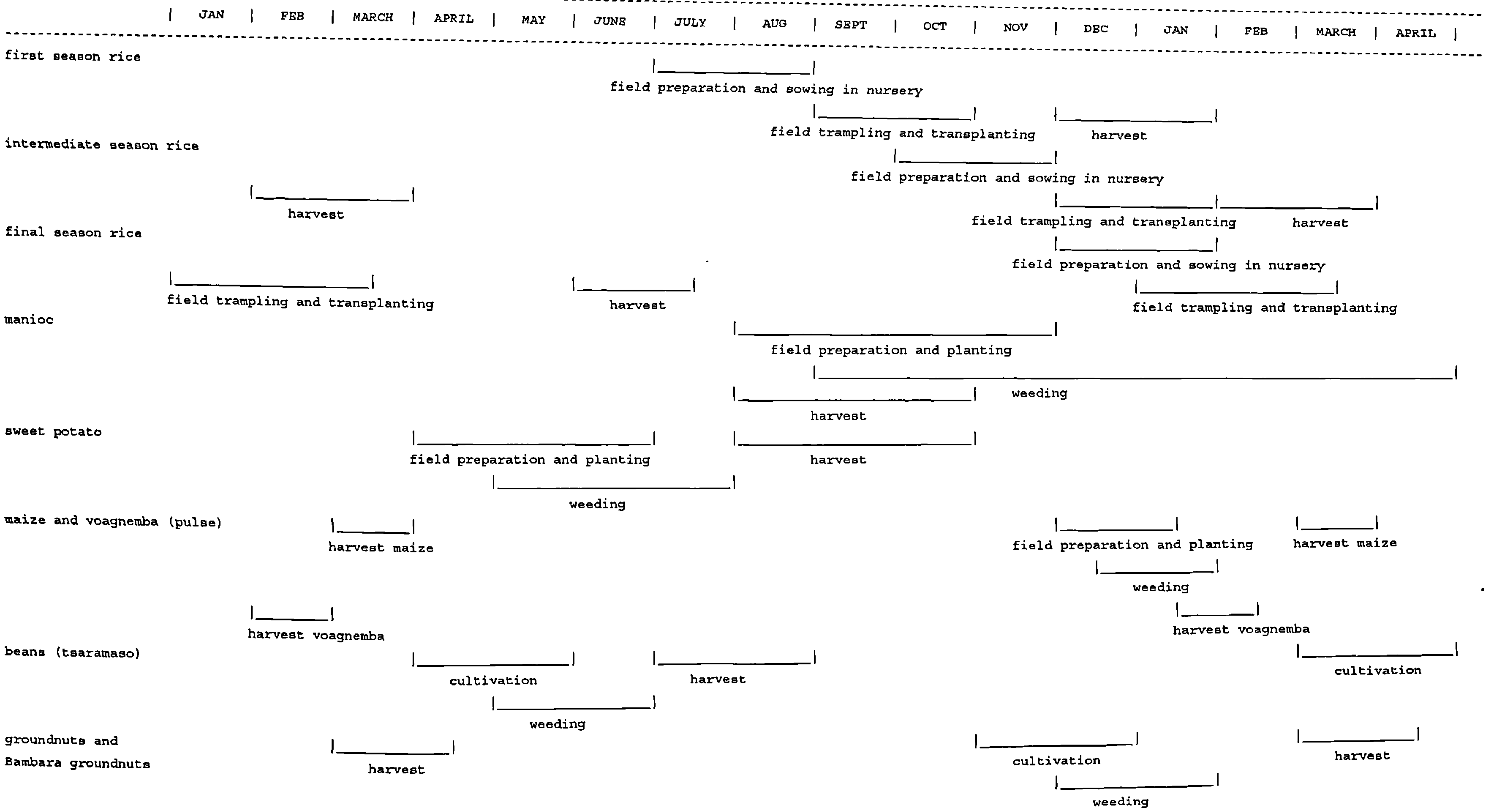
Appendix 6

AGRICULTURAL CALENDAR - EMINIMINY



Appendix 6

AGRICULTURAL CALENDAR - ESOMONY



Appendix 7. Table A7.1 AGRICULTURAL VARIATION IN STUDY VILLAGES

	ANTANANDAVA	ANTSIRA	ESOMONY	EMINIMINY
rice	mainly in flood plain in dry season, April-Dec some rain-fed in wet season, Dec-June	none, small quantities rain-fed rice in past	3 seasons, all irrigated by rivers from forest 1st) July-Jan 2nd) Oct-March 3rd) Dec-June	3 seasons, irrigated by rivers from forest & rain-fed 1st) April-Jan 2nd) July-April 3rd) Oct-June
manioc	very little cultivated soil too stony wet season, Nov-Jan around 9 months to mature	little grown, in pig-proof garden, planting starts wet season, Nov-Jan around 9 months to mature	planting dry season Aug-Nov 1 year to mature	planting dry season June-Oct 1 year to mature
other field cultivation			sweet potato maize beans: haricot, & others groundnuts:peanut,Bambara squashes melons: water melon,other sugar cane	sweet potato maize beans: haricot, & others groundnuts:peanut,Bambara squashes melons: water melon,other sugar cane
in gardens	manioc maize yams sugar cane beans: haricot, cowpeas chillies green leafy vegetables tomatoes aubergines onions, spring onions pumpkin, gourds mint ginger cotton, kapok	manioc maize yams sugar cane beans: haricot, cowpeas chillies green leafy vegetables tomatoes aubergines onions, spring onions pumpkin, gourds mint ginger cotton, kapok	small quantities of field crops green leafy vegetables onions, spring onions tomatoes	green leafy vegetables onions, spring onions tomatoes taro or coco-yam yams pineapples aubergines
fruit trees in gardens or village	banana papaya mango orange lemon guava coconut tamarind	banana papaya mango orange lemon guava coconut tamarind	banana papaya orange coconut tamarind	banana papaya orange coconut tamarind custard apple sour-sop lychee jack fruit avocado coffee
livestock	cattle hens ducks	cattle hens ducks turkeys guineau fowl	cattle sheep goats pigs hens ducks geese	cattle pigs hens ducks geese

Appendix 7 RICE CULTIVATION, ANTANANDAVA

stage	equipment	labourer	technique used	duration	timing
1 mibara	long handled knife	men	cut long grasses in fields	1 or more days	1 month before trampling
2 mandrevorevo	cattle	several men	cattle chased around field to churn and break up soil	1 day on 1 occasion	from May to August
3 mirara-bary	seed rice soaked, sprouting	1 man	sow in nursery	1 day	prepared in advance of main field
4 mikaoky	spade and knife	men, 1 or more women may help	remove all weeds and grasses from field and build walls	several weeks	during month after sowing
5 manietsa		women, eg.2-3 men may help	uproot rice seedlings, transplant 3-4 stems at 40-50cm spacing	1 day if many workers many days for 1 woman	1 month after sowing from June to August
6 mangalandrongay		women	remove weeds	many days	1 month after transplanting not necessary if mikaoky effective
7 miamby fody	bamboo stick	men, women & children	bamboo stick used to throw mud pellets at fodies and lovebirds	all daylight hours	3 weeks while grain ripens
8 manapa-bary mandidy vary	serrated sickle	men, 1 or more	cut rice stems when grain is ripe	several days	4-5 months after sowing
9 mimehy	palm leaf ties	women	tie sheaves of rice after cutting	1 day	
10 manao tonta	thin wooden stakes	men, usually 1	stack rice in square between wood stakes	several days	
11 magnaboky	wooden baton mat	men and women	threshing, hit rice stems with wooden batons to remove grains	several days	
12 mikorokoroky	mats baskets	women	winnowing of rice grains, poured from basket to mat in light breeze to separate unformed grains	several days	as threshing occurs
13	rice sacks ox-cart	men	transport rice to village to store in building with raised floor	1 day	

Appendix 7 RICE CULTIVATION, EMINIMINY

stage	equipment	labourer	technique used	duration	timing
1 firamorina or miasa morina	spade	men, 1 or more	clearing the edges of the rice field, making walls and irrigation channels	many days, or weeks	1st harvest April-June 3rd harvest Oct-Jan
2 manisy rano	spade	1 man	irrigation of the rice field with water	1 day	1 day before trampling
3 magnosy a) mandavorefy b) mamalikosy c) mandio-rano	cattle	several men	cattle chased around field to churn and break up soil between each trampling the walls and irrigation channels are checked	1 day each on 3 occasions	b) 1-2 weeks after a) c) a few days after b)
4 miasa rano	spade tavilo - giant palm leaf bract	men, 1 or more	level the field using leaf bract to drag soil	several days	between b) and c) mainly for terraced swamp fields used for first harvest
5 mamafy	rice seed	1 man	sow rice seed, soaked and sprouting, evenly across field	1 day	1st harvest June-Aug 3rd Harvest Dec-Feb
6 mangalakahim--bazaha		women, usually several	remove weeds and transplant some rice seedlings to redistribute evenly	1 day if many workers many days for 1 woman	1 month after sowing
7 mitataka or mandidy vary	serrated sickle	men, 1 or more	cut rice stems when grain is ripe	several days	4-5 months after sowing
mitsongo vary		women	selective harvesting of ripe heads of rice, alternative to rice cutting when some early harvest required	as required	
8 magnandroky manao androha		men, 1 or more	creation of rice stack, in circle with heads to centre, and area in centre used for threshing	1 day	a few days after cutting, can be stored several weeks in stack
9 mamofoky	mats	men and women	threshing, by hitting a bundle of rice heads on a rock on the ground to remove grains from stems	several days	
10 manororoky	mats baskets	women	winnowing of rice grains, poured from basket to mat in light breeze to separate unformed grains	several days	as threshing occurs
11 mitaona	baskets	men, 1 or more	transport rice to village to store	1 day	
12 manapy vary	mats	women	dry rice in sun prior to storage	1 day	
13 manao tsihim--bary	mats	women or men	sew mat to make large basket for storage in raised-floor building	1 day	

Appendix 7. RICE CULTIVATION, ESOMONY

stage	equipment	labourer	technique used	duration	timing
1 manisy rano	spade	1 man	irrigation of the rice field with water	1 day	1 day before trampling
2 magnosy a) mandavorefy b) mamalikosy c) mandio-rano	cattle	men, several	cattle chased around field to churn and break up soil	1 day each on 3 occasions	b) 1-2 weeks after a) c) a few days after b)
3 magnatsaky or managna-zozo	spade	men, 1 or more	between each trampling build the walls		rice is sown in nursery, prepared in advance of main field both field prepn and sowing:
4 mamafy	rice seed soaked, sprouting	1 man	sow rice seed in nursery, before main field prepared	1 day	1st harvest July-Sept 3rd Harvest Dec-Jan
5 manombo-bary	baskets	women, several men transport	uproot seedlings from nursery men help transport to field if nursery distant	1 day if many workers	1 month after sowing
6 manietsa		women, often several	transplant rice seedlings 1 stem at 15-20cm spacing	1 day if many workers many days for 1 woman	1 day after uprooting seedlings
7 miamby rano	spade	1 man	survey water level in fields	1 man	drain water 1 week before cutting
8 mitataka or mandidy vary	serrated sickle	men, 1 or more	cut rice stems when grain is ripe	several days	4-5 months after sowing leave to dry for 4 days
9 magnandroha		men and women	creation of rice pile, in circle with heads to centre, and area in centre used for threshing	1 day	
10 mamofoky	mats	men, 1 or more women may help	threshing, by hitting a bundle of rice heads on a rock on the ground to remove grains from stems	several days	
11 manororoka	mats baskets	women	winnowing of rice grains, poured from basket to mat in light breeze to separate unformed grains	several days	as threshing occurs
12 mitaom-bary	baskets	men, 1 or more	transport rice to village to store	1 day	
13 manapy vary	mats	women	dry rice in sun prior to storage	1 day	
14 manao tsihim- -bary	mats	women or men	sew mat to make large basket for storage in house, or separate building	1 day	

Appendix 6

AGRICULTURAL CALENDAR - ESOMONY cont.

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	APRIL
squashes and melons (taboara, voatango, voazavo)		harvest										cultivation		harvest		
greens (traka)				sowing	field preparation and transplanting		harvest									

Appendix 6

WILD RESOURCE USE CALENDAR - ANDOHAHELA

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	APRIL
both sites	most wild fruits are ripe (eg. raotsy, rotsy, lamoty)															
								fishing								
			collection of weaving materials		weaving mats											
Eminiminy only	collection and production of hovao nuts for oil															
										tubers (vorozy, via, lingirotsy)						
												mangoes and jack fruit				

Appendix 7. MANIOC CULTIVATION: EMINIMINY

stage	equipment	labourer	technique used	duration	timing
1 magnendaky mandavo zeky	spade	men	clear vegetation and turn soil	many days	June to October
2 mitrobaky	spade knife	men	make mounds, 0.5m apart, and plant 3 cuttings per mound		plant as land is prepared
3 miava	spade	men	weeding		twice, 1st 1-2 months after planting, 2nd after 3 months
4 magnombotsy		men, sometimes women	uproot the tubers, men if large quantity women may collect for meal		July to Oct, 1 year after planting
5 mampikihy	knife	women	remove outer skin, dry in sun for 1 week		when there is a surplus available for storage

MANIOC CULTIVATION: ESOMONY

stage	equipment	labourer	technique used	duration	timing
1 mandavo boka	spade	men	clear vegetation and turn soil	many days	August to November
2 topoha-rano	spade	men	irrigate the field	1 day	
3 mitrobaky & manitriky	spade knife	men	make mounds, 0.5m apart, and plant 3 cuttings per mound	1 or a few days	day after field irrigation
4 miava	spade	men	weeding		2,3 or 4 times depending on amount of weeds
5 magnapotaky		men, sometimes women	uproot the tubers	1 or a few days	August to October, 1 year after planting
5 mampikihy	knife	women	remove outer skin, dry in sun for 1 week	1 or a few days	immediately after harvesting often same day

Appendix 8. Table A8.1 Markets and prices for wild, non-cultivated resources

all prices are given in Malagasy Francs (FMG). 2,500 to 3,000 FMG to 1 Great Britain Pound during study period

ANDOHAHELA

Village	Price range	Inter-village	Price range	Market	Price range	Trader	Price range
planks	200-600 each	planks	200-600 each	baskets	500-1,000/pair	pachypodium	100/kapoaka
furniture	variable	furniture	variable	honey	1,000-1,500/l		
houses	10,000-90,000	houses	10,000-90,000	hovao oil	2,000-4,000/l		
thatch	250-600/2bundles	mats	1,000-5,000 each	mafotra	6,000/l		
mats	1,000-5,000 each	baskets	500-1,500/pair				
baskets	500-1,500/pair	pestles	350-1,500 each				
pestles	350-1,500 each	tool handles	250-750 each				
mortars	6,000 each	honey	1,000-1,500/l				
tool handle	250-750 each	hovao oil	2,000-4,000/l				
honey	1,000-1,500/l	wild pig	1,000-1,500/kg				
hovao oil	2,000-4,000/l	eels	250-1,000 each				
wild pig	1,000-1,500/kg	fish	variable				
eels	250-1,000 each	crustaceans	variable				
lemur	1,500 each	locusts	50-100/kapoaka				

SOALALA

Village	Price range	Inter-village	Price range	Market	Price range	Trader	Price range
mats	1,000-15,000 each	mats	1,000-15,000each	fresh fish (S)	500-1,000/kg	shark's fins	15,000-40,000/kg
baskets	500-1,500 each	brooms	500 each	dried fish (M)	900-1,300/kg	sea cucumbers	75-100 each
fish traps	750-1,500 each	fish traps	750-1,500 each	dried prawns (M)	1,500-3,000/kg	fresh prawns	1,500-2,000/kg
canoes	150,000-500,000	canoes	150,000-500,000	dried eels (M)	3,000-10,000/kg	dried prawns	3,000-4,000/daba
ox-carts	500,000-700,000	ox-carts	500,000-700,000	sea cucumber	5,000-20,000/kg	crabs	200-250/kg
dugong meat	1,500-2,000/kg	boat wood		crocodile skin	500-1000/cm wide	cashew nuts	5,000-15,000/dab
dugong oil	5,000/l	float/fagnary	10,000-30,000	tubers (S)	250/kg	fresh fish	250-500/kg
honey	1,500/l	planks	3000 each	honey (S)	1,500/l		
pestles		dugout wood	10,000/m	planks (M, buy)	6,000 each		
mortars		pestles		bees wax	2,000/kg		
tool handles		tool handles					
		raffia cord					
		dugong	1,000-2,000/kg				
		turtle meat	300/kapoaka				
		grilled fish	500-1000/kg				
		salted fish	500-1000/kg				
		crabs	500 for 2				
		dried prawns	3000-4,000/daba				
		tuber (kabija)	150/kapoaka				
		salt	1,500-2,500/daba				
		guineau fowl	2,000 each				
		honey	1,500/l				
		bees wax	2,000/kg				

kapoaka = 350 cubic cms (M = Mahajanga)

daba = approx. 6,500 cubic cms (S = Soalala)

Appendix 8. Table A8.2 Markets and prices for cultivated goods

all prices are given in Malagasy Francs (FMG). 2,500 to 3,000 FMG to 1 Great Britain Pound during study period

ANDOHAHELA

Village	Price range	Inter-village	Price range	Market	Price range	Trader	Price range
rice	500-1,400/kg	rice	500-1,400/kg	rice	500-1,400/kg	cattle	
manioc	200-1,000/plant	dried manioc	300-500/kg	dried manioc	300-500/kg	tobacco	
beans	300-500/kapoaka	sweet potatoes		maize	100-200/kapoaka	rum	
melons		tomatoes	100/5 or 6	coffee	700-1,600/kg	large pigs	100,000-150,000
bananas		onions		cattle			
oranges		beans	300-500/kapoaka	calf	35,000-60,000		
lychees		melons		bullock	150,000-230,000		
chickens	500-3,000 each	bananas		sheep	10,000-30,000		
piglets	10,000-15,000	oranges		goats	5,000-15,000		
cattle		chickens	1,000-3,000	chickens	1,000-3,000		
calf	35,000-60,000	piglets	10,000-15,000	ducks	3,000-5,000		
bullock	150,000-230,000	cattle		turkeys	7,500-12,500		
sheep	10,000-30,000	calf	35,000-60,000	rum	850-1,500/l		
pork	1,500-2,000/kg	bullock	150,000-230,000				
beef	1,000-1,500/kg	sheep	10,000-30,000				
goat meat	1,000/kg	pork	1,500-2,000/kg				
coffee beans	700-1,600/kg	beef	1,000-1,500/kg				
milk	750-1,000/l	goat meat	1,000/kg				
eggs		milk	750-1,000/l				
rum	1,000-2,000/l	eggs					
sugar cane		tobacco					
		rum	1,000-2,000/l				

SOALALA

Village	Price range	Inter-village	Price range	Market	Price range	Trader	Price range
rice	350-1000/kg	rice	350-1000/kg	rice	350-1000/kg	cattle	
	2,000-8,000/daba		2,000-8,000/daba	coconuts	300-400 each	calf	15,000-25,000
manioc	1,000/plant	manioc	2,500-4,000/daba	turkeys	7,000-15,000each	bullock	100,000-150,000
coconuts	350-500 each	coconuts	350-500 each	chickens	1,000-2,500	cashew nuts	5,000-15,000/daba
mangoes		mangoes		beef	1,500-2,000/kg	tobacco	
chickens	1,000-2,500	chickens	1,000-2,500				
beans	300-500/kapoaka	turkeys	7,000-15,000 each				
cattle		beans	300-500/kapoaka				
calf	15,000-25,000	cattle					
bullock	100,000-150,000	calf	15,000-25,000				
cart bullock	150,000-250,000	bullock	100,000-150,000				
		cart bullock	150,000-250,000				

kapoaka = 350 cubic cms

daba = approx. 6,500 cubic cms

Appendix 8. Table A8.3 Markets and prices for goods not produced locally

all prices are given in Malagasy francs (FMG). 2,500 to 3,000 FMG to 1 Great Britain Pound during study period

ANDOHAHELA

Village, occasional	Village Shop	Price Range	Market	Price Range	Itinerant Trader
sugar	sugar	1,500-2,000/kg	sugar	1,200-1,500/kg	medicines
paraffin	paraffin	1,000-1,250/l	paraffin	500-600/l	
soap	soap	250-500 each	cooking oil	3,500-4,000/l	
salt	salt	150-200/kapoaka	bread	50-100/piece	
coffee	coffee	250-500/kapoaka	salt	75-100/kapoaka	
bread	bread	100-150/piece	soap	200-300 each	
	medicines		coffee	250-400/kapoaka	
	hair oil		hair oil	900/0.25 l	
	cooking oil		batteries	800 each	
	matches		matches		
	school equipment		medicines		
			rice sacks		
			cartridges		
			clothes		
			blankets		
			cooking utensils		
			school equipment		
			corrugated iron		
			nails etc		
			spades		
			knives		

SOALALA

Village, occasional	Village Shop	Price Range	Market	Price Range	Itinerant Trader
sugar	sugar	1,600-2000/kg	sugar	1,000-1,200/kg	tobacco
paraffin	paraffin	1,000/l	paraffin	500-600/l	rum
cooking oil	cooking oil	4,000-6,000/l	cooking oil	3,000-5,000/l	
rum	batteries	1,000 each	rum	1,000-2,000/l	
tobacco	hair oil	750/0.25 l	batteries	900 each	
soap	soap	350-600 each	hair oil		
	coffee	500/kapoaka	soap	250-300 each	
	tea		coffee		
	medicines		tea		
	school materials		tobacco		
	fish hooks		medicines		
			clothes		
			school materials		
			cartridges		
			spades		
			knives		
			rice sacks		
			cooking utensils		
			fish hooks		
			fish/prawn nets		
			material for sail		
			paint		
			tar		
			nails and bolts		
			cart axle/wheels		

kapoaka = 350 cubic cms

Appendix 8. HOUSEHOLD BUDGET: EXPENSES

Village: EMINIMINY March 1993

Household Number: 1

Household expenses, non consumable, in last 12 months

Materials	Total	notes
clothes	35,750	
sandals	3,500	
sahafa	500	flat basket for winnowing rice
mat	2,500	
watches	25,000	
belt	4,000	
umberella	15,000	
bucket	5,000	
	91,250	

Household expenses, consumable, in last month

product	units	number /month	price	kap of rice	price of kap rice	Total /month	notes
paraffin	litre	4	600		250	2,400	
salt	kapoaka	4	100			400	
soap	piece	6	300			1,800	
sugar	kilo	3	1,200			3,600	
coffee	kapoaka	6	400			2,400	
batteries	each	6	750			4,500	
matches	box	4	125			500	
lighter		4	25			100	
coconut oil	0.25 litre	1	1000			1,000	
biscuits						1,000	
rum	litre	2	1500			3,000	
tobacco	zehy	10	200			2,000	
laoka						2,500	
meals at market						3,600	
						28,800	

Household Number: 2

Household expenses, non consumable in last 12 months

Materials	Total	notes
cooking stand	1,000	
bucket	4,500	
clothes	10,000	
rope	2,000	
fish hooks	600	
	18,100	

Household expenses, consumable, in last month

product	units	number /month	price	kap of rice	price of kap rice	Total /month	notes
paraffin	litre	0.5		3	250	750	
salt	kapoaka	3		3		750	
soap	piece	6	225			1,350	
coconut oil	litre	0.04	4000			160	
biscuits						750	
tobacco	zehy	5	200			1,000	
laoka				6		1,500	
						6,260	

Household Number: 3

Household expenses, non consumable in last 12 months

Materials	Number	Total	notes
bowls	4	2,000	
bucket	1	4,500	
knife	1	1,500	
frying pan	1	1,750	
jerry can	1	1,000	
bag	1	10,000	
hat	1	1,500	
watches	3	4,000	
trousers	1	7,500	
shorts	2	15,500	
		49,250	

Household expenses, consumable, in last month

product	units	number /month	price	kap of rice	price of kap rice	Total /month	notes
paraffin	litre	3.0		24	250	6,000	
salt	kapoaka	5		5		1,250	
brillantine	jar	0.5	2000			1,000	for women's hair conditioning
lighter	flint	4	50			200	
coffee	kapoaka	15		30		7,500	
tobacco	zehy	32	175			5,600	
laoka						4,000	2 kilos pork
						25,550	

Household Number: 4

Household expenses, non consumable in last 12 months

Materials	Number	Total	notes
bowls	1	1,000	
bucket	1	1,000	
plate	1	1,500	
spoons	5	1,250	
pestle	1	500	
basket	1	500	
clothes		20,500	
knife	1	750	
box	1	400	
cups	4	2,000	
		29,400	

Household expenses, consumable, in last month

product	units	number /month	price	kap of rice	price of kap rice	Total /month	notes
paraffin	litre	1.0		6	250	1,500	
salt	kapoaka	2		2		500	
pork fat	litre	0.5	4000			2,000	for women's hair conditioning
sugar	kap	3.5		10		2,500	
coffee	kapoaka	4		10		2,500	
laoka						2,000	1 litre hovao oil
						11,000	

Household Number: 5

Household expenses, non consumable in last 12 months

Materials	Number	Total	notes
clothes		50,000	
baskets	2	2,000	
		52,000	

Household expenses, consumable, in last month

product	units	number /month	price	kap of rice	price of kap rice	Total /month	notes
paraffin	litre	2.0	600		250	1,200	
salt	kapoaka	10		10		2,500	
soap	piece	5	250			1,250	
tobacco	zehy	5	200			1,000	
sugar	kapoaka	1		3		750	
coffee	kapoaka	4		10		2,500	
laoka						3,500	1 litre hovao oil
						12,700	

Household Number: 6

Household expenses, non consumable in last 12 months

Materials	Number	Total	notes
clothes		50,000	
		50,000	

Household expenses, consumable, in last month

product	units	number /month	price	kap of rice	price of kap rice	Total /month	notes
paraffin	litre	2.0		6	250	1,500	
salt	kapoaka	6		6		1,500	
sugar	kapoaka	1		3		750	
tobacco	zehy	4		8		2,000	
coffee	kapoaka	8	350			2,800	
laoka						1,000	0.5 litre hovao oil
						9,550	

Appendix 9. Examples of food fady in Soalala

local name	English name	Scientific name
Man 1, Antsira		
tsibahaka	Decken's sifaka	Propithecus verreauxi deckeni
gidro	brown lemur	Lemur fulvus rufus
dretsy	large eel	
fanihy	fruit bat	Pteropus rufus
lambo	pig (wild or domestic)	
lambondriaka (= fesoky)	dolphin	
karaoky	grey-headed lovebird	Agapornis cana
koera	vaza parrots	Coracopsis sp.
kilandy	cattle egret	Bubulcus ibis
fody	Madagascar red fody	Foudia madagascariensis
relinto	Malagasy kingfisher	Corythornis vintsioides
voronadabo	Madagascar green pigeon	Treron australis
Man 2, Antsira		
trandraly	non-carnivorous shark	
omby vandamena	white cow with red marks	
lambo	pig (wild and domestic)	
voronadabo	Madagascar green pigeon	Treron australis
reilovy	crested drongo	Dicrurus forficatus
lintotsy	Malagasy kingfisher	Corythornis vintsioides
soianga	souimanga sunbird	Nectarinia souimanga
voanjobory	bambarra groundnuts	
anamamy	type of green vegetable	
not fady but not eaten		
tsibahaka	Decken's sifaka	Propithecus verreauxi deckeni
gidro	brown lemur	Lemur fulvus rufus
angonoka	ploughshare tortoise	Geochelone yniphora
amalo	eel	
Woman 1, Antsira		
tsibahaka	Decken's sifaka	Propithecus verreauxi deckeni
gidro	brown lemur	Lemur fulvus rufus
lambo	pig (wild and domestic)	
fanihy	fruit bat	Pteropus rufus
trandraly	non-carnivorous shark	
ankio	all sharks	
karaoky	grey-headed lovebird	Agapornis cana
koera	vaza parrots	Coracopsis sp.
tokoza(=droviky)	white-throated rail	Dryolimnas cuvieri
fody	Madagascar red fody	Foudia madagascariensis
lintotsy	Malagasy kingfisher	Corythornis vintsioides
voronadabo	Madagascar green pigeon	Treron australis
kafe	coffee	
pilipilimena	small red chillies	
ronono mandry	tinned condensed milk	
(also to take a journey on a Monday)		

local name	English name	Scientific name
Woman 2, Antsira (from Besalampy)		
trandraly	non-carnivorous shark	
omby vandamena	white cow with red marks	
bengy	goat	
lambo	pig (wild and domestic)	
akoho	chicken	
toloho	Madagascar coucal	Centropus toulou
fody	Madagascar red fody	Foudia madagascariensis
not fady but not eaten		
tsibahaka		
gidro		
Woman 3, Antsira (from Amparafaka)		
trandraly	non-carnivorous shark	
tokoza(=droviky)	white-throated rail	Dryolimnas cuvieri
bengy	goat	
ondry	sheep	
omby vandamena	white cow with red marks	
omby kotra	horns soft & turn forward	
omby bory	no horns	
Man 3, Antanandava		
omby vandamena	white cow with red marks	
omby kotroky	horns soft & turn forward	
tsaramaso	haricot beans	
voanjobory	bambarra groundnuts	
kapiky asaly	roast freshwater turtle	
(also to buy salt for cash, although may barter)		
Woman 4, Antanandava (from Mahajamba)		
lambo	pig (wild and domestic)	
akoho	chicken	
dretsy	large eel	
amalo	eel	
Woman 5, Antanandava (from Kasany)		
lambo	pig (wild and domestic)	
trandraly	non-carnivorous shark	
fesoky	dolphin	
lintotsy	Malagasy kingfisher	Corythornis vintsioides

Appendix 10. SOALALA, LIST OF PLANTS IDENTIFIED

Uses: cons = construction; med = medicinal;
V = identification supported by vouchers

Family	Scientific name	Local Name	V	Type	Habitat	Uses
Acanthaceae	Hypoestes sp.	lengondrohy	x	shrub	scrub	med
Amaranthaceae	Herva? javanica	mokosa	x	herb	village	other
Anacardiaceae	Anacardium occidentale	mahabibo		tree	savanna/village	cons food
Anacardiaceae	Mangifera indica	manga		tree	village	cons food
Anacardiaceae	Poupartia caffra	sakoa	x	tree	village	cons med food
Anacardiaceae	Poupartia silvatica	atikonjo	x	tree	forest	cons
Apocynaceae	Mascarenhasia arborescens	kidroa	x	tree	forest	other
Apocynaceae	Pachypodium rutenbergianum	vontaka		tree	forest/scrub	other
Apocynaceae	Tabernaemontana sp.	mamalofolahy	x	tree	forest	cons
Araceae	Typhonodorum lindleyanum	via		herb	marsh	food
Aristolochiaceae	Aristolochia sp.	tontonga	x	shrub	forest/scrub	med
Asclepiadaceae	Leptadenia madagascariensis	vaironto	x	vine	scrub	med fodder
Avicenniaceae	Avicennia marina	afiafy	x	herb	coast	med
Bignoniaceae	Stereospermum sp.	mangarahara	x	tree	forest	cons other
Bombacaceae	Adansonia digitata	boy, bozo	x	tree	village	food
Bombacaeae	?Ceiba pentandra/?Bombax sp.	pamba		tree	village	cons
Bombacaeae	Adansonia za	reniala	x	tree	forest	food
Boraginaceae	Cordia subcordata	varoloho	x	tree	coast	cons
Boraginaceae	Cordia varo	adabo	x	tree	scrub	cons
Burseraceae	Commiphora guillaumini	arofy	x	tree	forest	cons
Caesalpinaceae	Bauhinia hildebrantii	hotrombengy	x	tree	scrub	
Caesalpinaceae	Caesalpinia bonduc	katra	x	tree	forest/scrub	med ritual
Caesalpinaceae	Cassia occidentalis	moanakontsovoky	x	herb	scrub	food
Capparidaceae	Boscia plantefolii	maroaka	x	tree	forest/scrub	cons ritual
Casuarinaceae	Casuarina sp.	fiofio		tree	coast	
Chenopodiaceae	?Salicornia sp.	felitsira		herb	salt pan	food
Combretaceae	Lumnitzera racemosa	kimiramira	x	tree	coast	cons med
Combretaceae	Terminalia mantaly	taly	x	tree	forest	cons other
Combretaceae	Terminalia sp.	amaninomby	x	tree	forest	cons
Connaraceae	Rourea orientalis	kitsongo	x	tree	forest/scrub	other
Cucurbitaceae	Luffa sp.	madrodroko	x	shrub	village	food
Cyperaceae	Cladium flexuosum	faho	x	herb	marsh	
Cyperaceae	Cyperis aequalis	voandoha	x	herb	marsh	ritual
Dichatepalaceae	Dichapetalum leucosa	kohokobo	x	tree	forest/scrub	food
Dioscoreaceae	Dioscorea sp.	bemandry		vine	forest/scrub	food
Dioscoreaceae	Dioscorea sp.	masiba		vine	forest	food
Ebenaceae	Diospyros mapingo	pingo lahy	x	tree	forest	cons
Ebenaceae	Diospyros perrieri	pingo vavy	x	tree	forest	cons
Ebenaceae	Diospyros sp.	jobifototsy	x	tree	forest	cons med
Erythroxylaceae	Erythroxylum sp.	boramena 1	x	tree	forest/scrub	cons
Euphorbiaceae	Bridelia pervilleana	kitata	x	tree	forest	cons
Euphorbiaceae	Croton sp.	somora	x	shrub	forest/scrub	ritual
Euphorbiaceae	Euphorbia famata	samata	x	shrub	scrub	cons other
Euphorbiaceae	Securinega sp.	mariragna	x	tree	forest/scrub	cons
Flacourtiaceae	Caesaria sp.	tainpapango	x	tree	forest	cons
Flacourtiaceae	Flacourtia ramontchi	tsingoma	x	tree	forest/scrub	food
Gramineae	Aristida rufescens	paikpaiky	x	herb	savanna	ritual
Gramineae	Heteropogon contortus	ahidambo	x	herb	savanna	fodder
Gramineae	Hyparrhenia rufa	sy	x	grass	savanna	fodder
Gramineae	Imperata cylindrica	magneviky	x	herb	marsh	med
Gramineae	Nastus sp.	valiha	x	herb	scrub	cons med other
Hernandiaceae	?Gyrocarpus americanus	mafay		tree	forest	cons
Hernandiaceae	?Hernandia voyroni	morasiny		tree	forest	cons med
Lauraceae	Cassytha filiformis	tsihitafototsy	x	vine	forest/scrub	med
Lecythidaceae	Foetidia sp.	namologna	x	tree	forest/scrub	cons

Family	Scientific name	Local Name	V	Type	Habitat	Uses
Leguminosae	Abrus precatorius	voamaintilagny	x	vine	scrub	med
Leguminosae	Cryptostegia madagascariensis	lombiry	x	vine	scrub/savanna	med ritual
Leguminosae	Dalbergia sp.	tainkindambo	x	tree	forest	cons
Leguminosae	Indigofera perrieri	tsihazondragnitsy	x	shrub	forest/scrub	cons
Leguminosae	Indigofera tinctoria	nietsy	x	shrub	scrub	other
Leguminosae	Tamarindus indica	madiro	x	tree	village	food
Leguminosae		sakonkomba	x	tree	forest/scrub	cons
Liliaceae	Aloe vahombe	sobiriala	x	herb	forest/scrub	med other
Loganiaceae	Strychnos sp.	hazomby	x	tree	village	
Loganiaceae	Strychnos sp.	vakakoa	x	tree	forest/scrub	cons
Loganiaceae	Strychnos spinosa	mokotra	x	tree	village/savanna	food
Loranthaceae?	Viscum sp.	velomihanto	x	vine	forest/scrub	ritual
Lythraceae	?Lawsonia inermis	moina		tree	village/scrub	ritual
Malphigiaceae	Acridocarpus excelsus	mavoravy	x	tree	savanna	cons ritual
Malvaceae	Hibiscus sp.	maignaty	x	tree	coast	cons
Malvaceae	Thespesia populnea	varo	x	tree	coast	cons med other
Meliaceae	Carafa obovata	fobo	x	tree	coast	cons med
Meliaceae	Cedrelopsis grevei	katrafay	x	tree	forest	cons med other
Meliaceae	Malleastrum psammophilum	ndramagnamora	x	tree	scrub	med food
Mimosaceae	?Entada chryostachys	fany		tree/vine	scrub	ritual
Mimosaceae	Albizia lebbeck	bonara	x	tree	scrub	cons
Mimosaceae	Dichrostachys sp.	kifiatry	x	tree	forest	cons
Mimosaceae	Erythrophleum couminga	komanga	x	tree	forest/scrub	cons
Mimosaceae	Mimosa latispinosa	raileja	x	shrub	scrub	ritual
Mimosaceae	Piptadenia pervilleae	morango	x	tree	forest/scrub	cons
Moraceae	?Chlorophora greveana	vory		tree	forest	cons
Moraceae	Ficus grevei	aviavy	x	tree	forest	cons
Myrtaceae	Eugenia jambolana	jambarao	x	tree	village,savanna	food
Myrtaceae	Eugenia sp.	zanabato	x	tree	forest/scrub	cons
Nymphaeaceae	Nymphaea sp.	agoago	x	herb	freshwater	food
Nymphaeaceae	Nymphaea sp.	makamba	x	herb	freshwater	food
Ochnaceae	Ouratea deltoideum	boramena 2	x	tree	forest/scrub	cons
Palmae	Bismarckia nobilis	satrabe		tree	savanna	cons food
Palmae	Chrysalidocarpus sp.	kindro		tree	forest/scrub	food
Palmae	Hyphaene shatan	satra mira		tree	coast	cons food
Palmae	Raphia ruffia	maivanaty		tree	marsh	cons other
Pandanaceae	Pandanus sp.	droa		tree	savanna	ritual
Papilionaceae	Baphia cappordifolia	antrendry	x	tree	coast	med food
Papilionaceae	Dalbergia greveana	magnary	x	tree	forest	cons
Papilionaceae	Erythrina sp.	monongo 1	x	tree	coast	cons
Papilionaceae	Mundulea sp.	fagnamohazo	x	tree	forest	ritual
Papilionaceae	Mundulea sp.	tsakafara	x		forest/scrub	ritual
Pedaliaceae	Uncarina peltata	tabotabo	x	shrub	forest/scrub	other
Pittosporaceae	Pittosporum verticillatum	antalihazo	x	tree	forest/scrub	cons med
Rhamnaceae	?Berchemia discolor	tsiandala		tree	forest	other
Rhamnaceae	Helinus ovatus	kadabiky	x		village/scrub	other
Rhamnaceae	Ziziphus spina-christi	mokonazy	x	tree	village/scrub	cons food
Rhizophoraceae	Bruguiera gymnorhiza	honkolahy	x	tree	coast	cons
Rhizophoraceae	Ceriops boiviniana	honkovavy	x	tree	coast	cons other
Rhizophoraceae	Rhizophora mucronata	tanga	x	tree	coast	cons
Rhopalocarpaceae	Rhopalocarpus lucidus	hazondragnitsy	x	tree	scrub	med
Rubiaceae	?Hymenodictyon decaryi	beholy		tree	forest/scrub	cons other
Rubiaceae	?Santalina madagascariensis	masonjoany		tree	forest	other
Rubiaceae	Breonadia salicina	sohihy	x	tree	scrub	cons med ritual
Rubiaceae	Gardenia sp.	embokimbe	x	tree	forest	ritual
Rubiaceae	Gardenia sp.	lohavato	x	tree	forest/scrub	cons
Rubiaceae	Genipa sp.	taolankena	x	tree	forest/scrub	cons
Rubiaceae	Ixorca sp.	kirepoky	x	tree	coast	food

Family	Scientific name	Local Name	V	Type	Habitat	Uses	
Rutaceae	Zanthoxylum sp.	monongo 2	x	tree	forest	cons	
Rutaceae		roitsiala	x	shrub	forest/scrub		food
Sapindaceae	Lepisanthes sp.	lipompo	x	tree	coast	cons	
Sapotaceae	Sideroxylon sp.	nato	x	tree	forest	cons	
Sapotaceae		hazonjia	x	tree	forest/scrub		other
Scrophulariaceae	Radamaea montana	tamotamohazo	x	tree	forest/scrub		ritual
Sonneratiaceae	Sonneratia alba	rogno	x	tree	coast	cons	
Sterculiaceae	?Sterculia ankaranensis	aboringa		tree	forest	cons	
Sterculiaceae	Heritiera littoralis	moromony	x	tree	coast	cons med	
Sterculiaceae	Waltheria indica	mandravinsarotsy	x		scrub		ritual
Strelitziaceae	Ravenala madagascariensis	antrandra		tree	forest/savanna	cons med	
Taccaceae	Tacca sp.	kabija		herb	forest		food
Tiliaceae	Grewia sp.	selivato	x	tree	forest/scrub	cons	
Tiliaceae	Grewia sp.	sely	x	tree	forest	cons med	
Tiliaceae	Grewia sp.	tokampototsy	x	tree	forest/scrub	cons	
Verbenaceae	?Vitex beraviensis	voamay		tree	forest	cons	

Total listed: 129

Total with vouchers: 103

APPENDIX 10: SOALALA, MOST COMMONLY USED PLANTS

Origin/found at: Sa=Cape Sada, Be=Beheta, Bt=bought

Local Name	Family	Scientific Name	Habitat	Origin
HOUSE POSTS: IN GROUND				
magnary	Leguminosae	Dalbergia sp.	forest	Sa,Be
kitata	Euphorbiaceae	Bridelia pervilleana	forest	
taolankena	Rubiaceae	Genipa sp.	forest/scrub	
honko	Rhizophoraceae	Ceriops boibiniana	coast	
kifiatry	Leguminosae	Dichrostachys sp.	forest	
katrafay	Leguminosae	Cedrelopsis grevei	forest	Sa,Be
amaninomby	Combretaceae	Terminalia bovinii	forest	Sa,Be
namologna	Lecithydaceae	Foetidia sp.	forest/scrub	Sa,Be
tokampototsy	Tiliaceae	Grewia sp.	forest/scrub	
taly	Combretaceae	Terminalia mantaly	forest/scrub	Sa,Be
volitsaka				
mariragna	Euphorbiaceae	Securinega sp.	forest/scrub	
nato	Sapotaceae	Sideroxylon sp.	forest	Sa,Be
antalihazo	Pittosporaceae	Pittosporum verticulatum	forest/scrub	
mokonazy	Rhamnaceae	Ziziphus spina-christi	village	
boramena	Ochnaceae	Ouratea deltoideum	forest/scrub	Sa,Be
sely	Tiliaceae	Grewia sp.	forest/scrub	
tamotamohazo	Scrophulariaceae	Radameaea montana	forest/scrub	Sa,Be
sofinankomba			forest	
HOUSE POSTS: ABOVE GROUND				
honko	Rhizophoraceae	Ceriops boibiniana	coast	
amaninomby	Combretaceae	Terminalia bovinii	forest	Sa,Be
taly	Combretaceae	Terminalia mantaly	forest/scrub	Sa,Be
zanabato	Myrtaceae	Eugenia sp.	forest/scrub	
tokampototsy	Tiliaceae	Grewia sp.	forest/scrub	
hazoambo				
maevalafoky				
mokonazy	Rhamnaceae	Ziziphus spina-christi	village	
boramena	Ochnaceae	Ouratea deltoideum	forest/scrub	Sa,Be
tapiakanga				
kirepoky	Rubiaceae	Ixorca sp.	coast	
namologna	Lecythidaceae	Foetidia sp.	forest/scrub	Sa,Be
sely	Tiliaceae	Grewia sp.	forest/scrub	
mamalofolahy	Apocynaceae	Tabernaemontana sp.	forest/scrub	
mavoravy	Malphigiaceae	Acridocarpus excelsus	savanna	
tainkindambo	Leguminosae	Dalbergia sp.	forest	
PLANKS FOR DOORS etc.				
aboringa	Sterculiaceae	?Sterculia ankaranensis	forest	Bt
maignaty	Malvaceae	Hibiscus sp.	coast	Sa,Be
valotsy	Rubiaceae	Gardenia sp.	forest/scrub	
monongo	Rutaceae	Zanthoxylum sp.	forest	Sa,Be
ROOF & WALL MATERIALS				
valiha	Gramineae	Nastus sp.	scrub	Sa,Be
maivanaty	Palmae	Raphia ruffia	marsh	
satra	Palmae	Bismarckia nobilis	savanna	

CORD FROM BARK				
sely	Tiliaceae	Grewia sp.	forest/scrub	
hotrombengy	Caesalpinaceae	Bauhinia hildebrantii	forest/scrub	
valoambaka				Be
tala				
kolohoto				
beholy	?Rubiaceae	?Hymenodictyon decaryi		Sa,Be
PESTLES				
nato	Sapotaceae	Sideroxylon sp.	forest	Sa,Be
tainkindambo	Leguminosae	Dalbergia sp.	forest	
taly	Combretaceae	Terminalia mantaly	forest/scrub	Sa,Be
amaninomby	Combretaceae	Terminalia bovinii	forest	Sa,Be
boramena	Ochnaceae	Ouratea deltoideum	forest/scrub	Sa,Be
jobifototsy	Ebenaceae	Diospyros sp.	forest	Sa,Be
hazompasy			forest	
MORTARS				
sakoa	Anacardiaceae	Pourpartia caffra	village	
manga	Anacardiaceae	Mangifera indica	village	
adabo	Boraginaceae	Cordia varo	village/savanna	
HANDLES OF AXES, SPADES, SPEARS etc.				
nato	Sapotaceae	Sideroxylon sp.	forest	Sa,Be
magnary	Leguminosae	Dalbergia sp.	forest	Sa,Be
tsihazondragnitsy	Leguminosae	Indigofera perrieri	forest	
GARDEN FENCES				
nato	Sapotaceae	Sideroxylon sp.	forest	Sa,Be
kitata	Euphorbiaceae	Bridelia pervilleana	forest	
taly	Combretaceae	Terminalia mantaly	forest/scrub	Sa,Be
hazompasy				
banty	Palmae	Bismarckia nobilis	savanna	
honko	Rhizophoraceae	Ceriops boiviniana	coast	
vakakoa	Loganiaceae	Strychnos sp.	forest/scrub	
fobo	Meliaceae	Carafa obovata	coast	
magnary	Leguminosae	Dalbergia sp	forest	Sa,Be
mavoka/maroaka?	Capparidaceae	Boscia plantefolii	forest/scrub	
taolankena	Rubiaceae	Genipa sp.	forest/scrub	
boramena	Erythroxylaceae	Erythroxylum sp.	forest/scrub	Sa,Be
tanga	Rhizophoraceae	Ryzophora mucronata	coast	
mangarahara	Bignoniaceae	Stereospermum sp.	forest	Sa,Be
namologna	Lecythidaceae	Foetidia sp.	forest/scrub	Sa,Be
mavoravy	Malphigiaceae	Acridocarpus excelsus	savanna	
komanga	Mimosaceae	Erythrophleum couminga	forest/scrub	Sa
MATS, BASKETS etc.				
satrabe	Palmae	Bismarckia nobilis	savanna	
satra mira	Palmae	Hyphaene shatan	savanna	
WILD TUBERS				
kabija	Taccaceae	Tacca pinnatifida	forest	
masiba	Dioscoraceae	Dioscorea sp.	forest	Be
bemandry	Dioscoraceae	Dioscorea sp.	forest/scrub	
makamba	Nymphaeaceae	Nymphaea sp.	freshwater	

WILD FRUITS

tsingoma	Flacourtiaceae	Flacourtia ramontchi	forest/scrub	
mokonazy	Rhamnaceae	Ziziphus spina-christi	village/scrub	
jambarao	Myrtaceae	Eugenia jambolana	village	
sakoa	Anacardiaceae	Pourpartia caffra	village	
maivanaty (maragnam	Palmae	Raphia ruffia	marsh	
satra (lakaoko)	Palmae	Bismarckia nobilis	savanna	
mokotra	Loganiaceae	Strychnos spinosa	village/scrub	

MOST FREQUENTLY USED FIREWOODS

sohihy	Rubiaceae	Breonadia salicida	forest/scrub	
nato	Sapotaceae	Sideroxylon sp.	forest	Sa,Be
magnary	Leguminosae	Dalbergia sp.	forest	Sa,Be
katrafay	Leguminosae	Cedrelopsis grevei	forest	Sa,Be
samira				
mokonazy	Rhamnaceae	Ziziphus spina-christi	village/scrub	
valotsy	Rubiaceae	Gardenia sp.	forest/scrub	
pamba	Bombacaceae	?Bombax sp.	village	
boramena	Erythroxylaceae	Erythroxylum sp.	forest/scrub	Sa,Be
mavoravy	Malphigiaceae	Acridocarpus excelsus	savanna	

WOODS FOR FACEPACKS

masonjoany	?Rubiaceae	?Santalina madagascariensis	forest	Bt
tamotamohazo	Scrophulariaceae	Radamaea montana	forest/scrub	Sa
madiro	Leguminosae	Tamarindus indicus	village	
tsiandala	?Rhamnaceae	?Berchemia discolor	forest	
afiafy	Avicenniaceae	Avicennia marina	coast	

CANOES

ROKA (dugout hull)

arofy	Burseraceae	Commiphora sp.	forest	Sa,Be
manga	Anacardiaceae	Mangifera indica	village	
mojiro/voamay				
monongo	Rutaceae	Zanthoxylum sp.	forest	Sa,Be
pamba	Bombacaceae	?Bombax sp.	village	

TAROMA (internal hull supports)

sakoa	Anacardiaceae	Pourpartia caffra	village	
afiafy	Avicenniaceae	Avicennia marina	coast	
manga	Anacardiaceae	Mangifera indica	village	
morango	Mimosceae	Piptadena pervilleae	forest/scrub	Sa,Be
bonara	Mimosaceae	Albizia lebbeck	village/savanna	
madiro	Leguminosae	Tamarindus indicus	village	
moromony	Sterculiaceae	Heritiera littoralis	coast	Sa

TOVO (shaped ends)

rogno	Sonneratiaceae	Sonneratia alba	coast	
mahabibo	Anacardiaceae	Annacardium occidentale	village/savanna	
manga	Anacardiaceae	Mangifera indica	village	
adabo	Boraginaceae	Cordia varo	scrub	
arofy	Burseraceae	Commiphora sp.	forest	Sa,Be
sakoa	Anacardiaceae	Poupartia caffra	village	

FAGNARY (outrigger)				
aboringa	Sterculiaceae	?Sterculia ankaranensis	forest	Bt
atikonjo	Anacardiaceae	Poupartia silvatica	forest	Sa, Be
tanatsatsaka				Sa, Be
pamba	Bombacaceae	?Bombax sp.	village	
mafay	?Hernandiaceae	?Gyrocarpus americanus	forest	Bt
TATIKY (pegs joining outrigger)				
varo	Malvaceae	Thespesia populnea	coast	
lipompo	Sapindaceae	Lepisanthes sp.	coast	
mangarahara	Bignoniaceae	Stereospermum sp.	forest	Sa, Be
maroaka	Capparidaceae	Boscia plantefolii	forest/scrub	
tanora				
nato	Sapotaceae	Sideroxylon sp.	forest	Sa, Be
kimiramira	Combretaceae	Lumnitzera racemosa	coast	
VAROGNA (small balance)				
taly	Combretaceae	Terminalia mantaly	forest/scrub	Sa, Be
tainkindambo	Leguminosae	Dalbergia sp.	forest	
amaninomby	Combretaceae	Terminalia bovinii	forest	Sa, Be
FAFA (planks for sides)				
monongo	Rutaceae	Zanthoxylum sp.	forest	Sa, Be
arofy	Burseraceae	Commiphora sp.	forest	Sa, Be
vory	?Moraceae	?Chlorophora greveana	forest	Bt
morasiny	?Hernandiaceae	?Hernandia voyroni	forest	Bt
FIHAMIKY (planks for seats)				
hazompasy				
monongo	Rutaceae	Zanthoxylum sp.	forest	Sa, Be
HONGORY, FORMALY, ANGIRA (masts and boom)				
sely	Tiliaceae	Grewia sp.	forest/scrub	
selivato	Tiliaceae	Grewia sp.	forest/scrub	Sa, Be
tokampototsy	Tiliaceae	Grewia sp.	forest/scrub	
maignaty	Malvaceae	Hibiscus sp.	coast	
FIVE (paddle)				
magnary	Leguminosae	Dalbergia sp.	forest	Sa, Be
hazompasy				
taly	Combretaceae	Terminalia mantaly	forest/scrub	Sa, Be
pingo	Ebenaceae	Diospyros sp.	forest	Sa, Be
boramena	Erythroxylaceae	Erythroxylum sp.	forest/scrub	Sa, Be
OXCARTS				
magnary	Leguminosae	Dalbergia sp.	forest	Sa, Be
maignaty	Malvaceae	Hibiscus sp.	coast	Sa, Be
bonara	Mimosaceae	Albizia lebbeck	village/savanna	
mokonazy	Rhamnaceae	Ziziphus spina-christi	village/savanna	

APPENDIX 10. SOALALA, MEDICINAL PLANTS

Local name	Scientific name	Part used	Condition treated
afiafy	Avicennia marina	leaves	fever: inhale vapours
antalihazo	Pittosporum verticillatum	wood, bark	fatigue, indigestion: lick wood or drink infusion of bark
antrandra	Ravenala madagascariensis	leaves	stomach ache
fobo	Carafa obovata	seed	abcess: grated and applied around un-ruptured abcess to con
hazondragnitsy	Rhopalocarpus lucidus	leaves	new wound: crush leaves, apply juice to wound
jobifototsy	Diospyros sp.	root, bark	headache: grated and paste spread on forehead
katra	Caesalpinia bonduc	seed, leaves	malaria, child's cough: drink infusion of leaves or powdere
katrafay	Cedrelopsis grevei	bark	stomach ache, cough: drink infusion, tastes bitter
kimiramira	Lumnitzera racemosa	bark	fever, diarrhoea: infusion, boiled until red
lengondrohy	Hypoestes sp.	leaves	chew leaves to maintain healthy gums
lombiry	Cryptostegia madagascariensis	shoot,leaves	persistent headaches: inhale vapours
magneviky	Imperata cylindrica	grass	cramp or pain in side: infusion, vapours inhaled,
morasiny	?Hernandia voyroni	wood	fever and headache: apply a paste of aromatic wood to foreh
moromony	Heritiera littoralis	fruit	abcess: grated and applied to abcess
ndramagnamora	Malleastrum psammophilum	whole plant	indigestion, or any pain: drink infusion
sakoa	Poupartia caffra	bark	diarrhoea, childbirth: infusion, drink and wash body
sely	Grewia sp.	leaves	fever: infusion drunk or vapour inhaled
sobiriala	Aloe vahombe	sap	constipation: mixed with hot water, drunk
sohihy	Breonadia salicina	bark	calms rash from 'tainkilotra'
tontonga	Aristolochia sp.	leaves, root	pain in intestines & back, or persistent headache: drink in
tsihitafototsy	Cassytha filiformis	stem	stomach ache: drink infusion
vaironto	Leptadenia madagascariensis	fruit	backache
valiha	Nastus sp.	sap of shoots	backache, chest problems
varo	Thespesia populnea	leaves	infusion for fatigue
voamaintilagny	Abrus precatorius	leaves	measles

Total listed: 25

APPENDIX 10. SOALALA, plants used for food, ritual and 'other' uses

Type	Local name	Scientific name	Part used	Use
fodder	ahidambo	Heteropogon contortus	leaf, stem	high quality pasture for cattle
fodder	sy	Hyparrhenia rufa	whole plant	eaten by cattle but 'ahidambo', Heteropogon contortu
fodder	vaironto	Leptadenia madagascariensis	leaves	shredded for young turkeys
	Total listed:	3		
food	agoago	Nymphaea sp.	tuber	eaten raw and are sweet
food	antrendry	Baphia cappordifolia	fruit	ripe October
food	bemandry	Dioscorea sp.	tuber	Tubers are eaten raw.
food	boy, bozo	Adansonia digitata	fruit	flesh of fruit eaten, can make cooking oil from seed
food	felitsira	?Salicornia sp.	leaves	mashed with oil and coconut to make a fresh chutney
food	jambarao	Eugenia jambolana	fruit	fruit eaten
food	kabija	Tacca sp.	tuber	starch washed out of grated root, dried powder used
food	kindro	Chrysalidocarpus sp.	shoot	palm heart, boiled in water, called 'potaky', slight
food	kirepoky	Ixorca sp.	fruit	
food	kohokobo	Dichapetalum leucosa	fruit	large fruits eaten in the wet season
food	madiro	Tamarindus indica	fruit	sharp flavour for cooking
food	madrodroko	Luffa sp.	fruit	eat when young, pan scrubber when old
food	mahabibo	Anacardium occidentale	fruit/nut	nuts eaten roasted and sold
food	makamba	Nymphaea sp.	tuber	tubers are peeled and boiled, taste bitter, eaten in
food	manga	Mangifera indica	fruit	raw when ripe and unripe for cooking
food	maragnambo	Raphia ruffia	fruit	fruit (maragnambo) of raphia tree (maivanaty)
food	masiba	Dioscorea sp.	tuber	cooked like manioc
food	moanakontsovoky	Cassia occidentalis	seed	roasted and used like coffee
food	mokonazy	Ziziphus spina-christi	fruit	fruit eaten, especially by children. Sold in towns,
food	mokotra	Strychnos spinosa	fruit	
food	ndramagnamora	Malleastrum psammophilum	fruit	fruit eaten
food	reniala	Adansonia za	fruit	
food	roitsiala		fruit	fruit eaten
food	sakoa	Poupartia caffra	fruit	fruit eaten
food	satra mira	Hyphaene shatan	fruit, sap	thin layer pith of fruit eaten, sap made into palm w
food	satrabe	Bismarckia nobilis	fruit, shoot	pith of fruits is eaten; interior shoot (palm heart)
food	tsingoma	Flacourtia ramontchi	fruit	fruit eaten
food	via	Typhonodorum lindleyanum	tuber	eaten in famines
	Total listed:	28		
other	beholy	?Hymenodictyon decaryi	root	soap substitute
other	hazonjia		root	soap
other	honkovavy	Ceriops boiviniana	bark	red dye for mats and cloth, historically exported fo
other	kadabiky	Helinus ovatus	root	soap, grated
other	katrafay	Cedrelopsis grevei	wood	cosmetic: wood paste used as face pack
other	kidroa	Mascarenhasia arborescens	sap	rubber, not used locally, historically exported
other	kitsongo	Rourea orientalis	bark, leaves	poison, to kill dogs
other	maivanaty	Raphia ruffia	new leaves	historically woven for clothes and sails (rango)
other	mangarahara	Stereospermum sp.	leaves	used in blood brother 'mpifatidraha' ceremony
other	masonjoany	?Santalina madagascariensis	wood	cosmetic: wood paste used as face pack
other	mokosa	Herva? javanica	flower	stuffing for pillows
other	nietsy	Indigofera tinctoria	leaves	dye, used for palm leaves woven into mats, baskets e
other	samata	Euphorbia famata	sap	blowpipe, latex used to prevent pipe cracking when s
other	sobiriala	Aloe vahombe	sap	wean children, place bitter sap on nipples
other	tabotabo	Uncarina peltata	fruit	mouse traps
other	taly	Terminalia mantaly	bark	catalyst for fermentation for rum
other	tsiandala	?Berchemia discolor	wood	cosmetic: red wood paste used for face pack
other	valiha	Nastus sp.	stem	pipe used in rum distillation
other	varo	Thespesia populnea	fruit	dye, dry brown fruits boiled for yellow dye mats

Type	Local name	Scientific name	Part used	Use
other	vontaka	Pachypodium rutenbergianum	bark	fibres woven for cloth used for sails and clothing i

Total listed: 20

ritual	droa	Pandanus sp.	flower, stam	used locally for perfume
ritual	embokimbe	Gardenia sp.	resin	burned as incense at traditional ceremonies such as
ritual	fagnamohazo	Mundulea sp.	bark	fish poison to kill and collect freshwater fish
ritual	fany	?Entada chryostachys	seeds	seeds used for divination 'sikidy'
ritual	katra	Caesalpinia bonduc	seed	game: board game of same name
ritual	lombiry	Cryptostegia madagascariensis	sap	potent poison & makes blind if goes in eyes
ritual	mandravinsarotsy	Waltheria indica	whole plant	sorcery, used against
ritual	maroaka	Boscia plantefolii	wood	used by traditional healer, 'moasy'
ritual	mavoravy	Acridocarpus excelsus	leaves	burned with other leaves in practice of 'doraka' to
ritual	moina	?Lawsonia inermis		dye for hands, used by women
ritual	paikpaiky	Aristida rufescens	stem	ears, put through newly pierced ears to keep open
ritual	raileja	Mimosa latispinosa	whole plant?	used by traditional healer, 'moasy'
ritual	sohihy	Breonadia salicina	wood	coffins of kings
ritual	somora	Croton sp.	leaves	smoked for stimulant effect
ritual	tamotamohazo	Radamaea montana	root, fruit	facepack, root ground to paste, berries for orange c
ritual	tsakafara	Mundulea sp.	fruit	used by traditional healer, 'moasy'
ritual	velomihanto	Viscum sp.	whole plant	used by traditional healer, 'moasy'
ritual	voandoha	Cyperis aequalis	whole plant?	used by traditional healer, 'moasy'.

Total listed: 18

Appendix 10. ANDOHAHELA, LIST OF PLANTS IDENTIFIED

Uses: cons = construction; med = medicinal;
V = identification supported by vouchers
Habitat: forest1 = primary forest; forest2 = secondary forest

Family	Scientific name	Local Name	V	Type	Habitat	Uses
Adantiaceae	Pellaea calomelanos	mangarato	x	herb		med
Agavaceae	Agave sisalana	laloa		succulent	village	cons
Anacardiaceae	Operculicarya sp.	zobihy	x	shrub	forest2	cons med
Anacardiaceae	Poupartia caffra	sakoa	x	tree		med food
Anacardiaceae	Protorhus deflexa	sohihy	x	tree	forest2	cons
Anacardiaceae	Protorhus sp.	tarata	x	tree		other
Anacardiaceae	Sorindeia madagascariensis	voasirindry	x	tree		food
Apocynaceae	Landoelphia sp.	rehapiny	x	liana		med
Apocynaceae	Voacanga thouarsii	kaboka	x	tree		other
Araceae	Typhonodorum lindleyanum	via		herb	village	food
Asclepiadaceae	Asclepias fruticarpus	tapoaky	x	herb		med
Asclepiadaceae	Cynanchum sp.	beronono	x	liana		med food
Asclepiadaceae	Leptadenia madagascariensis	tsitaritariky	x	liana		med other
Asclepiadaceae	Secemone sp.	kopotsy	x	herb		other
Bignoniaceae	Fernandoa madagascariensis	tsomotsoy	x	tree	savanna	cons
Bignoniaceae	Phyllarthron bernierianum	zahambe	x	tree	forest2	cons med
Bombacaceae	Adansonia za	ja		tree	savanna	food
Burseraceae	Commiphora aprevalii	daro	x	tree		cons
Cactaceae	Opuntia sp.	raketa		succulent	village	food
Caesalpinaceae	Cynometra sp.	mapay	x	tree		med
Cannaceae	Canna indica	lingirotsy	x	herb	village	food
Capparidaceae	Maerua filiformis	somangy	x	shrub		med
Celestraceae	Gymnosporia polyacantha	tsingilofilo	x	shrub		med
Chenopodiaceae	Chenopodium ambrosioides	akatsoavaly	x	herb	forest2	med ritual
Combretaceae	Combretum coccineum	salaitsy	x	liana		med
Combretaceae	Combretum sp.	tamenaky	x	liana		med food
Compositae	Ageratum conyzoides	bembo	x	herb		med
Compositae	Brachylaena ramiflora	vatoa	x	tree	forest1/2	cons med
Compositae	Helichrysum faradifani	vongavonga	x	herb		med
Compositae	Pluchea bojeri	famotogny	x	shrub		med
Compositae	Psiadia altissima	zira	x	herb		med
Compositae	Senecio fanjasoides	komboy	x	herb		med
Compositae	Senecio sp.	resa	x	herb		med
Compositae	Senecio sp.	angia	x	herb		med
Compositae	Tridax procumbens	angama	x	herb		med
Compositae	Vernonia sp.	saripeha	x	herb		med
Connaraceae	Cnestis polyphylla	tokambahatsy	x	shrub		med
Crassulaceae	Kalanchoe integrifolia	tingotingo	x	succulent		med
Cucurbitaceae	Xerosicyos decaryi	tapisaky	x	succulent	forest2	med
Cunoniaceae	Weinmannia rhodoxylon	lalo	x	tree	forest1/2	cons
Cyperaceae	Cyperus aqualis	beloha	x	herb	village	cons
Cyperaceae	Cyperus articulatus	boboky	x	herb	savanna	cons
Cyperaceae	Cyperus latifolius	hera	x	herb	village	cons
Cyperaceae	Cyperus sp.	vinda	x	herb	savanna	cons ritual
Cyperaceae	Cyperus sp.	vindavato	x	herb	savanna	cons
Cyperaceae	Heliocharis equisetina	harefo-piky	x	herb		cons
Cyperaceae	Heliocharis plantaginus	harefobe	x	herb	village	cons
Cyperaceae	Pycreus mundtii	donadona	x	herb		med
Didieraceae	Alluaudia procera	fantsilotsy		tree	forest2	cons
Didymelaceae	Didymeles sp.	manovala	x	tree		med
Dioscoraceae	Dioscorea soso	sosa	x	herb	forest2	food
Dioscoraceae	Dioscorea sp.	vorozy	x	liana	forest1	food
Ebenaceae	Diospyros sp.	hazomainty	x	tree	savanna	cons other
Ebenaceae	Maba sp.	bandro	x	shrub		med

Family	Scientific name	Local Name	V	Type	Habitat	Uses
Erythroxylaceae	Erythroxylum sp.	menahihy	x	tree	forest1/2	cons
Erythroxylaceae	Erythroxylum sp.	tsimahavagno	x	shrub		med
Euphorbiaceae	Bridelia pervilleana	ombitavy	x	tree	forest1	cons
Euphorbiaceae	Drypetes madagascariensis	angoto	x	tree		cons
Euphorbiaceae	Macaranga sp.	makaragna	x	tree	forest2	cons med
Euphorbiaceae	Phyllanthus casticum	sagnira	x	shrub		med
Euphorbiaceae	Phyllanthus sp.	masoandronandroa	x	shrub		med
Euphorbiaceae	Savia sp.	tanatsifoa	x	shrub		med
Euphorbiaceae	Suregada adenophorum	remetso	x	shrub		med
Euphorbiaceae	Uapaca sp.	voapaky	x	tree	forest1/2	cons
Euphorbiaceae		hazotoatsy	x	tree		
Flacourtiaceae	Aphloia theseformis	fandramana	x	shrub	forest1/2	food
Flacourtiaceae	Caesaria sp.	malainarety	x	shrub		med
Flacourtiaceae	Flacourtia ramontchii	lamoty	x	shrub	savanna	med food
Flacourtiaceae	Homalium sp.	fandrianakanga	x	tree	forest1/2	cons
Flacourtiaceae	Physena madagascariensis	mangily	x	shrub		other
Flacourtiaceae		avoha		tree		
Flagellariaceae	Flagellaria indica	hovavy	x	liana	forest2	cons
Gentianaceae	Exacum sp.	aferontany an'ala	x	herb	village	med
Gramineae	Coix lacryma-jobi	tsimaromana	x	herb		other
Gramineae	Heteropogon contortus	boka	x	herb	savanna	cons other
Gramineae	Hyparrhenia cymbaria	vero	x	herb		other
Gramineae	Imperata cylindrica	tegny	x	herb	savanna	cons other
Gramineae	Panicum maximum	ahibe	x	herb	forest1	other
Gramineae	Phragmites communis	fatakandahy	x	herb		med
Gramineae	Rynchelytrum repens	akatafotsy	x	herb	savanna	other
Gramineae		andrasiky	x	herb		med
Guttiferae	Eliea articulata	hela	x	tree	forest1/2	cons med
Guttiferae	Harungana madagascariensis	haronga		tree	forest2	cons
Guttiferae	Mammea sp.	amboraza	x	tree		cons
Guttiferae	Psorospermum sp.	harongampanihy	x	shrub		cons
Guttiferae	Rhudia sp.	litsaky	x	tree		med
Guttiferae	Rhudia sp.	tavolohazo	x	tree		cons
Labiatae	Ocimum canum	rombavola	x	herb	forest2	med
Labiatae	Ocimum gratissum	rombabe	x	herb		med
Labiatae	Tetradenia sp.	boroa	x	herb		med
Lecythidaceae	Barringtonia racemosa	fitadrano	x	tree		cons med
Leguminosae	Abrus precatorius	bizikoaky	x	liana		cons med ritual
Leguminosae	Cassia occidentalis	sarongaza	x	herb		med food
Leguminosae	Desmodium mauritanum	tsilavondrivotra	x	herb		med
Leguminosae	Dolichos fagnitse	fagnitsy	x		forest	food
Leguminosae	Entada abysinnica	fany	x	tree		ritual
Leguminosae	Indigofera cloiselii	hazomboatango	x	tree	forest2	cons
Leguminosae	Teramnus labialis	teloravy	x	liana		med
Leguminosae	Tetrapterocarpum geyai	vaovy		tree	forest1/2	cons
Liliaceae	Aloe divaricata	vahotsoy	x	succulent		med
Liliaceae	Aloe sp.	sarimanasa	x	succulent		med
Liliaceae	Aloe vahombe	vahombe	x	succulent		med
Liliaceae	Dracaena reflexa	falinandro	x	shrub		med
Liliaceae	Smilax kraussiana	fandrikatany	x	liana		med
Loganiaceae	Anthocleista sp.	lendemy	x	tree		
Loganiaceae	Buddleja madagascariensis	sevafotsy	x	shrub		med ritual
Loganiaceae	Nuxia sp.	vandagnira	x	tree	forest1/2	cons med food
Loganiaceae	Strychnos madagascariensis	vontaky		tree	savanna	food
Lythraceae	Woodfordia floribunda	rekery	x	herb		med
Malvaceae	Neohumbertiella decaryi	seta	x	tree	forest1/2	cons
Malvaceae	Sida rhombifolia	tsipotika	x	shrub		med
Malvaceae	Urena lobata	tsangafiafy	x	shrub		med

Family	Scientific name	Local Name	V	Type	Habitat	Uses
Marsileaceae	Marsilea sp.	savaha	x	herb		food
Melastomataceae	Tristemma virusanum	voatrotroky	x			med food
Meliaceae	Melia azedarach	voandelaky	x	tree	savanna	cons med
Meliaceae	Turraea sericea	fafara	x	tree	forest2	cons med
Meliaceae	Turraea sericea	ambiotsy	x	shrub		ritual
Meliaceae	Turraea sp.	retantely	x	tree		med
Mimosaceae	Acacia sp.	kirava	x	tree		med other
Mimosaceae	Acacia sp.	roy	x	tree		other
Mimosaceae	Albizia gumnifera	sambalahy	x	tree	forest2	cons med
Mimosaceae	Albizia sp.	hazomalany	x	tree		med
Mimosaceae	Mendoravia sp.	mendoravy	x	tree	forest1	cons ritual
Mimosaceae	Mimosa latispinosa	romimy	x	shrub		med
Monimiaceae	Tambourissa sp.	membotavy	x	tree		cons
Moraceae	Ampalis madagascariensis	vahimara	x	liana		cons med
Moraceae	Bosqueia(=Trilepisium)	volaly	x	tree		food
Moraceae	Ficus baroni	nonobe	x	tree		med
Moraceae	Ficus polyphlebia	sandrohy	x	shrub		cons med other
Moraceae	Ficus sp.	nonoky	x	shrub		cons med food
Myristicaceae	?Brochoneura frencei	mafotra		tree	forest1	med
Myrsinaceae	Maesa lauceolata	voarafiky	x	shrub		med
Myrtaceae	Eugenia jambolana	rotsy	x	tree	forest2	cons med food
Myrtaceae	Eugenia sp.	malemiloha	x	tree		cons
Myrtaceae	Psidium guajava	giavy	x	shrub		med food
Ochnaceae	Difonidium sp.	tsivoanizany	x	tree		med ritual
Oleaceae	Noronhia sp.	tsilaitsy	x	shrub		med
Oleaceae	Noronhia sp.	matsadrano	x	tree		food
Oleaceae	Olea sp.	matsabato	x	shrub		food
Onagraceae	Ludwigia octovalis	tsimenamena	x	herb		med
Oxalidaceae	Biophytum pensitivum	tokatomboky	x	herb		med
Palmae	Hyphaenae shatan	satrana		tree	forest1	cons
Palmae	Neodypsis ?malcomberi	tavilo	x	tree	forest1/2	other
Palmae	Neodypsis decaryi	lafa		tree	forest1/2	cons food
Palmae	Neophloga sp.	raotsy	x	tree		cons food
Pandanaceae	Pandanus sp.	vakoa		tree	forest1	cons
Papilionaceae	Dalbergia sp.	magnary	x	tree	forest1/2	cons
Pittosporaceae	Pittosporum sp.	memboloa	x	tree		med
Pittosporaceae	Pittosporum sp.	satraha	x	tree		med
Polygonaceae	Polygonna mite	fandriatsiriry	x	herb		med
Polypodiaceae	?Stenochloa tenuifolia	boreko	x	herb	forest2	food
Polypodiaceae	Microsorium sp.	hahatsy	x			ritual
Proteaceae	Dilobea thouarsii	hovao	x	tree	forest1	food
Ptaeroxylaceae	*Cedrelopsis grevei*	*katrafa*	*x*	*tree*	*forest1/2*	*cons med ritual*
Rhizophoraceae	*Anysophyllea fallax*	*hazomamy*	*x*	*shrub*		*med*
Rosaceae	Rubus rosaemifolius	vorotsaka	x			*med food*
Rubiaceae	Adina microcephala	soaravy	x	tree	savanna	*cons med food*
Rubiaceae	Borreria verticulata	tsitimbalala	x	herb		med
Rubiaceae	Canthium sp.	fatsikaitsy	x	tree	forest2	cons
Rubiaceae	Coffea sp./Tricalysia sp.	hazongalala	x	tree		cons med
Rubiaceae	Danais sp.	menavava	x	liana		med
Rubiaceae	Enterospermum (=Tarenna) sp.	matsaky	x	tree	forest2	cons
Rubiaceae	Mussaenda sp.	magni-bary	x	tree		cons
Rubiaceae	Paederia grevei	lengo	x	liana	forest2	cons med
Rubiaceae	Paederia sp.	jamala	x	liana		med
Rubiaceae	Sabicea diversifolia	tsevamanitsy	x	herb		med
Rubiaceae	Schistmatoclada sp.	beholitsy	x	tree	forest1/2	cons
Rubiaceae	Vangueria madagascariensis	vandriky	x	shrub		med food
Rutaceae	Evodia floribunda	hazondambo	x	tree	forest2	cons
Rutaceae	Vepris fitoravina	fitoravy	x	tree		med

Family	Scientific name	Local Name	V	Type	Habitat	Uses
Rutaceae	Vepris sp.	ampoly	x	tree	forest1	cons med
Sapindaceae	Allophyllus sp.	tsingena	x	tree	forest2	cons med
Sapindaceae	Cardispermum haliacacabrum	voafaria	x	liana		med
Sapindaceae	Dodonaea viscosa	tsiokanomby	x	shrub		med
Sapindaceae	Filicium longifolium	voatsoy	x	tree		cons
Sapotaceae	Capurodendron sp.	nato	x	tree	forest1	cons food
Sarcolaenaceae	Leptolaena panciflora	foto	x	tree	forest1	cons
Scrophulariaceae	Scoparia dulcis	mamiaho	x	herb		med
Solanaceae	Solanum sp.	agnambe	x	herb		med
Sphaerosepalacea	Rhopalocarpus lucidus	tsiongaky	x	tree		cons
Sterculiaceae	Dombeya sp.	halapo	x	tree	forest1/2	cons
Sterculiaceae	Waltheria indica	mavoandragnondahy	x	herb		med
Strelitziaceae	Ravenala madagacsariensis	ravinala		herb	forest2	cons
Tiliaceae	Grewia sp.	sely	x	tree		cons food
Tiliaceae	Grewia sp.	taikafotsy	x	shrub		cons med
Typhaceae	Typha angustifolia	vondro	x	herb	village	cons med
Ulmaceae	Trema orientalis	andrarezo	x	shrub	forest2	med

Total listed: 187

Total with vouchers: 173

APPENDIX 10: ANDOHAHELA, MOST COMMONLY USED PLANTS AT ESOMONY AND EMINIMINY

ESOMONY

Local Name	Family	Scientific Name	Abundance	Location
HOUSE: IN GROUND				
hazomboatango	Leguminósae	Indigofera closelii	abundant	secondary forest
katrafa	Meliaceae	Cedrelopsis grevei	rare	secondary forest
matsaky	Rubiaceae	Tarenna (Enterospermum) bernieranum	abundant	secondary forest
zahambe	Bignoniaceae	Phyllarthron bernierianum	medium	secondary forest
mendoravy	Mimosaceae	Mendoravia sp.	rare	secondary forest
vaovy	Leguminosae	Tetrapterocarpon geyai	rare	secondary forest
magnary	Papilionaceae	Dalbergia sp.	abundant	secondary forest
voatsoy	Sapindaceae	Filicium longifolium		secondary forest
HOUSE: ABOVE GROUND				
soaravy	Rubiaceae	Adina microcephala	abundant	near water
raotsy	Didieraceae	Alluaudia procera	rare	secondary forest
rotsy	Myrtaceae	Eugenia jambolena	abundant	near water
voatsoy	Sapindaceae	Filicium longifolium		secondary forest
beholitsy	Rubiaceae	Schismatoclada sp.	medium	secondary forest
vaovy	Leguminosae	Tetrapterocarpon geyai	rare	secondary forest
lalipito			medium	secondary forest
matsaky	Rubiaceae	Tarenna (Enterospermum) bernieranum	medium	secondary forest
voandelaky	Meliaceae	Melia azedarach	abundant	near water
FRAMES FOR DOORS, WINDOWS				
mendoravy	Mimosaceae	Mendoravia sp.	rare	secondary forest
voandelaky	Meliaceae	Melia azedarach	abundant	near water
soaravy	Rubiaceae	Adina microcephala	abundant	near water
PLANKS FOR DOORS etc.				
raotsy	Didieraceae	Alluaudia procera	rare	secondary forest
voandelaky	Meliaceae	Melia azedarach	abundant	by water
ROOF THATCH				
boka	Gramineae	Heteropogon contortus	abundant	savanna
tegny	Gramineae	Imperata cylindrica	rare	savanna
hindim-bary	Gramineae	Oryza sativa	abundant	fields
CORD FROM BARK				
sandrohy	Moraceae	Ficus polyphlebia		
sely	Tiliaceae	Grewia sp.	abundant	secondary forest
zobihy	Anacardiaceae	Operculicarya sp.	abundant	secondary forest
taikafotsy	Tiliaceae	Grewia sp.		secondary forest
tsiongaky	Sphaerosepalaceae	Rhopalocarpus lucidus		secondary forest
CORD FROM LIANE OR LEAF FIBRES				
vahindengo	Rubiaceae	Paederia grevei		secondary forest
vahipindy				secondary forest
laloa	Agavaceae	Agave sp.	abundant	in village
PESTLES				
vaovy	Leguminosae	Tetrapterocarpon geyai	rare	secondary forest
magnary	Papilionaceae	Dalbergia sp.	abundant	secondary forest
nato	Sapotaceae	Capurodendron sp.	medium	secondary forest
tsingilofilo	Celestraceae	Gymnosporia polyacantha	abundant	secondary forest

MORTARS				
soaravy	Rubiaceae	Adina microcephala	abundant	near water
halimboho				
sohihy	Anacardiaceae	Protorhus deflexa	abundant	near water
rotsy	Myrtaceae	Eugenia jambolena	abundant	near water
HANDLES OF AXES, SPADES, SPEARS etc.				
vaovy	Leguminosae	Tetrapterocarpon geyai	rare	secondary forest
magnary	Papilionaceae	Dalbergia sp.	abundant	secondary forest
voandelaky	Meliaceae	Melia azedarach	abundant	by water
andrapary			abundant	secondary forest
katrafa	Meliaceae	Cedrelopsis grevei	rare	secondary forest
zahambe	Bignoniaceae	Phyllarthron bernierianum	medium	secondary forest
seta			rare	secondary forest
tsitake			rare	secondary forest
mandoavato			rare	secondary forest
MATS, BASKETS etc.				
vondro	Typhaceae	Typha angustifolia	rare	near water
boboky	Cyperaceae	Cyperus articulatus	abundant	near water
vindavato	Cyperaceae	Cyperus sp.	abundant	near water
vindabe	Cyperaceae	Cyperus sp.	abundant	near water
tongoahara				
WILD TUBERS				
mangily			medium	secondary forest
ataly			medium	secondary forest
nako			abundant	secondary forest
sosa	Dioscoraceae	Dioscorea soso	abundant	secondary forest
tala			medium	secondary forest
halimanditsy			rare	secondary forest
fagnitsy			abundant	secondary forest
valaha			abundant	secondary forest
madaribo	Araceae	(like taro)	rare	near water
WILD FRUITS				
rotsy	Myrtaceae	Eugenia jambolena	abundant	near water
nato	Sapotaceae	Capurodendron sp.	rare	secondary forest
lamoty	Flacourtiaceae	Flacourtia ramontchii	abundant	savanna/village
raketa	Cactaceae	Opuntia sp.	abundant	village
kily	Fabaceae	Tamarindus indica	abundant	village/savanna
ja	Bombaceae	Adansonia za	medium	savanna
matsaky	Rubiaceae	Tarenna (Enterospermum) bernieranummedium		secondary forest
BEST FIREWOODS				
katrafa	Meliaceae	Cedrelopsis grevei	rare	secondary forest
hazomagnitsy			medium	secondary forest
magnary	Papilionaceae	Dalbergia sp.	abundant	secondary forest
soaravy	Rubiaceae	Adina microcephala	abundant	near water
MOST USED FIREWOODS				
tsingilofilo	Celestraceae	Gymnosporia polyacantha	abundant	secondary forest
rotsy	Myrtaceae	Eugenia jambolena	abundant	near water
kirava	Mimosaceae	Acacia sp.	abundant	secondary forest
sohihy	Anacardiaceae	Protorhus deflexa	abundant	near water
voandelaky	Meliaceae	Melia azedarach	abundant	by water
andrapary			abundant	secondary forest
vandagnira	Loganiaceae	Nuxia sp.		
sakoa	Anacardiaceae	Poupartia caffra	abundant	village/savanna
manga	Anacardiaceae	Mangifera indica	abundant	village
hazomagnitsy				
roy	Mimosaceae	Acacia sp.	abundant	secondary forest

EMINIMINY

Local Name	Family	Scientific Name	Abundance	Location
HOUSE: IN GROUND				
foto	Sarcolaenaceae	Leptolaena panciflora	medium	primary forest
hela	Guttiferae	Eliea articulata	abundant	secondary forest
teza lipaty			medium	secondary forest
teza magnary	Papilionaceae	Dalbergia sp.	medium	primary/secondary forest
ombitavy	Euphorbiaceae	Bridelia pervilleana	abundant	primary forest
kininy	Myrtaceae	Eucalyptus citriodora	medium	savanna
vatoa	Compositae	Brachylaena ramiflora	rare	primary forest
HOUSE: ABOVE GROUND				
voapaky	Euphorbiaceae	Uapaca sp.	abundant	primary/secondary forest
rotsy	Myrtaceae	Eugenia jambolena	abundant	secondary forest
kininy	Myrtaceae	Eucalyptus citriodora	medium	savanna
menahihy	Erythroxylaceae	Erythroxylum sp.	abundant	primary/secondary forest
fatsikaitsy	Rubiaceae	Canthium sp.	abundant	primary/secondary forest
makaragna	Euphorbiaceae	Macaragna sp.	abundant	secondary forest
andragnohy				
varogny			medium	primary forest
haronga	Guttiferae	Harungana madagascariensis	abundant	secondary forest
voandelaky	Meliaceae	Melia azedarach	abundant	savanna
malemiloha	Myrtaceae	Eugenia sp.	abundant	secondary forest
voatsila			abundant	secondary forest
FRAMES FOR DOORS, WINDOWS				
ombitavy	Euphorbiaceae	Bridelia pervilleana	abundant	primary forest
menahihy	Erythroxylaceae	Erythroxylum sp.	abundant	primary/secondary forest
halapo	Sterculiaceae	Dombeya sp.	abundant	primary forest
PLANKS FOR DOORS etc.				
halapo	Sterculiaceae	Dombeya sp.	abundant	primary forest
voandelaky	Meliaceae	Melia azedarach	abundant	savanna
falafa (stems)	Strelitziaceae	Ravenala madagascariensis	abundant	secondary forest
ROOF THATCH				
tegny	Poaceae	Imperata cylindrica	abundant	savanna
raty (leaves)	Strelitziaceae	Ravenala madagascariensis	abundant	secondary forest
WALLS				
falafa (stems)	Strelitziaceae	Ravenala madagascariensis	abundant	secondary forest
raotsy(thro'falafa)	Palmae	Neophloga sp.	abundant	secondary forest
vakapotsy (trunk)	Strelitziaceae	Ravenala madagascariensis	abundant	secondary forest
FLOORS				
vakak-anivy	Palmae		medium	secondary forest
vaka-kony	Palmae		medium	secondary forest
vakambe	Palmae		medium	secondary forest
LIANES FOR CORD				
vahy kerotsy			abundant	primary/secondary forest
vahy pindy			abundant	primary/secondary forest
vahy vaky			abundant	primary/secondary forest
PESTLES				
nato	Sapotaceae	Capurodendron sp.	rare	primary forest
ampoly	Rutaceae	Vepris sp.	rare	primary forest
tsingena	Sapindaceae	Allophyllus sp.	abundant	primary/secondary forest

MORTARS				
manga	Anacardiaceae	Mangifera indica	abundant	village
grevillea	Proteaceae	Grevillea sp.	medium	savanna
varongy			medium	primary forest
kininy	Myrtaceae	Eucalyptus citriodora	medium	savanna
HANDLES OF AXES, SPADES, SPEARS etc.				
tsingena	Sapindaceae	Allophyllus sp.	abundant	primary/secondary forest
teza magnary	Papilionaceae	Dalbergia sp.	medium	primary/secondary forest
teza lipaty			medium	secondary forest
kininy	Myrtaceae	Eucalyptus citriodora	medium	savanna
nato	Sapotaceae	Capurodendron sp.	rare	primary forest
voandelaky	Meliaceae	Melia azedarach	abundant	savanna
tsilorano			medium	secondary forest
fafara	Meliaceae	Turraea serricea	medium	secondary forest
voangy	Rutaceae	Citrus sp.	medium	village
MATS, BASKETS etc.				
hera	Cyperaceae	Cyperus latifolius	medium	marsh
harefo	Cyperaceae	Heliocharis plantaginus	abundant	marsh
boboky	Cyperaceae	Cyperus articulatus	medium	marsh
beloha	Cyperaceae	Cyperus aequalis	abundant	marsh
hovavy	Flagellariaceae	Flagellaria indica	abundant	secondary forest
WILD TUBERS				
lingirotsy	Cannaceae	Canna indica	abundant	village
via	Araceae	Typhonodorum lindleyanum	abundant	near water
vorozy	Dioscoraceae	Dioscorea sp.	medium	primary forest
taretsy	Dioscoraceae	Dioscorea sp.	medium	primary forest
ataly			medium	primary forest
WILD FRUITS				
voasary ala	Rutaceae	Citrus sp.	abundant	secondary forest
voaraotsy	Palmae	Neophloga sp.	abundant	secondary forest
rotsy	Myrtaceae	Eugenia jambolena	abundant	secondary forest
vorotsaka	Rosaceae	Rubus rosaemifolius	medium	secondary forest
vandriky	Rubiaceae	Vangueria madagascariensis	abundant	village/savanna
OTHER WILD FOODS				
hovao (nut oil)	Proteaceae	Dilobeia thouarsii	medium	primary forest
boaka (palm heart)	Palmae		medium	primary forest
boreko(fern leaves)	Polypodiaceae	?Stenochloa tenuifolia	medium	secondary forest
BEST FIREWOODS				
fatsikaitsy	Rubiaceae	Canthium sp.	abundant	primary/secondary forest
menahihy	Erythroxylaceae	Erythroxylum sp.	abundant	primary/secondary forest
lalo	Cunoniaceae	Weinmannia rhodoxylon	abundant	primary/secondary forest/sa
magnibary	Rubiaceae	Mussaenda sp.	medium	secondary forest/savanna
tsingena	Sapindaceae	Allophyllus sp.	abundant	primary/secondary forest
magnary	Papilionaceae	Dalbergia sp.	medium	primary/secondary forest
MOST USED FIREWOODS				
haronga	Clusiaceae	Harungana madagascariensis	abundant	secondary forest
vandriky	Rubiaceae	Vangueria madagascariensis	abundant	village/savanna
makaragna	Euphorbiaceae	Macaragna sp.'	abundant	secondary forest
fandramana	Flacourtiaceae	Aphloia theseformis	abundant	secondary forest
voandelaky	Meliaceae	Melia azedarach	abundant	savanna
sagnira	Euphorbiaceae	Phyllanthus casticum	abundant	secondary forest
retantely	Meliaceae	Turraea sp.	abundant	primary/secondary forest
votaky	Loganiaceae	Strycnos madagascariensis	abundant	savanna
tsiokanomby	Sapindaceae	Dodonaea viscosa		
giavy	Myrtaceae	Psidium guajava	abundant	savanna

kininy	Myrtaceae	Eucalyptus citriodora	medium	savanna
voasary	Rutaceae	Citrus sp.	abundant	secondary forest
kaboky	Apocynaceae	Voacanga thouarsii	abundant	savanna/secondary forest
nonoky	Moraceae	Ficus ps.	abundant	savanna/secondary forest
tavolohazo	Guttiferae	Rhudia sp.	abundant	primary/secondary forest
halapo	Sterculiaceae	Dombeya sp.	abundant	primary forest
apalibe	Moraceae	Artocarpus heterophyllus	abundant	village
fandrianakanga	Flacourtiaceae	Homalium sp.	abundant	primary/secondary forest
malemiloha	Myrtaceae	Eugenia sp.	abundant	secondary forest
memboloha	Pittosporaceae	Pittosporum sp.		

Appendix 10. ANDOHAHELA, MEDICINAL PLANTS

Local Name	Scientific name	Part used	Condition treated
aferontany an'ala	Exacum sp.	plant	keeps babies healthy
agnambe	Solanum sp.	leaves	activates mother's milk, overdose of medication
akatsoavaly	Chenopodium ambrosioides	leaves	intestinal worms
ampoly	Vepris sp.	leaves	stomach
andrarezo	Trema orientalis	leaves	pregnant women, and with difficulties with childbirth
andrasiky		plant	hepatitus
angama	Tridax procumbens	sap	wound
angia	Senecio sp.	leaves	inflamed eyes
bandro	Maba sp.	leaves	all illnesses
bembo	Ageratum conyzoides	leaves	after childbirth
beronono	Cynanchum sp.	sap	boil not yet fully formed
bizikoaky	Abrus precatorius	leaves	cough, measles
boroa	Tetradenia sp.	plant	boil
donadona	Pycreus mundtii	leaves	after childbirth
fafara	Turraea sericea	leaves	constipation, stomach ache, hepatitus, calves worms
falinandro	Dracaena reflexa	leaves	venereal disease
famotogny	Pluchea bojeri	leaves	cold, stomach ache, measles
fandriatsiriry	Polygonna mite	plant	after childbirth
fandrikatany	Smilax kraussiana	leaves, root	abcess, boil
fatakandahy	Phragmites communis	plant	pregnant women
fitadrano	Barringtonia racemosa	bark	dressing for wound
fitoravy	Vepris fitoravina	leaves	hepatitus
giavy	Psidium guajava	leaves	diarrhoea
hazomalany	Albizia sp.	leaves	leprosy
hazomamy	Anysophyllea fallax	leaves	after childbirth
hazongalala	Coffea sp./Tricalysia sp.	leaves	hemmorrage
hela	Eliea articulata	leaves	wound
jamala	Paederia sp.	leaves	keeps teeth healthy, indigestion
katrafa	Cedrelopsis grevei	bark, leaves	general fatigue, worms of calves
kirava	Acacia sp.	bark	after childbirth, tooth ache
komboy	Senecio fanjasoides	leaves	fontanelle, constipation, venereal disease, 'fandilofa'
lalipito		bark	eye infections
lamoty	Flacourtia ramontchii	green fruits	dysentery
lengo	Paederia grevei	leaves	diarrhoea, gum infection, 'fandilofa'
lengomantsy		leaves	fontanelle, 'fandilofa', typhoid, teeth
litsaky	Rhudia sp.	bark	burns
mafotra	?Brochoneura frencei	nuts	scabies
makaragna	Macaranga sp.	leaves	headache, chills
malainarety	Caesaria sp.	leaves	constipation, stomach
mamiaho	Scoparia dulcis	leaves	after childbirth
mangarato	Pellaea calomelanos	leaves	fontanelle
manovala	Didymeles sp.	leaves	stomach
mapay	Cynometra sp.	root	fontanelle
masoandronandroa	Phyllanthus sp.	plant	pregnant women
mavoandragnondahy	Waltheria indica	leaves	fontanelle
memboloa	Pittosporum sp.	bark	against leeches
menavava	Danais sp.	leaves	keeps teeth healthy
nonobe	Ficus baroni	sap	to stop bleeding from wound
nonoky	Ficus sp.	leaves	inflamed eyes
rehapiny	Landoelphia sp.	plant	pregnant women
rekery	Woodfordia floribunda	leaves	fontanelle, to stimulate appetite
remetso	Suregada adenophorum	leaves	hepatitus
resa	Senecio sp.	plant	fontanelle, constipation, venerial disease
retantely	Turraea sp.	leaves	keeps babies healthy, stomach ache
rombabe	Ocimum gratissum	leaves	after childbirth, eye infection
rombavola	Ocimum canum	leaves	after childbirth

Local Name	Scientific name	Part used	Condition treated
romimy	Mimosa latispinosa	bark	fontanelle, stomach ache in children
rotsy	Eugenia jambolana	leaves	pregnant woman, if baby doesn't move
sagnira	Phyllanthus casticum	leaves,root	fontanelle, boil, diarrhoea, insect bites
sakoa	Poupartia caffra	leaves, bark	wound, after childbirth
salaitsy	Combretum coccineum	leaves	hepatitus
sambalahy	Albizia gumnifera	leaves	back ache, asthma, toothache
sandrohy	Ficus polyphlebia	leaves	hepatitus
sarimanasa	Aloe sp.	sap of leaves	ears
saripeha	Vernonia sp.	leaves	fontanelle
sarongaza	Cassia occidentalis	leaves	hepatitus
satraha	Pittosporum sp.	leaves	keeps teeth healthy
sevafotsy	Buddleja madagascariensis	root	a cold
soaravy	Adina microcephala	leaves	gum disease
somangy	Maerua filiformis	leaves	after childbirth
taikafotsy	Grewia sp.	leaves	after childbirth
tamenaky	Combretum sp.	grains, leaves	intestinal worms, digestion
tanatsifoa	Savia sp.	leaves	all illnesses
tapisaky	Xerosicyos decaryi	leaves	'fandilofa', boil
tapoaky	Asclepias fruticarpus	root	insect stings
teloravy	Teramnus labialis	leaves	fontanelle
tingotingo	Kalanchoe integrifolia	leaves	cough, cold, measles
tokambahatsy	Cnestis polyphylla	root	boil, abcess, to poison dogs
tokatomboky	Biophytum pensitivum	plant	fontanelle
tsangafiafy	Urena lobata	leaves,root	hepatitus, venereal disease, measles
tsatsandrohy		leaves	nervous tension
tsevamanitsy	Sabicea diversifolia	plant	after childbirth
tsilaitsy	Noronhia sp.	leaves	all illnesses
tsilavondrivotra	Desmodium mauritanum	leaves	abcess, not yet fully formed
tsimahavagno	Erythroxylum sp.	leaves,root	abcess, boil
tsimatavindrano		stem	stomach
tsimenamena	Ludwigia octovalis	leaves	fontanelle
tsingena	Allophyllus sp.	leaves	pregnant women
tsingilofilo	Gymnosporia polyacantha	leaves	
tsiokanomby	Dodonaea viscosa	leaves	hepatitus
tsipotika	Sida rhombifolia	leaves	after childbirth
tsitaritariky	Leptadenia madagascariensis	leaves	after childbirth
tsitimbalala	Borreria verticulata	leaves	wounds
tsivoanizany	Difonidium sp.	leaves	stomach pain
vahimara	Ampalis madagascariensis	root	boil
vahombe	Aloe vahombe	leaves	after childbirth, haemhorrage, venereal disease
vahotsoy	Aloe divaricata	leaves	stomach, venereal disease
vandagnira	Nuxia sp.	leaves	pregnant women, wounds, inflamed eyes
vandriky	Vangueria madagascariensis	leaves	a cold
vatoa	Brachylaena ramiflora	leaves	hepatitus
voafaria	Cardispermum haliacacabrum	plant	pregnant women
voandelaky	Melia azedarach	root, leaves	intestinal worms, head lice
voarafiky	Maesa lauceolata	leaves	after childbirth
voatrotroky	Tristemma virusanum	leaves	wounds
vondro	Typha angustifolia	leaves	inflated stomach
vongavonga	Helichrysum faradifani	leaves	hepatitus
vorotsaka	Rubus rosaemifolius	leaves	keeps babies healthy
zahambe	Phyllarthron bernierianum	leaves	after childbirth
zira	Psiadia altissima	leaves	after childbirth, eczema, venereal disease, eye infection
zobihy	Operculicarya sp.	bark	after childbirth

Total listed : 110

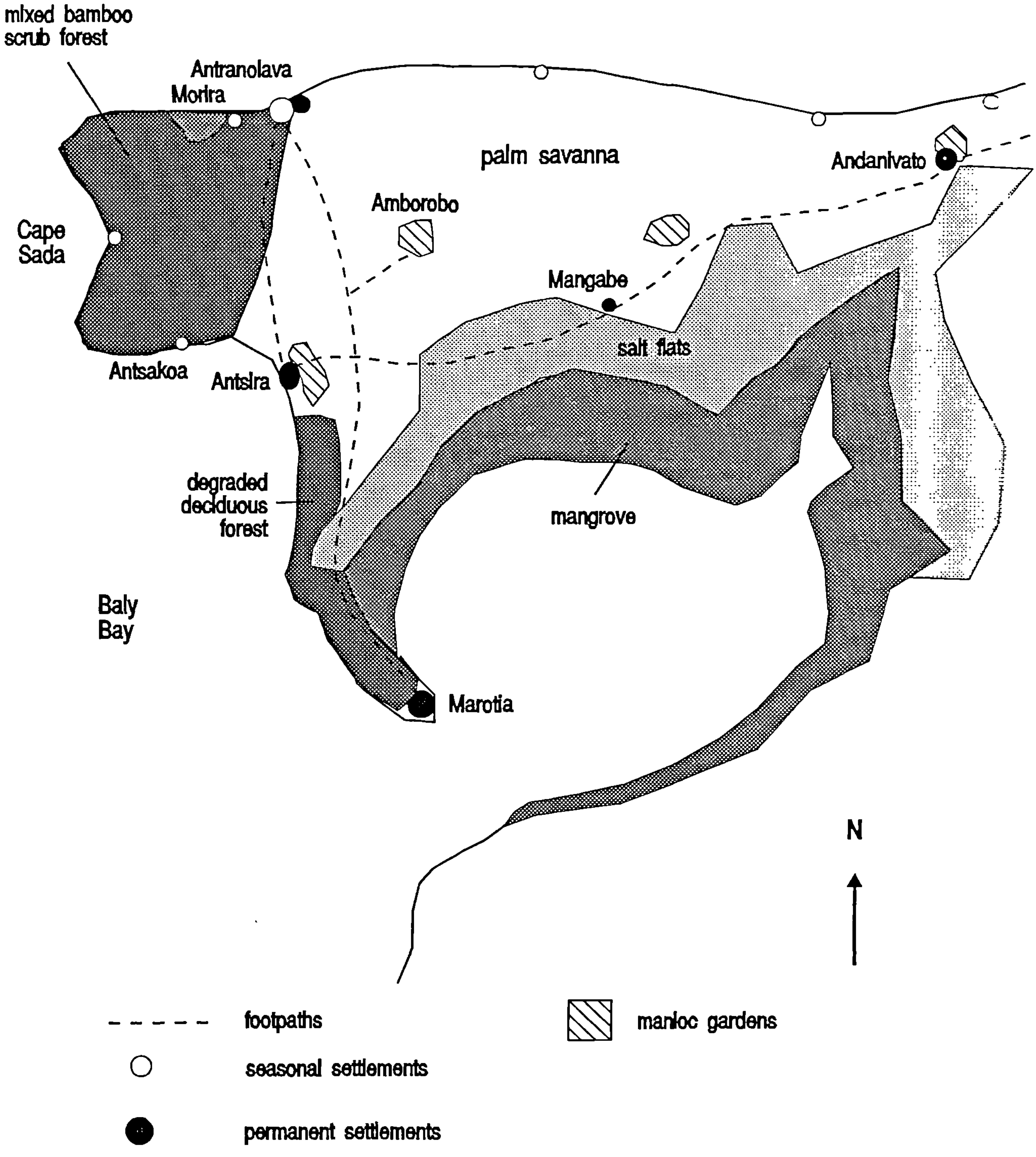
APPENDIX 10. ANDOHAHELA, plants used for food, ritual and other uses

	Local Name	Scientific name	Part used	Use
food	boreko	?Stenochloa tenuifolia	leaves	eaten
food	ja	Adansonia za	fruits	eaten
food	soaravy	Adina microcephala	bark	rum making
food	fandramana	Aphloia theseformis	leaves, fruits	infusion and fruits eaten
food	volaly	Bosqueia(=Trilepisium)	fruits	eaten
food	lingirotsy	Canna indica	tuber	eaten
food	nato	Capurodendron sp.	seeds, fruits	oil of nuts eaten
food	sarongaza	Cassia occidentalis	seeds	substitute for coffee
food	tamenaky	Combretum sp.	fruits	eaten
food	berononо	Cynanchum sp.	fruits	eaten
food	hovao	Dilobea thouarsii	seeds	oil from nuts eaten and used for hair
food	sosa	Dioscorea soso	tuber	eaten
food	vorozy	Dioscorea sp.	tuber	eaten
food	fagnitsy	Dolichos fagnitse	tuber	eaten
food	rotsy	Eugenia jambolana	fruits	eaten
food	nonoky	Ficus sp.	fruits	eaten
food	lamoty	Flacourtia ramontchii	fruits	eaten
food	sely	Grewia sp.	fruits	eaten
food	savaha	Marsilea sp.	plant	boiled and eaten with rice
food	lafa	Neodypsis decaryi	fruits	eaten
food	raotsy	Neophloga sp.	fruits	eaten
food	matsadrano	Noronhia sp.	fruits	eaten
food	vandagnira	Nuxia sp.	leaves	rum making
food	matsabato	Olea sp.	fruits	eaten
food	raketa	Opuntia sp.	fruits	eaten
food	sakoa	Poupartia caffra	fruits	eaten
food	giavy	Psidium guajava	fruits	eaten
food	vorotsaka	Rubus rosaemifolius	fruits	eaten
food	voasirindry	Sorindeia madagascariensis	fruits	eaten
food	vontaky	Strychnos madagascariensis	fruits	eaten
food	voatrotroky	Tristemma virusanum	fruits	eaten
food	via	Typhonodorum lindleyanum	tuber	eaten
food	vandriky	Vangueria madagascariensis	fruits	eaten
food	sonjorano		tuber	eaten
food	mandotsy		tuber	eaten
food	anjiky		tuber	eaten
food	ataly		tuber	eaten
food	ba		tuber	eaten
food	bagny		tuber	eaten
food	dagoa		fruits	eaten
food	halimanditsy		tuber	eaten
food	kobay		fruits	eaten
food	madaribo		tuber	eaten
food	mangily		tuber	eaten
food	nako		tuber	eaten
food	omboky		tuber	eaten
food	papa		tuber	eaten
food	tala		tuber	eaten
food	taretsy		tuber	eaten

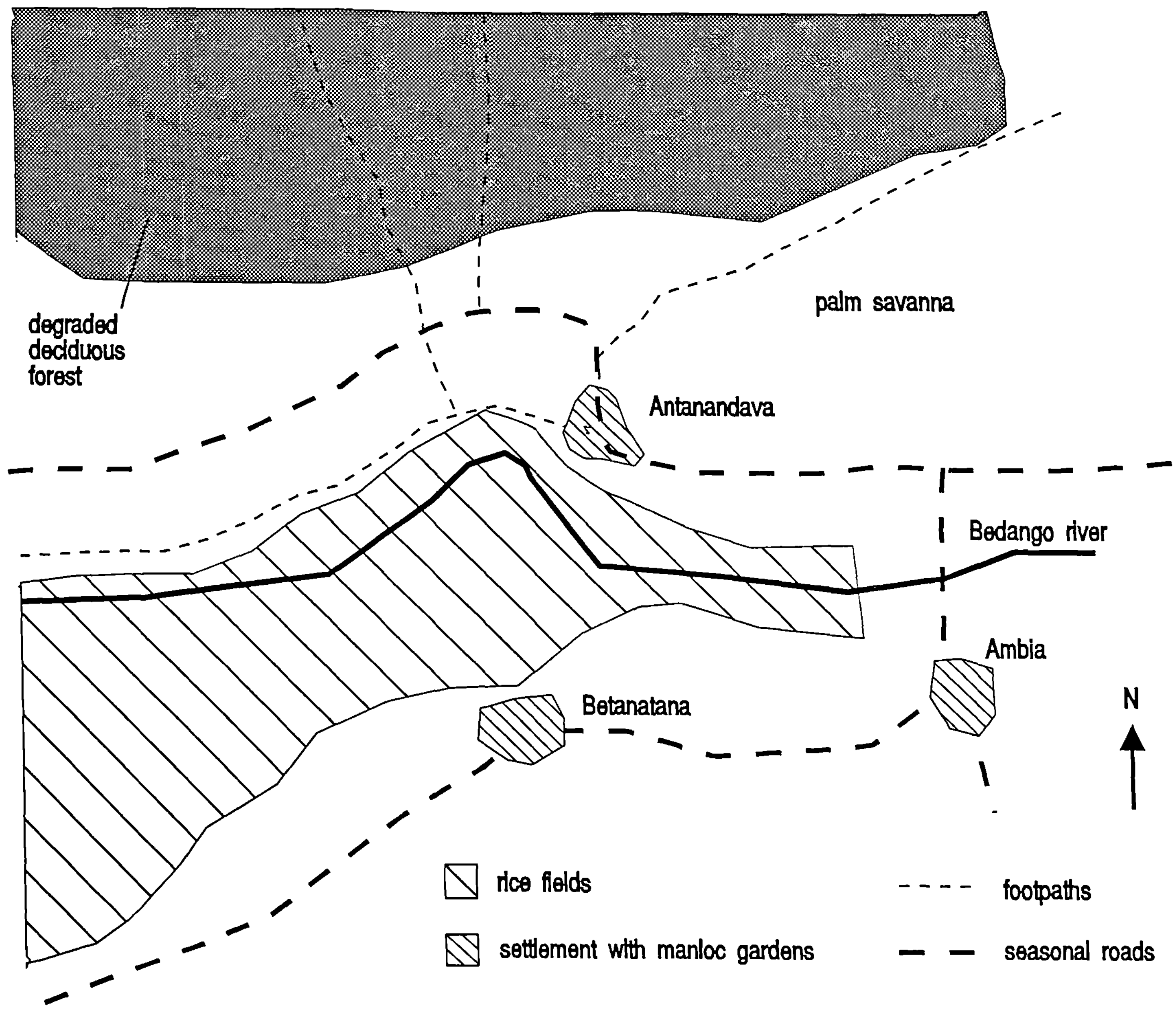
Total listed: 49

other	roy	Acacia sp.	pod	glue for paper
other	kirava	Acacia sp.	wood	best quality charcoal
other	tsimaromana	Coix lacryma-jobi	seeds	used for necklaces
other	hazomainty	Diospyros sp.	leaves	soap
other	sandrohy	Ficus polyphlebia	wood	to make fire

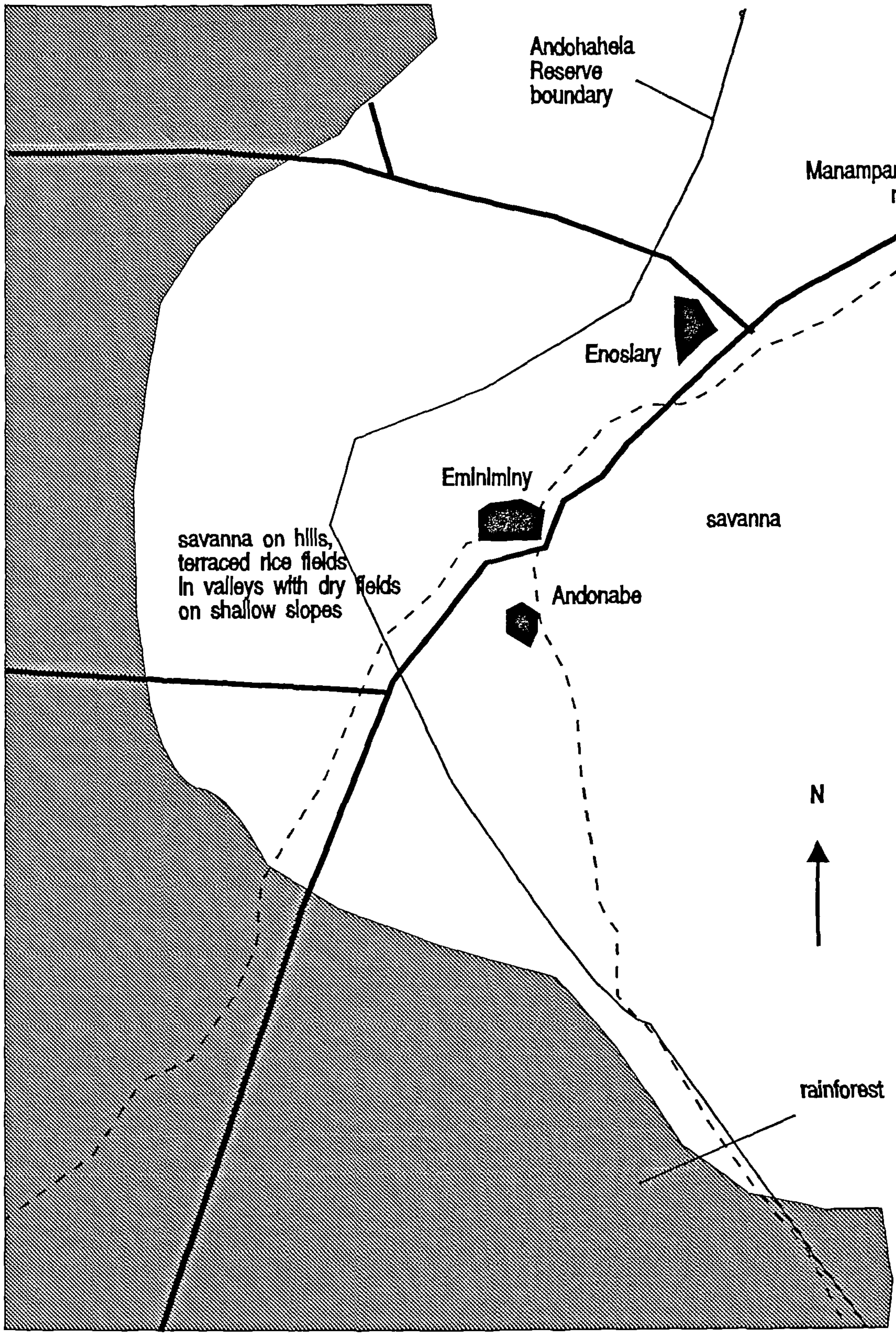
	Local Name	Scientific name	Part used	Use
other	boka	Heteropogon contortus	plant	cattle fodder
other	vero	Hyparrhenia cymbaria	plant	cattle fodder
other	tegny	Imperata cylindrica	plant	cattle fodder
other	tsitaritariky	Leptadenia madagascariensis	sap	used to remove spines from body
other	tavilo	Neodypsis ?malcomberi	leaves	to level rice fields
other	ahibe	Panicum maximum	plant	cattle fodder
other	mangily	Physena madagascariensis	bark	against leeches
other	tarata	Protorhus sp.	sap	glue
other	akatafotsy	Rynchelytrum repens	plant	cattle fodder
other	kopotsy	Secemone sp.	sap	glue for rubber
other	kaboka	Voacanga thouarsii	fruits	glue used as trap for small birds
	Total listed:	16		
ritual	bizikoaky	Abrus precatorius		used by traditional healer
ritual	sevafotsy	Buddleja madagascariensis	leaves	used in request for benediction
ritual	katrafa	Cedrelopsis grevei	wood	burn during circumcision
ritual	akatsoavaly	Chenopodium ambrosioides	leaves	against bad spirits
ritual	vinda	Cyperus sp.	stems	used at blood-brother ceremony
ritual	tsivoanizany	Difonidium sp.	leaves	used against sorcery
ritual	fany	Entada abysinnica	seeds	divination, 'sikidy'
ritual	mendoravy	Mendoravia sp.	wood	coffins
ritual	hahatsy	Microsorium sp.	leaves	possession, 'tromba'
ritual	ambiotsy	Turraea sericea	leaves	against sorcery
	Total listed:	10		



Appendix 11. Sketchmap of the area around Antsira

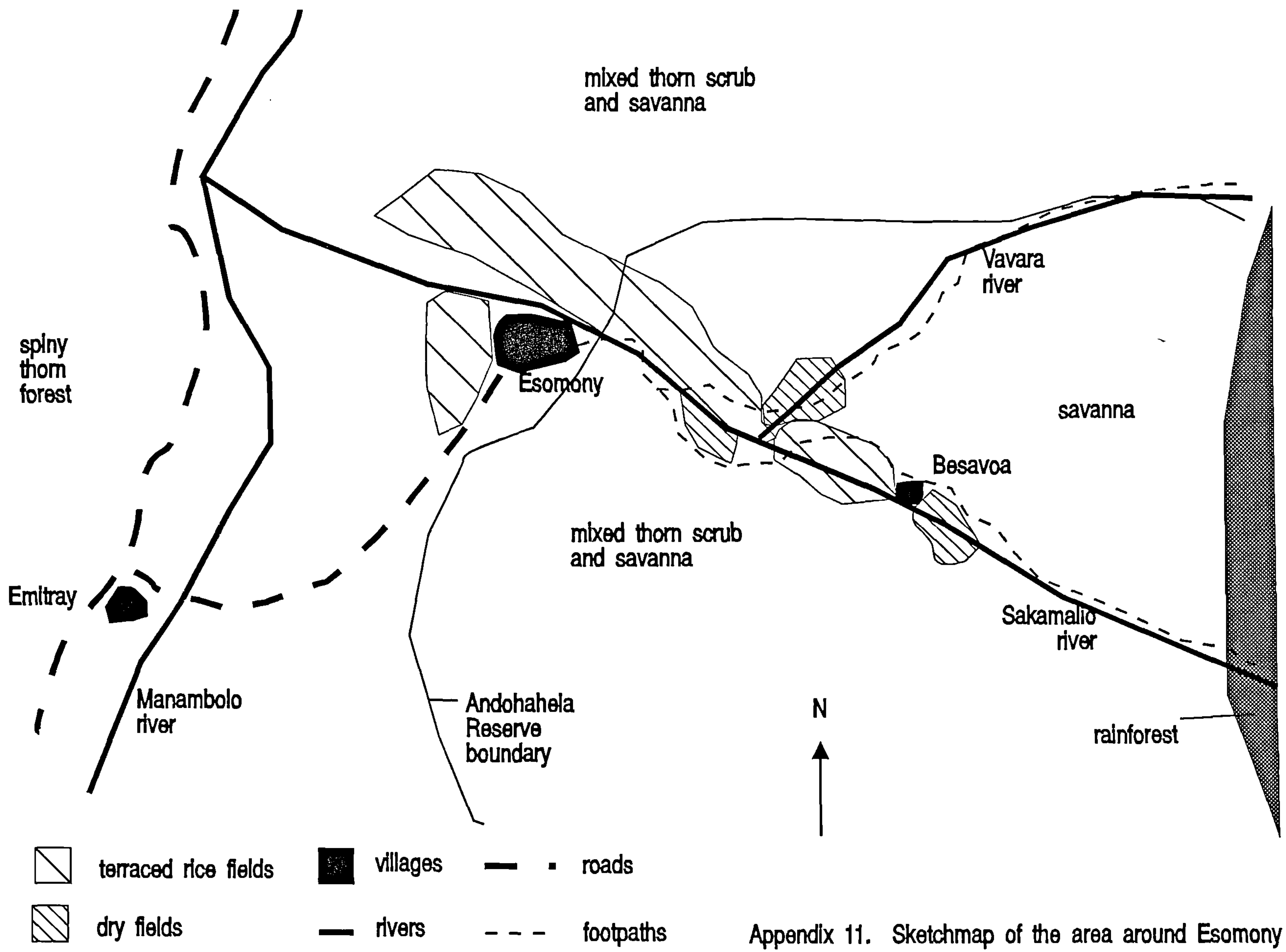


Appendix 11. Sketchmap of the area around Antanandava

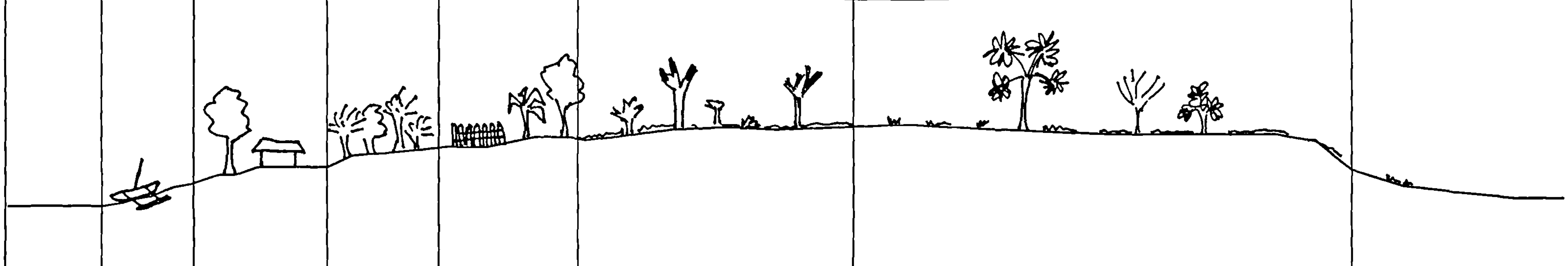


villages — rivers - - - footpaths

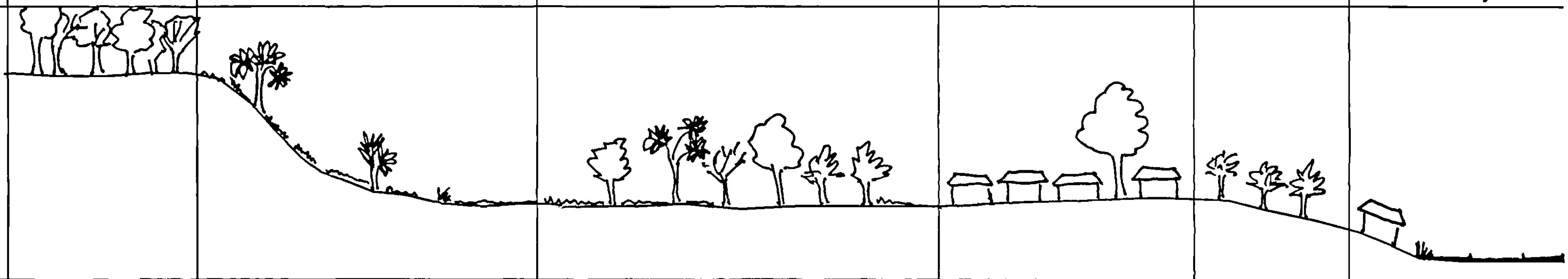
Appendix 11. Sketchmap of the area around Eminiminy



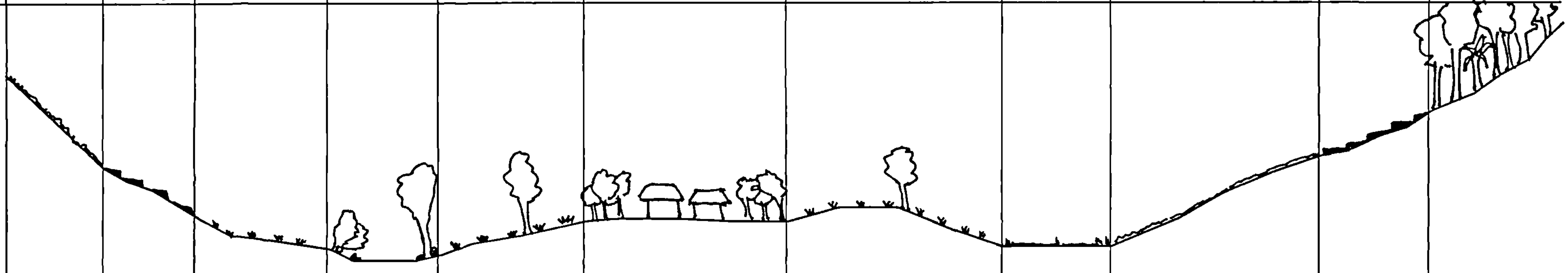
Appendix 11. Sketchmap of the area around Esomony

land type	sea 'riaka'	shore 'haranta'	village 'tanana'	scrub 'ala'	gardens 'vala mahogo'	burned forest 'ala may'	savanna 'alan-satra'	salt flat 'fahaka'
								
land use	- fishing	- fish preparation	- housing, - poultry rearing	- collection of firewood	- housing, - water well, - gardens, cultivating manioc, sugar cane, bananas, tomatoes etc.	- collection of firewood - collection of wood for garden fences	- cattle pasture - collection of palm leaves for thatch, and for mats - collection of palm trunks for garden fences	- salt making
ominant egetation genus)			*Tamarindus* *Poupartia* *Ficus* *Strychnos* *Casuarina* *Baphia* *Hyphaene* *Ziziphus*	*Indigofera* *Dalbergia* *Aloe* *Bauhinia*	*Tamarindus*	*Dichrostachys* *Bauhinia* *Terminalia* *Pittosporum* *Dalbergia* *Bridelia* *Leptadenia*	*Bismarckia* *Acridocarpus* *Heteropogon* *Hyparrhenia* *Aristida*	*Salicornia*

Appendix 11. WEST to EAST Transect of Antsira showing land-use zones

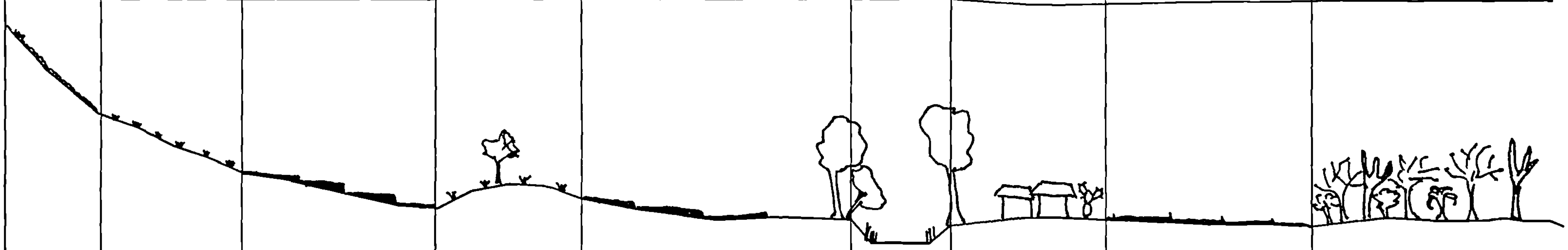
land type	forest 'ala'	hillside 'bongo'	scrub	village 'tanana'	scrub	rice fields 'tanim-bary'
						
land use	- collection of wood for housing, garden fences, ox-carts etc. - collection of firewood	- cattle pasture - collection of palm leaves for thatch, mats etc. - collection of palm trunks for garden fences	- collection of firewood - collection of fruits - cattle pasture	- housing - gardens, cultivating manioc, bananas, coconuts etc - poultry rearing	- collection of fruits	- rice cultivation - temporary housing - cultivation of tomatoes, onions etc. - collection of waterlily tubers - collection of small fish and prawns
dominant vegetation (genus)	*Bridelia* *Erythrophleum* *Mascarenhasia* *Sideroxylon* *Dichrostachys* *Nastus* *Zanthoxylum* *Chrysalidocarpus* *Dalbergia*	*Bismarckia* *Acridocarpus* *Heteropogon* *Hyparrhenia* *Aristida*	*Tamarindus* *Poupartia* *Psidium* *Bismarckia* *Strychnos* *Anacardium* *Mangifera* *Hyparrhenia*	*Mangifera* *Tamarindus* *Cocos* *Eucalyptus* *Bombax* *Eugenia*	*Anacardium* *Ziziphus* *Mangifera*	*Ziziphus* *Cryptostegia* *Typhonodorum* *Cyperus*

Appendix 11. NORTH to SOUTH Transect of Antanandava showing land-use zones



land type	savanna 'roanga'	terraced rice fields 'horaka halitany'	dry fields	river 'rano Manam -panihy'	dry fields	village 'tanana'	dry fields	valley bottom ricefields 'horaka mason-drano'	savanna 'roanga'	terraced rice fields 'horaka halitany'	rainforest 'ala'
land use	- cattle pasture - collect -ion of grass for thatch	- cultivation of late season rice	- cultivation of sweet potatoes	- collection of water - fishing	- cultivation of sweet potatoes, beans, maize, bananas, etc.	- housing - poultry and pig rearing - small gardens cultivating banana tomatoes, onions greens etc. - coffee plantations - cultivation of papaya, avocado, citrus	- cultivation of manioc, - Eucalyptus plantations	- cultivation of early season rice - collection of reeds for mats	- cattle pasture	- cultivation of late season rice	- collection of firewood - collection of construction wood - collection of forest fruits
dominant vegetation (genus)	*Imperata* *Psidium*			*Typhono -dorum* *Mangifera*	*Annona* *Bombax*	*Coffea* *Mangifera* *Artocarpus* *Annona* *Albizia* *Citrus* *Terminalia* *Canna*	*Eucalyptus* *Grevillea* *Mangifera*	*Heliocharis* *Cyperus*	*Imperata* *Heteropogon* *Psidium* *Strychnos* *Vangueria*		*Harungana* *Ravinala* *Dalbergia* *Tambourissa* *Symphonia* *Chrysalidocarpus*

Appendix 11. EAST to WEST transect of Eminiminy showing land-use zones

land type	savanna 'roanga'	dry fields	terraced rice fields 'horaka'	dry fields	terraced rice fields 'horaka'	river 'rano Sakamalio'	village 'tanana'	rice fields 'horaka'	thorn forest 'ala'
									
land use	- cattle pasture - collection of grass for thatch	- cultivation of manioc, sweet potato, maize	- rice cultivation all seasons	- cultivation of manioc, sweet potatoes, beans, maize	- rice cultivation all seasons	- collection of water - fishing - collection of reeds for mats - cultivation of tomatoes, onions, greens etc	- housing - poultry and pig rearing - cattle corrals used at night	- cultivation of late season rice	- collection of firewood - collection of construction wood
dominant vegetation (genus)	*Heteropogon*			*Aloe* *Pachypodium* *Alluaudia* *Indigofera* *Adansonia*	*Mangifera* *Tamarindus* *Melia*	*Cyperus* *Coix* *Phragmites* *Mangifera* *Citrus* *Poupartia* *Agave*	*Opuntia* *Tamarindus*	*Mangifera*	*Alluaudia* *Aloe* *Pachypodium* *Euphorbia* *Adansonia* *Eugenia* *Mendoravia*

Appendix 11. EAST to WEST transect of Esomony showing land-use zones

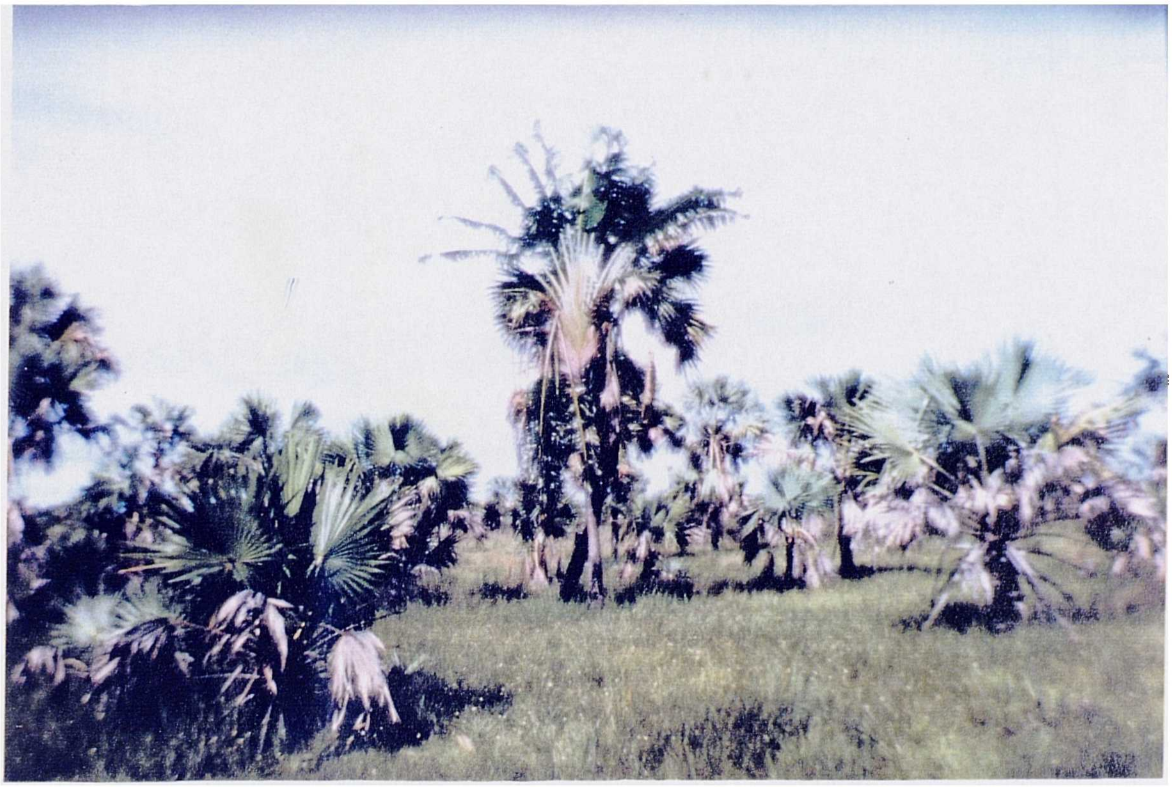


Figure A12.1 Palm savanna, Soalala.

The shorter palms in this photograph are *Bismarckia nobilis*, and the tallest palm is *Ravenala madagascariensis*.

Figure A12.2 Burned forest 0.5 km inland from Antsira.

Figure A12.3 House, Soalala.
Bismarckia nobilis palm leaves are used for roof and wall thatch, attached to a frame of wooden posts.

Figure A12.4 Mat weaving at Antsira, Soalala.
Strips of *Bismarckia nobilis* and *Hyphaene shatan* leaves are woven to make mats and baskets.

Figure A12.5 Salt making at salt flats near Antsira. *Ravenala madagascariensis* leaves are used to line the hollows.

Figure A12.6 Canoe (**laka**), Soalala. Canoes are made locally from special woods.

Figure A12.7 Removing shark's fin for sale, Antsira.

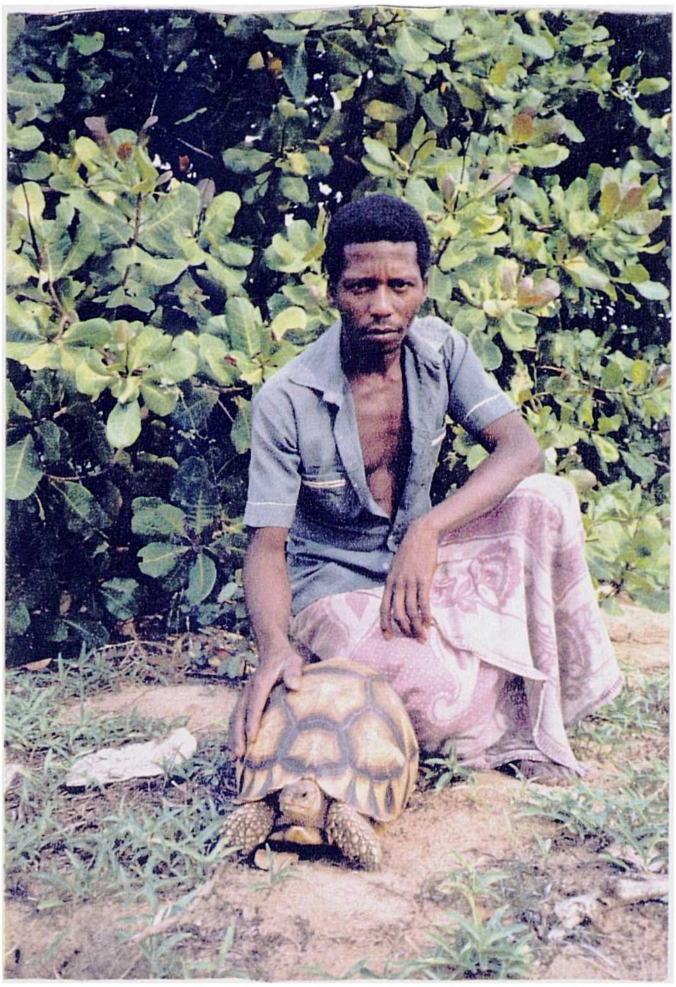


Figure A12.8 Pet angonoka (*Geochelone yniphora*).

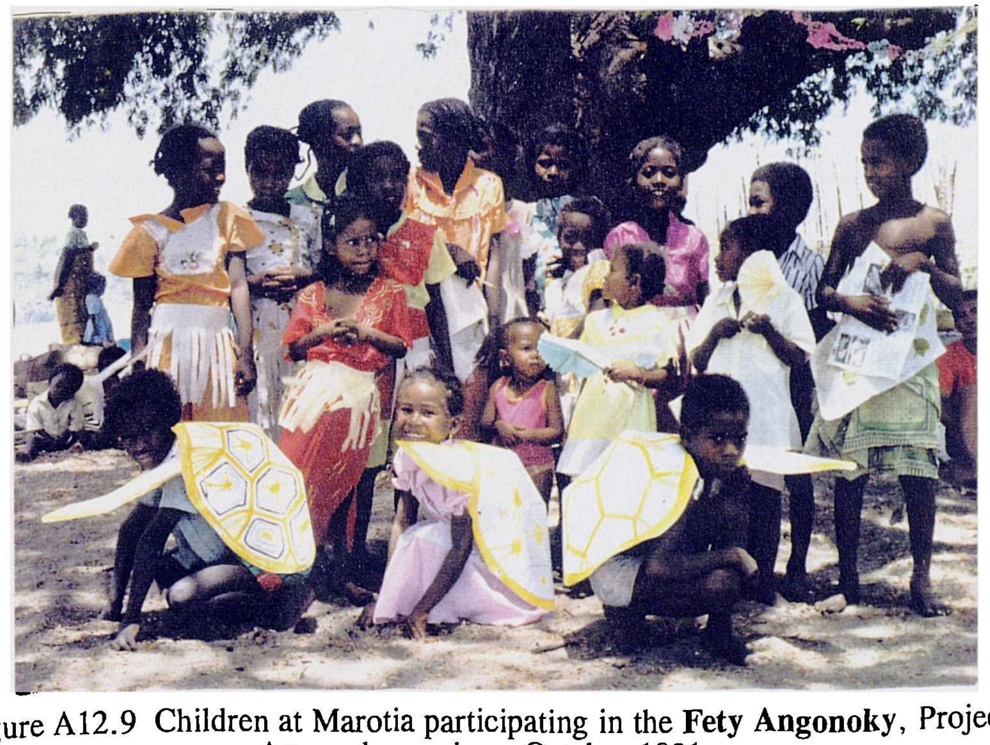


Figure A12.9 Children at Marotia participating in the **Fety Angonoky**, Project Angonoka seminar, October 1991.

Figure A12.10 View to the west near Eminiminy.
In the distance is forest in the Andohahela Reserve, terraced rice fields are in the foreground, and there is savanna with some erosion gulleys in between.

Figure A12.11 Cattle trampling rice fields to break up soil before planting, Eminiminy.

Figure A12.12 Eminiminy village.
Hovao (*Dilobeia thouarsii*) nuts are drying in the foreground, and there is a house with walls made from split palm trunk planks in the background.

Figure A12.13 Using the giant leaf bract of an endemic palm (undescribed species of *Neodypsis*) to drag soil to level terraced rice fields

Figure A12.14 House in Esomony.
The frame is made from wooden posts and the walls are plastered with mud. Manioc (*Manihot esculenta*) tubers are drying on the roof.

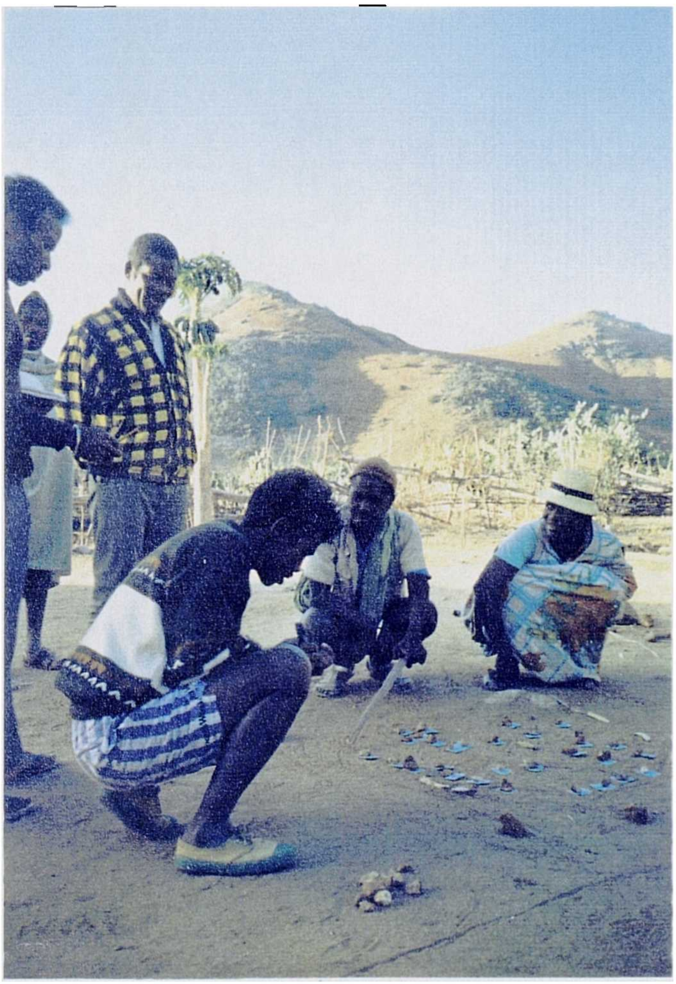


Figure A12.15 Villagers drawing a map of Esomony.
Members of the Andohahela Project team (foreground) employing techniques of Participatory Rural Appraisal.

ABBREVIATIONS

Abbreviations listed here are only those used more than once; expanded versions are given at the first mention in the text.

ANGAP	: `Association Nationale pour la Gestion des Aires Protégées', National Association for Protected Area Management
APN	: `Agent de la Protection de la Nature', Nature Protection Agent
ASE	: `Association pour la Sauvegarde de l'Environnement', Association to Safeguard the Environment
CFPF	: `Centre de Formation Professionelle Forestière', Professional Forestry Training Centre
CITES	: Convention on the International Trade in Endangered Species
DEF	: `Direction des Eaux et Forêts', Directorate of Waters and Forests
DICE	: Durrell Institute of Conservation and Ecology
EAP	: Environmental Action Plan
EIU	: Economist Intelligence Unit
FMG	: `Francs Malgache', Malagasy Francs
GBP	: Great Britain Pounds
GDP	: Gross Domestic Product
GNP	: Gross National Product
ICD(P)	: Integrated Conservation and Development (Project)
IUCN	: International Union for the Conservation of Nature
NGO	: non-governmental organisation
PN	: `Parc National', National Park
RNI	: `Réserve Naturelle Intégrale', Strict Nature Reserve
RS	: `Réserve Spéciale', Special Reserve
SAF-CO	: `Sauvegarde et Aménagement des Forêts - Côte Ouest', Protection and Management of Forests - West Coast
UNDP	: United Nations Development Programme
UNEP	: United Nations Environment Programme
UNESCO	: United Nations Educational, Scientific and Cultural Organisation
USAID	: United States Agency for International Development
USD	: United States Dollars
WWF	: World Wide Fund for Nature

GLOSSARY OF MALAGASY WORDS

Malagasy words mentioned here are only those used more than once in the text. Plant species names are given in Appendix 10. Malagasy nouns have no plural form.

ala	forest
akoho	chicken (also used in Andohahela for cattle killed at funerals for food for guests)
andro	day
atihena	blood-brother (Andohahela)
daba	petrol can measure (approximately 6,500 cms^3, holding about 12 kg of paddy rice)
dina	traditional convention or law
doany	royal tomb (Soalala)
fady	taboo
faly	sometimes used for taboo in place of fady in Andohahela
fanafody	medicine
Faritany	highest administrative level, equivalent to 'Province' in the Colonial system; above 'District'.
fatidraha	blood-brother (Soalala and most of Madagascar)
Firaisana	administrative level equivalent to 'District' in the Colonial system; below 'Region' and above 'Village'
Fivondronona	administrative level equivalent to 'Region' in the Colonial system; below 'Province' and above 'District'
fokonolona	village community (see Chapter 6, Section 6.6)
Fokontany	lowest administrative level, equivalent to 'Village' in the Colonial system; below 'District'
fomba	custom, tradition
hazo	wood, tree
hazomanga	decorated wooden post in villages around Andohahela, and used in that region as a generic term for lineages
horaka	rice field (Andohahela)
kapoaka	condensed milk tin measure (approximately 350 cm^3, holding around 0.285 kg of white rice)
kija	cattle pasture (Soalala)
laka	wooden canoe
lambo	pig, wild or domestic

laoka	meat, fish or vegetables eaten at meals with the main carbohydrate (the word kabaka is used in Soalala)
lonaka	head of lineage (Andohahela)
lova	inheritance
moasy	traditional healer (Soalala)
mpangataka	leader at sacrifice and benediction rituals (Soalala)
mpanjaka	head of royal family (Soalala)
mpijoro	leader at sacrifice and benediction rituals (Soalala)
mpivady	husband and wife
omby	cattle
ombiasy	traditional healer (Andohahela)
ray aman-dreny	elders
razana	ancestors (also used as a generic term for clans in Andohahela)
sikidy/sikily	divinatory practice employing seeds from the **fany** *(Entada abyssinica)* tree and beads
tanana	village, town
tanim-bary	rice fields (Soalala)
taninaomby	cattle pasture (Andohahela)
tany	land
tavy	slash-and-burn cultivation
tompon-tanana	master of the village
tompon-tany	master of the land
tromba	spirit of a royal ancestor, or the occasion when they are manifested
vady	spouse
vaha	basket used in Andohahela to transport goods and as a measure (holds holding around 20 kg of paddy rice)
vahiny	stranger
vary	rice
Zanahary	God
zanaka	child, children

REFERENCES

Abé, Y. (1984). *Le riz et la riziculture à Madagascar: une étude sur le complexe rizicole d'Imerina.* 232 pp. CNRS, Paris, France.

Abel, N. and Blaikie, P. (1986). Elephants, people, parks and development: the case of the Luangwa Valley, Zambia. *Environmental Management*, Vol 10. No 6, pp. 735-751.

Acheson, J.M. (1987). The lobster fiefs revisited: economic and ecological effects of territoriality in Maine lobster fishing. pp. 37-65 in B.J. McCay and J.M. Acheson (eds) *The Question of the commons: the culture and ecology of communal resources.* University of Arizona Press, USA.

Adams, J.S. and McShane, T.S. (1992). *The myth of Wild Africa: conservation without illusion.* 266 pp. W.W. Norton, London, UK.

Alcorn, J.B. (1991). Ethics, economies and conservation. pp. 317-349 in M.L. Oldfield and J.B. Alcorn (eds) *Biodiversity: culture, conservation and ecodevelopment.* Westview Press, Boulder, USA.

Anderson, D. and Grove, R. (1987). *Conservation in Africa: people, policies and practice.* ix + 355 pp. Cambridge University Press, Cambridge, UK.

Andriamampianina, J. (1981). Les réserves naturelles et la protection de la nature. pp. 105-111 in P. Oberlé (ed.) *Madagascar: un sanctuaire de la nature.* Librairie de Madagascar, Antananarivo, Madagascar.

Axelrod, R and Hamilton, W.D. (1981). The Evolution of Cooperation. *Science,* Vol. 211, pp. 1390-6.

Balmford, A., Leader-Williams N. and Green, M. (1992). The protected areas system. pp. 69-80 in Sayer, J.A., Harcourt, C.S. and Collins, N.M. (eds) *The conservation atlas of tropical forests.* IUCN, Cambridge, UK.

Barbier, E.B. (1987). The concept of sustainable economic development. *Environmental Conservation,* Vol. 14, No. 2, pp. 101-110.

Barbour, R.C. (1988). Annexe 4: Trip report from visit to Reserve No. 11. pp. 28-30 in *Plan de travail pour les activités de developpement à Beza Mahafaly.* Unpublished report to WWF Madagascar, Antananarivo, Madagascar.

Barth, F. (1967). 'Economic spheres in Darfur' pp. 149-174 in Raymond Firth (ed.) *Themes in economic anthroplogy*, ASA Monographs No.6. Tavistock Publications Ltd. London, UK.

Basnet, K. (1992). Conservation practices in Nepal: past and present. *Ambio*, Vol. 21, No. 6, pp. 390-393.

Batisse, M. (1982). The biosphere reserve: a tool for environmental conservation and management. *Environmental Conservation.* Vol. 9, No. 2. pp. 101-111.

Beaujard, P. (1983). *Princes et paysans. Les Tanala de l'Ikongo. Un espace social dans le sud est de Madagascar.* 670 pp. Harmattan, Paris, France.

Bell, R. (1987). Conservation with a human face: conflict and reconciliation in African land use planning. pp. 79-101 in D. Anderson and R. Grove (eds) *Conservation in Africa: people, policies and practice.* Cambridge University Press, Cambridge, UK.

Berkes, F. (1987). Common property resource management and Cree Indian fisheries in Subarctic Canada. pp. 66-91 in B.J. McCay and J.M. Acheson (eds) *The Question of the commons: the culture and ecology of communal resources.* University of Arizona Press, USA.

Berkes, F. (ed) (1989). *Common property resources: ecology and community-based sustainable development.* x + 302 pp. Belhaven, London, UK.

Berkes, F. and Farvar, M.T. (1989). Introduction and overview, pp. 1-17 in Berkes, F. (ed) *Common property resources: ecology and community-based sustainable development.* Belhaven, London, UK.

Berkmuller, K., Mukherjee, S. and Mishra, B. (1990). Grazing and cutting pressures on Ranthambhore National Park, Rajasthan, India. *Environmental Conservation*, Vol. 17, No. 2, pp. 135-140.

Bernstein, B. (1981). Ecology and economics: complex systems in a changing environment. *Annual Review of Ecology and Systematics*, Vol. 12, pp. 309-330.

Bishop, R.C. (1978). Endangered species and uncertainty: the economics of the safe minimum standard. *American Journal of Agricultural Economics,* Vol. 60, pp. 10-18.

Blanc C.P. (1974). Status survey of *Testudo yniphora.* pp. 93-94 in *World Wildlife Fund Yearbook, 1972-3.* WWF, Gland, Switzerland.

Bloch, M. (1973). 'The long-term and the short-term: the economic and political significance of the morality of kinship' pp. 75-87 in J. Goody (ed.) *The character of kinship.* Cambridge University Press, Cambridge, UK.

Bloch, M. (1975). 'Property and the end of affinity' pp. 203-228 in M. Bloch (ed.) *Marxist analyses and social anthroplogy.* John Wiley, New York, USA.

Bloch, M. (1986). 'Hierarchy and equality in Merina Kinship' pp. 215-228 in C.P. Kottak, J.-A. Rakotoarisoa, A. Southall and P. Verin (eds) *Madagascar: society and history.* Wenner-Gren, USA.

Boudou, R. (1932). La côte ouest de Madagascar en 1852, notes d'Edmond Samat. *Bulletin de l'Academie Malgache*, Vol. 15. pp 53-78.

le Bourdiec, F. (1974). *Hommes et paysages du riz à Madagascar.* 648 pp. Antananarivo, Madagascar.

le Bourdiec, F. (1980). Le developpement de la Riziculture dans l'ouest Malgache. pp. 133-152 in *Changements sociaux dans l'ouest Malgache.* 521 pp. ORSTOM, Paris, France.

Brandsetter, R.H. and Gilruth, P.T. (1992). *Aménagement des Aires Protégées, Andohahela, Madagascar, WWF Project No. 3746-02, Evaluation.* 39 pp. Unpublished report to World Wildlife Fund, Washinton DC, USA.

Brusberg F.E. (1992). *Final report: monitoring and evaluation system for integrated conservation and devlopment projects: development components.* 23 pp. Unpublished report to ANGAP, Antananarivo, Madagascar.

Carew-Reid, J. (1990). Conservation and protected areas on South Pacific islands: the importance of tradition. *Environmental Conservation*, Vol. 17, No. 1, pp. 29-38.

Casley, D.J. and Lury, D.A. (1981). *Data collection in developing countries.* xi + 244 pp. Clarendon Press, Oxford, UK.

CFPF (1991). *Fiches dendrologiques.* Octobre 1991. 20 pp. CFPF, Morondava, Madagascar.

Chambers, R. (1983). *Rural development: putting the last first.* 246 pp. Longman, New York, USA.

Chambers, R. (1991). Shortcut and participatory methods for gaining social information for projects. pp. 515-537 in Cernea, M. (ed.) *Putting people first: sociological variables in rural development.* (2nd Edition) xxi + 575 pp. Oxford University Press, Oxford, UK.

Cocklin, C.R. (1989). Methodological problems in evaluating sustainability. *Environmental Conservation,* Vol. 16, No. 4, pp. 343-351.

Collett, D. (1987). Pastoralists and wildlife: image and reality in Kenya Maasailand. pp. 129-148 in D. Anderson and R. Grove (eds) *Conservation in Africa: People, Policies and Practice.* Cambridge University Press, Cambridge, UK.

Conway, G.R. (1985). Agroecosystem Analysis. *Agricultural Administration*, Vol. 20, pp. 31-55.

Cooke, H.J. (1983). Environmental Change in Botswana. pp. 7-12 in *Which Way Botswana's Wildlife?*, Proceedings of the Symposium of the Kalahari Conservation Society, April 15-16 1983, Gaborone, Botswana.

Corkhill, T. (1979). *A glossary of wood.* 656 pp. Stobart Davies, London, UK.

Covell, M. (1987). *Madagascar: Politics, Economy and Society.* xxii + 187 pp. Frances Pinter, London, UK.

Croll, E. and Parkin, D. (1992). Cultural Understandings of the Environment, pp. 3-36, in E. Croll and D. Parkin (eds) *Bush Base: Forest Farm: Culture, Environment and Development.* xi + 263 pp. Routledge, London, UK.

Curl, D.A., Scoones, I.C., Guy, M.K., and Rakotoarisoa G. (1985). The Madagascan tortoise Geochelone yniphora: current status and distribution. *Biological Conservation*, Vol. 34, pp. 35-54.

Curl, D.A. (1986). A recovery programme for the Madagascan plowshare tortoise *Asterochelys (=Geochelone) yniphora. Dodo*, Volume 23, pp. 68-79.

Cuvelier, A. (1992). *Rôle de la recherche dans la Programme d'Appui à la Sauvegarde des Ressouces Naturelles du Menabe.* Paper presented to the Atelier Sous-régional sur les Populations Rurales et les Aires Protégées. Morondava 14-18 Décembre 1992.

Decary, R. (1950). *La faune Malgache: son rôle dans les croyances et les usages indigènes.* Payot, Paris, France.

Decary, R. (1954). Tortues terrestres de Madagascar. *Revue de Madagascar*, No.20, 3me tremestre, pp. 40-44.

DEF/ANGAP (1992). *Manuel de procédure pour la création des Aires Protégées.* 43 pp. ANGAP, Antananarivo, Madagascar.

Deschamps, H. (1972). *Histoire de Madagascar.* 358 pp. Berger-Levrault, Paris, France.

Dewar, R,E. (1984). Extinctions in Madagascar: the loss of the subfossil fauna. pp. 574-593 in P.S. Martin and R.G. Klein (eds) *Quaternary extinctions: a prehistoric revolution.* University of Arizona Press, Phoenix, USA.

Dingwall, P.R. (1984). 'Overcoming problems in the management of New Zealand mangrove forests' pp. 97-106 in H.J.Teas (ed.) *Physiology and management of mangroves.* Junk, The Hague, Netherlands.

Dixon, J.A. and Sherman, P.B. (1990). *Economics of Protected Areas: A New Look at Benefits and Costs.* xvii + 234 pp. Island, Washington DC, USA.

Donque, G. (1972). The climatography of Madagascar. pp. 87-144 in R. Battistini and G. Richard-Vindard (eds) *Biogeography and ecology in Madagascar.* xv + 765 pp. Junk, The Hague, Netherlands.

Dove, M.R. (1983). Theories of Swidden Agriculture, and the Political Economy of Ignorance. *Agroforestry Systems,* Vol. 1, pp. 85-99.

Dugdale, R.E. (1989). 'Global reactions of the oceans and seas' pp. 31-49 in J.C. Doornkamp (ed.) *The greenhouse effect and rising sea levels in the UK.* 61 pp. M1 Press, London, UK.

Durrell, L., Groombridge, B., Tonge, S. and Bloxam, Q. (1989). *'Geochelone yniphora* ploughshare tortoise, plowshare tortoise, angulated tortoise, angonoka' pp. 99-102 in I.R. Swingland and M.W. Klemens (eds), *The conservation biology of tortoises.* Occasional Papers of the Species Survival Commission No. 5, IUCN, Gland, Switzerland.

Durrell, L., Rakotonindrina, R., Reid, D. and Durbin, J. (1993). The recovery of the angonoka (*Geochelone yniphora*) - an integrated approach to species conservation, pp. 384-393 in P.J.S. Olney, G.M.Mace and A.T.C. Feistner *Creative conservation: interactive management of wild and captive animals.* Chapman and Hall, London, UK.

Durrenberger, E.P. and Palsson, G. (1987). The grass roots and the state: resource management in icelandic fishing, pp. 370-392 in B.J. McCay and J.M. Acheson (eds) *The Question of the commons: the culture and ecology of communal resources.* University of Arizona Press, USA.

EIU (1993). *Economist Intelligence Unit Country report, 4th Quarter, 1993: Mauritius, Seychelles and Madagascar.* 41 pp. EIU, London, UK.

Ehrlich, P.R. and Ehrlich, A.H. (1981). *Extinction: The Causes and Consequences of the Disappearance of Species.* xiv + pp.305. Victor Gollancz, London, UK.

Ellen, R.F. (1978). *Nuaulu settlement and ecology: an approach to the environmental relations of an eastern Indonesian community.* xi + 265 pp. Martinus Nijhoff, The Hague, Netherlands.

Ellen, R.F. (ed.) (1984). *Ethnographic research: a guide to general conduct.* ASA Research Methods in Social Anthropology: 1. xvi + 403 pp. Academic Press, London, UK.

Faramalala, H.M. (1988). *Etude de la vegetation de Madagascar à l'aide des données spatiales.* Thèse du Doctorat d'Etat, L'Université Paul Sabatier de Toulouse (Sciences), France.

Fauroux, E. (ed.) (1989). *Aombe 2: Le boeuf et le riz dans la vie economique et sociale Sakalava de la vallée de la Maharivo.* 295 pp. MRSTD/ ORSTOM, Antananarivo, Madagascar.

Feeley Harnik, G. (1982). The King's men in Madagascar: slavery, citizenship and Sakalava monarchy. *Africa*, Vol. 52, No. 2, pp. 31-50.

Feeley Harnik, G. (1991). *A Green Estate: restoring independence in Madagascar.* xxvii + 627 pp. Smithsonian Institution Press, Washington and London.

Fenn, M. (1992). *Ranomafana National Park Project: Progress Report No. 6. for period July 1 - September 30, 1992.* 11 pp. Unpublished report to USAID, Antananarivo, Madagascar.

Ferraro, P.J. (1991). *Ranomafana National Park Project: preliminary assessment of local population forest use, forestry initiatives, agricultural operations, cultural diversity, and the potential for rural development.* 52 pp. Unpublished report to Ranomafana National Park Project, Antananarivo, Madagascar.

Flacourt, E. de (1661). Histoire de la grande île de Madagascar, in A. Grandidier, Charles-Roux, H. Froidevaux and G.Grandidier (1913) *Collection des ouvrages anciens concernant Madagascar.* Tome V111. Union Coloniale, Paris, France.

Fox, J. (1992). The problem of scale in community resource management. *Environmental Management*, Vol. 16, No. 3, pp. 289-297.

Frankel O.H. and Soulé, M.E. (1981). Chapter 5. Nature reserves, pp 97-193 in *Conservation and evolution.* vii + 327 pp. Cambridge University Press, Cambridge, UK.

Genini, M. (1992). *Action Monka: présentation des principes de l'action.* 5 pp. SAF-CO, Morondava, Madagascar.

Ghimire, K.B. (1992). Parks and People: Livelihood issues in National Parks Managament in Thailand and Madagascar. *UNRISD Discussion Paper No. 29.* 39 pp. UNRISD, Geneva, Switzerland.

Gradwohl, J. and Greenberg, R. (1988). *Saving the Tropical Forests.* 207 pp. Earthscan, London, UK.

Grandidier, A., Charles-Roux, Froidevaux, H. and Grandidier, G. (eds) (1905). *Collection des ouvrages anciens concernant Madagascar*, Tome 111. Union Coloniale, Paris, France.

Grandidier, A., Charles-Roux, Froidevaux, H. and Grandidier, G. (eds) (1913) *Collection des ouvrages anciens concernant Madagascar.* Tome V111. Union Coloniale, Paris, France.

Grandidier, G. (1928). Ethnographie de Madagascar, Volume IV. 535 pp. in A. Grandidier and G. Grandidier *Histoire Physique, Naturelle et politique de Madagascar.* Société d'editions geographiques, maritimes et coloniales, Paris, France.

Green G.M. and Sussman, R.W. (1990). Deforestation history of the eastern rain forests of Madagascar from satellite images. *Science*, Vol. 248, pp. 212-215.

Greve, A.M. (ed) (1992). *Madagascar Programme Environmental Bulletin.* Vol. 2, No. 2. The World Bank, Washington D.C., USA.

Griveaud, P. (1981). Les invertebrés: un univers prodigieux. pp. 49-56 in P. Oberlé (ed.) *Madagascar, un sanctuaire de la nature.* Librairie de Madagascar, Antananarivo, Madagascar.

Grove, R. (1987). Early themes in African conservation: the Cape in the nineteenth century. pp. 21-39 in D. Anderson and R. Grove (eds) *Conservation in Africa: People, Policies and Practice.* Cambridge University Press, Cambridge, UK.

Gueye, B. and Schoonmaker-Freudenberger, K. (1991). *Introduction a la méthode accélerée de la recherche participative (MARP): quelques notes pour appuyer une formation pratique.* 70 pp. IIED, London, UK.

Hagen, R.T. (1991). *Propositions d'amenagement de la Foret Classee de Tsitongambarika.* 23 pp. Unpublished report to WWF, Antananarivo, Madagascar.

Haltenorth, T. and Diller, H. (1980). *A fieldguide to the mammals of Africa, including Madagascar.* 400 pp. Collins, London, UK.

Hannah, L. (1992). *African people, African parks.* 76 pp. Conservation International, Washington DC, USA.

Hardin, G. (1968). The tragedy of the commons. *Science*, Vol. 162, pp. 1243-1248.

Harrison, P. (1987). *The greening of Africa: Breaking Through in the Battle for Land and Food.* 380 pp. IIED/Earthscan, Paladin, London, UK.

Hawkins, A.F.A. (1994). *The conservation of birds in Madagascar.* Poster presentation at 'Bird Conservation: the science and the action'. BOU/RSPB/JNCC conference. April 1994, Bedfordshire, UK.

Hawkins, A.F.A., Chapman, P., Ganzhorn, J.U., Bloxam, Q., Tonge, S, Barlow, S., (1990). Vertebrate conservation in Ankarana Special Reserve, Northern Madagascar. *Biological Conservation*, Vol. 54, No. 2, pp. 83-110.

Hawkins, A.F.A and de Valois, P. (1993). *Preliminary report on fieldwork in Baly Bay region, Western Madagascar, 28/1/93-28/2/93.* 13 pp. Unpublished report to Jersey Wildlife Preservation Trust, Jersey, UK.

Hays, S. (1987). *Beauty, health and permanence: environmental politics in the United States 1955-1985.* xv + 630 pp. Cambridge University Press, Cambridge, UK.

Heinen, J.T. (1993). Park-people relations in Kosi Tappu Wildlife Reserve, Nepal: a socio-economic analysis. *Environmental Conservation.* Vol. 20, No. 1, pp. 25-34.

Heinen, J.T. and Low, R.S. (1992). Human behavioural ecology and environmental conservation. *Environmental Conservation.* Vol. 19, No. 2, pp 105-116.

Hill, M. (1983). Kakadu National Park and the Aboriginals: Partners in Protection. *Ambio,* Vol. 12, No. 3-4, pp. 158-167.

Homewood, K.M and Rodgers, W.A. (1987). Pastoralism, conservation and the overgrazing controversy. pp. 111-128 in D. Anderson and R. Grove (eds) *Conservation in Africa: People, Policies and Practice.* Cambridge University Press, Cambridge, UK.

Homewood K.M. and Rodgers, W.A. (1991). *Maasailand Ecology: pastoralist development and wildlife conservation in Ngorongoro, Tanzania.* xiii + 298 pp. Cambridge University Press, Cambridge, UK.

Hough, J.L. (1988). Obstacles to effective management of conflicts between national parks and surrounding human communities in developing countries. *Environmental Conservation*, Vol. 15, No. 2 pp. 129-136.

Hough, J.L. and Sherpa, M.N. (1989). Bottom Up vs. Basic Needs: Integrating Conservation and Development in the Annapurna and Michiru Mountain Conservation Areas of Nepal and Malawi. *Ambio*, Vol. 18, No. 8. pp. 434-441.

Huntington, R. (1988). *Gender and social structure in Madagascar.* xii + 148 pp. Indiana University Press, Bloomington, USA.

IUCN/UNEP/WWF (1980). *World Conservation Strategy; living resouce conservation for sustainable development.* IUCN, Gland, Switzerland.

Jenkins M.D. (ed.) (1987). *Madagascar: an environmental profile.* xiii + 374 pp. IUCN, Gland, Switzerland.

Johannes, R.E. (1978). Traditional marine conservation methods in Oceania and their demise. *Annual Review of Ecology and Systematics*, Vol. 9, pp. 349-364.

Johnson, A. (1975). Time allocation in a Machiguenga Community. *Ethnology*, Vol. 14, pp. 301-310.

JOMD (1939). *Journal Officiel de Madagascar et Dépendances,* 29 July 1939.

JORM (1966). *Journal Officiel de la République Malagasy*, 11 June 1966.

Juvik, J.O., Andrianarivo, A.J. and Blanc, C.P. (1981). The ecology and status of *Geochelone yniphora*: a critically endangered tortoise in northwestern Madagascar. *Biological Conservation*, Vol. 19, pp. 297-316.

Juvik, J.O., Kiester, A.R., Coblentz, B.E. and Hoffman, J.A. (1992). The conservation biology of the angonoka (*Geochelone yniphora*) in northwestern Madagascar: 1992 fieldwork report. 21 pp. Unpublished report to Jersey Wildlife Preservation Trust, Jersey, UK.

Kent, R.K. (1979). 'Religion and State: a comparison of Antanosy and Sakalava in 1600's' in R.K. Kent (Ed.) *Madagascar in History: Essays from the 1970s.* xvi + 354 pp. Foundation for Malagasy Studies, Albany, California, USA.

Kiss A. (ed.) (1990). *Living with wildlife: wildlife resource management with local participation in Africa.* xi + 217. World Bank Technical Paper No. 130, World Bank, Washington DC, USA.

Krebs, J.R. and Davies, N.B. (eds) (1984). *Behavioural ecology: an evolutionary approach.* xi + 493 pp. Blackwell, Oxford, UK.

Langrand, O. (1990). *Guide to the birds of Madagascar.* xi + 364 pp. Yale University Press, New Haven, USA.

Lewis, D., Kaweche, G.B. and Mwenya, A. (1990). Wildlife conservation outside protected areas: lessons from an experiment in Zambia. *Conservation Biology,* Vol. 4, No. 2, pp. 171-180.

Lindsay, W.K. (1987). Integrating parks and pastoralists: some lessons from Amboseli. pp. 149-167 in D. Anderson and R. Grove (eds) *Conservation in Africa: people, policies and practice.* Cambridge University Press, Cambridge, UK.

Little, P.D. and Brokensha, D.W. (1987). Local institutions, tenure and resource management in East Africa. pp. 193-209 in D. Anderson and R. Grove (eds) *Conservation in Africa: people, policies and practice.* Cambridge University Press, Cambridge, UK.

Lusigi, W.J. (1981). New approaches to wildlife conservation in Kenya. *Ambio,* Vol.10 No.2-3, pp. 87-92.

Mabberley, D.J. (1987). *The plant-book: a portable dictionary of the higher plants.* xii + 707 pp. Cambridge University Press, Cambridge, UK.

McCabe, J.T., Perkin, S. and Schofield, C. (1992). Can Conservation and Development be coupled among pastoral people? An examination of the Maasai of the Ngorongoro Conservation Area, Tanzania. *Human Organization*, Vol.51, No.4, pp. 353-366.

McCay, B.J. (1978). Systems ecology, people ecology, and the anthropology of fishing communities. *Human Ecology*, Vol.6, No.4, pp. 397-422.

McCay, B.J. (1987). The culture of the commoners: historical observations on old and new world fisheries. pp. 195-216 in B.J. McCay and J.M. Acheson (eds) *The Question of the commons: the culture and ecology of communal resources.* University of Arizona Press, USA.

McCay, B.J. and Acheson, J.M (1987). Human ecology of the commons. pp. 1-34 in B.J. McCay and J.M. Acheson (eds) *The question of the commons: the culture and ecology of communal resources.* University of Arizona Press, USA.

MacEwan, A. and MacEwan, M. (1982). *National Parks: conservation or cosemtics.* xvi + 314 pp. Allen and Unwin, London, UK.

Macfarland, C.G., Villa, J. and Toro, B. (1974). The Galapagos giant tortoises (*Geochelone elephantopus*), Part 1: status of the surviving populations. *Biological conservation*, Vol. 6, pp. 118-133.

Mackenzie, J.M. (1987). Chivalry, social Darwinism and ritualised killing: the hunting ethos in Central Africa up to 1914. pp. 41-61 in D. Anderson and R. Grove (eds) *Conservation in Africa: people, policies and practice.* Cambridge University Press, Cambridge, UK.

Mackinnon, J., Mackinnon, K., Child, G. and Thorsell, J. (1986) *Managing protected areas in the tropics.* xvi + 295 pp. IUCN, Gland, Switzerland.

McNeely, J.A. (1988). *Economics and biological diversity: developing and using economic incentives to conserve biological resources.* 236 pp. IUCN, Gland, Switzerland.

McNeely, J.A. (1992). *The contributions of protected areas to sustaining society.* Paper presented to the IVth World Congress on National Parks and Protected Areas, Caracas, Venezuela, 10-21st February 1992.

Maille, R.L. (1991). *Forest resource use and its implications for conservation and development around the Beza Mahafaly Special Reserve: Final Report.* 20 pp. WWF Project No. 6894. Unpublished report to WWF Madagascar, Antananarivo, Madagascar.

Mariano, L. (1614). 'Routier redigé par le père Jésuite Luis Mariano' in Grandidier, A., Charles-Roux, Froidevaux, H. and Grandidier, G. (eds) (1905), *Collection des ouvrages anciens concernant Madagascar.* Tome 111. Union Coloniale, Paris, France.

Mbaelele, M. (1992). Bilan régional: l'Afrique de l'Ouest. pp. 3.1-3.24 in *Regional Reviews.* IUCN, IVth World Congress on National Parks and Protected Areas, Caracas, Venezuela, 10-21 February 1992.

Mittermeier, R., Konstant, W., Nicoll, M. and Langrand, O. (1992). *Lemurs of Madagascar: an action plan for their conservation.* iv + 58 pp. IUCN, Gland, Switzerland.

Moran, E.F. (1990a). Ecosystem Ecology in Biology and Anthropology: A Critical Assessment. pp 3-40 in E.F. Moran (ed.) *The ecosystem approach in anthropology: from Concept to Practice.* xix + 475 pp. University of Michigan Press, Ann Arbor, USA.

Moran, E.F. (1990b). Levels of analysis and analytical level shifting: examples from Amazonian ecosystem research. pp 279 - 308 in E.F. Moran (ed.) *The ecosystem approach in anthropology: from Concept to Practice.* xix + 475 pp. University of Michigan Press, Ann Arbor, USA.

Morren, G.E.B. (1986). *The Myanmin: human ecology of a Papua New Guinea society.* xvii + 355 pp. UMI Research Press, Ann Arbor, Michigan, USA.

Munasinghe, M. (1992). Biodiversity protection policy: environmental valuation and distribution issues. *Ambio*, Vol. 21, No. 3, pp. 227-236.

Munasinghe, M. (1993). *Environmental economics and sustainable development.* World Bank Environment Paper No. 3. vi + 112 pp. The World Bank, Washington DC, USA.

Murindagomo, F. (1990). Zimbabwe: Windfall and CAMPFIRE. pp. 123-139 in A. Kiss (ed.) *Living with wildlife: wildlife resource management with local participation in Africa.* World Bank technical paper 130, The World Bank, Washington D.C., USA.

Murphree, M.W. (1991). *Communities as Institutions for Resource Management.* 21 pp. CASS Occasional Paper Series, Centre for Applied Social Sciences, Harare, Zimbabwe.

Murphy, P.G. and Lugo, A. (1986). Ecology of tropical dry forest. *Annual review of ecology and systematics*, Vol. 17, pp. 67-88.

Nash, R. (1982). *Wilderness and the American mind.* xvii + 425 pp. 3rd edition. Yale University Press, New Haven, USA.

Netting, R.M., Wilk, R.R., and Arnould, E.J. (eds) (1984). *Households: comparative and historical studies of the domestic group.* University of California Press, USA.

Nicoll, M.E. and Langrand, O. (1989). *Madagascar: revue de la conservation et des aires protegées.* xvii + 374 pp. WWF, Gland, Switzerland.

Nietschman, B. (1973). *Between land and water.* xiv + 279 pp. Seminar Press, New York, USA.

Nyerges, A.E. (1989). Coppice swidden fallows in tropical deciduous forest; biological, technical, sociocultural determinants of secondary forest succession. *Human Ecology*, Vol. 17, pp. 379-399.

O'Connor, S., Pidgeon, M. and Randria, Z. (1985). *A conservation program for the Andohahela Reserve (Réserve Naturelle No. 11).* Paper given at 'Seminaire Scientifique International sur l'état de recherche sur l'equilibres des ecosystèmes forestiers de Madagascar'. Antananarivo, October 1985.

O'Connor, S. (1988). *Outline of an action plan for Andohahela to be submitted to DEF.* 11 pp. Unpublished report to WWF-Madagascar, Antananarivo, Madagascar.

O'Connor, S. (1990). Beza Mahafaly and Andohahela Reserves - Madagascar. pp. 41-51 in A. Kiss (ed.) Living with wildlife: wildlife resource management with local participation in Africa. World Bank technical paper 130, The World Bank, Washington D.C., USA.

Olson, S. (1984). The robe of the ancestors: forests in the history of Madagascar. *Journal of Forest History*, October 1984, pp. 174-186.

Ostrom, E. (1990). *Governing the commons: the evolution of institutions for collective action.* xviii + 280 pp. Cambridge University Press, Cambridge, UK

Oxby, C. (1985). The transformation of land use and society in eastern Madagascar. *Unasylva*, Vol. 37, pp. 42-51.

Owen-Smith, G. and Jacobsohn, M. (1989). Involving a local community in wildlife conservation. A pilot project at Purros, South-Western Kaokoland, SWA/Namibia. *Quagga*, Vol. 27. pp. 21-28.

Parry, D. and Campbell, B. (1992). Attitudes of rural communities to animal wildlife and its utilization in Chobe Enclave and Mababe Depression, Botswana. *Environmental Conservation*, Vol. 19, No. 3, pp. 245-252.

Parry, M. (1990). *Climate change and world agriculture.* 157 pp. Earthscan, London, UK.

Paulian, R. (1981). Madagascar: un petit continent entre l'Afrique et Asie. pp. 11-28 in P. Oberlé (ed) *Madagascar: un sanctuaire de la nature.* 118 pp. Librairie de Madagascar, Antananarivo, Madagascar.

Pearce, D. (1993). *Economic Values and the Natural World.* 129 pp. Earthscan, London, UK.

Pearce, D., Barbier, E.B., Markandya, A. (1988). *Environmental economics and decision-making in Sub-saharan Africa.* UCL London Environmental Economics Centre Paper 88-01, 25 pp. IIED, London, UK.

Pearsall, S.H. (1984). *In absentia* benefits of nature preserves: a review. *Environmental Conservation*, Vol. 11, No. 1, pp. 3-10.

Pellew, R. (1994). *Best way to save the rhinoceros.* Letter to the editor, Monday 21st March 1994, The Independent, London, UK.

Pernetta, J.C. and Hill, L. (1984). Traditional use and conservation of resources in the Pacific Basin. *Ambio* Vol. 13, No. 5/6, pp. 359-364.

Peters, C.M., Gentry, A.H. and Mendelsohn, R.O. (1989). Valuation of an Amazonian rainforest. *Nature,* Vol. 339, pp. 655-656.

Peters, P.E. (1987). Embedded systems and rooted models: The grazing lands of Botswana and the commons debate. pp. 171-194 in B.J. McCay and J.M. Acheson (eds) *The Question of the commons: the culture and ecology of communal resources.* University of Arizona Press, USA.

Press, A.J. (1992). *Issues in planning: indigenous rights, land ownership, public participation and the role of government in the preparation of plans of management for Kakadu and Uluru National Parks, Australia.* Paper presented to the IVth World Congress on National Parks and Protected Areas, Caracas, Venezuela, February 1992.

Pretty, J.N. and Scoones,I. (1989). *Rapid Rural Appraisal for economics: exploring incentives for tree management in Sudan.* 47 pp. IIED, London, UK.

Prins, H.H.T. (1992). The pastoral road to extinction: competition between wildlife and traditional pastoralism in East Africa. *Environmental Conservation*, Vol. 19, No. 2, pp. 117-123.

Quansah, N. (1993). *Forest conservation and appropriate healthcare development in Madagascar.* Seminar, 25th November 1993, at DICE, University of Kent, Canterbury, UK.

Rabinowitz, P.D. Coffin, M.F., Falvey, D. (1983). The separation of Madagascar and Africa. *Science*, Vol. 220, pp. 67-69.

Rackham O. (1976). *Trees and woodland in the British landscape.* 204 pp. J.M.Dent, London, UK.

Rakotomanana, E.J, Andrianaivason, F.R. and Randrianasolo, B. (1989). *Ny voary: initiation pratique à la conservation de la nature et à la protection de l'environnement.* 140 pp. Projet MINESEB - WWF, Antananarivo, Madagascar.

Rakotonirina, B. and Cooke, A. (1994). Sea turtles of Madagascar - their status, exploitation and conservation. *Oryx*, Vol. 28, No. 1, pp. 51-61.

Randrianasolo, J., Favre, J.-C. and Cuvelier, A. (1992). *Opération sauvegarde et aménagement des forêts - Côte Ouest et le Centre de Formation Professionelle Forestière.* Presentation made at the 'Atelier sous-regional sur les populations rurales et les aires protegées', 14th-18th December 1992, Morondava, Madagascar.

Rappaport, R. (1967). *Pigs for the ancestors: ritual in the ecology of a New Guinea people.* xx + 311 pp. Yale University Press, New Haven, USA.

Redclift, M. (1987). *Sustainable development: exploring the contradictions.* 221 pp. Methuen, London, UK.

Reid, D.B. (1990). *Report of a field study of Geochelone yniphora in January 1990.* 15 pp. Unpublished report to Jersey Wildlife Preservation Trust, Jersey, UK.

Reid, D.B. (1991). Report on a field visit to angonoka habitat to the west of Baly Bay, 25 September - 17 October 1991. 8 pp. Unpublished report to Jersey Wildlife Preservation Trust, Jersey, *UK.*

Richard, A.F. and Dewar, R.E. *(1991). Lemur ecology. Annual Review of Ecology and Systematics.* Vol. 22, pp. *145-175.*

Sattaur, O. (1987). Trees for the People. *New Scientist*, 10 September 1987, pp. 58-62.

Sayer, J.A., Harcourt, C.S. and Collins, N.M. (eds) (1992). *The Conservation Atlas of Tropical Forests, Africa.* 288 pp. IUCN, Cambridge, UK.

Service Météorlogique (1984). *Perturbations tropicales de la saison 1983-1984.* Service Météorlogique, Ampandrianomby, Antananarivo, Madagascar.

SGM (1958). Maps: Scale 1:100,000, Sheets H 39-40 and I 39-40. Service Geographique de Madagascar, Antananarivo, Madagascar.

Shaw, W.D. (1991). Environmental economics: can economics help Mother Earth? *Environmental Conservation*, Vol. 18, No. 3, pp. 237-242.

Shepherd, G. (1992). *Managing Africa's tropical dry forests: a review of indigenous methods.* Overseas Development Institute Agricultural Occasional Paper 14. 117 pp. ODI, London, UK.

Showers, K.B. and Malahela, G.M. (1991). *Report of a pilot study for the development of methodology to be used for an historical environmental impact assessment of colonial soil conservation schemes in Lesotho, Southern Africa.* 24 pp. Unpublished.

Simon, D. (1989). Sustainable development: theoretical construct or sustainable goal. *Environmental Conservation,* Vol. 16, No. 1, pp. 41-48.

Smith, A.H. and Berkes, F. (1991). Solutions to the 'Tragedy of the commons': sea-urchin management in St. Lucia, West Indies. *Environmental Conservation,* Vol. 18, No. 2, pp. 131-136.

Smith, E.A. (1984). Anthropology, evolutionary ecology and the explanatory limitations of the ecosystem concept, pp. 51-85 in E.F. Moran (ed) *The ecosystem concept in anthropology.* AAAS, USA.

Smith, L.L. (1993). *Distribution and ecology of the angonoka Geochelone yniphora in northwest Madagascar: Research Proposal.* 10 pp. Unpublished report to JWPT, Jersey, UK.

Smith, L.L., Joby, M. and Bourou, R. (1994). *Project Angonoka Field Study, Quarter 2 Report, December 1993-February 1994.* 8 pp. Unpublished report to JWPT, Jersey, UK.

Stocks, A. (1987). Resource management in an Amazon Varzea Ecosystem: the Cocamilla case. pp. 108-120 in B.J. McCay and J.M. Acheson (eds) *The Question of the commons: the culture and ecology of communal resources.* University of Arizona Press, USA.

Swanson, T.M. and Barbier, E.B. (1992). *Economics for the wilds: wildlife, wildlands, diversity and development.* xii + 226 pp. Earthscan, London, UK.

Sykes, J.B. (ed.) (1977). *The Concise Oxford Dictionary of Current English.* 6th Edition. xxiii + 1368 pp. Oxford University Press, Oxford, UK.

Talbot, L. and Olindo, P. (1990). The Maasai Mara and Amboseli reserves, Kenya. pp. 67-74 in A. Kiss (ed.) *Living with wildlife: wildlife resource management with local participation in Africa.* World Bank technical paper 130, The World Bank, Washington D.C., USA.

Tainton N.M, and Mentis, M.T. (1984). 'Fire in grasslands' in P.V. de Booysen and N.M. Tainton (eds), *Ecological effects of fire in South African ecosystems.* Ecological Studies 48. Springer Verlag, Heidelberg, Germany.

Thomas, D.H.L., Ayache, F. and Hollis, G.E. (1991). Use and Non-Use Values in the Conservation of Ichkeul National Park, Tunisia. *Environmental Conservation*, Vol. 18, No. 2, pp. 119-130.

Thorsell, J. (1992). *The road to Caracas: a post audit of the implementation of the Bali Action Plan 1983-1992.* Paper presented at Plenary Session 3 of the IVth World Congress on National Parks and Protected Areas, Caracas, Venezuela, 10-21 February 1992.

Tisdell, C.A. (1989). Environmental conservation: economics, ecology and ethics. *Environmental Conservation*, Vol. 16, No. 2, pp. 107-112.

Tobias, D. and Mendelsohn, R. (1991). Valuing Ecotourism in a Tropical Rainforest Reserve. *Ambio*, Vol. 20, pp. 91-93.

Toone, W.D. and Wallace, M.P. (1994). The extinction in the wild and reintroduction of the California condor (*Gymnogyps californianus*) pp. 411-419 in P.J.S. Olney, G.M.Mace and A.T.C. Feistner *Creative conservation: interactive management of wild and captive animals.* Chapman and Hall, London, UK.

Turton, D. (1987). The Mursi and national park development in the Lower Omo Valley. pp. 169-186 in D. Anderson and R. Grove (eds) *Conservation in Africa: people, policies and practice.* Cambridge University Press, Cambridge, UK.

UNCED (1991). *Handbook of International Trade and Development Statistics.* xx + 563 pp + 55 appendices. United Nations Conference on Environment and Development 1990, United Nations, New York, USA.

UNESCO (1992). Recommandations des participants. *Compte rendu du Atelier Sous-Régional sur les populations Rurales et les Aires Protégées.* Morondava, Madagascar, 14-18th December 1992. Programme des Nations Unies pour le Développement Commission Nationale Malgache pour l'UNESCO, Antananarivo, Madagascar.

Verin, P. (1986). *The history of civilisation in north Madagascar.* xii + 431 pp. A.A. Balkemer, Netherlands.

Vermeer, E.B. (1977). *Water conservancy and irrigation in China: social, economic and agrotechnical aspects.* 350 pp. Leiden University Press, Netherlands.

Waast, R. (1980). 'Les concubins de Soalala' pp.153-188 in G.Sautter *et al.* *Changements sociaux dans l'ouest malgache.* Collection mémoires 90. ORSTOM, Paris, France.

Walsh, G.E. (1977). 'Exploitation of mangal' pp. 347-362 in V.J.Chapman (ed.), *Ecosystems of the world 1: wet coastal ecosystems*, xi + 428 pp. Elsevier, Amsterdam, Netherlands.

Wells, M.P. (1988). *The contribution of integrated conservation/development projects to the protection of Madagascar's biodiversity: a preliminary evaluation.* World Bank, Washington DC, USA.

Wells, M., Brandon, K. and Hannah, L.J. (1992). *People and parks: linking protected area management with local communities.* xii + 99 pp. World Bank, Washington DC, USA.

Wells, M.P. and Brandon, K.E. (1993). The principles and practice of buffer zones and local participation in biodiversity conservation. *Ambio*, Vol. 22, No. 2-3. pp. 157-162.

Western, D. (1982). Amboseli National Park: Enlisting Landowners to Conserve Migratory Wildlife. *Ambio,* Vol. 11, No. 5, pp. 302-308.

White, F. (1983). *The vegetation of Africa. A descriptive memoir to accompany the UNESCO/AEFTAT/UNSO vegetation map of Africa.* Natural Resources Research 20. 356 pp. Unesco, Paris, France.

Wilkinson, G.S. (1984). Reciprocal food sharing in the vampire bat. *Nature*, Vol. 308, pp. 181-184.

Williams, C.N., Chew, Y.W. and Rajaratnam, J.A. (1980). *Tree and field crops of the wetter regions of the tropics.* ix + 262 pp. Intermediate Tropical Agriculture Series, Longman, UK.

Woods, P. (1989). Effects of logging, drought and fire on structure and composition of tropical forests in Sabah, Malaysia. *Biotropica* Vol. 21, pp. 290-298.

WWF (1992). *WWF Madagascar Country Plan FY 92/93 - FY 96/97.* Third draft, September 1992. 61 pp. Unpublished document, WWF, Gland, Switzerland.

WWF/EEC/ODNRI (1989). *Republic of Cameroon, The Korup Project: Plan for developing the Korup National Park and its support zone.* ODNRI, Chatham, UK.

Young, H.G., Safford, R.J. and Ravonjiarisoa, P. (1993). Survey and Capture of Madagascar Teal *Anas bernieri*. *Threatened Wildfowl Research Group Newsletter*, Vol. 3, No. 12, p. 17.