BRIDGING THE GAP:

Linking timber trade with infrastructural development in Southern Tanzania—Baseline data before completion of Mkapa Bridge

Simon A.H. Milledge
Bariki K. Kaale

TRAFFIC East/Southern Africa

The Rufford Foundation

WWF

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Front cover photograph: Hard wood logs awaiting collection in village, Rufiji District.

Credit: Simon Milledge/TRAFFIC East/Southern Africa

"The overall national vision on biodiversity conservation is to build a society that values all the biodiversity richness, using it sustainably and equitably, while taking the responsibility for actions that meet both the competing requirements of the present and the legitimate claims of the future generations."

National Biodiversity Strategy and Action Plan (1999)

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ABBREVIATIONS

CAWM	College of African Wildlife Management (Tanzania)
CBNRM	Community Based Natural Resource Management
CBD	Convention on Biological Diversity
CCD	Convention to Combat Desertification
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DANIDA	Danish International Development Agency
EAC	East African Community
ERP	Economic Recovery Programme (Tanzania)
ESAP	Economic and Social Action Programme (Tanzania)
FBD	Forest and Beekeeping Division (Tanzania)
FINNIDA	Finnish International Development Agency
GDP	Gross Domestic Product
GIS	Geographic Information System
GPS	Global Positioning System
MDC	Mtwara Development Corridor
MNRT	Ministry of Natural Resources and Tourism (Tanzania)
MTEF	Medium Term Expenditure Framework
NCAA	Ngorongoro Conservation Area Authority
NEMC	National Environment Management Council (Tanzania)
NEPAD	The New Partnership for Africa's Development
NFP	National Forest Programme (Tanzania)
NPES	National Poverty Eradication Strategy (Tanzania)
OPEC	Organisation of Petroleum Exporting Countries
PIC	Portfolio Investment Company Limited
PRSP	Poverty Reduction Strategic Paper (Tanzania)
RDFAPTF	Rufiji District Forest Action Plan Task Force
REMP	Rufiji Environment Management Programme
SADC	Southern Africa Development Corporation
TANAPA	Tanzania National Parks
TASONABI	Tanzania Specialists Organisation on Natural Resources and Biodiversity
TAWICO	Tanzania Wildlife Corporation
TAWIRI	Tanzania Wildlife Research Institute
TFCG	Tanzania Forest Conservation Group
TFCMP	Tanzania Forest Conservation and Management Project
TWCM	Tanzania Wildlife Conservation Monotoring Unit
TWICO	Tanzania Wood Industries Corporation
TZS	Tanzania Shillings
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNFCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
WMA	Wildlife Management Area
WWF	World Wide Fund for Nature (known as World Wildlife Fund in USA)
WSSD	World Summit on Sustainable Development

EXECUTIVE SUMMARY

The close relationship between livelihoods, economies and woodlands has been well documented both globally and within the United Republic of Tanzania. Rural and urban households, the private sector, and local and central governments show varying degrees of dependence upon woodland timber resources, which provide some of the most highly-valued products and services in poorer countries. Woodlands therefore present enormous potential in alleviating poverty and enhancing social development. On the other hand, growing disparities in poverty levels, population growth, unsustainable practices and growing pressure on limited resources are increasingly threatening this potential, resulting in negative impacts on both woodland integrity and the quality of livelihoods.

One apparent irony is that improved development may often result in greater negative impacts on livelihoods and the environment, and these impacts may vary both spatially and temporally. Sustainable development, particularly in areas where people rely heavily on environmental resources, therefore relies on striking a careful balance. Development projects that are prone to negative environmental impacts in the absence of adequate implementation of environmental impact assessment findings include mining, aquaculture, hydroelectric power plants and transport development. Further, despite clear linkages between social development, poverty alleviation and timber products, woodland management normally suffers from insufficient funding, and available resources are rarely used proactively to mitigate adverse consequences of development initiatives. Instead, efforts tend to be reactionary after negative impacts have been felt.

This study, the first of its kind in the country, has documented valuable baseline information on timber trade dynamics from miombo woodlands and coastal forests in southern Tanzania before completion of an important development project. The *Mkapa Bridge* spanning the Rufiji River, the longest bridge of its kind in east and southern Africa, officially was opened in August 2003. This bridge will greatly enhance access to large expanses of timber resources south of the delta, which were previously inaccessible from the north during seasonal floods. This area has one of the highest levels of poverty in Tanzania, but also contains some of the last remaining viable stands of miombo woodland and coastal forest in the country. Indeed, this region has the highest proportion of unreserved woodlands whose management depends on the same communities who derive so many benefits, including a range of environmental services and timber products.

This study was conducted using a combination of methodologies, including field research, analysis of official trade-related data, mapping of logging roads and other spatial information, stakeholder interviews and a review of available literature. As a result it was possible to assemble detailed baseline data on a range of important factors and to present a series of indicators to facilitate the future monitoring of the environmental and socio-economic impact of the Mkapa Bridge. Key challenges were identified, including management capacity and practices, revenue collection, forest management, evidence of unsustainable offtake and large-scale, illegal trade. These issues are discussed together with recommendations for future work that will help ensure that the bridge has a positive impact on poverty alleviation and woodland management in southern Tanzania.

Baseline timber trade data

In order to increase available knowledge on trade dynamics of natural resources from miombo woodlands and coastal forests, baseline data is presented on volumes, products, species, sizes, harvest areas, trade routes, markets, revenues and various sociological factors over the past year. An estimated 2.1 million m^3 of wood fuel is consumed annually in the study area, whilst around 42 000 m^3 of timber (round wood

equivalent) was transported north over the Rufiji River and some 2 420 m^3 shipped from the three ports in the study area during 2001. In addition, significant quantities of timber products are used in rural and urban centres within the study area, as well as leaving the mainland unrecorded by sea.

At least 24 hard wood timber species were harvested from the study area during 2001, with the most popular tree species being Gum Copal *Hymenaea verrucosa,* Cape Mahogany *Trichilia emetica,* African Teak *Pterocarpus angolensis,* Snake Bean Tree *Swartzia madagascarensis* and Pod Mahogany *Afzelia quanzensis*. *Hymenaea verrucosa* accounted for 82% of small logs that were recorded at Kibiti checkpoint (the first official checkpoint north of the Rufiji River), while 57% of large logs were *Swartzia madagascarensis*. Four species, namely *Hymenaea verrucosa, Pterocarpus angolensis, Trichilia emetica* and *Afzelia quanzensis*, accounted for 92% of sawn wood passing the checkpoint during 2001.

Higher accessibility to woodlands in Rufiji District, in particular north of the Rufiji River, has resulted in the highest harvesting pressures. Rufiji District accounted for 85% of the total harvested wood while Kilwa District accounted for 10%. Taking into account woodland areas and harvest levels, Rufiji District has by far the highest theoretical harvest pressure, a factor of almost five times higher than Kilwa and 50 times higher than Liwale District. Major harvest areas in the study area include Ngumburuni, Ruhoi, Ikwiriri, Nyamwage, and the woodland complex of Nainokwe-Zinga-Likawage-Liwiti.

Almost all products moving north over the river are destined for Dar es Salaam. Greater seasonality in trade was documented south of the Rufiji River due to restricted access during the rainy season, although this is predicted to change following completion of the bridge. Sawn wood accounted for less than two-thirds of officially recorded trade but 83% of the actual trade. An estimated six per cent of all sawn wood (mostly planks) moving north originates from sawmills in Ikwiriri, north of the Rufiji River.

Sociological profiles of timber product traders were collected for the first time, including gender, education and age. The majority of traders were aged between 26 and 45, and 93% had left primary school. Women constituted the minority (11%), half of whom traded planks. Men, on the other hand, showed a preference for trading logs.

Levels of unsustainable and illegal timber trade activities

The results revealed two disturbing trends, namely evidence of unsustainable timber trade and large-scale, illegal activities. These trends were particularly evident north of the Rufiji River where access to woodlands is currently greatest. Timber harvest fees vary according to which one of the five Classes the species is listed. The highest fees are paid for the most valuable species listed in Class I, whilst the least valued species are included in Class V. Overharvesting of the higher-value hardwood species from Rufiji District has pushed traders to exploit a larger number of alternative species, mostly Class V. Indeed, these alternative species accounted for almost all Class V licences issued from the entire study area. On the other hand, the proportion of the most valuable hardwood species harvested increases markedly moving southwards from the Rufiji River. During 2001, over 80% of licences issued from districts in Lindi Region was comprised of Class I and II species.

In addition to an increasing proportion of lower value species in trade, other evidence of unsustainable timber trade activities included changes in harvest areas following systematic clearance moving southwards, fewer large trees remaining in wild stands, harvesting of undersize trees, and declining plank sizes. An alarming rate of woodland clearance for agriculture expansion, mainly in unreserved land, was observed throughout the study area. The absence of suitable property rights, security of tenure, poor enforcement of laws related to woodland management, and inadequate administrative and technical

guidance from central and district authorities for sustainable management of woodlands (due to a critical shortage of skilled manpower and insufficient funding) are some of the factors contributing to extensive woodland clearance.

Large-scale, uncontrolled and often illegal trade throughout the study area resulted in large discrepancies between government records and actual trade levels. For example, five times as much timber passes north through Kibiti checkpoint than was officially recorded. The types, causes and impacts of illegal trade are discussed. Of particular concern was the lack of evidence demonstrating legal timber harvesting during field work, such as accompanying, official documentation or felled timber bearing legal hammer marks. The incidence of misclassification and the issue of "offcuts" as a means to mask illegal trade in preferred species were also disturbingly high. Evidence from the study area showed that illegal trade is resulting in significant loss of revenue - vital income for local government authorities and communities - as well as woodland degradation. It is clear that several species have already become commercially extinct in parts of the study area. For example, *Afzelia quanzensis, Millettia stuhlmannii* and *Swartzia madagascarensis* are predicted to join the growing list of commercially extinct hardwood species in Rufiji District that currently include *Dalbergia melanoxylon, Khaya anthotheca, Milicia exelsa, Newtonia* spp. and *Pterocarpus angolensis.*

Future outlook

The majority of people in the study area depend heavily on free forest goods, products and services to support their livelihoods in the absence of viable alternatives. Wise utilization of natural resources in the study area has the potential to be the foundation for poverty alleviation efforts in southern Tanzania in addition to supporting local and central governments. Improved forest/woodland management and socially equitable access, use and trade of forest and woodland resources could drastically increase long-term benefits to rural communities – at the very least helping to mitigate further poverty, but at the very best contributing towards poverty alleviation.

However, forestry is not currently regarded as a priority sector in the study area despite the fact that it influences the progress of other priority sectors for development. The threat posed by malpractices, lost revenues and forest degradation to the long-term sustainability of timber trade are likely to be exacerbated following increased access to harvest areas after completion of the *Mkapa Bridge*. Given its proximity to the bridge, it is expected that the study area is most likely to be affected in terms of increased exploitation by outsiders and lost incomes from trade in timber products by both community and government sectors.

Insufficient management capacity is the major limiting factor to effecting proper forest management in the study area, thereby securing its role in helping poverty eradication efforts in the long term. Recommendations to improve management for the long-term benefit of sustainable development in the study area include extensive capacity building at checkpoints, empowerment of local communities in forest management, improved forest management plans and law enforcement assistance.

Importantly, it is recommended that sustained monitoring and research complement future initiatives in order to assess changes in trade dynamics, the impacts on livelihoods and the success of any interventions. A proposed monitoring methodology with preliminary list of 63 indicators is presented. Baseline timber trade data are presented prior to completion of the *Mkapa Bridge*, to enable the monitoring of numerous predicted changes including the magnitude, seasonality, legality, harvest areas, trade routes, species and product composition.

INTRODUCTION

Forests and national development

The United Republic of Tanzania, along with many other countries in the Southern Africa Development Corporation (SADC) region, is in the process of political and economic reform in an attempt to achieve poverty eradication goals. In this regard, all sectors, including the environment, are required to address national development objectives. The Vice-President's Office identified the linkage between poverty and the environment as a major challenge for combating poverty in Tanzania (Anon., 2002e). The higher dependence of poorer people on natural resources, especially forest products, and the evident overutilisation of natural resources that is leading to environmental degradation and increased poverty, highlights the need to ensure environmental concerns are acknowledged within other sectoral policies (Anon., 2000d; Anon., 2002e). However, richer people also have an impact and a role to play. Empirical evidence in other countries has shown clear linkages between the environment and poverty, demonstrating how poorer households have the greatest dependence on natural resources, including the generation of income, whilst richer households have the most impact on the environment through the use of greater quantities of environmental resources (Cavendish, 2000).

Whilst forestry is not amongst the priority sectors for poverty eradication in Tanzania, the sustainable conservation of forests and woodlands is a prerequisite for the development of the priority sectors, namely education, health, agriculture, roads, water and judiciary (Kilahama, 2002). Indeed, forests and woodlands, covering over a third of the land area, are the most valuable natural resources in Tanzania, supporting rural and urban livelihoods through the provision of essential products[1], commercial services[2] and many other, generally undervalued, environmental services[3]. The Vice-President's office stated that biological diversity services and their commercial enterprises could potentially become the biggest source of foreign exchange in the future, helping alleviate poverty (Anon., 2002e). The National Forest Policy (1998) further recognizes that *"trade in wood and non-wood forest products offer considerable potential for increased economic development through income and employment generation as well as export earnings"* (Anon., 1998a).

Nevertheless, the undervaluation of forest and woodland resources (both economic and social values), and a poor understanding of their links to national sustainable development, has plagued effective management in the past. Serious degradation of priority forests and woodlands from both environment and development perspectives has been well documented in Tanzania, both in protected and unprotected land. This degradation - predicted to continue at least for the next generation – will likely lead to further losses of biodiversity values at all levels, and will hinder development in the priority sectors if allowed to continue, consequently contributing to an increase in poverty (Turuka, 1998; Anon., 2001a,e).

[1] Forest products, timber and non-timber, include wood energy, building poles and timber, medicines, fruits, mushrooms, oils, beverages, bamboo, gums, fodder, fibre, honey, candles, dyes, ornamental plants, household utensils and handicrafts.

[2] Commercial services include income and employment from a range of enterprises, including food processing plants (fisheries and agriculture), furniture and pulp enterprises (forestry) and the tourism and hotel industry (wildlife and forestry).

[3] Forest services include maintaining ecological cycles and micro-climates, nutrient cycling, soil fertility, erosion control, water catchment, watershed protection, stabilising stream flows, and sink filter for air pollution emissions and carbon sequestration.

The National Forest Policy (1998) states that *"unregulated trade can instigate uncontrolled exploitation and has the potential of accelerating forest destruction and degradation through loss of biodiversity"* (Anon., 1998a). Trade in forest products, in particular for timber and charcoal, has contributed to the degradation of miombo woodlands and coastal forests that cover two-thirds of the country (Anon., 2001b). The past decade has shown marked changes in timber trade dynamics, with a geographic shift in supply and changes in species composition influenced by accessibility to, and abundance of, forest resources. For example, with decreasing availability of the preferred *Pterocarpus angolensis*, preference has turned to other species, notably *Brachystegia speciformis* and *Afzelia quanzensis*. Further, decline in availability and size of targeted species such as *Pterocarpus angolensis* in western and central Tanzania has led to rising exploitation of less accessible sources, including the coastal forests and miombo woodlands of Lindi Region.

Miombo woodlands remain a vital natural resource for the country, both for economic and ecological reasons. They make up two-thirds of Tanzania's forests and woodlands and stretch down through Zambia and Mozambique into Zimbabwe. These areas have a high floral diversity and concentrations of large and, sometimes, rare mammals, many of which migrate seasonally (e.g. elephants). Miombo woodland intergrades with coastal forests and surround some of the Eastern Arc Mountains, both areas of global conservation value for their high levels of species richness and endemism.

Isolation of southern Tanzania miombo woodlands and coastal forests

Up until 2003, poor roads and the absence of permanent river crossings largely isolated the southern miombo woodlands and coastal forests from Dar es Salaam. In particular, seasonal flooding across the Rufiji River delta almost completely prevented terrestrial movements of timber and other cargo across its banks during parts of the year (Figure 1). Before the newly constructed Mkapa Bridge was opened, only one major ferry operated on the Rufiji River, situated at a small settlement called Ndundu, south of Ikwiriri town.

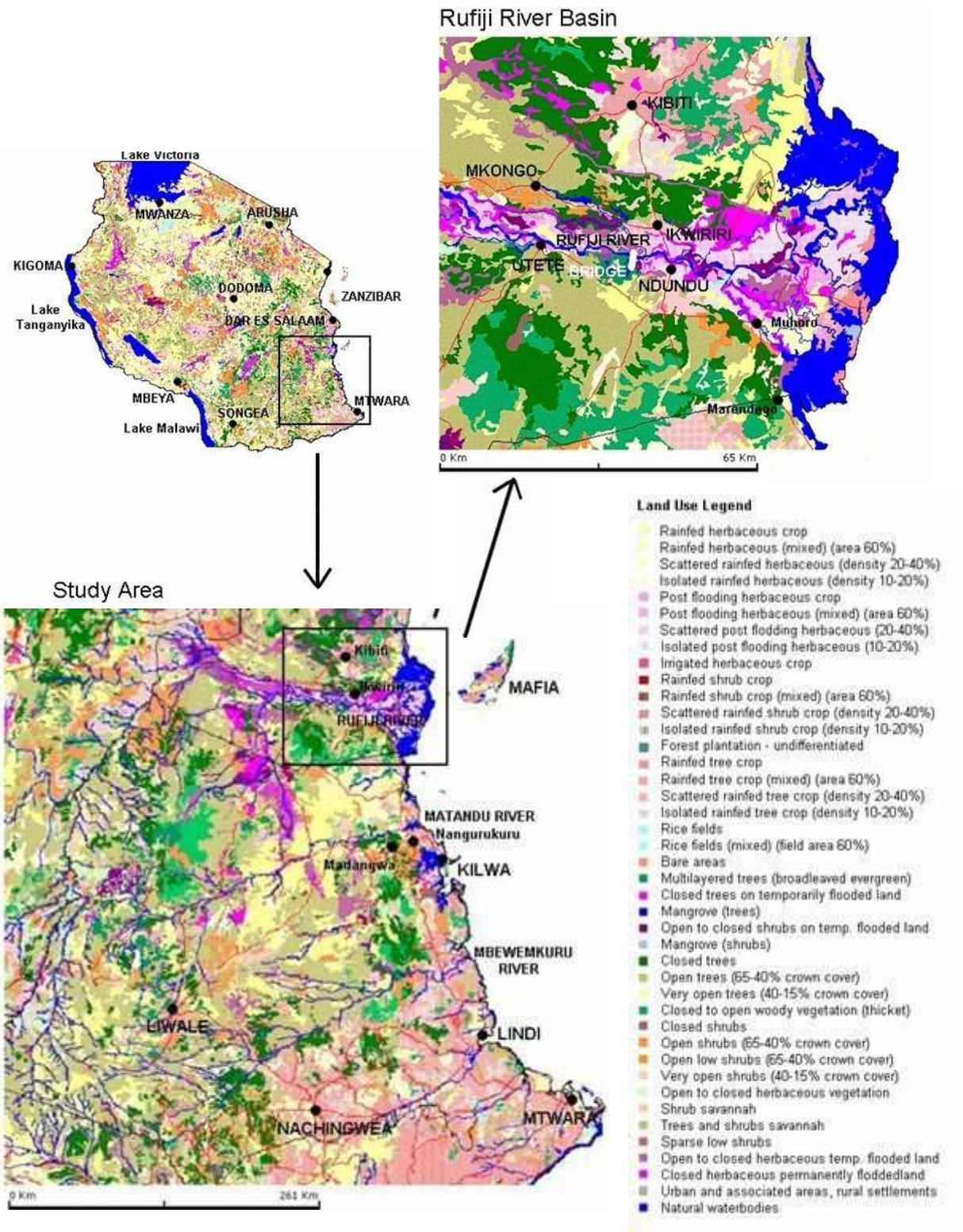
With over 33% of the nation's population, 75% of its industry and the highest national rate of urban migration, Dar es Salaam is Tanzania's largest consumer and export market for hardwood timber. However, relative isolation has prevented the large natural stands of valuable hardwoods occurring in miombo woodlands and coastal forests in Lindi and Mtwara Regions from the massive exploitation witnessed in other parts of the country. Further, this isolation has left these regions with amongst the poorest infrastructure in the country, particularly roads, power and communications. Low economic prospects have resulted in this area being one of the nation's poorest (Anon., 2000d).

It can be reasonably argued that economic and social progress in the area have been hindered by not fully capitalizing on the existing development potential of natural resources from the remaining tracts of wildnerness. On the other hand, isolation may have also prevented the likely scenario whereby outsiders[4] gain unrestricted access to, and receive most of the benefits from, these woodland and forest resources, to the detriment of local communities who lack the capacity to ensure equitable and sustainable benefit sharing.

[4] People not from the local area, often characterized by their higher capital and capacity to trade than local communities, but with fewer incentives for sustainable management.

Figure 1

Map of southern Tanzania showing location of Rufiji River and other geographic details



Sources: Tanzania Natural Resources Information Centre; Hunting Technical Services, 1997.

However, significant changes in development and timber harvest are predicted in the future, sparked by the construction of Mkapa Bridge across the Rufiji River[5]. Officially opened in August 2003, this bridge creates a permanent link between Dar es Salaam and southern Tanzania. Moreover, government and SADC level initiatives, the development of the Mtwara Development Corridor[6] (a joint undertaking of Malawi, Mozambique, Tanzania and Zambia) and growing private investment are likely to accelerate development in the south. Whilst on the one hand this will improve many aspects of development in the region, these changes will almost certainly increase pressure on the timber resources. Therefore, there is an urgent need for effective sustainable use initiatives that help maintain the integrity of miombo woodlands and coastal forests as well as contribute positively towards poverty alleviation strategies.

Justification for study area

This project has concentrated on the interface between development and conservation, seeking to increase the potential for completion of the Mkapa Bridge to have a positive impact on poverty alleviation and natural resource management in southern Tanzania.

The study area covered by this project included seven districts belonging to three regions, namely Rufiji District (Coast Region), Lindi, Kilwa, Liwale, Ruangwa and Nachingwea Districts (Lindi Region), and Mtwara District (Mtwara Region). This study area was selected based upon various criteria. Firstly, these districts are in closest proximity to the Mkapa Bridge, and are likely to be the most directly affected (positively and negatively) in the near future. Secondly, from the national development perspective, this area represents one of the poorest in Tanzania and most rural livelihoods are heavily dependent upon woodland and forest resources in the form of food, housing, fuel, medicines and income. Thirdly, from an environmental perspective, this area contains some of the largest remaining wild stands of miombo woodland in Africa, as well as some of the largest areas of unprotected woodland and the highest quantities of woodland per capita in Tanzania. Their future integrity is largely dependent upon management by surrounding communities. These woodlands still contain large, commercially-viable stands of many timber species, although spatial declines have been noted for some species.

Credit: Simon Milledge/TRAFFIC East/Southern Africa

Children sitting on logs, Kilwa Masoko.

By providing credible timber trade information on the situation in southern Tanzania before and after completion of the Mkapa Bridge (and other associated development activities), this project provides a unique opportunity to study and positively influence the impacts of a national development project on both natural resource use and peoples' livelihoods. It is hoped that this information will help future management interventions address both sustainable utilization of miombo woodlands and national poverty alleviation objectives during the subsequent period of economic growth and development. It is also hoped that the same principles and approaches may be applied appropriately to other development projects.

[5] The USD 29 million project was financed by the Government of Tanzania, the Kuwait Fund for Arab Economic Development, OPEC Fund for International Development and the Saudi Fund for Development.

[6] The Mtwara Development Corridor initiative started in 1997 and includes the construction of the Unity Bridge across the Ruvuma River, a 829 km Mtwara-Mbamba Bay road project, the Mchuchuma Colliery and Thermal Power Project, in addition to various mining, oil, gas, fisheries, agriculture and fisheries initiatives.

In this way, the project is helping to address the following challenges in the forestry sector with respect to the Rio Declaration as identified by the Government of Tanzania (Anon., 2002e):

i. *To enhance the potential utilization of forests while managing them to ensure sustainability;*

ii. *To achieve high levels of integration of forestry consideration into all development initiatives which adversely affect forestry; and*

iii. *To strike a balance between the economic use of forestry and forest conservation.*

This project also aims to contribute towards one of the high priority issues identified under the first objective of the National Forestry Programme (2001-2010):

> *Objective #1: Sustainable supply of forestry products and services ensured to meet the needs at the local and national levels*
>
> > *Priority issue: Inadequate data on available forest resources for utilization, and baseline data for conservation and management purposes*

METHODOLOGY

This study was conducted during a 12-month period commencing in August 2001, and was co-ordinated by the Tanzania office of TRAFFIC East/Southern Africa. The timeframe was designed to ensure that essential baseline data were collected before completion of Mkapa Bridge. Prior to conducting any fieldwork, stakeholder consultations were conducted with more than 70 people to collect existing literature, understand perceptions from different sectors, and to modify and plan the research methodologies. Stakeholders were visited in Dar es Salaam, Rufiji, Kilwa and Lindi Districts, including representatives from the Forestry and Beekeeping Division, regional and district government offices, foreign aid agencies, village committee members, local and international non-governmental organizations, commercial logging companies and other members of the private sector. Over 150 relevant documents were collected pertaining to natural resource distribution, use, trade, socio-economics, monitoring, trade regulation, policies, legislation and poverty alleviation.

Three field trips were conducted in total, spanning the period from October 2001 to January 2002. During these field trips, information was collected through: government data; roadside trade research; and mapping of logging roads.

Data collection of government records

Central and local government timber trade records were collected from five districts: Rufiji, Kilwa, Lindi, Nachingwea and Liwale. An attempt was made to collect data for at least the most recent calendar year (Table 1). Comprehensive records were collected and analysed from timber harvest licensing offices throughout the study area, major government natural resource checkpoints, the Ndundu ferry service, one sawmill in Ikwiriri, and shipments from Mtwara, Lindi and Kilwa ports (Table 1; Figure 2).

Timber harvest licensing offices

Wherever possible, data were collected from original harvest licences in order to obtain the most detailed and accurate information available. Annex 2 provides further information on the fee structure for harvest licences. In addition, numerous monthly, biannual and annual reports were collected. Special attention was paid to analysing harvest areas specified on the harvest licences as these are not routinely analysed by authorities.

Government natural resource checkpoints

Raw data were collected from five strategic checkpoints (Figure 2). All five checkpoints exhibited poor infrastructure and equipment, a factor that was reported to negatively affect motivation and possibly drive corrupt practices. Records taken at Kibiti checkpoint - located north of Ikwiriri, the most important checkpoint strategically with respect to the Rufiji River crossing - were expanded for a three-month period to include additional social variables, namely the age, gender and education level of the traders involved (Table 1).

Table 1

Data collected from government sources

Period of data collection	Description of data collected
Timber Harvest Licensing Offices	
Rufiji District (Kibiti Office)	
12 months: 2001 monthly licence summaries	Month, product, species, quantity and revenue
6 months: Apr-Sep 2000 monthly licence summaries	Month, product, species, quantity and revenue
Kilwa District (Kilwa Masoko Office)	
66 months: Jan 1995 to Jun 2000 monthly summaries	Month, product, species, quantity
15 months: Jul 2000 to Sep 2001 monthly summaries	Month, product, species, quantity and revenue
12 months: 99/00 revenue summary	Month, revenue
4 years: 94/95 – 97/98 *D. melanoxylon* summaries	Year, quantity, revenue
12 months: Jul 1999 to Jun 2000	Month, quantity, revenue
6 months: Jul-Dec 1997 individual licences	Month, species, quantity, origin
15 months: Jul 2000 to Sep 2001 individual licences	Month, species, quantity, origin
Lindi, Nachingwea, Ruangwa, Liwale Districts (Lindi Town Office)	
19 months: Jul 2000 to Jan 2002 individual licences	Month, species, quantity, origin
Government Natural Resource Checkpoints	
Kibiti - 3 months: mid-Oct 2001 to mid-Jan 2002	Date, vehicle registration and type, owner sex, age, education, cargo type, origin, quantity, species, value
Kibiti - 15 months: Jul 2000 to Sep 2001	Date, vehicle registration and type, cargo type, origin, quantity, species and value
Madangwa - 2 months: Aug to Sep 2001	Date, vehicle registration and type, source, species and quantity
Malendego - 2 months: Aug to Sep 2001	Date, vehicle registration and type, source, species and quantity
Muhoro - 2 months: Aug to Sep 2001	Date, vehicle registration and type, source, species and quantity
Migeregere - 2 months: Sep to Oct 2001	Date, vehicle registration and type, source, species and quantity
Rufiji River Crossing	
Ndundu ferry - 12 months: Jan to Dec 2001	Month, number of vehicles, direction of travel
Ikwriri Sawmills	
PIC Ltd. – 12 months: Jan to Dec 2001	Date, species, length, girth
Marine Shipments from Major Ports	
Dar es Salaam - 24 months: Jan 2001 to Dec 2002	Month, product type, quantity, source, destination
Mtwara - 24 months: Jan 2001 to Dec 2002	Month, product type, quantity, source, destination
Zanzibar - 24 months: Jan 2001 to Dec 2002	Month, product type, quantity, source, destination

Other sources of official data

Summarized monthly data for different weight ranges of vehicles crossing the Rufiji River on the Ndundu ferry during 2001 were obtained from the Ministry of Works. In addition, three major ports ship timber products from southern Tanzania – Kilwa, Lindi and Mtwara (Figure 2). Official timber trade records from these three ports during 2000 and 2001 were obtained from the Tanzania Harbours Authority. Lastly, detailed sawmill purchase records were made available to TRAFFIC from one major sawmill in Ikwiriri - Portfolio Investment Company Limited (PIC). These data included the species and dimensions of all logs processed during 2001. Attempts to collect similar information from the other two sawmills in Ikwiriri were unsuccessful.

Field Research

Research assistants were positioned at strategic locations to collect relevant data pertaining to the trade in timber products from southern Tanzania. The purpose of this information was to verify the accuracy of official data especially regarding the quantity and type of logs, planks and charcoal. Other timber products were generally too small or difficult to identify by this methodology.

A total of seven research assistants at different locations were identified and trained, prior to collecting data continuously for a period of just over three months. Training lasted a period of one week and data collected during this training period were not included in the analysis. Locations were primarily chosen based on their strategic positioning with respect to major roads and junctions, logging routes, river crossings and government checkpoints (Figure 2). The locations where also chosen to detect those vehicles that may later avoid official natural resource checkpoints, by selecting sites where most transport routes become more restricted or bottle-necked (e.g. at rivers). Final selection of the sites also correlated to the availability of suitable research assistants (e.g. literacy, knowledge of trade in timber products, vehicle identification skills, honesty, lack of connections with the timber trade, etc.). Information was collected covertly and included date, time, direction of travel, vehicle type (make and tonnage), registration number, cargo and approximate quantity. Data were recorded in exercise books and later entered into computerized spreadsheets.

Credit: Simon Milledge/TRAFFIC East/Southern Africa

Rufiji River, Utete

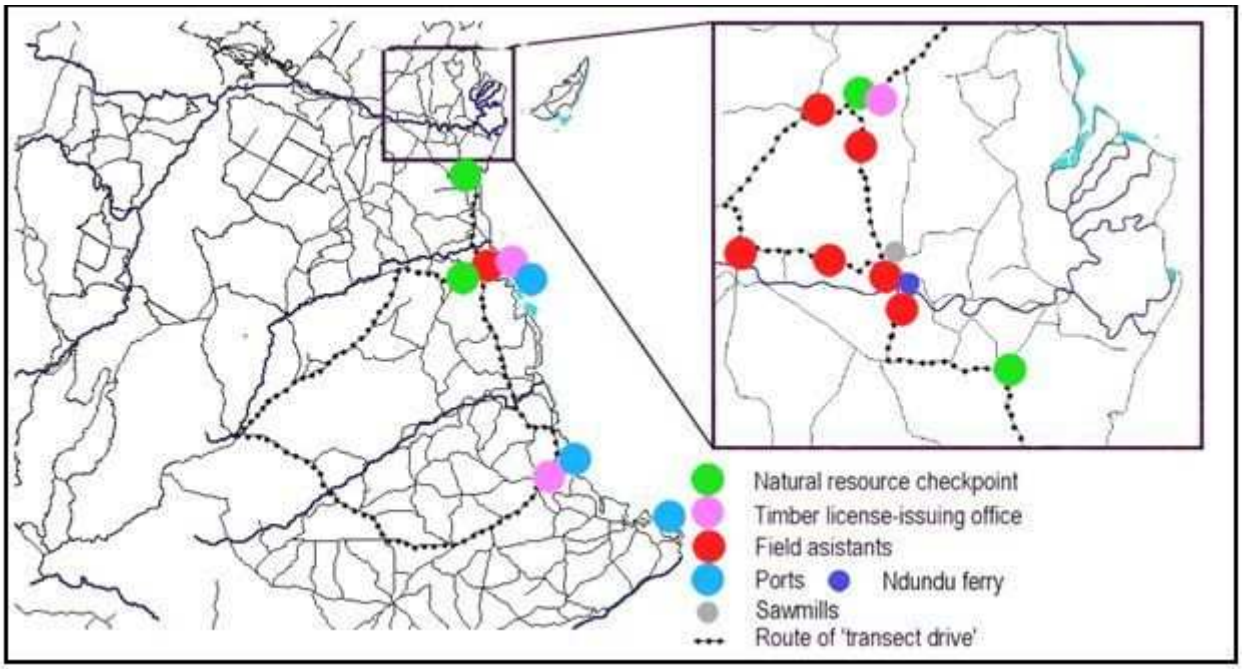
The positioning of some research assistants was also chosen to enable double-checking of other research assistants. This helped improve data accuracy, particularly at critical locations such as the Ndundu ferry crossing. During the research period, one research assistant was discontinued, and the data collected by another research assistant were not included in the analysis due to concerns over their accuracy. By the end of the three-month period, a total of over 4000 vehicles had been recorded by the research assistants and related information entered into a computer for analysis.

Mapping of logging roads

In the same way that stump surveys in woodlands can provide indicators of harvest activity, the density of off-road logging routes used by trucks may also provide indicators of harvest and trade levels. Driving along all major truck routes in the study area, the location of all logging truck routes and forest product outlets along the main trunk routes was recorded using a four-wheel drive vehicle and a Global Positioning System (GPS). Only those logging roads deemed to be in current use were recorded, characterised by the presence of vehicle movement since the last rainy season. In addition to recording spatial information, the relative size of different forest product outlets was recorded (e.g. number of sacks of charcoal, volume of firewood observed). The route taken through southern miombo woodlands included the Kibiti-Mkongo-Ikwiriri ‘triangle’, extending from Ikwiriri to Nangururkuru, Kilwa, Lindi, Nachingwea and Liwale (Figure 1). GPS co-ordinates were later downloaded and analysed using ArcView GIS software. During the process of mapping logging roads, a photographic diary was kept and observations regarding timber trade dynamics recorded.

Figure 2

Location of major sources of data



Note: Refer also to Figure 1.

Data analysis

Due to the enormous amount of information collected during the study, data analysis was prioritized around the following timber products: logs, sawn wood, charcoal and carvings. Data from different sources were compared together as shown in Table 2 to determine the following: volumes; species composition; harvest areas; trade routes; transport techniques; seasonality and trends; timber size; and socio-economic factors.

Due to differences in data recording from different sources, it was necessary to standardize all information before any analysis could take place. The standardization of three categories of information was particularly challenging: volumes, vehicle types and place names. Products are commonly recorded with differing units, for example, firewood was recorded as bundles, cubic metres and sacks. Every product was converted into one common unit to ease data analysis. For example, firewood was expressed as cubic metres, furniture as number of pieces, and charcoal as number of sacks. All sawn wood volumes were converted and expressed as cubic metre round wood equivalents so that they could be directly compared with volumes of logs (round wood) in trade. The average conversion rate of 1 m^3 round wood = 0.3 m^3 sawn wood was used, as recommended by the Ministry of Natural Resources and Tourism (MNRT). Official timber shipment records from the three ports in the study area were converted from tonnages to cubic metre round wood equivalent at the ratio of 1:0.7 for hardwoods, as recommended by the Forest and Beekeeping Division.

Table 2

Types of analyses made among different sources of information

Sources of information:	Ndundu ferry crossing	Natural resource checkpoints	Timber licencing offices	Ikwiriri sawmill records	Port timber shipments
Natural resource checkpoints	Seasonality during 2001; number of vehicles and tonnages				
Timber licencing offices	Seasonality during 2001	Volumes; species composition; seasonality, 2001; harvest areas			
Ikwiriri sawmill records	Seasonality during 2001	Volumes; seasonality, 2001; species composition	Volumes; species composition; seasonality, 2001		
Port timber shipments	Seasonality during 2001	Volumes; harvest areas; species composition	Volumes; species composition	Species; seasonality	
Field data assistants	Trends during Oct-Dec 01; vehicle tonnages	Trade routes; vehicle tonnages; trends in vehicles; species; trends in products; volumes; harvest areas	Trends; volumes; harvest areas; species composition	Volumes; timber measurements	Volumes

In the case of logs, official records indicate two categories – small logs (*vigogo*) and large logs (*magogo*) – although these categories are not described in any relevant legislation or policy. However, close analysis of all such records from the study area revealed that almost without exception, there is a clear differentiation with small logs representing volumes above 10 pieces per m^3 whilst large logs represent volumes of less than 10 pieces per m^3. In cases where the volume was not known and the number of pieces was recorded instead, the average value for that particular product, species and source district was used. During final analysis, all figures were recorded to the nearest 10 m^3.

Analysis of vehicle types was necessary to assist in estimating volumes of timber products. For example, research assistants stationed on either side of the Ndundu ferry were able to discreetly inspect the cargo of each vehicle stopping before crossing the Rufiji River and subsequently record vehicle make, tonnage, cargo, capacity filled, and other details. Using estimations of carrying capacity of major forest products by different vehicles obtained from the Forest and Beekeeping Division, reliable estimations of timber product volumes were calculated. These values were subsequently compared to government records from licensing offices, checkpoints and ports. More detailed information such as vehicle number plate and colour was used firstly to avoid double counting and, secondly, to enable accuracy checks between different research assistants. Great variation in the accuracy of timber trade data exists for a variety of reasons. Thus, one objective of this study was to scrutinize methodologies used to ensure successful application in future work.

Standardisation of place names was required to enable GIS mapping of source areas and trade routes for major timber products. This was an extremely time-consuming process since many locations described on harvest licences represent broad geographic areas, or may not be represented on available cartographic

maps. The source of timber, as shown on checkpoint and harvest licence records, in addition to the mapping data, was mapped using Arc View 3.2 software. Analysis benefited from the collection of additional map layers including vegetation types, protected areas and infrastructure. Theoretical harvest pressure maps were derived from harvest licences using 'regularized' contour lines.

Unless otherwise specified, all currencies expressed in Tanzania shillings (TZS) were converted to US dollars using the January 25th 2003 rate of USD 1.00 to TZS 1030 (Anon., 2003a).

Limitations of methodology

A number of limitations exist with analysis of timber product trade data. With respect to official trade records, perhaps the most challenging limitation is the accuracy of such records. For example, it is clear that timber harvested does not always match the species, quantity or area prescribed on the harvest licences. Indeed, this was precisely the reason for using research assistants to collect complementary data covertly to enable checking of accuracy.

The data from research assistants stationed at Ndundu ferry were far more accurate than those from other locations for two main reasons. Firstly, the ability to identify products positively at other locations was impacted by the fact that most vehicles could pass by at greater speeds and could not be stopped for inspection. For example, the cargo of 79% of the heavy vehicles traveling north past a research assistant stationed along the Ikwiriri-Kibiti road was not known during one three-month study period (data not used in analysis). However, in the case of the Ndundu ferry, all vehicles were forced to stop prior to boarding, enabling adequate time for covert inspection of goods.

Secondly, nocturnal movements of timber products along roads north of Rufiji River continue despite prohibitory regulations, and some research assistants were unable to observe such activities. However, research assistants stationed on both sides of the ferry were further advantaged since the ferry is not operational at night, the period when research assistants were also off duty.

Many other factors affect the accuracy of data collected by research assistants, including literacy, education, experience and motivation. In addition, some researchers had another job in the vicinity, which at times detracted from the time and effort put into collecting the timber trade data. For example, there was a significant difference between data collected on opposite banks of the Ndundu ferry. Since both research assistants were only collecting data for vehicles traveling north, it would be expected that the data collector on the south bank would collect more data since the vehicles traveling north stop there for longer. In reality, the collector on the north bank noted more vehicles carrying timber products, reflecting a greater efficiency in recording. However, both research assistants at Ndundu ferry noted vehicles that the other failed to record, and both demonstrated varying levels of accuracy due to misrecording of information. These factors highlight the need to carefully select research assistants and ensure strategic positioning of research assistants to help check data accuracy.

As noted above, data collected by the research assistants at Ndundu ferry varied considerably in the total number of vehicles passing during the three-month period. For example, in the case of planks, an estimated 2260 m^3 were recorded on the north bank, compared to 1270 m^3 reported from the south bank. The higher value, 2260 m^3, was taken as the *minimum* estimate. After detailed analysis and crosschecks, it was determined that the most accurate estimate of planks moving across the Ndundu ferry during the three-month period was 2690 m^3 (see below and section on *Movement of Timber Across Rufiji River*). Whilst this figure is close to the figure recorded at the north bank (2260 m^3), it is much higher than the

south bank (1270 m^3). Therefore, the estimated number of planks traveling over the ferry would have been vastly underestimated had data been recorded from the south bank only. This underlines the importance of having more than one individual collecting data at each location to enable crosschecking.

Further, it is important to make a detailed analysis of these data, down to the level of individual vehicles crossing the ferry. After detailed comparison of the data collected from both sides of the Ndundu ferry crossing, it can be seen that whilst the individual stationed at the north bank was clearly more vigilant in recording planks, some vehicles were still missed, which were recorded on the south bank. Based on careful matching of records from both sides of the crossing, a *maximum* estimate of 3110 m^3 planks was established. However, this maximum estimate might be an overestimate due to data recording errors. For example, if a particular vehicle is (accidentally) recorded in a differently manner on both sides of the river, it may be treated as two different vehicles during analysis. For this reason, the estimate used in this report is the *average* of the minimum and maximum estimates, or (2690 m^3 planks). Analysis and crosschecking should therefore be conducted at the level of individual vehicles.

In conclusion, experience from this study showed that four main factors strongly contribute towards greater data accuracy:

the *strategic positioning* of research assistants to detect as many vehicles as possible and help check data accuracy (preferably situated where vehicles can stop and/or junctions of offroad logging (*panya*) routes);

the *careful selection* of research assistants;

the use of *two data gatherers per location* to enable crosschecking; and

detailed analysis of records to the level of individual vehicles.

BACKGROUND

National overview

The United Republic of Tanzania is located along the east coast of Africa between parallels 1^0-12^0 S and meridians 29^0 – 41^0 E. Bordering eight countries and the Indian Ocean, Tanzania covers 945 090 km^2 of which 62 000 km^2 are water bodies (Figure 3). The total land area of the Tanzania mainland is 881 000 km^2 and that of Zanzibar is 2000 km^2 (Anon., 1999a). Most of the country is located at 1000-1500 m above sea level, although a lower plateau occurs south of the Rufiji Valley at 500-700 m above sea level. There are a number of mountain ranges including the highest peak in Africa, Mount Kilimanjaro, at 5,895 m. Tanzania mainland is divided administratively into 20 regions, each sub-divided into a total of 113 districts (Anon., 2000e). Tanzania is a member of both the Southern Africa Development Community (SADC) and the East African Community (EAC), and is part of The New Partnership for Africa's Development (NEPAD).

Figure 3

Map of Tanzania

The population of Tanzania is estimated at 34.6 million people of which 51% are women and about 46% are under the age of 15 (Anon., 2003b). Tanzania has experienced rapid population growth from seven million people in 1961 and continues to grow at an estimated rate of 2.8% per year (Rajabu, 2002). Urban migration is a growing phenomenon with urban populations growing at seven to eight per cent per year. The percentage of the population living in urban areas has changed from 15% in the 1970s to 25% in 2000 (Rajabu, 2002). HIV/AIDS, malaria and water-borne diseases result in low life expectancies of only 48 years (Anon., 2002b).

Agriculture is the mainstay of the Tanzanian economy, contributing 45-50% of GDP, 75% of foreign exchange earnings and employing around 80% of the working population. However, only five per cent of the mainland is utilised for cultivation whilst grazing occupies over 50% (Table 3). Contributions of other sectors to the GDP based on 1998 estimates include industry (7%) and social services (2%) (Rajabu, 2002).

Table 3

Land use types and their distribution in Tanzania mainland

Type of land use	Area (000 ha)	%	Type of land use	Area (000 ha)	%
Grazing land	48 740	51.7	Small holder cultivation	3 880	4.1
Forests and woodlands	33 555	35.6	Urban development	1 600	1.7
Inland water	5 900	6.3	Large-scale cultivation	585	0.6

Source: Anon. (2000a).

Since the mid-1980's, Tanzania has implemented various reforms in the political system, economic management and government administration. In 1992, a multiparty democracy system was introduced and successful multiparty elections were first held in 1995. The economic reform programmes that

commenced in 1986 have converted the command-based economy into a market-oriented economy. Trade, exchange rates and interest rates are now fully liberalised. Public service reform has included the privatisation of most parastatals and local governments have been strengthened through the Local Government Reform Programme (Anon., 2000e). As a result, the country's GDP has been increasing for the last decade, and inflation has declined from 30% in 1995 to little more than 7.9% in 2000 (Anon., 1999b). However, despite its high potential and progress in recent years, Tanzania continues to be ranked amongst the five poorest countries in the world with half the population living below the locally-defined poverty line, equivalent to USD 180 per year (Anon., 1998d).

Tanzania has a wealth of natural resources including minerals, wildlife, fisheries, forestry and beekeeping (Anon., 2000e). The country has notably high floral and faunal species diversity and endemism (among the 12 most biologically diverse countries in the world) and the country earns an estimated USD 70 million annually from wildlife tourism and sport hunting (Anon., 1999g). Rapid population growth and urban migration has created land pressure in isolated areas and unsustainable utilisation of natural resources.

Forest and woodland distribution and status

Based on 1998 records from the MNRT, Tanzania has 33.5 million hectares (ha) of forests and woodlands that constitute approximately 36% of the total mainland area (Anon., 1998a,b; Table 4; Figure 4a). The majority are woodlands - mostly *Brachystegia-Julbernardia* savanna woodland - with a smaller area covered by montane forests, coastal forests and mangroves (Table 4; Figure 4d). Tabora, Rukwa and Lindi Regions possess the largest areas of woodlands and forests in the country, at 5.3, 4.9 and 4.3 million ha, respectively.

Figure 4b illustrates how the average forest area per inhabitant varies across the country. Four regions have particularly good natural forest cover of more than two ha per inhabitant, namely Lindi, Rukwa, Tabora and Coast (i.e. including the study area). On the other hand, regions with poor natural forest cover (less than 0.5 ha per inhabitant) included Mara, Dar es Salaam, Mwanza, Kilimanjaro, Kagera and Shinyanga. These regions are currently experiencing acute scarcity of wood fuel and other forest products and services (Anon., 2001c).

Table 4

Type, use and legal status of forests and woodlands in Tanzania

Description		Area (000 ha)	Total area (000 ha)
Forest type	Montane forests	1 141	33 555
	Mangrove forests	115	
	Woodlands	32 299	
Uses of Forest Land	Production forest area	23 810	33 555
	Protection forest area (mainly catchment areas)	9 745	
Legal Status	Forest Reserves	12 517	33 555
	Forests/woodlands in National Parks etc.	2 000	
	Non-reserved forest land	19 038	

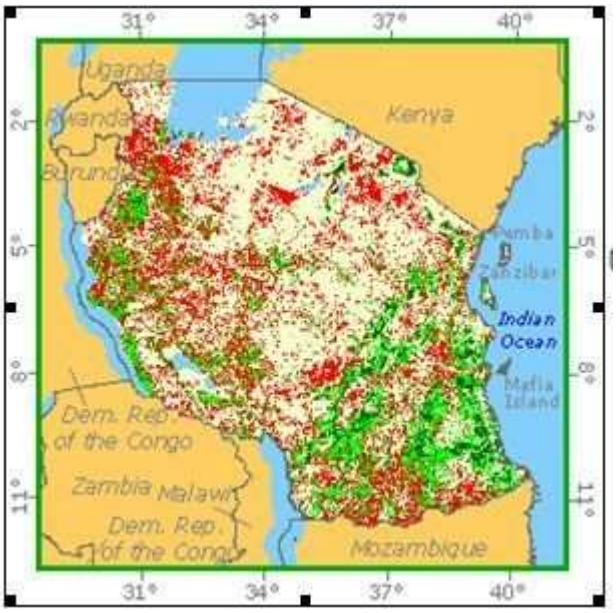
Source: Anon. (1998a).

Over two-thirds of the forests and woodlands are under production including 16 industrial softwood plantations and three hardwood plantations covering around 80 000 ha (Annex 1). Around 12.5 million ha of the total forest area in Tanzania have been gazetted as Forest Reserves and a further 2000 ha occur in National Parks and Game Reserves (Table 4; Figure 4c). All mangrove forests in Tanzania are gazetted as Forest Reserves (Holmes, 1995).

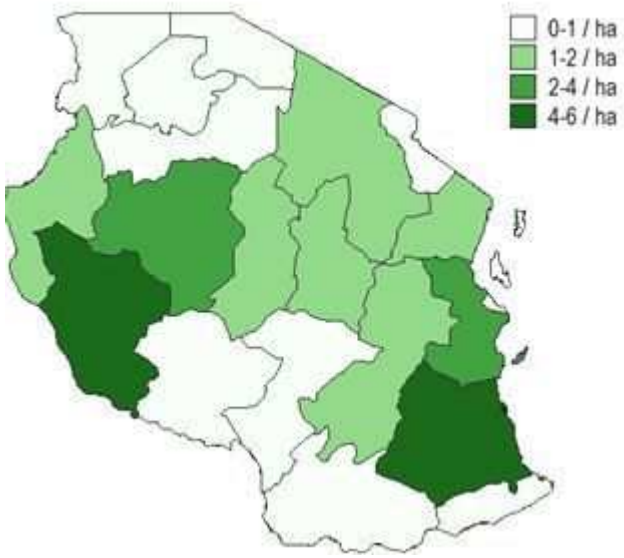
Figure 4

Forest and protected area distribution in Tanzania

(a) Forest and woodland cover

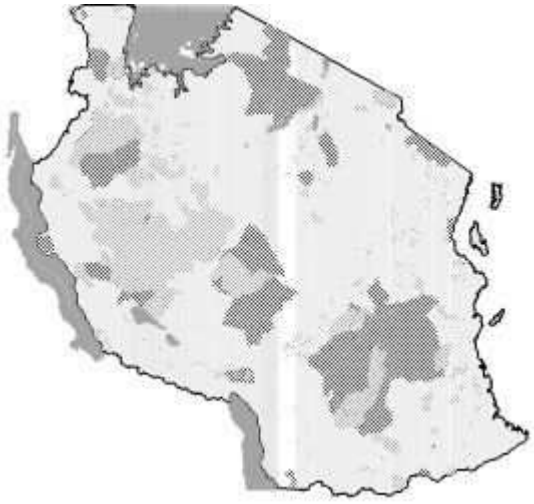


(b) Regional forest distribution per inhabitant in ha



Key: Dark green areas represent closed forest; light green areas represent open/fragmented forest; red areas represent other wooded lands.

(c) Distribution of protected areas



Key: Light shaded areas represent Forest Reserves; dark shaded areas represent other protected areas.

(d) Miombo woodlands and coastal forests

Key: Light areas represent miombo woodland; dark shaded areas represent coastal forests

Sources: Anon. (1994; 1998a,b; 2000a,b,c; 2002d); Mnzava (1989).

The majority of reserved forests and woodlands are managed by the central government (10.9 million ha) with the remainder (1.9 million ha) managed by local government. The regulatory and institutional framework of the forestry sector, including policies and legislation covering protected areas, trade and use of forest resources is given in Annex 2. The largest areas of reserved forest occur in Rukwa, Tabora and Morogoro Regions. The same regions have the greatest area of Forest Reserves managed by the central government. Tabora, Shinyanga, Mbeya and Iringa have the largest areas of local government Forest Reserves. Almost two-thirds (61%) of Tanzania's woodlands and forests are unreserved, lacking proper management (Table 4). Lindi Region has the largest area of unreserved woodland/forest in the country, totaling around 3.75 million ha.

Credit: Simon Milledge/TRAFFIC East/ Southern Africa

Miombo woodland, Lindi District.

In Tanzania, *Brachystegia - Julbernardia* savanna woodland covers almost two-thirds of the forested land (Mgoo *et al*., 2000). A detailed description of miombo woodlands is given in Annex 3. The floral diversity in the miombo woodlands of Tanzania is estimated at around 8500 species (Anon., 2000a; Anon., 1999i). These woodlands are equally rich in fauna and provide habitats for rare large mammals, including approximately half the remaining Black Rhino *Diceros bicornis* in the country (including all of the subspecies D.b. minor), 92% of African Elephant *Loxodonta africana*, populations of Wild Dog *Lycaon pictus*, Hartebeest *Alcelaphus buselaphus*, Sable *Hippotragus niger* and Roan Antelope *H. equinus* (Barnes *et al*., 1999). In the Selous Game Reserve alone, the largest protected area in Africa (45 000 km^2) and home to the largest elephant population in the world, at least 440 species of bird, 2045 species of vascular plant and a rich herpetofauna have been recorded (Vollesen, 1980). Other parts of the miombo woodlands in Tanzania are equally unique. Rukwa Valley encompasses one of the last remaining montane Chimpanzee *Pan troglodytes* populations in the Mahale Mountains, the Kilombero Valley holds around 75% of the remaining global population of Puku *Kobus vardoni*, whilst several large mammal herbivores rely on migratory routes in South Ruvuma connecting Tanzania and Mozambique (East, 1998; Anon., 1999h).

For these reasons, almost half (96,000 km2) of miombo woodlands in Tanzania has been set aside as some form of wildlife protected area (Mgoo *et al*., 2000). These include world-renowned protected areas and heritage sites such as the Selous Game Reserve, Ruaha, Udzungwa and Mahale Mountains National Parks. These conservation areas have pioneered numerous forms of wildlife management including non-consumptive tourism, sustainable utilization programmes and community-based natural resource management.

Credit: IUCN/O. Hamerlynck

Rare and endemic East Coast Akalat.

Coastal forests cover a coastal belt approximately 50-200 km wide, except where they penetrate further inland along broad river valleys (Figure 4). Coastal forests and thickets occur as isolated and fragmented patches (in some cases as small as 2 km^2) limited to hilltops and offshore islands and total around 800 km^2. Coastal forests, together with the Eastern Arc Mountains[7], are globally recognised for their

[7] The Eastern Arc Mountains are characterized as a separate ecosystem from coastal forests, their relatively long period of environmental stability and isolation has led to extremely high levels of biodiversity and endemism.

high levels of species richness and endemism. Lindi District coastal forests contain the highest number of threatened species of all districts in Tanzania (Table 5).

Table 5

Numbers of threatened species occurring in Tanzania coastal forests

Site Name	ANIMALS				PLANTS				Totals
	IUCN Red List Category				IUCN Red List Category				
	CR	EN	VU	Total	CR	EN	VU	Total	
Lindi District		4	4	8		13	21	34	**42**
Kisarawe District		4	4	8		2	19	21	**29**
Bagamoyo District		4	4	8		2	11	13	**21**
Rufiji District		2	4	6		5	10	15	**21**
Muheza District		2	5	7			6	6	**13**
Kilwa District		2	2	4	2	1	5	8	**12**
Mafia Island		2	2	4		1	7	8	**12**
Pangani District		2	3	5	1		4	5	**10**

Sources: IUCN 2004 Red Data List; Conservation International Critical Ecosystem Partnership Fund.

Whilst there are no data available on the levels of forest loss, severe degradation is known to occur with an estimated 79% of coastal forests in East Africa highly or very highly threatened. In Tanzania, almost all of the coastal forest patches are threatened. Major threats include unsustainable extraction of timber, poles and charcoal, expanding agriculture, fire and enroachment. Fifty-two of the 76 known forest sites in Tanzania are located in Forest Reserves, and these contain around 82% of the known coastal forest area (Burgess *et al*., 1996). However, their limited size makes them extremely vulnerable to these threats (Sheil, 1992).

Trends in forest and woodland degradation

Tanzania, like many other African countries, is experiencing serious degradation of its forest and woodland resources (Okello, 1994; Anon., 1999i). Forest resources, particularly those on unreserved land, are under enormous pressure from the expansion of agricultural activities, livestock grazing, fires and other human activities (Iddi, 2002; Anon., 2001a).

Current studies on Tanzania forest cover have indicated that between 1970 and 1998, Tanzania lost around 10 million ha of forests land through uncontrolled clearing of forests mainly for agriculture and livestock expansion (Anon., 1998a; Anon., 2001a,b). According to the National Forest Programme (NFP), forest cover change between 1990 and 1995 was estimated at –1.0% per year, slightly higher than the regional average of –0.8% per year. The National Forest Policy estimated current deforestation rates at 130 000 - 500 000 ha per year, however, current estimates are lower at 91 000 - 98 000 ha per year (Mariki *et al*., 2003; Anon., 1998a; Anon., 2002d).

However, at lower altitudes (below 1000 m) they integrade with coastal forest, for example, areas in the Usambara and Uluguru Mountains (Burgess *et al*., 1996).

Degradation of forests and deforestation is taking place both in government Forest Reserves and in unreserved forests on public land (Salehe, 1995; Anon., 1997a; 1998e; 2000e). However, forests and woodlands are particularly overexploited on public lands where population pressure for agricultural land and fuel wood has been greatest and management is weakest. Research in central Tanzania revealed that the restoration process of degraded miombo woodlands through natural regeneration is slowed by the semi-arid climate of the area combined with poor soil nutrient status (Eliapenda, 2000). A maximum increment in standing volume of 7.4 m^3/ha/yr has been recorded for Morogoro District, and an average stand re-growth of 2.3 m^3/ha/yr recorded in the Kitulangalo area (Malimbwi *et al.*, 1998; Malimbwi *et al.*, 2000).

In many cases, the economic opportunities lost through forest degradation and deforestation is not realistically known (Mnzava, 1989; Kaoneka, 2000). The situation has been exacerbated by a decline in government capability to police Forest Reserves over the past two decades due to financial constraints. Wells *et al*. (2000) claimed that whilst economic liberalization policies have facilitated systems of wood supply and trade, it has also reduced the government's ability to control resource exploitation. Indeed, some Forest Reserves have been completely cleared and turned to agriculture or wasteland (Anon., 2001a,b,c).

Credit: Simon Milledge/TRAFFIC East/ Southern Africa

Clear felling and burning, Kilwa District.

Kaoneka (2000) cited indirect or underlying causes of deforestation as rapid population growth, poverty, market failures, absence of proper definition of property rights and security of tenure and general policy failures. The United Nations Environment Programme (UNEP) identified the effects of trade liberalisation as one root cause of accelerated deforestation, through expanding activities within the sector and related sectors such as agriculture (Anon., 2002i). Other factors contributing to the degradation and deforestation of woodlands include: unavailability of alternative sources of products and services from woodlands for subsistence livelihoods to the majority of users; use of inefficient utilization technologies on wood products; and poor enforcement of laws related to woodland management (Anon., 2001b). There is inadequate administrative and technical guidance from central and local authorities for conservation and management of woodland and forest resources due to a shortage of skilled human resources and insufficient funding. Un-coordinated land uses by different land use stakeholders in the rural areas are also contributing to degradation of woodlands. For example, exhaustive clearance of miombo woodland for short-term agriculture and excessive burning regimes threaten their integrity and therefore the services they provide to peoples' livelihoods and the entire ecosystem in general. Large-scale and intensive logging is threatening the commercial and ecological viability of some timber species.

Importance of miombo woodlands and coastal forests to development in Tanzania

The importance of woodland and forest resources to the socio-economic development of Tanzania includes a combination of ecological, economic and social values benefiting rural and urban societies. The forestry sector contributes an estimated 3.0-3.4% of total gross domestic product, although this is a gross underestimate due to the unvalued provision of services such as water catchment for hydropower dams, water supplies, maintaining ecological cycles and micro-climates, soil erosion control, nutrient

cycling, soil fertility, employment opportunities, and a sink filter for air pollution emissions and carbon sequestration (Anon., 2001a,b,e; Mariki *et al.,* 2003; Mogaka *et al*., 2001; Roe *et al*., 2002; Turpie, 2000; Anon., 1998e; 2002i). In Tanzania, miombo woodlands form the catchment areas for hydropower plants including Kidatu, Mtera and Kihansi dams (Iddi, 1997). They also include the major catchment areas for the Malagarasi wetland Ramsar site, a globally important site for avian conservation, including Wattled Cranes *Bugeranus carunculatus* and Shoebill Storks *Balaeniceps rex* (Anon., 1999f).

Tourism-related employment and other economic activities from miombo woodland and, to a lesser extent, coastal forests, contribute towards the nation's GDP. Foreign exchange earnings from tourism reached USD 730 million in 2002, accounting for 16% of the GDP. This compares very favourably to the estimated average annual export earnings from wildlife and tourism of USD 81 million in the late 1990s (Anon., 1998b). Within the study area, the Selous Conservation Programme has been instrumental in helping to ensure benefits from wildlife management activities are also accrued to local communities, with an average gross income per village at nearly TZS 1 million during 1999/2000 (Hahn *et al*., 2001).

There are also many undervalued forest products, both timber and non-timber, including wood energy, building poles and timber, herbal medicines, edible fruits, mushrooms, plant-derived oils, leaves and beverages, bamboo, gums, fodder, fibre, honey, candles, dyes, ornamental plants, household utensils and handicrafts (Iddi, 1997). Underestimation of their value has been estimated at 35-60%. Various studies have confirmed that the value to communities of forest products consumed directly is immense (Anon., 2001a,e; Mogaka *et. al.,* 2001). In the early 1990s, the local and national values of forests are estimated at approximately USD 1050 and USD 1500 per ha, respectively, although this still does not include some important indirect benefits such as cultural benefits (Anon., 1994; Mgoo *et al*., 2000). UNEP estimated that the total monetary value of benefits arising from the impacts of trade liberalisation policies on the forestry sector of Tanzania was USD 44 million (Anon., 2002i). Positive socio-economic and environmental impacts included an increase in the production, distribution and marketing of forest products. The forestry sector employs about three per cent of paid labour and over three million people in the informal sector, selling charcoal, firewood, timber, honey and other non-woody products (excluding wildlife products) (Anon., 2001b).

Credit: Simon Milledge/TRAFFIC East/Southern Africa

Dovecote, Liwale District.

Fuel wood remains the most important use of wood, accounting for at least 92% of the country's energy use and around 95% of the total wood products consumed in the country. Per capita consumption is estimated at 1 m^3 per year (Anon., 1998a; 2002a,i). Households in the Kitulangalo area realize an income of TZS 43 000 (USD 53.09 [8]) per month from charcoal production from miombo woodlands, higher than the minimum government salary (Malimbwi *et al*., 2000). Non-woody forest products such as bee products, food, fruits, nuts, medicinal plants, gums, resins, barks, natural dyes, aromatics and fibres contribute positively to household economy in rural areas and are good sources of income to women. Beekeeping in miombo areas of Tanzania contributed around 58% of farmers' cash income, equivalent to USD 1050 per ha.

Due to their low cost and wide availability, plant-based traditional medicines are more popular than western alternatives in many areas of Tanzania, and it is estimated that about 70% of Tanzanians use

[8] Using exchange rate of USD 1.00 to TZS 810, 31st December 2000 (Anon., 2003a).

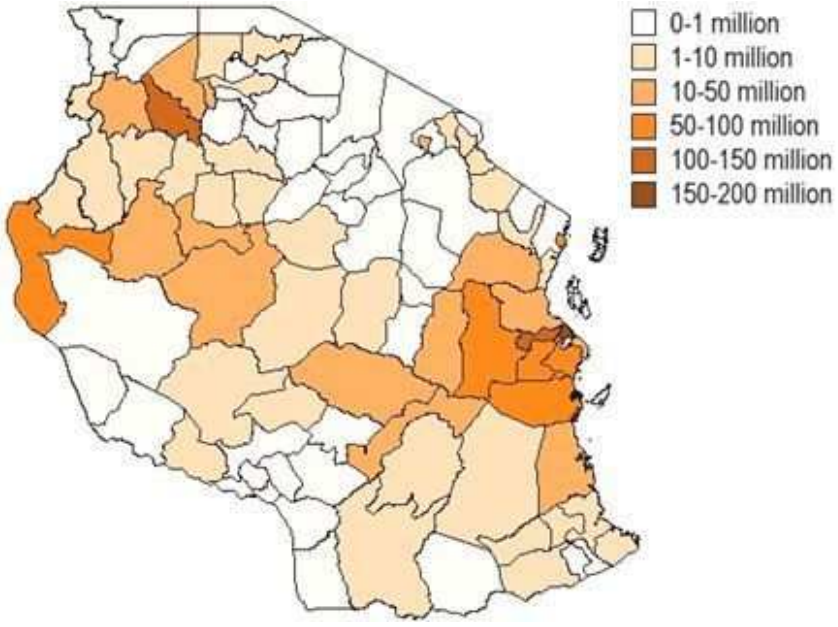
medicinal plants for curing illnesses (Marshall, 1998; Anon., 2001a,b). A total of around 1000 species are used in traditional medicine, with at least 98 traded in urban centres (Mariki *et al*., 2003).

Commercially valuable timber species in Tanzania include *Pterocarpus angolensis, Milicia excelsa, Ocotea usambarensis, Khaya anthotheca, Elea welwitschii, Brachystegia speciformis, Cephalosphera usambarensis, Afzelia quanzensis, Beilschmiedia kweo, Millettia stuhlmannii, Brachylaena huillensis, Dalbergia melanoxylon, Grevillea robusta, Newtonia buchananii*, and *Podocarpus* spp. (Anon., 2000c; Roe *et al*., 2002). The main sources of hardwood timber include the miombo woodlands of Tabora and Rukwa Regions, the coastal forests and miombo woodlands of Kilwa, Liwale and Lindi Districts, and some highland pockets in Morogoro and Tanga Regions. Coastal forests were subjected to heavy commercial logging pressure during the 1950s and early 1960s, continuing until the 1980s and beyond in some areas (Burgess *et al*., 1996). Miombo woodlands harbour particularly high value, export-quality hardwood timber species such as *Pterocarpus angolensis, Dalbergia melanoxylon, Milicia excelsa, Khaya anthotheca* and *Afzelia quanzensis* (Munyanziza *et al*., 1999). For example, the retail price for African Blackwood *Dalbergia melanoxylon* export-quality billets reaches up to USD 18 000/m^3 (Jenkins *et al*., 2002; Nshubemuki, 1993). Pit sawyers supply over half of the total domestic demand for forest wood (Wells *et al*., 2000).

A total of almost TZS 3412 million (USD 4.21 million) in forest revenue was collected by central government during 2000/2001, out of which two-thirds originated from plantations (projects) and one-third from timber harvested from central government Forest Reserves. Figure 5 illustrates how revenue collection from Forest Reserves was particularly high in districts around Dar es Salaam, a reflection of both relative forest product trade levels and relative revenue collection capacity levels (e.g. capacity is highest along major trunk roads entering Dar es Salaam). Local governments are also highly dependent on forest-derived revenue. For example, Rufiji District derives some 60% of its locally derived income from forests (John *et al*., 2003).

Figure 5

Revenue collection (TZS) from central government Forest Reserves, 2000/2001



Source: Anon. (2001b).

In 1998, the government budget for forestry was less than 1% of the total national budget (Anon., 1998a). In 1999/2000, the financing structure of the Forest and Beekeeping Division (FBD) operations was TZS 11,465 million (USD 14.30 million), consisting of TZS 7,748 million (USD 9.66 million) donor contributions, TZS 2,570 million (USD 3.20 million) government budget and TZS 1,147 million (USD 1.43 million) retention scheme (Salmi *et al*., 2000).

The forestry sector accounts for around 10% of foreign exchange earnings, derived from exports of timber (sawn wood, softwood pulp, paper and round wood), timber products, honey, beeswax, mushrooms and other non-wood forest products (Roe *et al.*, 2002). Average annual export earnings from forest products is around USD 14 million (Anon., 1998a). In 1999/2000, a total of 7965 m^3 sawn wood (worth USD 0.99 million) and 1337 m^3 round wood (USD 0.38 million) was exported (Table 6). Major markets include Japan, Singapore, Hong Kong, India, Taiwan and there was a growing preference for *Swartzia madagascarensis* and Teak *Tectonia grandis*. Honey and beeswax exports average 4860 t and 324 t per year respectively (Anon., 2001b).

Table 6

Reported exports of forest products, 1996/1997 – 1999/2000

Product	1996/97		1997/98		1998/99		1999/2000	
	Amount	USD (1000)	Amount	USD (1000)	Amount	USD (1000)	Amount	USD (1000)
Logs, m^3	2 178.0	436.0	9 525.0	6 191.6	3 896.5	718.0	1 366.7	382.4
Sawn timber, m^3	51.0	5.7	8 630.8	1 035.7	8 065.9	684.5	7 964.7	993.0
Blackwood, m^3	28.6	355.0	107.5	1 357.6	122.3	1 193.2	75.7	852.3
Floorings, m^3	329.7	998.0	1 125.5	3 405.6	67.8	128.4	45.7	76.3
Carvings, pcs	52 197.0	105.0	264 512.0	891.5	253 124.0	967.6	169 870.0	238.3
Tree seeds, t	-	-	-	-	0.2	11.6	21.2	2.0
Beeswax, t	202.0	678.0	316.0	1 044.8	332.0	1 202.7	251.0	1 229.8
Honey, t	2.5	2.1	225.0	274.9	39.0	35.5	44.7	32.5
Others	-	-	-	-	3 645.3	481.2	-	9.7
Total		**2 579.8**		**14 180.7**		**5 422.7**		**3 616.3**

Source: Anon. (2001b).

STUDY AREA OVERVIEW

The study area covered by this project included seven districts belonging to three regions, namely Rufiji District (Coast Region), Lindi, Kilwa, Liwale, Ruangwa and Nachingwea Districts (Lindi Region), and Mtwara District (Mtwara Region). The total population in the study area was estimated at over 1.3 million people in 2000. Selected social indicators are shown in Table 7. Rural people's livelihoods are heavily dependent upon woodland and forest resources in the form of food, housing, fuel, medicines and income. The transport and communications infrastructure are poor in relation to the rest of the country. For example, out of a total 5596 km of road networks in Mtwara Region, only 135 km are tarmac. The study area holds only one major road linking to Dar es Salaam, one airport capable of handling large aircraft, and one marine port capable of handling deep berth cargo. There are no railway networks, and telecommunication and electricity services are few and unreliable. Major rivers flowing through the study area include the Mbewekuru, Matandu and Rufiji (Figure 1).

Table 7

Regional ranking of selected social indicators in study area

Social indicator	Coast	Lindi	Mtwara
GNP per capita regional ranking (1997)	7	10	9
Food security regional ranking	4	5	9
Nutrition level regional ranking	11	6	9
Health status regional ranking	9	4	8
Gross enrollment (primary school)	9	2	13

Note: Rank '1' implies most deprived region and '20' least deprived region.
Source: Poverty and Welfare Monitoring Indicators, Vice President's Office, November 1999.

A significant proportion of the study area is covered by miombo woodland, which disperses into coastal forest and thicket to the east (Figure 6). Open woodland, wooded grassland and bushland dominate the landscape of Lindi Region. A detailed vegetation map of the study area is shown in Figure 1 and further information on the study area is given in Annex 4.

The study area contains some of the largest remaining wild stands of miombo woodland in Tanzania, with among the highest indices of forest density, quantities of forest per capita and unprotected woodland in the country (Table 8). Lindi Region has the third highest forest area of any region in the country, 4.3 million ha, following Tabora (5.3 million ha) and Rukwa (4.9 million ha).

Coast, Lindi and Mtwara Regions, along with others in eastern Tanzania, are characterised by having a high proportion (over 85%) of forests as unreserved, public land. Lindi Region has the largest forest area on public land in the country, estimated at 3.75 million ha, and also has the largest forest cover per capita (5.4 ha per inhabitant). Based on 1998 records from the MNRT, Coast Region also had a higher forest cover per capita (3.0 ha per inhabitant) than the national average of one ha per inhabitant (Figure 4b; Anon., 1998a). Despite the high percentage of unreserved forest in Lindi and Coast Regions and the high forest cover per capita, community-based management efforts are largely undeveloped.

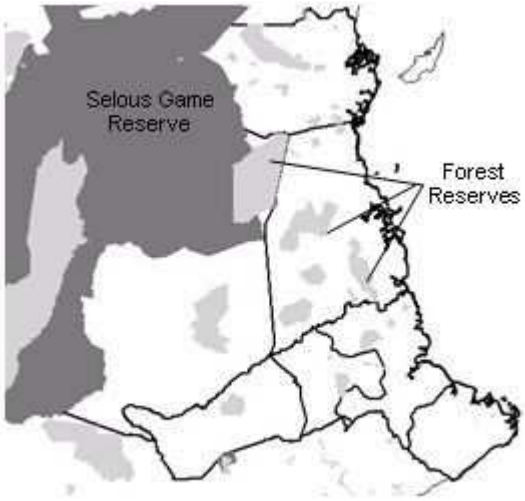
Figure 6

Maps showing details of study area

(a) District boundaries

(b) Roads and villages

(c) Protected Area coverage



(d) Extent of major vegetation types

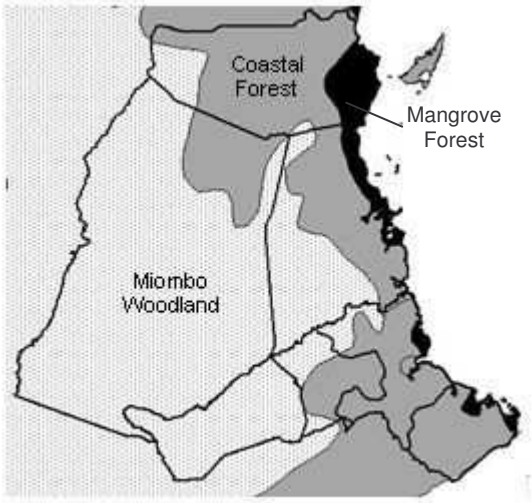


Table 8

Regional and district distribution of forests (ha) in study area

Region	District	Central Government	Local authority	Public land	Total forest area
Coast	Rufiji	81 787	68 633	1 081 510	**1 231 930**
Lindi	Kilwa	206 713	0	1 084 787	**1 291 500**
	Lindi	46 522	2 218	727 230	**775 970**
	Liwale	303 158	0	1 434 942	**1 738 100**
	Nachingwea	28 491	0	506 209	**534 700**
Mtwara	Mtwara	8 402	668	261 263	**270 333**

Source: Anon. (2001b).

The coastal forests found in the study area are of national biodiversity importance (Burgess and Clarke, 2000). Lindi District contains more threatened animal and plant species found in coastal forests than any other district in Tanzania, whilst Kilwa District has the highest number of critically endangered plants found in coastal forests (Table 5).

The study area includes a significant proportion of the Selous Game Reserve (Figure 6), although wildlife also occurs outside protected areas. Significant returns, mostly at national level, are accrued from tourism in the Selous Game Reserve. At the local level, greater financial returns to communities in the study area come from trophy hunting and government approved sales of game meat (Baldus *et al.,* 2001; Malima, 2002; Ndunguru *et al.*, 1998). Communities also consume large but unquantified amounts of game meat from illegal sources (Barnett, 2000).

Benefits from wild animal species are poorly understood when compared to timber products, and it is not known whether they offset the significant impacts of human-wildlife conflicts such as threats to personal life and property (Anon., 1998c; Hahn and Kaggi, 2001). The study area has amongst the highest levels of human-wildlife conflict in the country (Milledge *et al.,* 2003). Between October 2002 and February 2003, lions on the southern Rufiji River delta floodplain, which borders the Selous Game Reserve, killed 13 people and wounded an additional four. The farming communities in Rufiji District lose on average 20% of their crops to wildlife (Hamerlynck, 2003).

A large proportion of the population of Lindi and Mtwara Regions live near the coast and approximately 5500 fishermen and 1700 vessels may be found along the coastline of Kilwa, Lindi and Mtwara Districts (Anon., 2001d). The marine ecosystem, coral reefs in particular, provide food, services and employment opportunities, although most reefs in Lindi and Mtwara Regions are extensively damaged above a depth of 10m, primarily by dynamite fishing (Anon., 2001g). Kilwa, Lindi and Mtwara together have a total of 64 permanent landing sites (Anon., 2001d). Nearly 60% of households in Rufiji District engage in fishing activities and, in those households, fishing accounts for some 70% of the income from natural resources (Turpie, 2000).

Kilwa, Lindi and Mtwara Districts support 22 430, 4500 and 8940 ha of mangrove forest respectively, whilst the Rufiji delta supports the largest single mangrove forest in eastern Africa, covering 53 000 ha (Anon., 2001g). The main threat to mangroves is overexploitation, especially to produce poles for building and export, firewood and charcoal. Trade in mangrove products was not covered in detail during this study although they are in high demand. Conversion of habitat for agricultural production presents another threat. In the northern Rufiji delta alone, over 1700 ha of mangrove were cleared for rice cultivation in the decade from 1989 and 1999, and current replanting efforts are unable to compensate for the continued clearing (Anon., 2002h).

VOLUMES OF ROUND WOOD IN TRADE

Whilst each district in the study area has harvest licensing offices, checkpoints and forest/revenue collection officers, the management capacity varies enormously and, in all cases is insufficient compared to the size of forest areas currently harvested.

As a result of insufficient capacity, poor infrastructure and vast areas over which harvesting takes place, the timber trade in southern Tanzania is characterised by high levels of illegal harvesting, sale and transport, and therefore losses in revenue. For this reason, officially recorded volumes of timber in trade need to be verified against other indicators to estimate actual trade levels. Analysis of official records included harvest licences, port shipments, district checkpoint record and sawmills, all of which was compared with data collected covertly at strategic locations.

Credit: Simon Milledge/TRAFFIC East/ Southern Africa

Logging truck passing through Kibiti checkpoint.

Timber harvest records

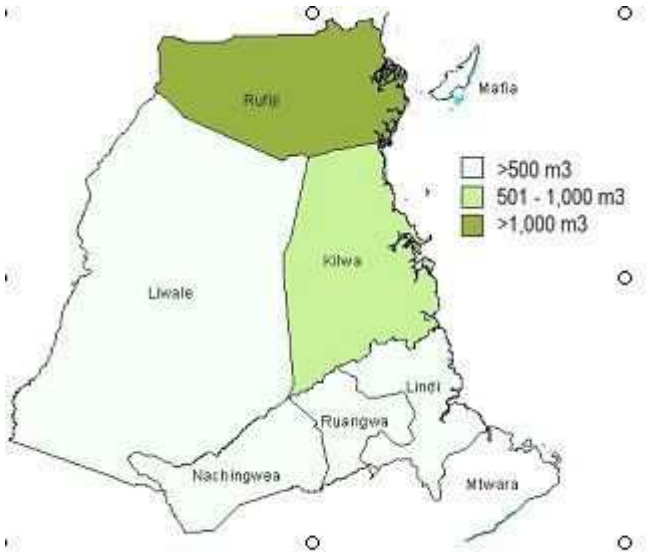
During 2001, harvest licences were issued by the six districts in the study area for a total of 10 163 m^3 of timber (Table 9). This compares to 12 962 m^3 of timber for which harvest licences were issued during 2000. During this two-year period, over three-quarters of the harvest licences by volume (77%) were issued in Rufiji District, with a further 17% issued in Kilwa District. Notable decreases in harvest volumes on the licences were recorded between 2000 and 2001 from Kilwa, Liwale and Rufiji Districts.

Table 9

Volume of round wood (m^3) licensed for harvest by district, 2000-2001

District	2000	2001
Kilwa	2 119	988
Lindi	163	172
Liwale	271	119
Nachingwea	* 57	163
Ruangwa	* 53	123
Rufiji	10 299	8 598
Total	**12 962**	**10 163**

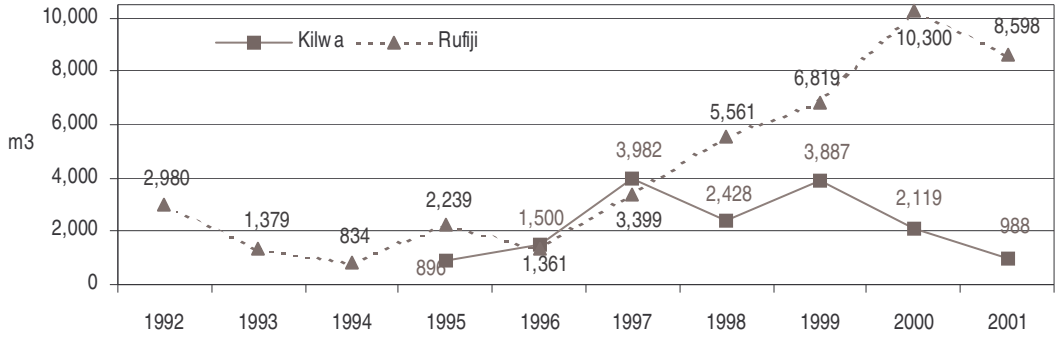
Source: District timber licences, 2000-2001.
Note: * data not collected for January to June 2000 for Nachingwea and Ruangwa Districts. Map shows 2001 data only



Data on harvest licences covering a longer time period were collected from Rufiji and Kilwa Districts. Since 1992, the volumes of timber licensed for harvest in Rufiji have steadily increased, reaching a maximum of 10 300 m^3 in 2000 before dropping to around 8600 m^3 in 2001 (Figure 7). The pattern in Kilwa since 1995 is slightly different, reaching just less than 4000 m^3 in 1997 and 1999, then declining to 988 m^3 in 2001 (Figure 7).

Figure 7

Volumes of round wood (m^3) licensed for harvest in Kilwa and Rufiji Districts, 1992-2001



Source: District licence statistics, 1992-2001.

Timber harvested south of the Rufiji River has three main destinations. Firstly, timber may be utilised within the district in which it was harvested, in both urban centres (such as Lindi and Mtwara towns) and rural households. Secondly, timber may be shipped by sea, either from the major ports of Mtwara, Kilwa or Lindi, or via informal exit points particularly in Kilwa and Lindi Districts. Lastly, timber products may be taken northwards, across the Rufiji River. Most of the goods taken northwards are destined for Dar es Salaam, although some logs are taken to sawmills en route for processing.

Timber trade dynamics south of Rufiji River

Forest resources used in rural and urban areas

Limited information is available regarding quantities and use/trade dynamics of woodland and forest products by rural and urban communities in the study area. There is little doubt that there is high dependence by rural communities on these products, although absolute volumes used by rural and urban households is unknown.

A comprehensive study on subsistence use of wood and non-wood products from miombo woodlands in Kisarawe and Kibaha Districts, Coast Region, revealed that eight main forest products were collected at no monetary cost from miombo woodlands for subsistence purposes, mainly construction, fuel, food and medicine (Kaale *et. al*., 2002). An estimated 695 kg (1 m^3) of firewood was collected per year per person, whilst the construction of a three-roomed grass-thatched house required on average 143 poles, 481 small sticks, 28 bundles of ropes and 33 bundles of grass. Houses last between four and 10 years, although the grass roof is replaced every one to two years. Large quantities of mushrooms, wild fruits and traditional medicines

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Grass bundles, Liwale District.

are also collected at no or little cost. Valuation of these forest products indicated that they contributed around TZS 43 424 (USD 42.16) towards per capita income (Kaale *et. al*., 2002; Table 10). It is important to note that these values are rarely included in household valuation exercises; in 1997, the average per capita income in Coast Region was reported to be only TZS 22 624 (USD 36.79) (Anon., 1997f). In addition, some villagers purchase forest products including firewood, charcoal, poles, withies, thatch grass, ropes, wooden kitchen utensils, wooden furniture and construction timber (Kaale *et. al*., 2002).

Table 10

Value per capita (TZS) of different timber products collected in Coast Region

Product	Value per capita (TZS)	Product	Value per capita (TZS)
Firewood	12 498	Grass	815
Poles	930	Wild fruits	15 237
Withies	245	Mushrooms	11 726
Ropes	241	Medicines	1 762

Source: Anon., 1997f.

A study conducted by the Rufiji Environmental Management Project (REMP) in Ikwiriri township and Mbunjumvuleni village in Rufiji District revealed that an average of 523-600 kg of firewood (0.75-0.86 m^3) and 32-42 kg charcoal per capita per year were used in 2000 (Kaale *et al.*, 2000). It can be seen that these figures are slightly lower, but comparable to those from Kisarawe and Kibaha Districts. These figures also fall within the range of 1-2 kg/person/day estimated for Eastern Africa (Anon., 1999j). Based upon these estimates of fuel wood consumption and population figures, almost 2.1 million m^3 fuel wood is consumed in the study area per year.

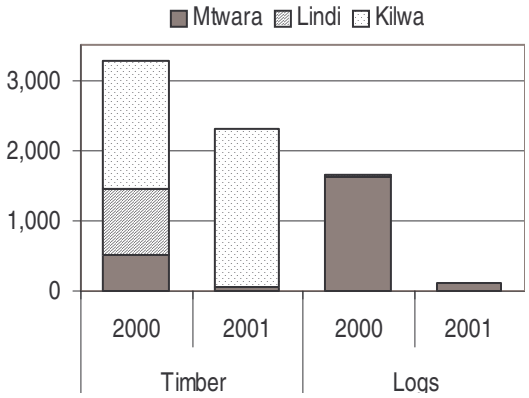
Timber shipped from southern Tanzania

According to official records collected from the three major ports in southern Tanzania, Mtwara, Lindi and Kilwa, shipments during 2000 and 2001 totalled the equivalent of 7357 m^3 of round wood, including 5576 m^3 sawn wood and 1781 m^3 of logs (Figure 8). In general, these data show an apparent decline from 2000 to 2001. According to government records, three-quarters of the sawn wood is shipped from Kilwa port, whilst almost all logs were shipped from Mtwara port (Figure 8). However, approximately 400 stamped logs were observed at Kilwa port awaiting shipment during this study.

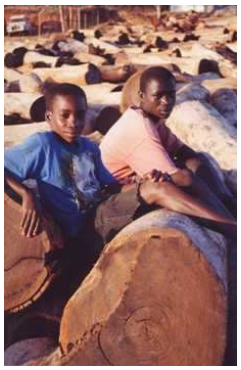
Figure 8

Sawn wood and logs shipped from major ports, 2000-2001 (m^3 round wood equivalent)

Port	2000	2001
Sawn wood		
Mtwara	510	43
Lindi	943	0
Kilwa	1 824	2 257
Logs		
Mtwara	1 631	120
Lindi	30	0
Kilwa	0	0



Source: Tanzania Harbours Authority, Port Manager Mtwara, 2002.



Credit: Simon Milledge/ TRAFFIC East/ Southern Africa

Logs ready for export, Kilwa Masoko, October 2002.

However, in addition to these official shipments from designated ports, large quantities of sawn wood (and charcoal) is also known to be transported from smaller ports lacking government checkpoints along the coastline to Zanzibar and Mafia Island. Some of this wood is subsequently exported from Zanzibar. The majority of this wood is cut into planks using pitsaws and later transported to these minor ports using bicycles. Teams of six to eight bicycles are common, each carrying six planks every journey. Dhows are used to transport the wood, mostly to Zanzibar, with up to 600 planks carried on each trip. A maximum of two trips can be made in one month.

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Team of bicycles carrying planks to coastal ports, Kilwa District.

Shipment of timber across Rufiji River

Ndundu ferry crossing

During the three-month period from 15th October 2001 to 14th January 2002, an estimated 10 500 m^3 wood (round wood equivalent) was shipped north across the Rufiji River via the Ndundu ferry, according to data collected by research assistants. Planks constituted 85% of the trade (approximately 8950 m^3) whilst logs amounted to 1545 m^3 (Table 11).

A very rough estimate of the total quantity of timber products transported northwards over Ndundu ferry during 2001 can be calculated using Ndundu vehicle records. These records provide monthly totals for vehicles from different weight classes crossing the ferry and show seasonal variations throughout the year. During 2001, a total of 3933 3-14 t vehicles (the weight of vehicles known to carry timber products) were recorded as using the ferry, of which 1017 (26%) crossed during the months of October-December. If it assumed that the total quantity of products crossing via ferry is directly proportional to the number of vehicles, then the volume of wood products ferried north during 2001 could be on the order of 40 400 m^3. However, this calculation is likely to be an overestimate owing to seasonal variation in goods transported; October and November are peak months for timber trade across the river, coinciding as they do with the dry season.

It is already known that some trucks carrying timber northwards subsequently transport other goods southwards. For example, one ten tonne Mercedes Benz was recorded carrying oranges, small logs and planks on different occasions during the study period. It is therefore possible that timber may be transported northwards by particular transporters during certain months, but other goods (e.g. salt or fish products) transported at other times of the year. For this reason, this total figure should be treated as a crude estimate and further work is required to ascertain what seasonal variations in cargo preference exist.

Table 11

Estimated volumes (m^3) of timber transported north across Ndundu ferry, Oct 2001 to Jan 2002

Description	Logs, large	Logs, small	Planks	Total
Total volume recorded on north bank	920	270	7 530	**8 720**
Total volume recorded on south bank	530	450	4 230	**5 210**
Volume taking into account double-counting on both banks	1 120	600	10 370	**12 090**
Minimum volume crossing Ndundu ferry	920	450	7 530	**8 900**
Maximum volume crossing Ndundu ferry	1 120	600	10 370	**12 090**
Average volume crossing Ndundu ferry	1 020	525	8 950	**10 500**

Ikwiriri sawmills

During the study period, three sawmills were operating at Ikwiriri, namely Badr East Africa Enterprises Limited (BEAE Ltd.), Mahmood International Limited (MI Ltd.) and Portfolio Investment Company Limited (PIC Ltd.). Some information on the first two mills was collected, while detailed records on logs processed by PIC Ltd. during 2001 were collected and analysed.

Established in 1998, PIC Ltd. (Ikwiriri) is a small sawmill utilising a bend saw to cut large tree trunks, and a few circular saws for re-sawing and sizing (Kaale *et al*., 2000). During 2001, PIC Ltd. processed a total of 2536 logs with a total volume of 2432 m^3. The average monthly purchases of 203 m^3 closely match earlier estimates of 208 m^3 (Kaale *et al*., 2000). Peak trade occurred during the driest period between August and November (averaging 237 m^3 monthly), when timber originating from south of the Rufiji River could easily cross the ferry. Monthly processing levels remained above 150 m^3 throughout the year with substantial volumes processed even when the Rufiji River remained largely impassable during the long rainy season and timber was sourced mostly from north of the river.

BEAE Ltd. is a smaller sawmill, also equipped with a bend saw and two circular saws. Kaale *et al.* (2000) estimated total log inputs at around 1200 m^3 of logs per year (based on 5 m^3 per day and 240 working days per year).

MI Ltd. was established in 1995 and mainly deals in *Dalbergia melanoxylon* for export. Log input was estimated at 2 m^3 per day and around 480 m^3 per year (Kaale *et al*., 2000). The availability of *D. melanoxylon* logs from Ikwiriri area was

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Export quality *Dalbergia melanoxlyon* billets.

reported to be very low, with most sourced from Utete area and Kilwa District.

The total volume of round wood processed by these three sawmills during 2001 was, therefore, estimated at 4112 m^3.

Kibiti checkpoint

Kibiti checkpoint is the first official checkpoint north of the Rufiji River. It is strategically located at the intersection of two roads that theoretically supply all timber (and other goods) moving north towards Dar es Salaam. It is, therefore, of national importance in terms of monitoring and revenue collection. Whilst a significant proportion of the wood products (especially sawn wood and large logs) do pass through Kibiti checkpoint, in reality, many vehicles bypass the checkpoint using smaller roads to avoid payment of village and district timber levies. This highlights the enormous challenges already faced by authorities, a situation that will only be exacerbated after the Mkapa Bridge is opened. Official records were collected from Kibiti checkpoint for 2001, which tend to be handwritten ledger books containing vehicle and harvest licence details in addition to actual timber volumes. It should be noted that deficiencies in staff capacity (particularly numbers of personnel, skill levels and motivation) result in inaccuracies and frequent underestimation of timber products.

During 2001, a total of 8608 m^3 round wood equivalent of logs and planks were recorded at Kibiti checkpoint (Table 12). Due to the high turnover from the Ikwiriri sawmills, planks outweighed logs (1:1.6), driven by the lower royalties paid for sawn wood when compared to uncut logs (**Figure 9**). It is notable how much higher the ratio between sawn wood and logs was at Ndundu ferry crossing (1:5.8) than at Kibiti checkpoint (1:1.6). One would expect the reverse since many planks are produced from Ikwiriri sawmills. The discrepancy is believed to be attributable to large-scale illegal and unrecorded trade in planks. More small logs were recorded at Kibiti checkpoint than large logs since the Ikwiriri sawmills purchase most of the large logs. Further, smaller operators are reportedly felling undersize trees, as well as returning to previously felled trees to collect remaining branches ('off-cuts').

Table 12

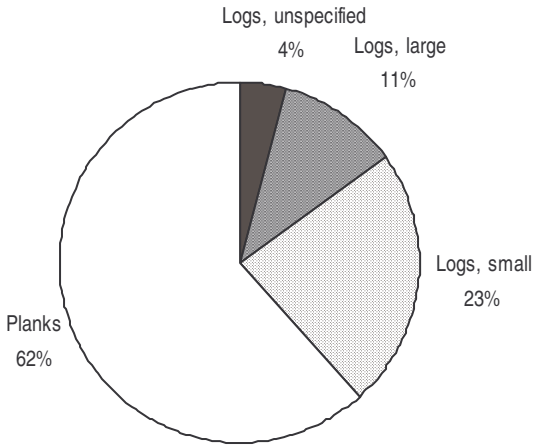
Quantities of timber products recorded at Kibiti checkpoint, 2001

Description	Volume (m^3)	Description	Volume (m^3)
Planks	5 312.1 m^3	Logs, large	944.1 m^3
Logs, small	2 001.4 m^3	Logs, unspecified	350.6 m^3

Source: Kibiti checkpoint records, 2001.

Figure 9

Quantities of planks (round wood equivalent) and logs recorded at Kibiti checkpoint, 2001



Source: Kibiti checkpoint records, 2001.

Total volume of timber transported north across Rufiji River

Comparison of data collected by research assistants at Kibiti checkpoint with complimentary data collected at other specific locations north of the Rufiji River was made to ascertain true volumes of timber transported north of the Rufiji River. In summary, an estimated 23% of the timber that was shipped over the Rufiji River was actually recorded at Kibiti checkpoint (Table 13). The majority of this discrepancy was due to unrecorded sawn wood. This can be attributed to numerous causes, including underdeclaration of goods (either due to inaccurate estimations of volumes or corrupt practices at the checkpoint) and using minor roads to bypass the official checkpoint. As a result, approximately 80% of the potential revenue was lost during this three-month period.

Table 13

Volumes (m^3) of round wood passing through Kibiti, 15th October 2001 to 14th January 2002

Description	Logs	Planks	Total
Estimated volume passing across Ndundu ferry crossing (A)	1 550	8 950	**10 500**
Estimated volume passing from Mkongo to Ikwiriri (B)	160	330	**490**
Estimated volume passing from Mkongo to Kibiti (C)	660	900	**1 560**
Estimated volume processed by sawmills (D)	1 000	0	**1 000**
Estimated volume produced by sawmills (E)	0	666	**666**
Predicted volume passing Kibiti (F = A+B+C-D+E)	1 370	10 850	**12 220**
Recorded volume passing Kibiti (G)	1 300	1 570	**2 870**
Percentage volume recorded at Kibiti ((G-F)*100)/G)	95%	15%	**23%**

Source: TRAFFIC survey data and Kibiti checkpoint records, 2001/2002.

Further, a large discrepancy exists between the volumes of timber for which harvest licences were issued and volumes actually harvested. During 2001, licences were only issued for the harvest of 10 163 m^3

round wood from the study area. Over the same period, an estimated 42 000 m^3 timber was transported north over the Rufiji River, and 2420 m^3 shipped from the ports of Mtwara, Lindi and Kilwa Masoko. This does not include informal shipments by sea, charcoal and construction timber sold in urban markets within the country, nor vast quantities of wood fuel (approximately 2.1 million m^3) and other forest products used by individual households.

Estimated harvest pressure by district

If the forest areas of each district are taken into account, an estimated average harvest pressure may be calculated for each district, with the assumption that average forest stocking densities are the same for each district and all areas of forest are harvestable (Table 14). As expected, this analysis shows that Rufiji District has by far the highest estimated harvest pressure, a factor of almost five times higher than Kilwa District and 50 times higher than Liwale District, highlighting the immediate need for harvest plans.

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Dalbergia melaxolyon stand, Lindi district.

Table 14

Volume of timber licensed for harvest and estimated harvest pressure by district, 2000-2001

District	Estimated forest area (ha)	Year	Volume timber issued on harvest licences (m^3)	Estimated harvest pressure (m^3/10,000Ha)	Average harvest pressure, 2000-1 (m^3/10,000Ha)
Nachingwea and Ruangwa	534 700	2000	109.5	2.0	3.7
		2001	286.5	5.4	
Liwale	1 738 100	2000	271.1	1.6	1.1
		2001	118.8	0.7	
Lindi	775 970	2000	163.3	2.1	2.2
		2001	171.9	2.2	
Kilwa	1 291 500	2000	2 119.4	16.4	12.0
		2001	987.8	7.6	
Rufiji	1 231 930	2000	5 484.6	44.5	57.0
		2001	8 559.4	69.5	

Source: District licence records; Anon. (1997g).

SPECIES COMPOSITION OF ROUND WOOD IN TRADE

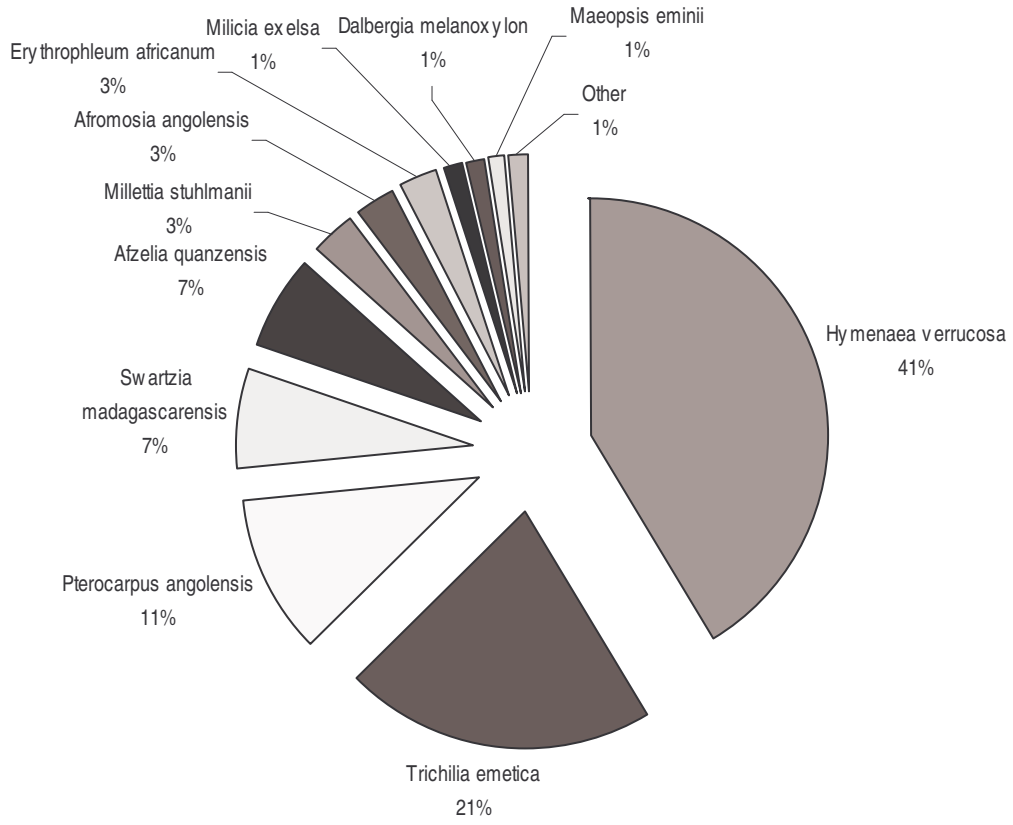
The species composition of round wood in trade was determined from comparison of records from timber harvest licences, Kibiti natural resource checkpoint, sawmills and forest stump surveys. Tree species belong to one of five different classes (I-V) according to their value. Log fees in 2002 ranged from TZS 70 000/m^3 (USD 68.29/m^3) for class I species, to TZS 10 000/m^3 (USD 9.76/m^3) for Class V species (refer to Annex 2).

Timber harvest records

Harvesting licences were issued for a total of 27 hardwood timber species in the study area during 2000 and 2001 (Table 15). During 2001, the two most popular species by harvest volume were Class V species, *Hymenaea verrucosa* (41%) and *Trichilia emetica* (21%), with licences issued almost exclusively for harvest within Rufiji District. Other popular species during 2001 included Class II *Pterocarpus angolensis* (11%), *Swartzia madagascarensis* (7%) and *Afzelia quanzensis* (7%). In fact, Class V and II species constituted the majority by volume during 2001, at 66% and 28% respectively. According to official harvest licence records, the single Class I species, *Dalbergia melanoxylon*¸ constituted a relatively low volume at just 107 m^3. As shown in Figure 10, four species comprised 80% of the harvest licences by volume during 2001.

Figure 10

Relative volume of harvests licensed for timber species, 2001



Source: District licence statistics, 2001.

Species harvested in 2001, but not harvested in 2000, included *Albizia gummifera, Newtonia* spp. and *Sterculia quinqueloba*.

Table 15

Volumes (m^3) of round wood licensed for harvest in study area by Class and species, 2000-2001

Class and Scientific name	Kilwa		Lindi		Liwale		Nachingwea		Ruangwa		Rufiji		Totals	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Class I														
Dalbergia melanoxylon	160.0	10.5					39.0	86.0		0.5	5.0	10.3	**204.0**	**107.3**
Class II														
Pterocarpus angolensis	1449.0	745.5	75.0	45.1	245.0	96.8	2.0	7.9	31.0	102.9		60.3	**1 802.0**	**1 058.5**
Swartzia madagascarensis	98.0										483.0	678.8	**581.0**	**678.8**
Afzelia quanzensis	111.0	69.3		2.3	7.0	3.5	3.0	62.0	4.0		693.0	508.6	**818.0**	**645.7**
Millettia stuhlmannii	71.0	45.0								10.0	171.0	224.4	**242.0**	**279.4**
Milicia exelsa	32.0	1.0	70.0	122.5					5.0				**108.0**	**123.5**
Newtonia spp.												2.0	**0.0**	**2.0**
Class III														
Albizia versicolor	1.0	15.5					1.0				23.0	17.7	**25.0**	**33.2**
Brachystegia spp.	63.0	58.0									109.0	6.0	**172.0**	**64.0**
Julbernardia globiflora							4.0		5.0		29.0	52.6	**38.0**	**52.6**
Class IV														
Albizia gummifera												28.9	**0.0**	**28.9**
Erythrophleum africanum											52.0	264.3	**52.0**	**264.3**
Bombax rhodognaphalon	6.0		18.0		20.0	18.5	7.0	7.2	8.0	10.1		1.5	**58**	**37.3**
Maeopsis eminii	62.0	27.0									114.0	78.2	**176.0**	**105.2**
Class V														
Hymenaea verrucosa		4.0									2464.0	4072.7	**2464**	**4 076.7**
Trichilia emetica											613.0	2074.6	**613.0**	**2 074.6**
Afrormosia angolensis											331.0	274.6	**331.0**	**274.6**
Grewia bicolor	30.0												**30.0**	**0.0**
Sclerocarya birrea											140.0	80.0	**140.0**	**80.0**
Manilkara mochisia											104.0		**104.0**	**0.0**
Amblyogonocarpus obtusangulus											92.0	26.3	**92.0**	**26.3**
Sterculia quinqueloba												8.6	**0.0**	**8.6**
Other	37.0	70.1		2.0			1.0					95.0	**38.0**	**167.1**
TOTALS	**2120.0**	**1045.9**	**163.0**	**171.9**	**272.0**	**118.8**	**57.0**	**163.1**	**53.0**	**123.5**	**5423.0**	**8565.4**	**8 088.0**	**10 188.6**

Note: Data not collected for January to June 2000 for Nachingwea and Ruangwa Districts, and from January to March and October to December 2000 for Rufiji District.
Source: District licence statistics, 2000-2001.

Comparison of timber harvest records between districts

The species for which harvest licences are issued varies greatly with different districts, both in terms of the numbers of different species and the proportion of each species licensed for harvest (Table 15). A declining number of species were issued on harvest licences as one moves southwards from the Rufiji River. During 2000 and 2001, the highest numbers of species (22) were included on licences issued for

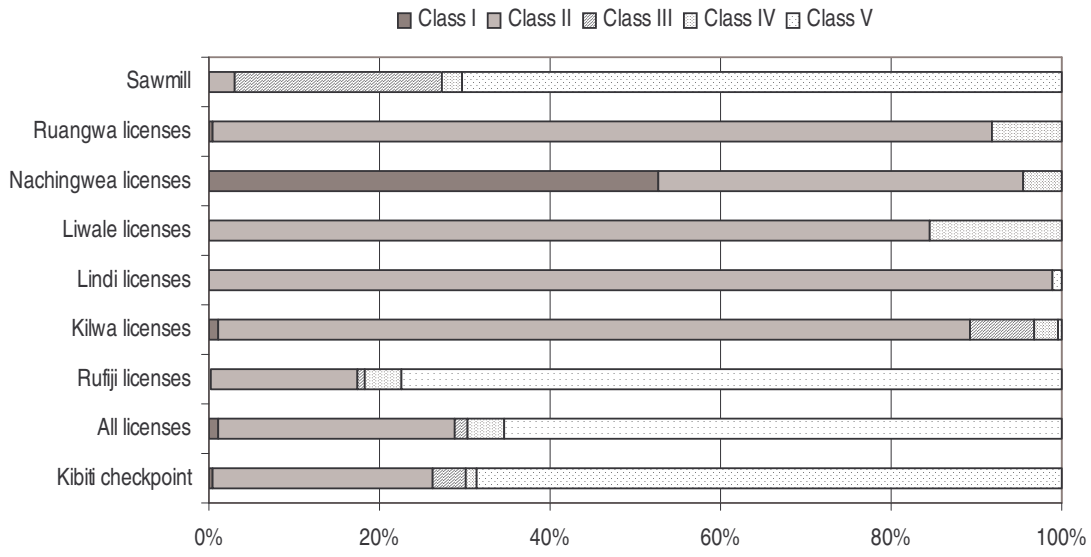
Rufiji District, while licences for nine were issued for Kilwa District and licences for no more than four each were issued for Lindi, Liwale, Nachingwea and Ruangwa Districts.

Secondly, the harvest licences from each district vary in terms of the proportion of different species (Figure 11). The majority of licences issued in Rufiji District are Class V species and account for almost all Class V licences issued from the entire study area (Table 15). Almost half of the licences issued from Rufiji District in 2001 were *Hymenaea verrucosa,* with a further quarter attributable to *Trichilia emetica*. The low proportion of Class II species from Rufiji District suggests overexploitation of these higher value species.

Moving southwards from the Rufiji River, the proportion of Class I and II species increases markedly. During 2001, over 80% of licences issued from Kilwa, Lindi, Nachingwea, Liwale and Ruangwa Districts were comprised of Class I and II species. Class I *Dalbergia melanoxylon* was issued from four districts, predominantly Kilwa and Nachingwea Districts. Indeed, this species alone accounted for over 50% by harvest volume licensed for Nachingwea District in 2001. *Pterocarpus angolensis* remains the most popular Class II species, accounting for 83% by harvest volume licensed for Ruangwa, 81% for Liwale and 75% for Kilwa. The most popular species by harvest volume licensed for Lindi was *Milicia exelsa* (71%).

Figure 11

Relative proportion of different classes of timber between district harvest licences, Kibiti checkpoint and an Ikwiriri sawmill



Sources: Rufiji, Kilwa, Lindi, Nachingwea and Liwale District harvest licences (2001), Kibiti checkpoint (October 2001 to January 2002) and PIC Ltd. (Ikwiriri) sawmill (2001).

Timber moving north of Rufiji River

Three indicators of species composition were obtainable for timber moving north of the Rufiji River, which in turn was compared with harvest records from the study area. These included official district

checkpoint records from Kibiti, stump survey results from selected Forest Reserves, and sawmill records in Ikwiriri. In addition, field observations were used to assist data interpretation.

Species composition of timber recorded at Kibiti checkpoint

During the three-month period from October 2001 to January 2002, over one-half of the round wood recorded was declared as *Hymenaea verrucosa*, followed by *Pterocarpus angolensis, Trichilia emetica, Afzelia quanzensis* and *Swartzia madagascarensis* (Table 16 and Figure 17). These were the same top five species recorded from harvest licences issued in the study area during 2001. Together, these five species accounted for over 90% all round wood passing though Kibiti checkpoint, again closely comparable to the figure of 87% from harvest licences. Similarly, the proportions by class were very similar between the two data sources (Figure 11).

Table 16

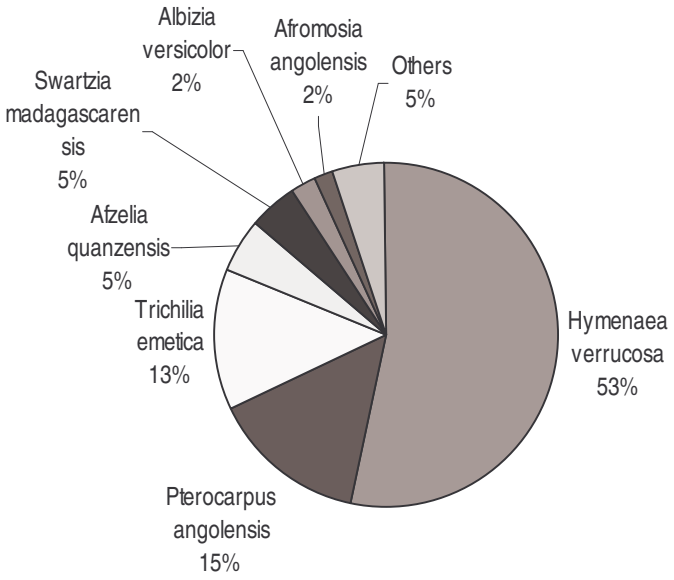
Round wood volume of hardwoods passing through Kibiti checkpoint, Oct 2001 to Jan 2002

Scientific name	m^3 round wood	Scientific name	m^3 round wood
Hymenaea verrucosa	1 861	*Julbernardia globiflora*	40
Pterocarpus angolensis	512	*Maeopsis eminii*	26
Trichilia emetica	461	*Dalbergia melanoxylon*	16
Afzelia quanzensis	175	*Albizia gummifera*	15
Swartzia madagascarensis	169	*Brachystegia* spp.	14
Albizia versicolor	85	*Erythrophleum africanum*	7
Afrormosia angolensis	67	*Amblyogonocarpus obtusangulus*	5
Millettia stuhlmannii	43	*Newtonia* spp.	5

Source: Kibiti checkpoint records, 2001-2002.

Figure 12

Proportion of hardwood species passing through Kibiti checkpoint, Oct 2001 to Jan 2002



Source: Kibiti checkpoint records, 2001-2002.

Species composition of timber processed at Ikwiriri sawmills

During the period of research, three sawmills were operational in Ikwiriri. One sawmill, MI Ltd., specialised in *Dalbergia melanoxylon* whilst the other two companies, including PIC Ltd., were less restrictive in their selection of timber species (Table 17).

Table 17

Main species processed by different sawmills in Ikwiriri, Rufiji District, 2001

Scientific name	PIC Ltd.	BEAE Ltd.	MI Ltd.
Afzelia quanzensis	Yes	Yes	
Amblyogonocarpus obtusangulus	Yes	Yes	
Brachystegia spp.	Yes	Yes	
Burkea africana		Yes	
Dalbergia melanoxylon			Yes
Erythrophleum africanum	Yes		
Hymenaea verrucosa	Yes	Yes	
Julbernardia globiflora	Yes		
Millettia stuhlmannii	Yes	Yes	
Swartzia madagascariensis		Yes	
Trichilia emetica	Yes	Yes	

Sources: PIC Ltd records, 2001; Kaale *et al*. (2000).

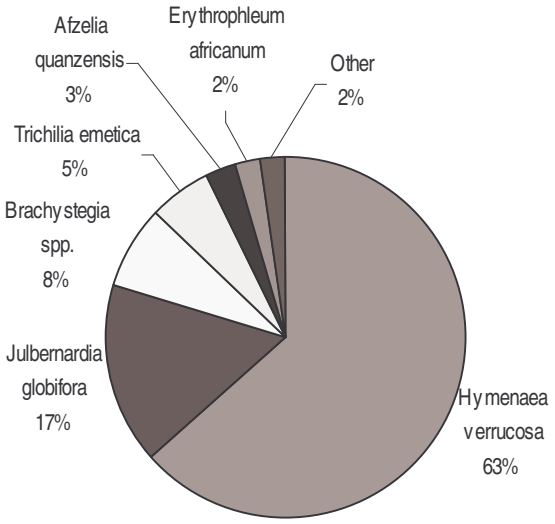
Detailed records of timber processed were collected from one major sawmill in Ikwiriri, PIC Ltd., for the year 2001. A total of around 20 species were processed by PIC Ltd. during that`year. Five species constituted 96% of all processed timber by volume, with two species constituting nearly four-fifths of all timber processed – *Hymenaea verrucosa* (1453 logs, 1538.5 m^3) and *Julbernardia globiflora* (311 logs, 401.3 m^3) (Figure 13).

Overall, three-quarters of timber processed by PIC Ltd. was Class V species, similar to records collected from both harvest licences issued in the study area and Kibiti checkpoint records (Figure 11). On the other hand, many more Class III species and far fewer Class II species were processed by PIC Ltd. compared to harvest licence and Kibiti checkpoint records, largely due to the large volume of *J. globiflora* processed. It is not clear whether the large quantities of *J. globiflora* were used locally (e.g. bridge and jetty construction), or if they were transported undetected or misidentified, hence their omission from Kibiti checkpoint records.

The majority of timber species processed by BEAE Ltd. were cut into sawn wood for local and export markets, although two species, *Millettia stuhlmannii* and *Swartzia madagascariensis*, were cut into parquet flooring tiles purely for export (Kaale *et al*., 2000). Table 17 shows similarity in species processed by PIC Ltd. and BEAE Ltd.

Figure 13

Main species processed by PIC Ltd. sawmills in Ikwiriri, Rufiji District, 2001



Source: PIC Ltd records, 2001.

Species composition from forest reserve stump surveys

Forest stump surveys are one method to help ground truth other information, such as that contained on the harvest licences. A stump survey was conducted at Ruhoi Forest Reserve in Rufiji District during 2000 (Anon., 2002f). The weighted percentage of stumps (i.e. taking into account variable average diameters of different species) revealed that *Trichilia emetica* and *Afzelia quanzensis* accounted for the largest volumes of freshly felled timber (Table 18). The stump survey (N=322) also showed that there were large differences between the species composition of harvests observed in the field and on harvest licences. Most notably, *Pterocarpus angolensis*, a Class II species that was not issued on any harvest licences in Rufiji District during 2000, was indeed being harvested (Table 18). This high value species was clearly being illegally targeted for trade. This species is the most favoured timber in Dar es Salaam, although prices continue to rise (Wells *et al.*, 2000). Similarly, fresh stumps of *A. quanzensis* and *Swartzia madagascariensis* (Class II) accounted for more than twice their harvest volumes recorded on licences, resulting in underreporting and losses in revenue. On the other hand, fresh stumps of *Hymenaea verrucosa* (Class V) accounted for eight per cent of the total stumps found in the forest, but nevertheless accounted for 46% of the total permitted harvest volume recorded on licences. Traders appear to have been illegally harvesting and trading in the more valuable Class II species having paid lower royalties for the cheaper Class V species.

Unfortunately, individual harvest licences detailing the harvest areas were not available for 2000, and Kibiti checkpoint records did not record species at that time. Whilst species selection almost certainly varies between different areas of the same district, Ruhoi Forest Reserve is known to be a major source of timber in the case of Rufiji District and the results are therefore believed to be fairly reliable. Between October 2001 and January 2002, the species and origin of all timber originating from Ruhoi Forest Reserve and passing through Kibiti checkpoint was recorded, showing a similar species composition to the licence records for 2000 (Table 18). These data would be a useful benchmark to compare against a more updated stump survey in Ruhoi Forest Reserve. Nevertheless, one cannot assume that the same

patterns occur over the entire study area and it is imperative that more systematic stump surveys are conducted and compared to licence and/or checkpoint records. Despite the problems experienced in stump identification and stump age determination, stump surveys are a particularly important technique in areas where illegal harvesting and/or misclassification is suspected and species have different royalties. Whilst royalty setting and enforcement mechanisms should in theory facilitate compliance, the generally low enforcement capacity results in compliance difficulties. The temptation for avoiding royalty payments is highest for the higher-ranking classes where there is a large difference in potential profit margins between different classes (Anon., 2002f).

Table 18

Comparison of species composition between official records and Ruhoi Forest Reserve stump survey

Scientific name	Weighted % of stumps in Ruhoi Forest Reserve, 2000	% volume timber issued on harvest licences from Rufiji District, 2000	% volume timber from Ruhoi Forest Reserve passing Kibiti checkpoint, Oct 01-Jan 02
Trichilia emetica (V)	22.4	10.1	18
Afzelia quanzensis (II)	21.6	12.4	4
Swartzia madagascarensis (II)	14.9	6.9	3
Pterocarpus angolensis (II)	10.7	0	1
Hymenaea verrucosa (V)	8.4	45.5	67

Sources: Anon. (2002f); Kibiti checkpoint statistics, 2001/2.

Species composition of timber products

Unlike harvest licence records, information collected from Kibiti checkpoint allowed for an analysis of wood product by species. Indeed, this highlights the importance of maintaining this level of detail in the checkpoint records, as otherwise such an analysis would be impossible. It is noticeable how the species composition varies with different wood products (Table 19). *Hymenaea verrucosa* accounted for the majority of small logs (82%), whilst 57% of large logs belonged to *Swartzia madagascarensis*. Four species accounted for 92% of the planks passing Kibiti checkpoint (*H. verrucosa, Pterocarpus angolensis, Trichilia emetica* and *Afzelia quanzensis*). Some timber species in Rufiji District are not targeted by pitsawyers, either because they are too hard or heavy (e.g. *H. verrucosa*, *T. emetica*) or because they are exported from Tanzania as logs (e.g. *S. madagascarensis, Millettia stuhlmannii, Afrormosia angolensisi)* (Anon., 2002f). It is also noticeable how many more species are recorded as planks when compared to logs (Table 19). This can be attributed to the large volume of wood that is cut into planks at Ikwiriri sawmills as well as pit saws throughout the study area.

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Confiscated timber products, Kibiti.

Two species, *Swartzia madagascarensis* and *Afrormosia angolensis*, were only transported as large logs, whilst at least four other species were only transported as planks. Other species show different ratios that provide useful baseline information for future monitoring.

Table 19

Species composition (m^3) of wood products recorded at Kibiti checkpoint, Oct 2001 to Jan 2002

Scientific name	Firewood	Logs	Logs, large	Logs, small	Planks	Totals
Hymenaea verrucosa		5.0	41.8	826.9	668.3	**1 542.0**
Pterocarpus angolensis				21.9	415.5	**437.4**
Trichilia emetica		2.0	2.0	73.0	285.2	**362.2**
Afzelia quanzensis		10.0	10.0	25.1	100.6	**145.7**
Swartzia madagascarensis			132.5			**132.5**
Albizia versicolor		8.0		47.0	20.6	**75.6**
Millettia stuhlmannii			20.2		23.0	**43.2**
Afrormosia angolensis			27.0			**27.0**
Maeopsis eminii					26.0	**26.0**
Julbernardia globiflora				5.0	15.7	**20.7**
Albizia gummifera				4.0	10.8	**14.8**
Dalbergia melanoxylon	14.6					**14.6**
Brachystegia spp.					12.0	**12.0**
Erythrophleum africanum					7.1	**7.1**
Newtonia spp.					5.0	**5.0**

Source: Kibiti checkpoint records, 2001-2002.

It should be noted that the classification 'firewood' for *Dalbergia melanoxylon* actually refers to off-cuts, and may not be an adequate description since these off-cuts are rarely burnt, but instead are used in Dar es Salaam for furniture, parquet flooring and other decorative purposes. Further, investigations during this study revealed that transporters commonly conceal large consignments of export-quality billets of *D. melanoxylon* beneath off-cuts classified as 'firewood'.

Changes in species composition

Available data supports anecdotal reports that depletion of the more valuable hardwoods has changed species preference towards a higher proportion of the cheaper and lower value species (Class IV and V). Analysis of historical licence data for Rufiji District (which accounts for the majority of harvest licences issued in the study area by volume) dating back to 1992 reveals that Class V species were issued licences from 1995 although they only started to constitute over 50% all licences by volume from 1998 onwards (Table 20; Figure 14).

Table 20

Class composition of hardwood licences (m^3) issued in Rufiji District, 1992-2001

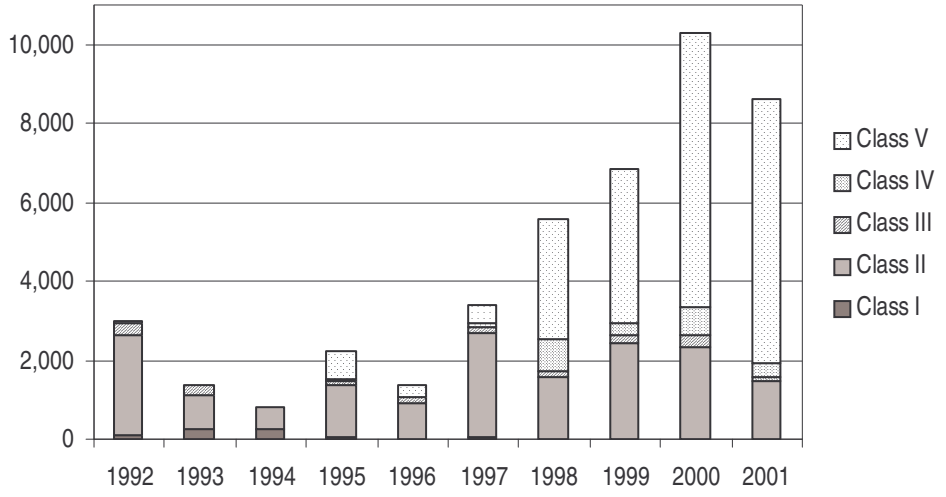
Class	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Total
Class I	106.8	232.9	263.0	70.5	23.5	30.0	0.0	6.3	7.0	10.3	**750.3**
Class II	2 521.5	895.5	562.2	1 317.2	913.2	2 663.0	1 591.7	2 431.4	2 319.0	1 482.3	**16 697.0**
Class III	334.8	220.5	0.0	107.4	131.9	149.0	153.3	199.3	317.0	76.3	**1 689.5**
Class IV	0.5	4.5	1.0	40.0	4.0	109.0	802.3	278.0	727.0	372.9	**2 339.2**
Class V	16.0	25.5	8.0	704.1	288.8	451.0	3 013.9	3 903.7	6 929.0	6 655.9	**21 995.9**
Total	**2 979.6**	**1 378.9**	**834.2**	**2 239.2**	**1 361.4**	**3 402.0**	**5 561.2**	**6 818.7**	**10 299.0**	**8 597.7**	**43 471.9**

Source: Rufiji District licence data, 1992-2001.

Table 20 also shows how Class IV species have increased since 1997 and *Dalbergia melanoxylon* (Class I) declined dramatically after 1994. The latter trend supports ground observations showing how less valuable timber species are being selected following mass reduction of wild stands of the more valuable hardwoods due to overexploitation. Within Class II, declines in *Pterocarpus*, *Newtonia, Milicia* and *Khaya* were gradually replaced by alternatives such as *Swartzia, Milletia* and *Afzelia*. The DFAPTF reported that *Dalbergia melanoxylon, Khaya anthotheca, Milicia exelsa* and *Pterocarpus angolensis* are already commercially extinct in Rufiji District, whilst *Afzelia quanzensis, Millettia stuhlmannii* and *Swartzia madagascarensis* are threatened with commercial extinction in the future (Anon., 2002g).

Figure 14

Class composition of hardwood licences (m^3) issued in Rufiji District, 1992-2001



Source: Rufiji District licence data, 1992-2001.

Similarly, south of the Rufiji River in Kilwa District where Class II species currently dominate harvest licences issued, increasing quantities of lower value timber species (e.g. *Brachystegia* spp., *Maeopsis eminii*) have been issued since 1998 (Table 21). Further, the proportions of high-value *Dalbergia*

melanoxylon (Class I), *Milicia excelsa* (Class II) and *Khaya anthoteca* (Class II) started to decline in 1995 (Figure 15).

Table 21

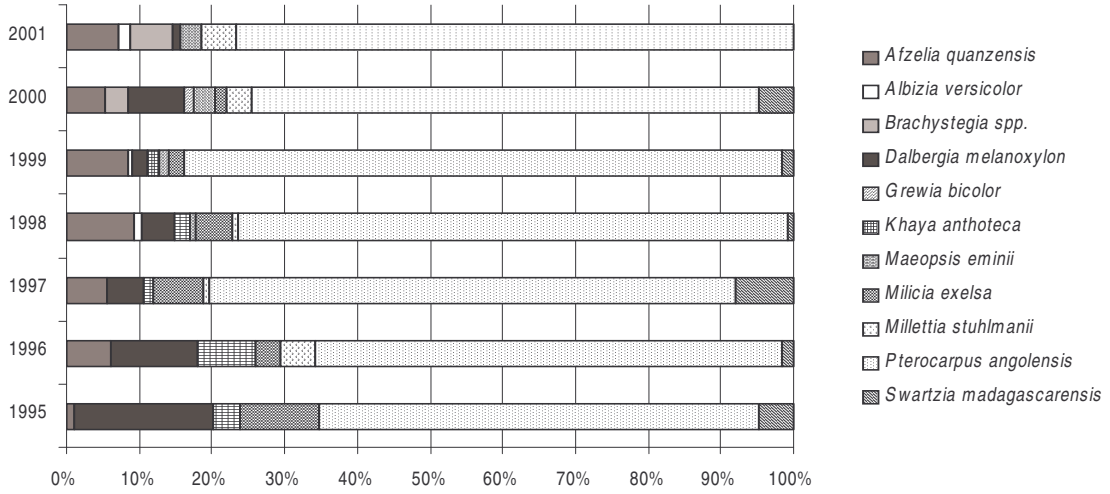
Class composition of hardwood licences (m^3) issued in Kilwa District, 1992-2001

Class	1995	1996	1997	1998	1999	2000	2001	Total
Class I	169.8	178.0	202.0	108.3	81.7	160.4	10.5	**910.7**
Class II	723.2	1 320.3	3 779.8	2 271.6	3 720.3	1 761.0	860.8	**14 437.0**
Class III		1.7	0.7	22.5	24.0	63.3	73.5	**185.7**
Class IV	3.0			24.5	60.8	67.8	27.0	**183.1**
Class V						30.0	4.0	**34.0**
Total	**896.0**	**1 501.0**	**3 982.5**	**2 426.9**	**3 886.8**	**2 082.5**	**975.8**	**15 750.5**

Source: Kilwa District licence data, 1995-2001.

Figure 15

Relative volumes (m^3) of major timber species issued on licences in Kilwa District, 1995-2001

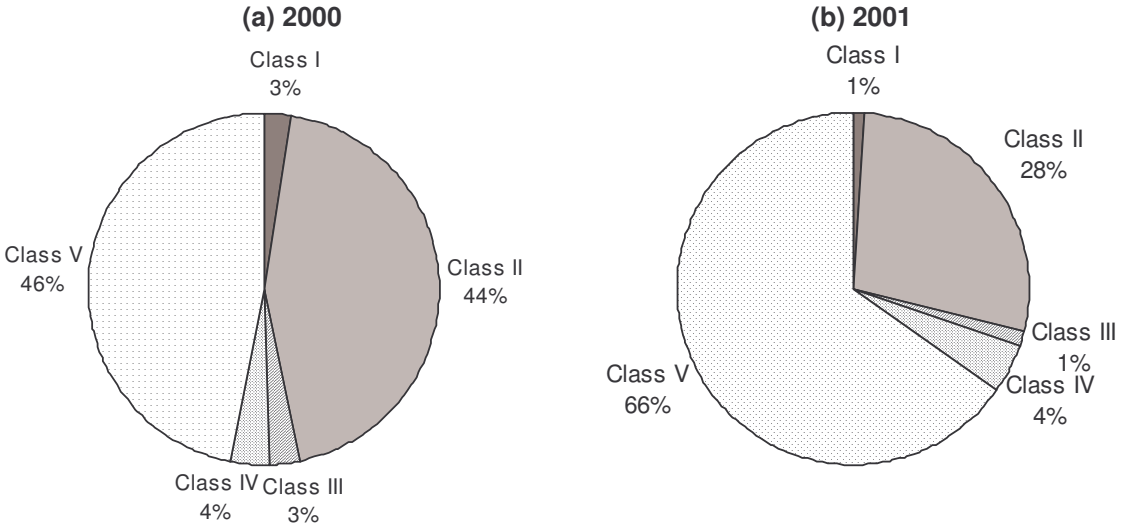


Source: Kilwa District licences, 1995-2001.

Data covering species composition of harvest licences over the entire study area were available for the years 2000 and 2001 only. Whilst it is recognized that comparison of data covering two years is not sufficient alone to determine trends, it is useful to detect differences between successive years. Comparison is compounded by inaccuracies in some official data sources. Nevertheless, comparison of data between 2000 and 2001 matched the longer-term changes in species composition and preference observed in Kilwa and Rufiji Districts. It is therefore unlikely that these changes represent random fluctuations in trade data. Harvest licences issued in 2000 and 2001 from all six districts shows how the proportion of Class IV and V species has increased, in contrast to the more valuable Class I, II and III species (Figure 16).

Figure 16

Volume of round wood harvested from study area by class, 2000-2001

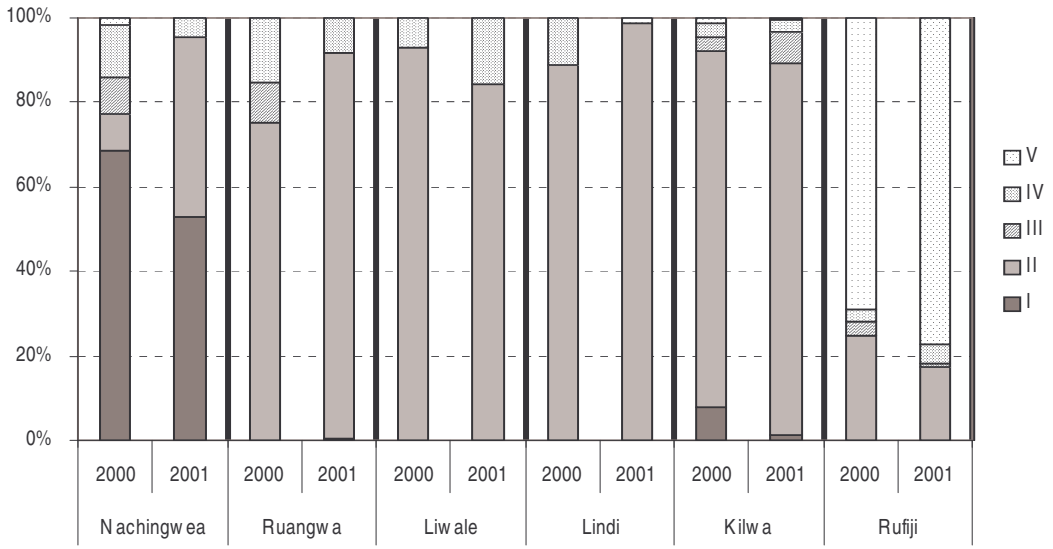


Source: District licences, 2000-2001.

Figure 17 illustrates the changes in class composition of wood harvested from the study area by district between 2000 and 2001, showing two indicators of declining trade in higher value timber compatible with evidence presented earlier. Firstly, the increase in Class V round wood harvested from Rufiji District, and secondly the decline in Class I round wood harvested from Nachingwea and Kilwa Districts. It is possible that the increase in Class V species is fuelled by high profit margins, with selling prices of TZS 300 000 - 425 000/m^3 (*Trichilia emetica, Hymenaea verrucosa, Afromosia angolensis*) considerably higher than licence rates (TZS 10 000/m^3 for round wood, equivalent to TZS 30 000/m^3 for sawn wood).

Figure 17

Comparison of volumes of round wood harvested in study area by class, 2000-2001



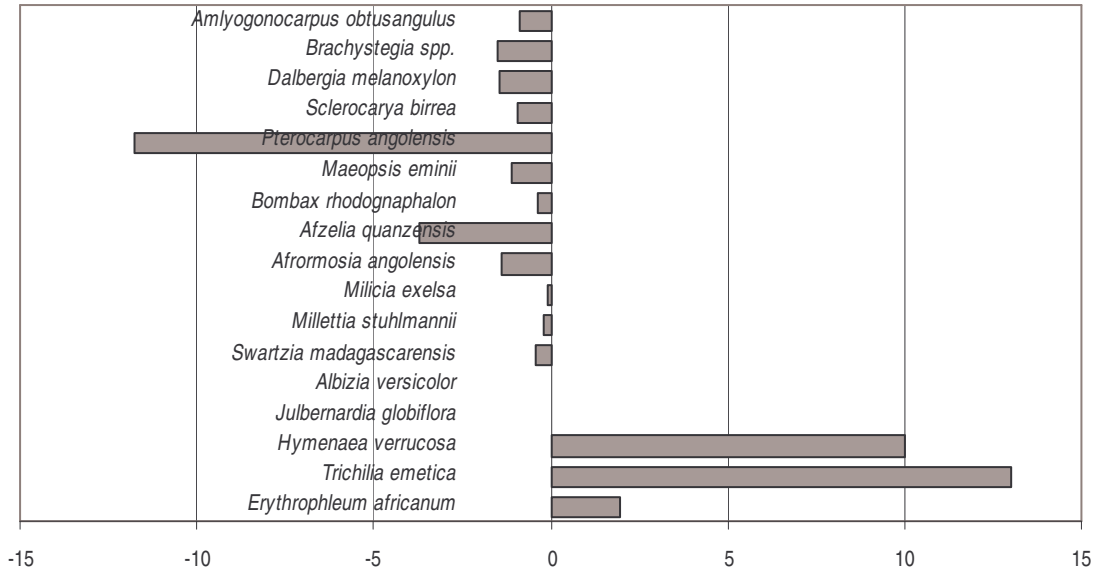
Source: District licence data, 2000-2001.

A few species have shown particularly large changes in volumes harvested between 2000 and 2001. Out of 17 hardwood species issued on harvest licences during both years, the volumes increased for eight species and declined for the remaining nine species (Table 15). The largest increases were recorded for the less valuable Class IV and V species *Erythrophleum africanum,* (408%), *Trichilia emetica* (238%) and *Hymenaea verrucosa* (65%), followed by Class III *Julbernardia globifora* (37%) and *Albizia versicolor* (34%). On the other hand, the majority of Class I and II species all showed declines in harvest licence volumes between 2000 and 2001.

In terms of overall species composition, the proportion of most species issued on harvest licences changed little between 2000 and 2001, with four species changing by more than 4% (Figure 18). The proportion of *Trichilia emetica* and *Hymenaea verrucosa* increased by 13% and 10% respectively, whilst *Pterocarpus angolensis* and *Afzelia quanzensis* decreased by 12% and 4% respectively.

Figure 18

Percentage change in species composition of round wood (m^3) harvested in study area, 2000-2001



Source: District licence data, 2000-2001

Size of harvested timber

Preliminary baseline information on timber sizes currently in trade was obtained from 2001 records of processed timber at PIC Ltd. sawmill, Ikwiriri. During 2001, this company processed a total of 2536 logs with a total volume of 2432 m^3. Five species constituted 96% of all processed timber by volume, with two species constituting nearly four-fifths of all timber processed – *Hymenaea verrucosa* and *Julbernardia globiflora*.

The average log measurements of different species are shown in Table 22. These values and associated graphs provide baseline data on average volume, girth and length measurements, which are useful indicators to monitor in response to changes in availability in the wild or changes in market preference.

Table 22

Log size of main timber species processed by PIC Ltd., 2001

Scientific Name	Total volume (m^3)	Average length (m)	Average girth (m)	Average volume (m^3)
Hymenaea verrucosa	1 538.5	3.3	2.0	1.1
Julbernardia globiflora	401.3	3.6	2.1	1.3
Brachystegia spp.	184.7	3.1	1.9	0.9
Trichilia emetica	131.7	3.6	1.2	0.4
Afzelia quanzensis	69.0	2.3	1.7	0.6
Erythrophleum africanum	53.4	2.9	1.5	0.6
Amblyogonocarpus obtusangulus	9.1	3.1	1.7	0.7
Apodytes dimidiata	5.1	3.8	1.7	0.8
Rhus spp.	4.9	3.5	2.1	1.2
Newtonia spp.	2.9	3.6	1.8	1.0
Lannea schweinfurthii	2.8	3.8	2.1	1.4
Sclerocarya birrea	2.6	2.8	1.7	0.7
Pterocarpus angolensis	1.1	2.9	1.6	0.6
Millettia stuhlmannii	0.5	2.9	1.1	0.3

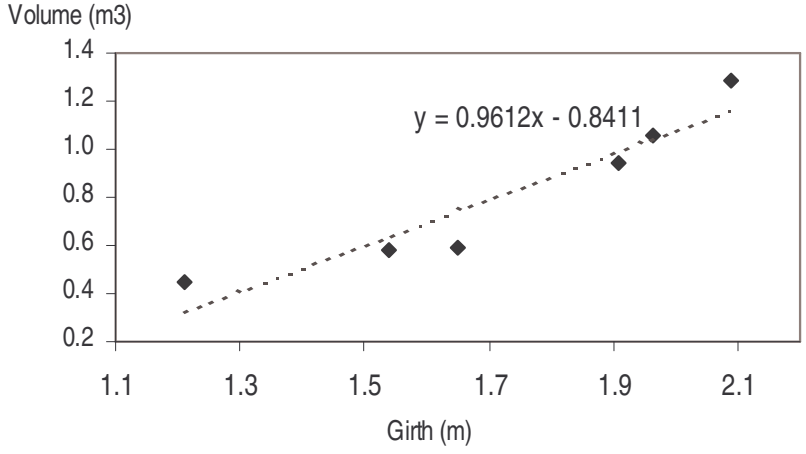
Source: PIC Ltd. sawmill, 2001.

There is significant variation in log size between different timber species. The average length, girth and volume were 3.3 m (ranging 2.3 – 3.8 m), 1.8 m (ranging 1.1 – 2.1 m) and 1 m^3 (ranging 0.3 – 1.4 m^3), respectively. The largest girth sizes were for *Lannea schweinfurthii, Julbernardia globiflora, Rhus* spp. and *Hymenaea verrucosa,* whilst smallest sizes were for *Millettia stuhlmannii* and *Trichilia emetica.* As expected, a clear relationship exists between average log volume and average girth measurements (Figure 19):

$$\text{volume} = (0.93 \times \text{girth}) - 0.82$$

Figure 19

Relationship between average volume and average girth of timber species whose processed volumes by PIC Ltd. exceeded 10 m^3 during 2001



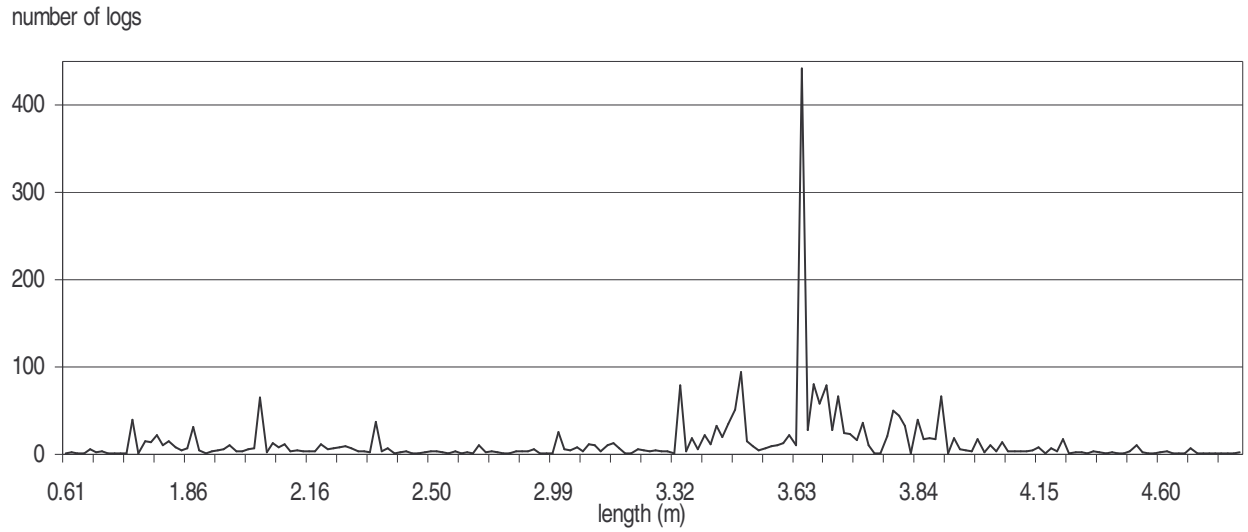
Source: PIC Ltd. sawmill, 2001.

The frequency distributions of length and girth measurements are shown in Figure 20. Whilst both measurements have a similar range, the girth measurements have a more normal distribution. Two-thirds (67%) of all logs processed measured between 3.35 and 3.96 m in length (between 11 and 13 feet exactly) including 22% measuring precisely 3.66 m (12 feet) long. This is due to the preferred length of planks being around 12 feet.

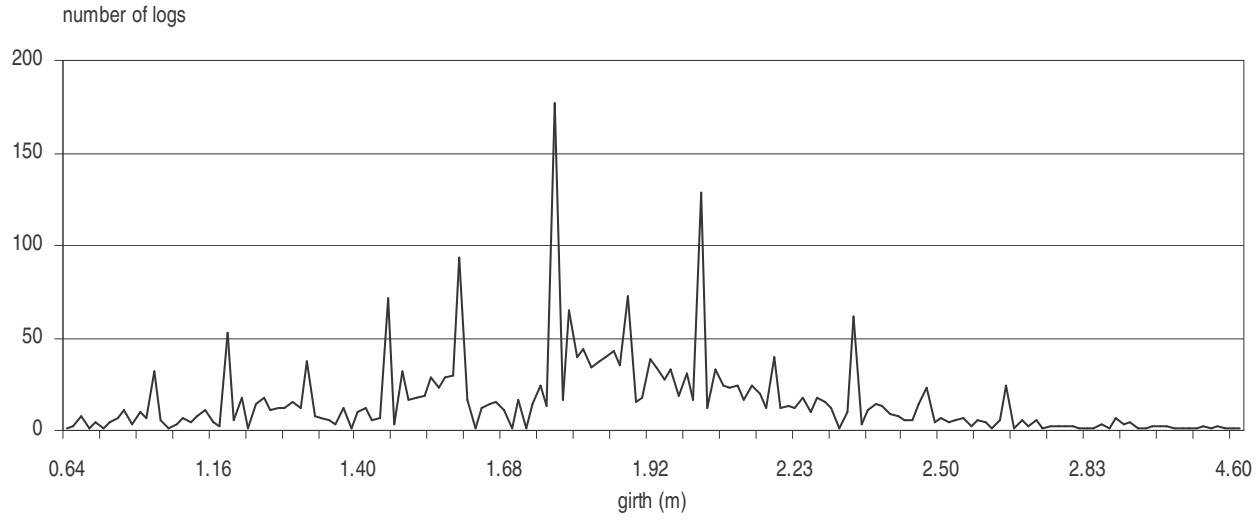
Figure 20

Measurements of logs processed by PIC Ltd. during 2001

(a) Length (m)



(b) Girth (m)



Source: PIC Ltd. sawmill, 2001.

Declining sizes of sawn wood

Table 22 shows how the average length of some valuable Class II logs processed by PIC Ltd. is now smaller than the market preference for sawn wood lengths, 3.66 m (12 feet). These include *Pterocarpus angolensis* (2.9 m), *Millettia stuhlmannii* (2.9 m) and *Afzelia quanzensis* (2.3 m). The smaller log lengths of these valuable species, in particular *Pterocarpus angolensis*, matches claims by traders throughout the study area that plank sizes have decreased markedly since the 1980s. Field observations during this study confirmed *Pterocarpus angolensis* planks in some areas measuring only 1.8-2.1 m in length due to the scarcity of mature specimens, as well as evidence of recent harvesting of young trees throughout the study area. Further evidence of unsustainable harvesting comes from a survey conducted along the Kibiti-Ikwiriri road by REMP in 2000, which revealed that the average diameter of fresh *Pterocarpus angolensis* stumps in Ngumburuni Forest Reserve was 0.3 m, half the minimum harvestable diameter of 0.6 m for sustainable harvest practices (Anon., 2002f,h). This wood is subsequently traded as 'off-cuts' (normally branches from previously felled trees) that are not subject to licensing or other forms of regulation, hence fall outside existing measures to control and monitor timber utilisation.

Credit: IUCN/O. Hamerlynck

Harvesting of young *Pterocarpus angolensis* in Rufiji District, later to be sold as 'off-cuts'.

Hamerlynck (2003) reported steep declines in the availability of *Afzelia quanzensis* in Rufiji District since 1999, with traders even targeting diseased and irregular specimens for the production of short 1.8m planks.

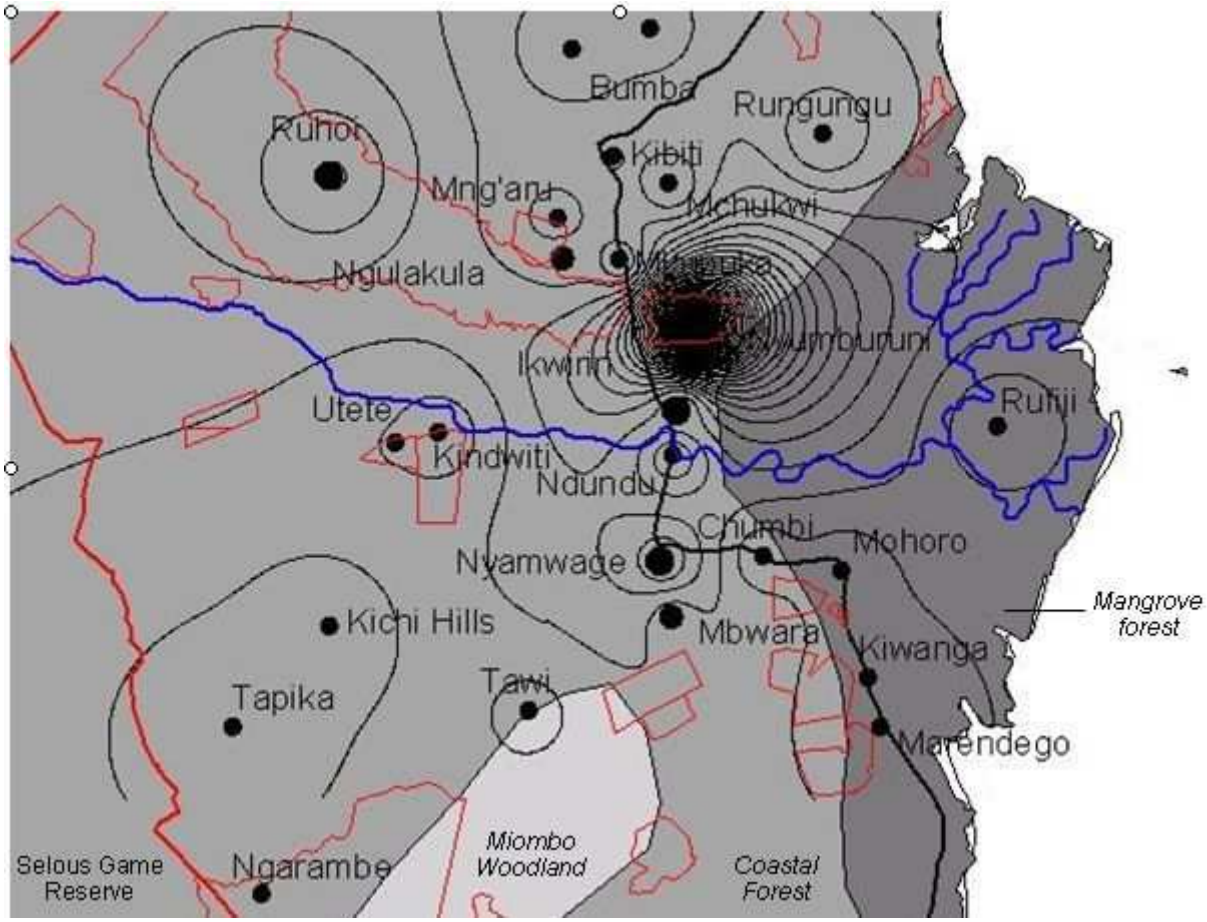
Official Kibiti checkpoint records reveal further evidence of unsustainable trade leading to declining plank sizes. Whilst sawn wood sizes are never homogenous, sawn wood travelling north through Kibiti from October 2001 to January 2002 averaged just 0.05 m^3 round wood equivalent (or 18.41 planks per m^3 round wood). According to the Rufiji District Forest Action Plan Task Force (RDFAPTF), a cubic metre of round wood from well-stocked miombo woodland should yield around 12 standard planks (Anon., 2002f). The higher number of planks being cut from a cubic metre of wood indicates smaller sized planks. However, the average sawn wood volume of 0.05 m^3 round wood equivalent should be interpreted with caution since the accuracy of source data is questionable.

HARVEST AREAS, DESTINATIONS, MARKETS AND SEASONALITY

Major harvest areas in Rufiji District

Rufiji District accounted for 85% of all hardwood licensed for harvest from the study area during 2001 (Table 9). Data regarding harvest areas and relative harvest pressure in Rufiji District were obtained from Kibiti checkpoint records, all based on harvest licence information (Figure 21). The contour map for logs recorded at Kibiti checkpoint between October 2001 and January 2002, where each contour represents a difference of 50 m^3 round wood, revealed that the area of highest harvest pressure was Ngumburuni, followed by Ruhoi, Ikwiriri and Nyamwage (Figure 21). The major harvest areas for sawn wood were almost identical to those for round wood.

Figure 21
Timber harvest pressure in relation to protected areas and major vegetation types, Rufiji District



Sources: Kibiti checkpoint records, 2000-2001.
Note: Number of neighbours = 20; power = 2; contour interval = 50 m^3 round wood.

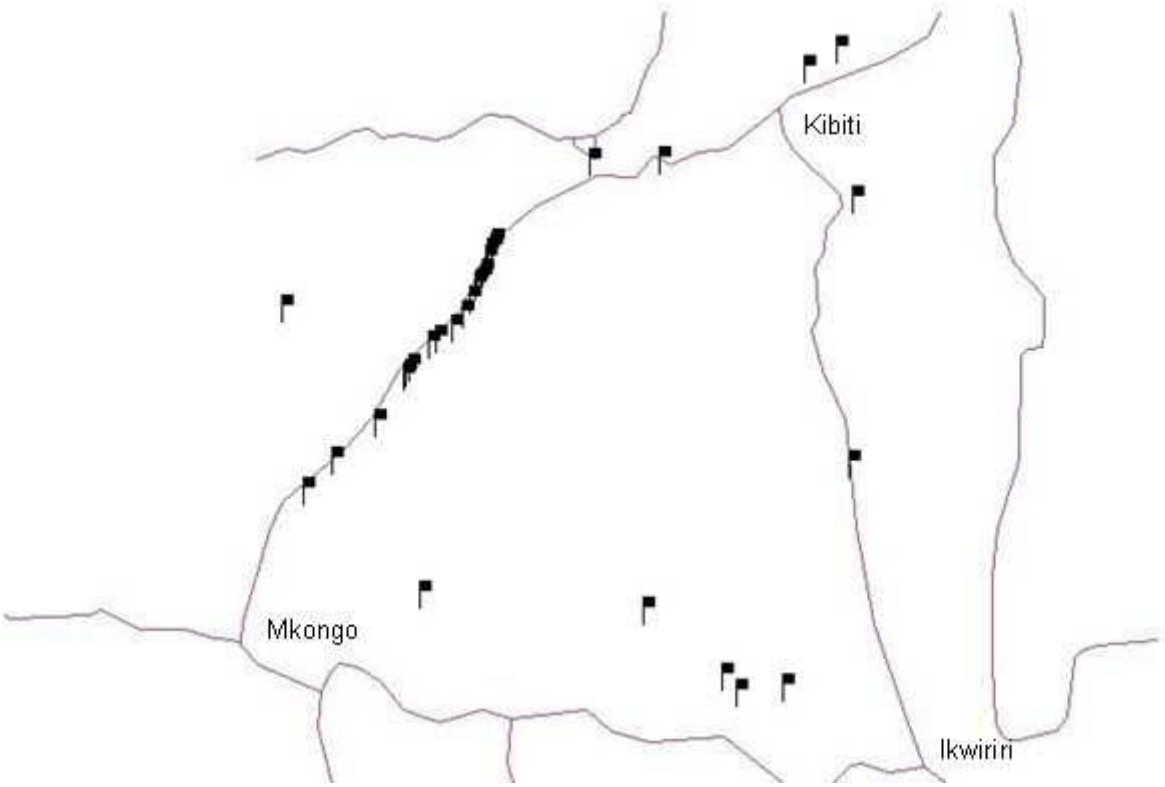
Surveys conducted in the southern part of Ngumburuni Forest Reserve during 2001-2 reported that the forests were criss-crossed by roads and in places excessive logging has opened the canopy (Anon., 2002h). Ngumburuni, Ruhoi, Namakutwa, Utete and Ngulakula were noted as areas that were increasingly attracting settlers and charcoal burners.

Logging truck routes along the main roads north of the Rufiji River revealed a similar picture to the harvest licences although a much higher concentration of roads, and therefore expected harvest pressure, was evident in Ruhoi Forest Reserve (Figure 22). This matches reports made by the RDFAPTF that Ruhoi Forest Reserve was a major source of timber issued on Rufiji District licences (Anon., 2002f).

Whilst it is possible that some harvesting moved from Ngumburuni Forest Reserve in 2001 to Ruhoi Forest Reserve in 2002, it is also evident that significant quantities of timber issued on Ngumburuni Forest Reserve licences during 2001 were actually harvested from other areas. Although contrary to forest regulations, this practice is sometimes knowingly conducted by district authorities to increase their revenues. For example, a local authority Forest Reserve[9] in Rufiji District may be listed as the source area even if it is known that timber will be harvested from open land in the same district, or even from woodlands from another district. This method is employed to increase district forestry revenue but adversely affects attempts at monitoring the spatial variation in timber harvesting, information that is needed for sustainable forestry management[10]. It is therefore possible that significant quantities of the timber recorded as originating from Ngumburuni Forest Reserve during 2001 actually came from other areas.

Figure 22

Distribution of off-road logging routes (represented by flags) along Kibiti-Ikwiriri-Mkongo 'triangle' north of Rufiji River, Oct 2001



[9] A local authority Forest Reserve is owned and managed by the local (usually district) government, including collection of harvest levies. Other Forest Reserves are managed by the central government, whilst large areas of forest occur in open, unreserved land (unprotected).

[10] Royalties (according to the *Forests (Amendment) Rules*) for wood harvested from central government Forest Reserves are sent to the Forest and Beekeeping Division headquarters in Dar es Salaam. District authorities retain royalties collected from wood harvested in district authority Forest reserves according to their by-laws (Annex 2).

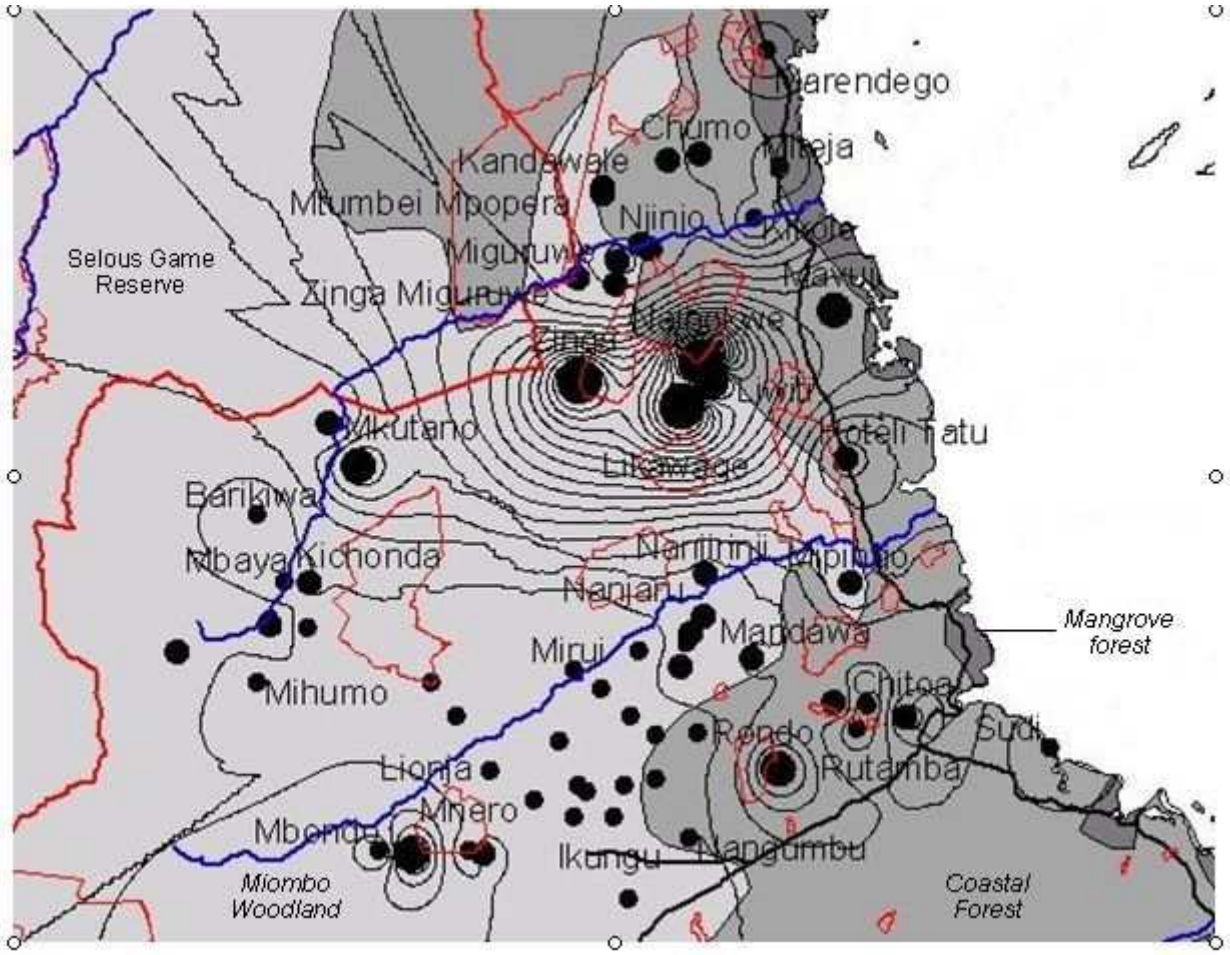
Major harvest areas in Lindi Region

Data from licences issued for major miombo woodland and coastal forest areas in Lindi Region (i.e. not including Rufiji District, Coast Region) were maped to determine harvest areas. Licensed harvest areas were spread throughout Kilwa, Lindi, Ruangwa, Nachingwea and Liwale Districts.

Figure 23 highlights the relative harvest pressures over the entire area based upon harvest licences. Each contour represents a difference of 10 m^3 round wood. The contour map highlights more graphically the relatively high harvest pressure throughout Kilwa District, particularly in the north and spreading into Liwale District. Areas of particularly high harvest pressure include Nainokwe-Zinga-Likawage-Liwiti. Other timber harvest foci include Hoteli Tatu, Njinjo and Mavuji in Kilwa District; Chimbendenga-Kipara in Nachingwea District; Rondo and Namichiga-Nambilanje in Ruangwa District; Ng'apa-Milola and Mipingo in Lindi District; and Mkutano-Kikulyungu and Nangando-Kipule-Kichonda in Liwale District (Figure 23). The map closely matches reports from the Kilwa District forest officer who claimed areas of highest harvest in Kilwa are Njinjo, Likawage and Narnjirinji.

Figure 23

Timber harvest pressure in Lindi Region in relation to protected areas and major vegetation types

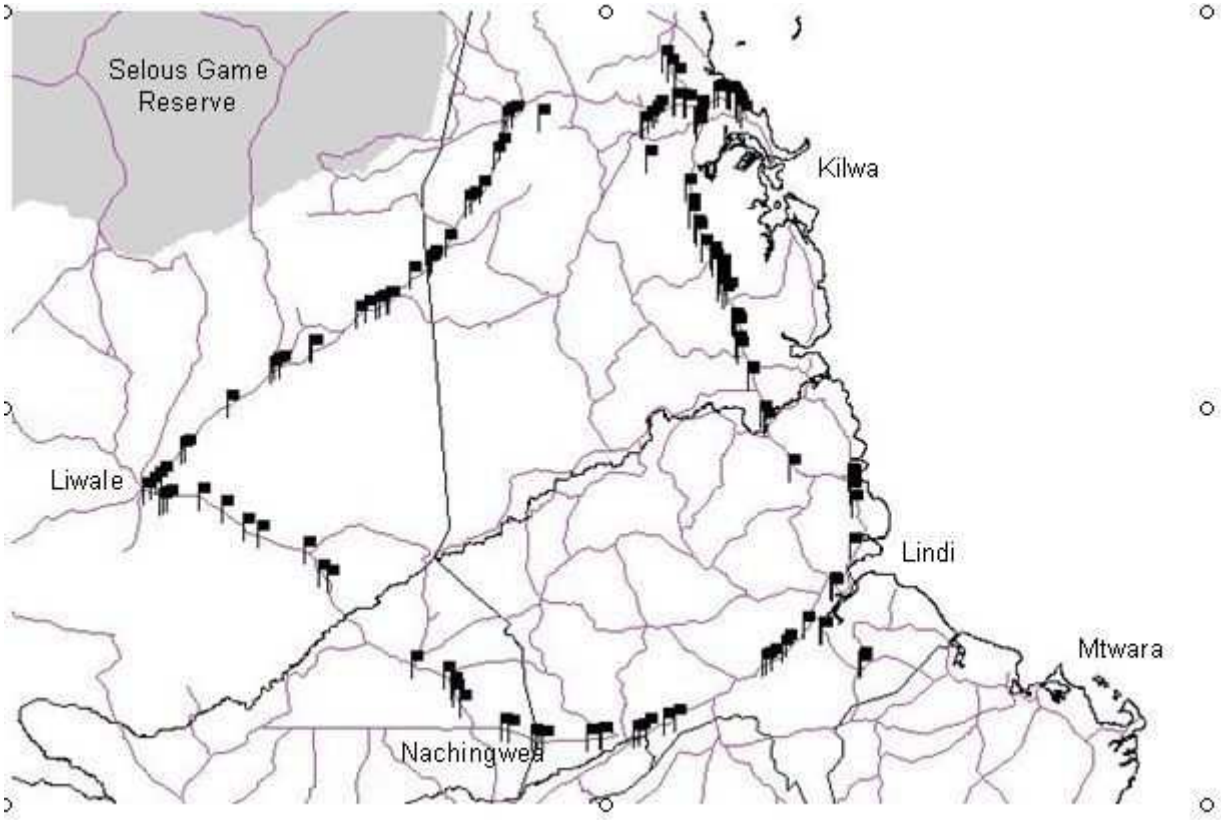


Sources: District timber harvest licences, 2000.
Note: Number of neighbours = 20; power = 2; contour interval = 10 m^3 round wood.

This harvest pattern is supported by mapping of logging vehicle routes in Lindi Region, where higher densities of roads were observed adjacent to areas where high numbers of harvest licences were issued (Figure 24).

Figure 24

Distribution of off-road logging routes (represented by flags) in Lindi Region, October 2001



Mapping of information from harvest licences issued in Lindi region indicated that there is significant harvest pressure inside the Selous Game Reserve (Figure 23). Indeed, this matched field observations, and was further supported by reports of harvesting inside the Reserve (Hamerlynck, 2003). As mentioned above, some caution should be made when interpreting these results due to inaccuracies in information recorded on harvest licences. The general absence of woodland and forest inventory data means that no comparative analysis can be undertaken to calculate relative harvest pressures and sustainability.

Changes in harvest areas

A number of traders and government officials reported that stocks of certain species had declined in abundance locally, particularly *Pterocarpus angolensis*, resulting in traders traveling much further to find harvestable trees. De Waal (2001) reported increasing scarcity of *P. angolensis* and *Dalbergia melanoxylon* in Liwale District. These reports are supported by information presented earlier whereby increases in the harvesting of lower value species was evident from Rufiji District and Kilwa District from 1995 and 1998 onwards, respectively. For example, overharvesting of *D. melanoxylon* in the study area has pushed harvesting progressively southwards. Jenkins *et al.* (2001) reported that *D. melanoxylon* had effectively been harvested out from Rufiji District, with a southerly shift in harvesting. Harvest

licences show how MI (Ltd.), the largest sawmill specialising in the species in the study area, used to harvest in Rufiji District but was forced to shift to Kilwa District as stocks declined. Table 23 shows how the harvest areas within Kilwa District have also changed significantly in recent years.

Table 23

Changes in harvest area for *Dalbergia melanoxylon* in Kilwa District, 1997-2000

1997 harvest areas	Quantity licensed for harvest	2000 harvest areas	Quantity licensed for harvest
Nandera	22.6	Mavuji	80.0
Kikole	45.6		
Chumo	50.0		
Nanjirinji	24.0		
Mingumbi	37.9		

Source: Kilwa District harvest licences, 1997-2000.

On the other hand, it is evident that some traders are now specializing in smaller logs, returning to heavily harvested areas to collect the larger branches of previously felled trees ('off-cuts').

Further, stocks have declined so severely in some areas that undersize trees are now being felled indiscriminantly. In turn, traders claim these smaller logs as 'off-cuts', thereby avoiding all forms of regulation and royalty payment (Anon., 2002f,h). For example, the thriving, unregulated market for 'off-cuts' from Ngumburuni Forest Reserve in Rufiji District was not supplied by branches, but from undersize trees (Anon., 2002h). In 2001, the average diameter of fresh *Pterocarpus angolensis* stumps recorded between the Kibiti – Ikwiriri road was just below 30 cm, half the minimum allowed harvestable diameter of 60 cm (Anon., 2002f).

Credit: IUCN/O. Hamerlynck

Young *Pterocarpus angolensis*, generally traded as 'off-cuts'.

Major markets and trade routes

Two main markets exist for hardwood timber harvested from the study area – Dar es Salaam and Zanzibar. Other urban markets include Lindi and Mtwara. The majority is used for construction (e.g. windows, doors, boats, furniture, etc.). The annual demand for construction wood in Dar es Salaam is estimated at 103 000 m^3 softwood and 42 000 m^3 hard wood (Wells *et al.*, 2000). In addition, significant quantities are exported in the form of parquet flooring tiles or musical instrument billets. According to government records from Mtwara, Lindi and Kilwa ports, more shipments are destined for Zanzibar than mainland Tanzania (Table 24), although the destination was not clear for large quantities of logs and timber (Figure 25). It is believed that the majority of timber transported by boat, including timber from informal ports along the Kilwa coastline, is destined for Zanzibar, whilst most timber transported by road is destined for Dar es Salaam.

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Boating building using *Pterocarpus angolensis* in Zanzibar

Table 24

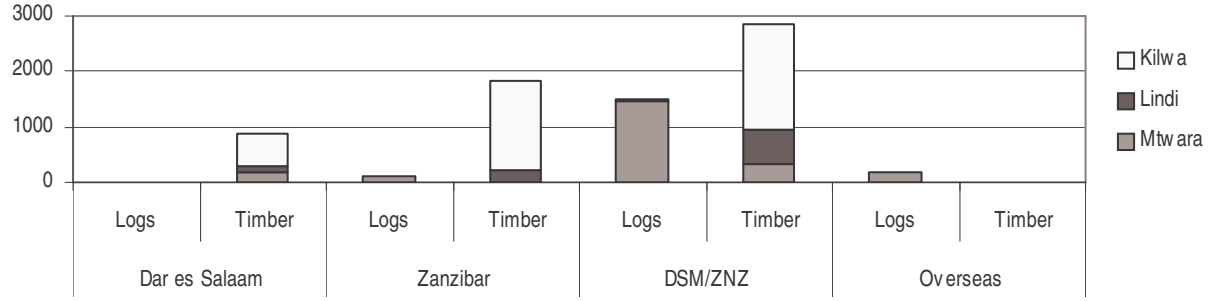
Destination of timber and logs shipped (m^3 round wood) from southern Tanzania ports, 2000-2001

	Dar es Salaam		Zanzibar		DSM/ZNZ		Overseas		Not specified		Totals	
	Logs	Timber	Logs	Timber	Logs	Timber	Logs	Timber	Logs	Timber	Logs	Timber
Mtwara	0.0	195.2	120.0	14.3	1 465.0	323.8	166.0	9.5	0.0	9.5	1 751.0	552.4
Lindi	0.0	95.2	5.0	204.8	25.0	642.9	0.0	0.0	0.0	0.0	30.0	942.9
Kilwa	0.0	585.7	0.0	1 614.3	0.0	1881.0	0.0	0.0	0.0	0.0	0.0	4 081.0
Total	**0.0**	**876.1**	**125.0**	**1 833.4**	**1 490.0**	**2 847.7**	**166.0**	**9.5**	**0.0**	**9.5**	**1 781.0**	**5 576.3**

Source: Tanzania Harbours Authority, Port Manager Mtwara, 2002.

Figure 25

Destination of timber and logs shipped from southern Tanzania ports, 2000-2001



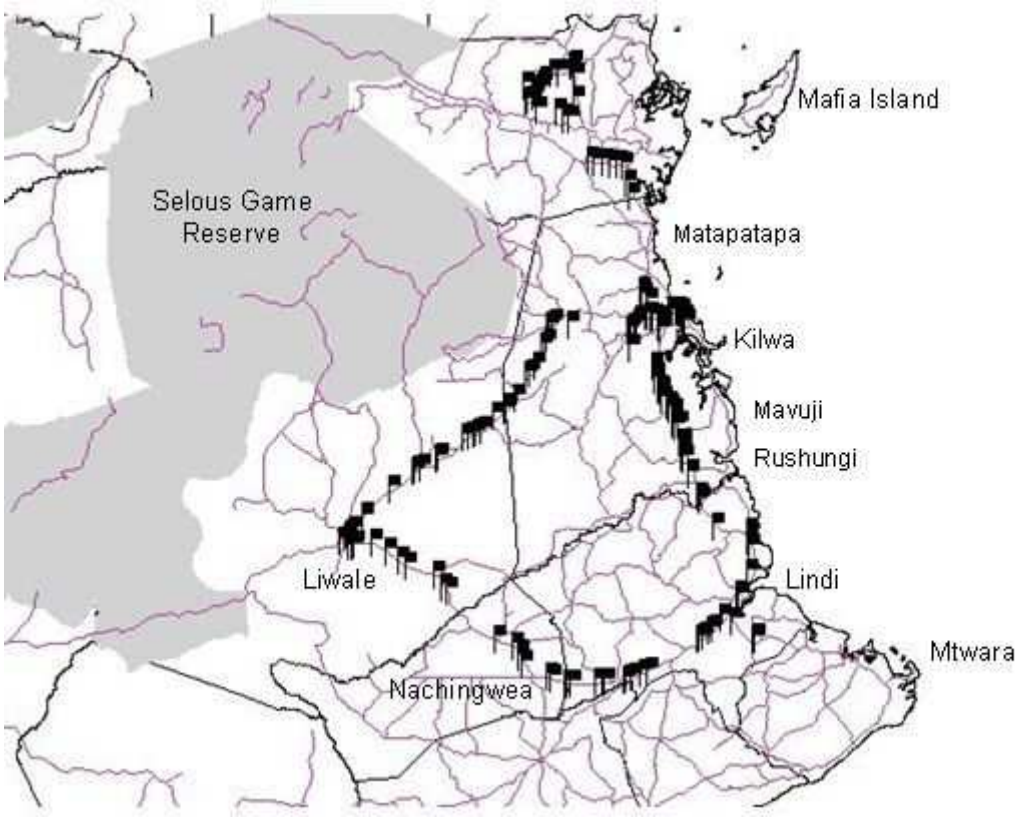
Source: Tanzania Harbours Authority, Port Manager Mtwara, 2002.

Mtwara was the only port in southern Tanzania from which logs or timber were directly exported overseas, although in relatively small quantities (176 m^3 during 2000 and 2001). Whilst it is known that significant quantities originating from southern Tanzania are exported from Dar es Salaam and Zanzibar, statistics do not differentiate between the precise sources of timber products (Table 24).

In addition to the ports of Mtwara, Lindi and Kilwa Masoko, a further four ports are known to ship hardwoods from the mainland: Matapatapa, Kilwa Kivinje, Mavuji and Rushungi. Considerable quantities, as yet undetermined, of sawn wood are transported unrecorded by vehicles and teams of bicycles to these ports. The latter commonly consist of around six to eight bicycles travelling up to six hours with timber sourced from as far as the Selous Game Reserve. GIS mapping of logging truck routes throughout the study area clearly revealed a low density of used tracks between Nangurukuru and the Rufiji River, partly attributable to the unfavourable condition of the soil for transport during seasonal flooding (Figure 26). Instead, teams of bicycle dominated transport of planks in this part of the study area.

Figure 26

Off-road logging truck routes joining the main road (shown as flags) between the Rufiji River and Nangurukuru town



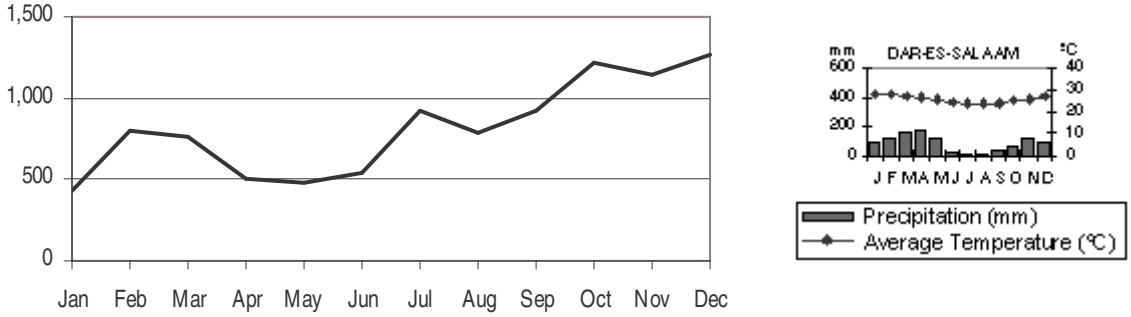
The low proportion of tarmac roads in the study area limits timber product transport, and most trucks prefer to keep to such primary roads, particularly in the wet season. Secondary, dirt roads are used either to bypass checkpoints or as access routes to timber harvest or storage areas. The majority of timber transported by road crosses the Rufiji River at the Ndundu ferry with smaller quantities crossing at Utete. Timber traders commonly change vehicles in Nangurukuru, strategically positioned as a junction for traffic originating from Kilwa, Lindi and Liwale Districts. Most commonly, planks are reloaded into sealed lorries, often at night to avoid detection.

Transport across the Rufiji River

According to statistics collected by the Ministry of Works, a total of 9790 vehicles were carried over the Rufiji River by the Ndundu ferry during 2001. Using the assumption that around half of these vehicles travelled north and the other half travelled south, a monthly average of around 400 vehicles crossed the Rufiji River northwards using the Ndundu ferry during 2001, with a minimum of nearly 250 in May and a maximum of 630 in December. Lowest numbers of vehicles occur during April and May since heavy rains cause rising water levels and faster currents to slow down the ferry (sometimes stopping completely), whilst waterlogged roads hinder movement south of the river (Figure 28).

Figure 27

Number of vehicles crossing Ndundu ferry by month during 2001 and meteorological information



Source: Ministry of Works, 2002.

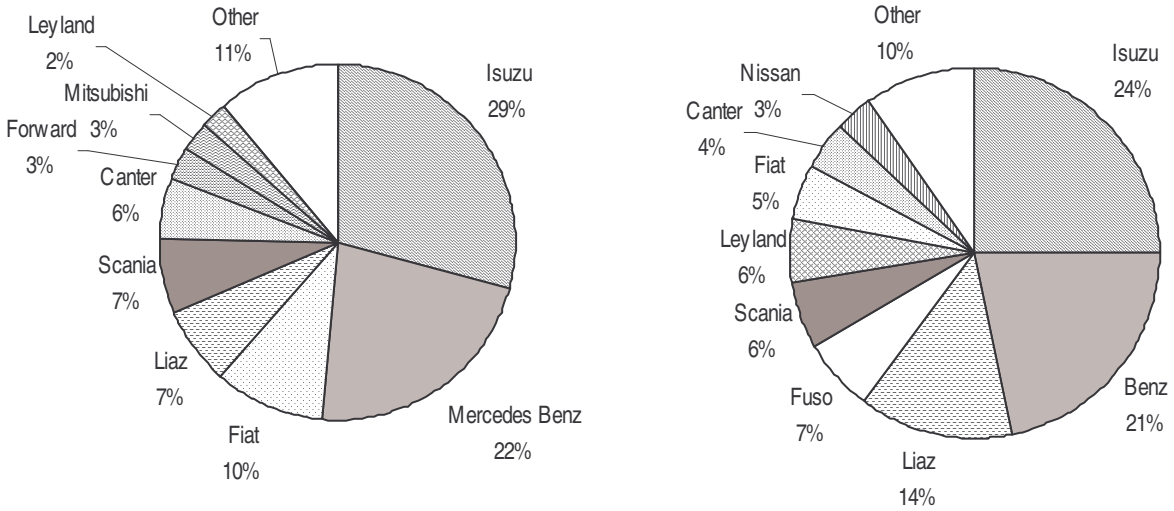
Vehicle types used for timber trade

Data collected from the Ndundu ferry and Kibiti District checkpoint show that Isuzu and Mercedes Benz are the most common vehicle brands for transporting logs and sawn wood, accounting for around one-half of all wood products by volume (Figure 28). A total of 18 vehicle makes were recorded at Kibiti District checkpoint, compared to 24 at Ndundu ferry.

Figure 28

Pie charts to show volume of logs and sawn wood (m^3) transported by different vehicles

(a) Kibiti check point **(b) Ndundu ferry**



Sources: Kibiti checkpoint, 2001; TRAFFIC survey data, 2000-2001.

Six categories of vehicle (as determined by Ministry of Works records) were recorded at the Ndundu ferry crossing, each with different fees according to their weight (Table 25). The most common vehicles belong to the 3-7 t category (58%), followed by 8-14 t (15%), 1-2 t (14%) and >15 t (Figure 29). Small, private vehicles weighing less than one tonne and trucks carrying trailers are the most affected by the wet season (from March to May) due to their inability to tolerate poor road conditions (Table 25).

Table 25

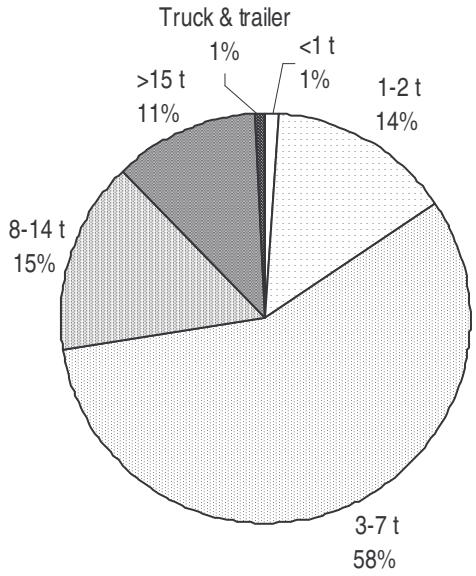
Total number of vehicles recorded at Ndundu ferry, Rufiji District, 2001

Vehicle category	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
<1 tonnes	5	4	5	10	1	15	67	41	30	45	49	36	308
1-2 tonnes	63	121	221	226	201	275	364	306	456	613	555	698	4 099
3-7 tonnes	248	307	242	93	126	116	217	187	184	242	188	189	2 339
8-14 tonnes	67	280	211	96	85	48	146	151	112	146	119	133	1 594
>15 tonnes	49	53	72	65	66	78	114	79	123	155	181	210	1 245
Truck and trailer	4	30	11	11	5	9	16	26	20	20	53	0	205
Total	**436**	**795**	**762**	**501**	**484**	**541**	**924**	**790**	**925**	**1 221**	**1 145**	**1 266**	**9 790**

Source: Ministry of Works, 2002.
Note: These figures represent vehicles passing both northwards and southwards across Rufiji River.

Figure 29

Frequency of vehicle types recorded at Ndundu ferry, Rufiji District, 2001



Source: Ministry of Works, 2002.

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Truck carrying logs near Kibiti checkpoint.

However, not all of these vehicles carried wood products. More detailed information regarding vehicles carrying forest products was obtained from Kibiti checkpoint records and research assistants stationed at Ndundu ferry and other stations north of the Rufiji River. Vehicles in the 3-7 t and 8-14 t range accounted for almost all of the wood products (Table 26; Figure 30). Vehicles carrying forest products accounted for around 27% of all vehicles during the study period. More significantly, 96% of all the 3-14 t trucks were carrying forest products, compared to only two per cent of the >15 t trucks and 0.2% of the <2 t vehicles.

Table 26

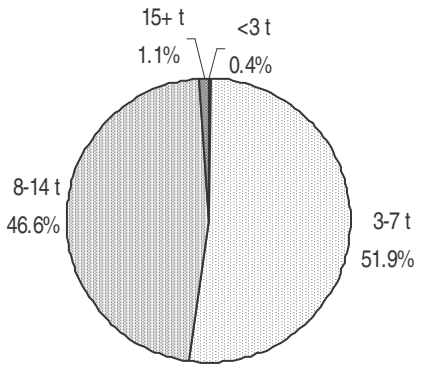
Frequency of vehicles and volume of wood products carried by vehicles of different tonnage recorded at Ndundu ferry, October 2001 to January 2002

Vehicle tonnage	Logs, large		Logs, small		Planks		Totals	
	Number of vehicles	Estimated volume	Number of vehicles	Estimated volume	Number of vehicles	Estimated volume	Number of vehicles	Estimated volume
<3 t	0	0	0	0	4	35	4	35
3-7 t	82	245	50	134	385	4 580	517	4 959
8-14 t	143	849	76	453	245	5 550	464	6 852
15+ t	3	15	1	6	7	170	11	191
Totals	**228**	**1 109**	**127**	**593**	**641**	**10 335**	**996**	**12 037**

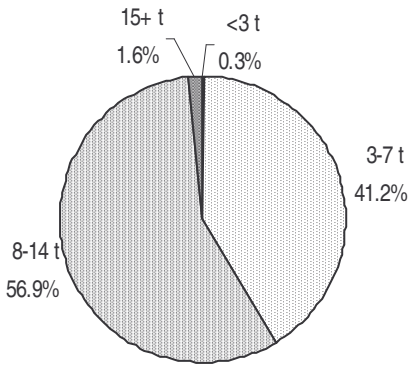
Figure 30

Proportion of vehicles by tonnage carrying timber and logs north across Ndundu ferry

(a) frequency of vehicles



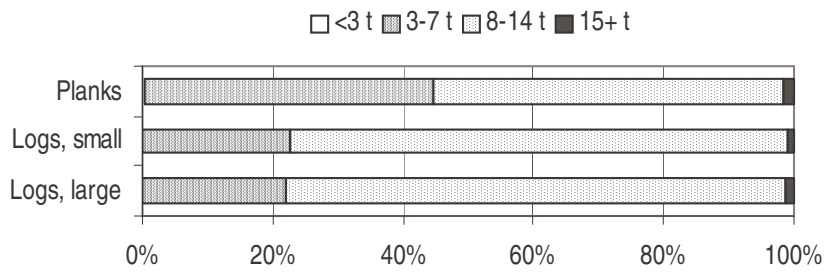
(b) estimated volume of timber and logs carried



A different vehicle preference was noted between logs and sawn wood. Vehicles weighing 8-14 t carried almost 80% of all logs transported across Ndundu ferry, with the remaining 20% carried by vehicles weighing 2-7 t. No difference was observed between vehicles carrying large logs (mostly tree trunks) and those carrying smaller logs (mostly the branches of previously harvested trees). On the other hand, a much higher proportion of 3-7 t vehicles carried sawn wood (Figure 31).

Figure 31

Proportion of logs and planks transported north across Ndundu ferry by different vehicles



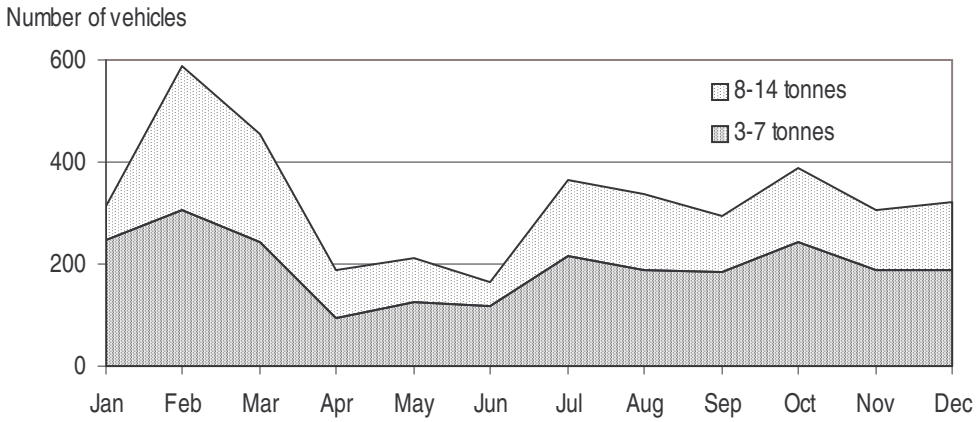
Source: TRAFFIC survey data, October 2001 to January 2002.

Seasonal variations in timber trade

A more accurate indication of seasonal patterns in vehicles carrying wood products over the Rufiji River can therefore be obtained by concentrating only on vehicles with tonnages between three and 14 tonnes (Figure 32). The resulting trend shows a high peak of activity in February and a period of least activity extending from April through to June during, and shortly after, the long rainy season. Unlike the rising trend seen for all vehicles types (Figure 27), numbers of 3-14 t vehicles remained fairly constant between July and December, averaging 335 per month (Figure 32).

Figure 32

Number of 3-7 t and 8-14 t vehicles crossing Ndundu ferry by month, 2001

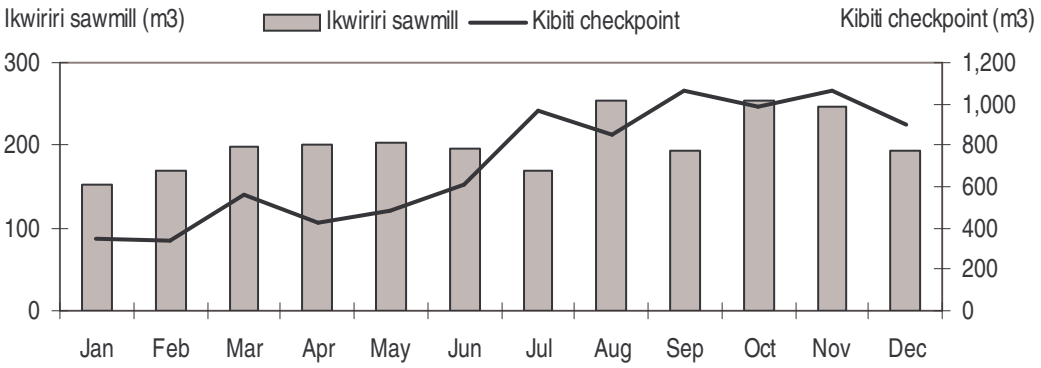


Source: Ministry of Works, 2002.

As expected from the close relationship between the Ndundu ferry, Ikwiriri sawmills and Kibiti checkpoint, a similar seasonal pattern is seen from both Kibiti checkpoint records and purchases made by a major sawmill in Ikwiriri, PIC Ltd., except that no peak in activity is seen for the month of February (Table 27). The highest volumes of wood products passed Kibiti checkpoint between July and December, and the highest timber purchase levels by PIC Ltd. occurred between August and November (Figure 33).

Figure 33

Volumes of round wood (m^3) recorded at Kibiti checkpoint and processed by PIC Ltd., 2001

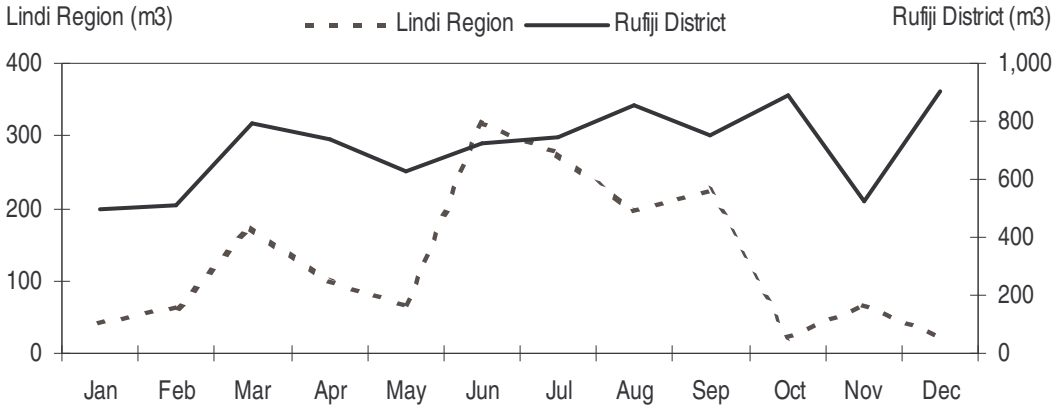


Sources: PIC Ltd. sawmill, Ikwiriri, 2001; Kibiti checkpoint records, 2001.

The Ikwiriri sawmill data shows the least variation since timber can still be sourced from north of the Rufiji River even when the river is not crossable. The seasonal patterns for issuance of harvest licences seem to support this theory (Table 27). Harvest licences issued from Lindi Region peak shortly after the rainy season has subsided between June and September, a month or two in advance of the peaks in movement of timber northwards between July and November (Figure 34). In reality, this one to two month time lapse is not due to the time taken in between obtaining the licence, felling, stamping and transporting, since in most cases the timber has been felled long in advance (including continued felling during the wet season). Observations showed that dealers in logs continue to fell trees and leave the logs in the forest during the wet season. During the dry season when accessibility to the forest improves, the dealers obtain the harvest licences necessary to transport. Therefore, the true pattern of tree felling cannot be determined from harvest licence or checkpoint records. The actions of tree fellers, transporters and traders is well co-ordinated and the current regulations covering tree harvesting and transport are not being followed due to a shortage of forestry manpower at district level.

Figure 34

Volumes of hardwood licensed for harvest, 2001



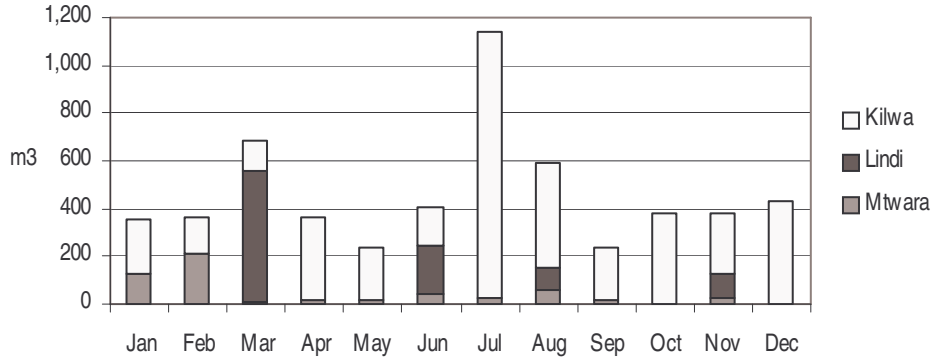
Source: District harvest licences, 2001.

In contrast to Lindi Region, there are neither clear peaks nor troughs in harvest licences issued from Rufiji District (Figure 34). This is largely because harvest, transport and trade levels remain constant throughout the year, including the wetter months since harvest areas in northern Rufiji District (i.e. north of the Rufiji River) are by far the most accessible areas when the Rufiji River and surrounding delta is impassable. Indeed, during these wetter months, harvest pressure north of the Rufiji River is almost certainly many factors higher than areas to the south.

Official shipment records from Kilwa, Lindi and Mtwara ports did not show the same patterns as the Ndundu ferry, Kibiti checkpoint and Ikwiriri sawmill data described above (Table 27). Given the relatively sporadic nature of timber shipments from southern Tanzania, a more accurate picture of seasonality was obtained by combining data for 2000 and 2001 (Figure 35). Two peaks in shipments are noticeable, the first in March and the second in July. It is possible that the peak in March, the wettest time of the year, effects shipment by sea owing to the logistical difficulties of transporting timber north across the Rufiji River, although data over a longer time period are needed to confirm this.

Figure 35

Total timber shipments from Mtwara, Lindi and Kilwa ports by month, 2000-2001



Source: Tanzania Harbours Authority, Port Manager Mtwara, 2002.

Table 27

Various timber statistics by month (m^3 round wood)

Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Timber passing through Kibiti checkpoint, 2001													
Planks	308.1	219.7	261.3	153.9	285.1	351.5	736.3	619.7	707.5	623.5	530.3	515.2	5 312.1
Logs	42.3	121.5	295.4	275.8	197.8	257.9	231.7	229.0	356.9	364.8	537.0	386.1	3 296.2
Total	350.4	341.2	556.7	429.7	482.9	609.4	968.0	848.7	1 064.4	988.3	1 067.3	901.3	8 608.3
PIC Ltd. sawmill, 2001													
Purchases	151.8	169.9	197.9	199.9	202.2	1 96.3	170.3	253.0	194.7	254.1	247.3	194.4	2 431.8
Harvest licences, 2001													
Lindi Region	42.2	64.8	173.5	99.8	67.0	317.6	275.3	194.8	222.8	21.4	65.1	20.8	1 565.1
Rufiji District	496.0	509.4	793.5	739.0	631.0	725.2	748.2	855.1	749.1	887.8	524.7	900.3	8 559.3
Total	538.2	574.2	967.0	838.8	698.0	1 042.8	1 023.5	1 049.9	971.9	909.2	589.8	921.1	10 124.4
Shipments, 2000-2001													
Mtwara	123.8	209.5	9.5	19.0	14.3	42.9	28.6	57.1	19.0	0.0	28.6	0.0	552.3
Lindi	0.0	0.0	547.6	0.0	0.0	204.8	0.0	95.2	0.0	0.0	95.2	0.0	942.8
Kilwa	228.6	157.1	123.8	342.9	223.8	161.9	1 114.3	442.9	219.0	376.2	257.1	433.3	4 080.9
Total	352.4	366.6	680.9	361.9	238.1	409.6	1 142.9	595.2	238.0	376.2	380.9	433.3	5 576.0

Sources: Kibiti checkpoint records, 2001; PIC Ltd. sawmill, 2001; Tanzania Harbours Authority; District licence records, 2001; Port Manager Mtwara, 2002.

Shipment of sawn wood showed greater seasonal variation than logs (Figure 36). According to Kibiti checkpoint records, the volume of planks transported dipped in the wettest month, April, and peaked from July through to December.

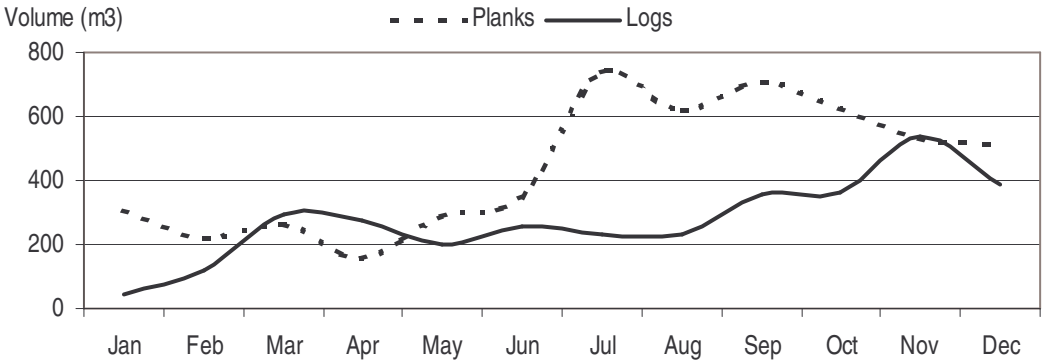
Log volumes, however remained at relatively low levels from January to August, then rose steadily to a peak in November. This gradual rise is probably related to the gradual increase in accessibility of remote harvest areas in the months proceeding the wet season.

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Checking consignment, Kibiti checkpoint.

Figure 36

Volumes of logs and sawn wood (expressed as round wood equivalents in m^3) recorded passing Kibiti checkpoint, 2001



Source: Kibiti checkpoint records, 2001.

Trade in key timber species

The following section provides information for species that have shown significant changes in demand and/or high levels of current harvest (see section on *Trends in Species Composition*).

Pterocarpus angolensis *(African Teak, Mninga) - Class II*

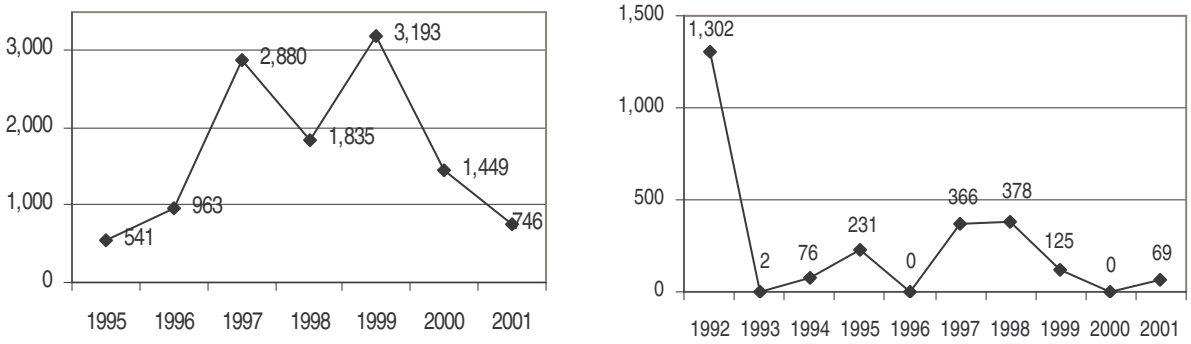
Pterocarpus angolensis is one of the most well known woods in southern tropical Africa, with a highly desired golden red-brown colour used for quality furniture and construction. It is a medium-sized to large deciduous tree, up to 20 m tall, found in woodland and wooded grassland in Kilwa, Lindi, Morogoro and Tabora (Mbuya *et al.*, 1994).

According to official harvest statistics, the proportion of *P. angolensis* decreased by 12% from 2000 to 2001. Harvest licences show that the species constitutes a large proportion of timber trade from the study area (10%), although this is suspected to be considerably higher due to illegal trade and misclassification. The majority of harvest permits were issued for Lindi Region during 2001, especially Kilwa, Ruangwa and Liwale Districts. Kilwa District alone accounted for 54% of harvests, although volumes had been significantly higher in the previous three years (Figure 37).

Evidence of unsustainable harvesting of *P. angolensis* north of Rufiji River revealed that the average diameter of fresh stumps was half the minimum harvestable diameter for sustainable harvest practices (Anon., 2002f,h). As discussed earlier, this wood is subsequently traded as 'off-cuts' that are not subject to licensing or other forms of regulation, and this practice has led to massive overexploitation in some areas.

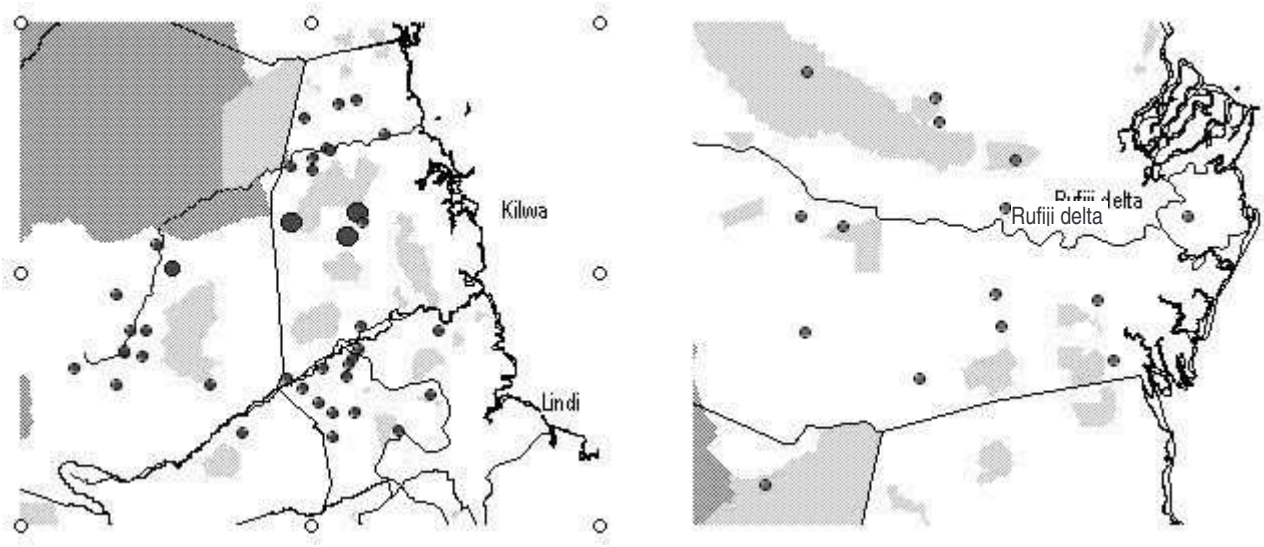
Major source areas included Nainokwe, Zinga and Likawage (Figure 38). According to licences issued, harvesting was spread relatively evenly throughout Rufiji District where harvest volumes have declined significantly since 1992.

Figure 37
Volumes (m^3) of *Pterocarpus angolensis* harvest licences issued for Kilwa and Rufiji Districts
(a) Kilwa District **(b) Rufiji District**



Sources: Kilwa District timber harvest licence statistics, 1995-2001; Kibiti checkpoint statistics, 1992-2001.

Figure 38
Harvest areas for *Pterocarpus angolensis* showing major rivers, district and protected areas
(a) Lindi Region **(b) Rufiji District**



Sources: District timber harvest licence records, 2001; Kibiti checkpoint records, 2001.

Afzelia quanzensis *(Pod mahogany, Mbambakofi) - Class II*

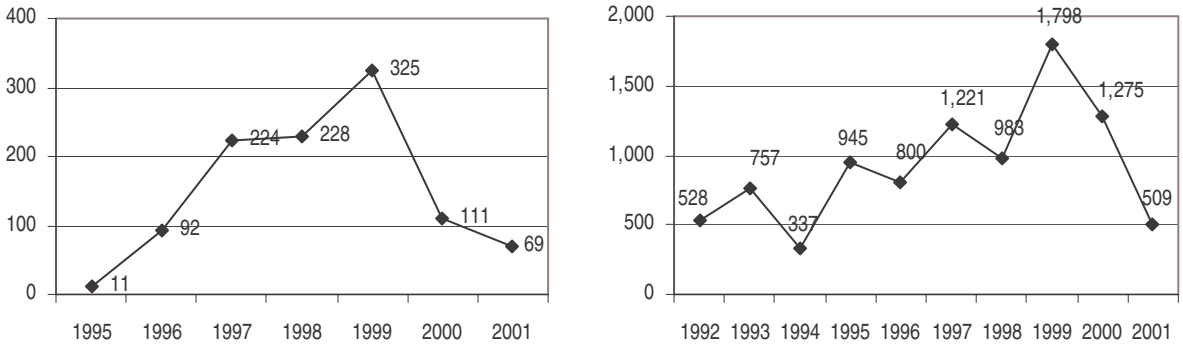
Afzelia quanzensis is a fairly fast growing semi-deciduous tree species growing to 12-35 m tall in miombo woodlands, lowland thicket and dry woodland (Mbuya *et al*., 1994). It is targeted for furniture, construction and carving (e.g. doors, dhows, canoes). Along with *Pterocarpus angolensis*, it is another species that is harvested in relatively high volumes and has witnessed a decline in overall composition in harvest levels. In Rufiji District, *A. quanzensis* had traditionally been protected as a kind of holy or taboo tree, although this stopped in the mid-1990s after outsiders started to target the species (Hamerlynck, 2003). According to government records, the proportion of *A. quanzensis* in overall trade decreased by four per cent between 2000 and 2001. Harvest licences show that the species constitutes six per cent of

all timber trade in the study area, although this is suspected to be considerably higher due to illegal harvesting.

Figure 39

Volumes (m^3) of *Afzelia quanzensis* harvest licences issued for Kilwa and Rufiji Districts

(a) Kilwa District **(b) Rufiji District**



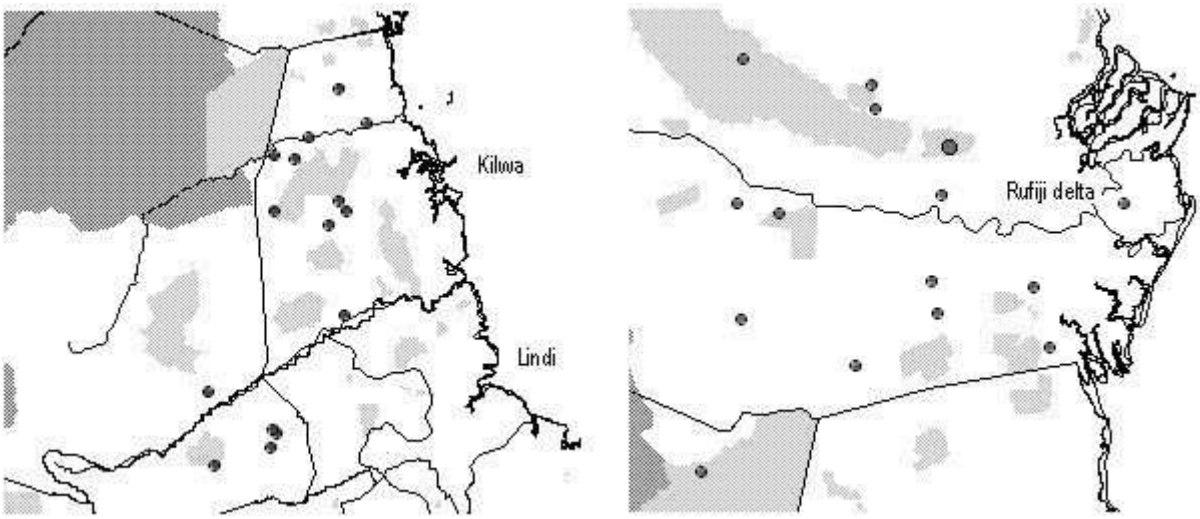
Sources: Kilwa District timber harvest licence statistics, 1995-2001; Kibiti checkpoint statistics, 1992-2001.

Rufiji District was the source of three-quarters of all *A. quanzensis* harvested in the study area during 2001. Trends in harvest licences issued from Rufiji and Kilwa Districts show how volumes increased from the early 1990s to a high in 1999 before declining rapidly (Figure 39). Hamerlynck (2003) reports steep declines in the availability of this species from Rufiji District. Harvest areas according to licences are shown in Figure 40.

Figure 40

Harvest areas for *Afzelia quanzensis* showing major rivers, district and protected area boundaries

(a) Lindi Region **(b) Rufiji District**



Source: District timber harvest licence records, 2001; Kibiti checkpoint records, 2001.

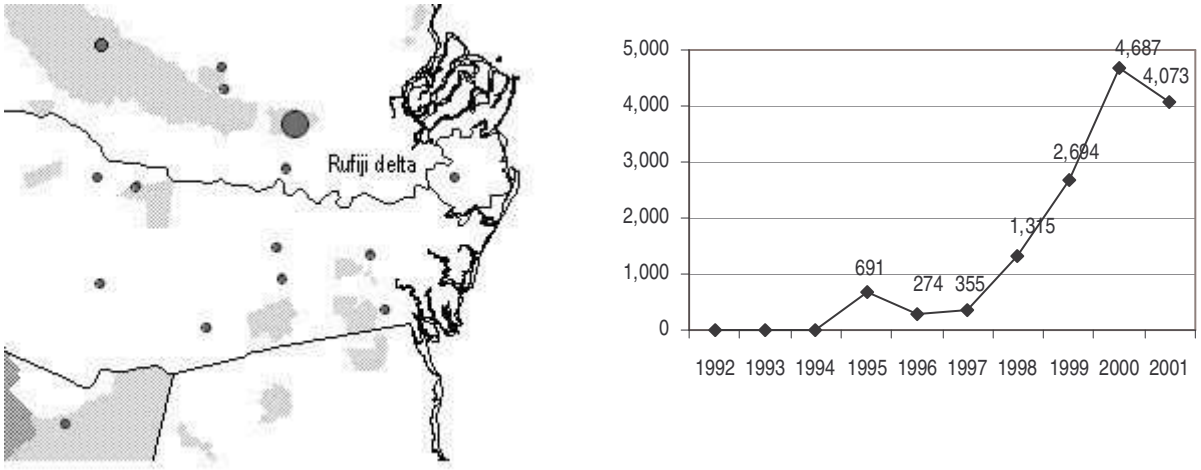
Hymenaea verrucosa *(Gum copal tree, Mnangu) - Class V*

This tree earns its name from valued gum extracted from the bark and fruit, although it also has a valuable, hard, but workable, timber (Mbuya *et al.*, 1994). An evergreen tree of dry lowland forests and coastal forests, it grows to 6-25 m tall.

According to available records, *Hymenaea verrucosa* currently accounts for the highest trade levels, representing 40% of all licences issued in the study area during 2000-2001. Further, the proportion of *H. verrucosa* has increased by 10% during this period, although it is also apparent that in some areas higher value (Class II) species are illegally harvested using licences for *H. verrucosa*. According to government records, harvesting of *H. verrucosa* from Lindi Region is almost negligible. Harvest volumes have increased markedly in Rufiji District since 1995 (Figure 41). Currently, the main source areas in Rufiji District are Ngumburuni and Ruhoi Forest Reserves (Figure 41).

Figure 41

Rufiji District harvest areas and volumes (m^3) for *Hymenaea verrucosa*



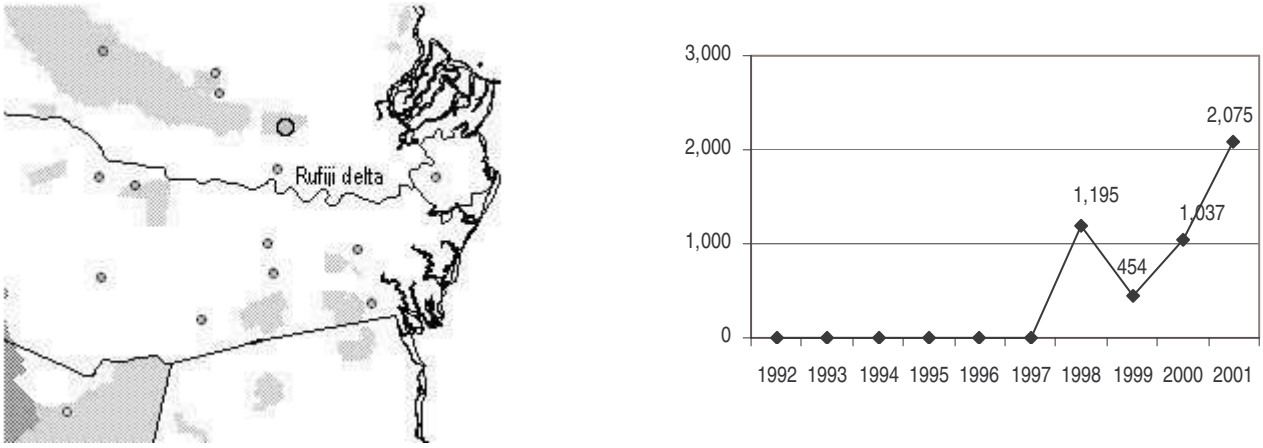
Sources: District timber harvest licence records, 2001; Kibiti checkpoint statistics, 1992-2001.

Trichilia emetica *(Cape mahogany, Mlopolopo) - Class V*

Trichilia emetica is an evergreen tree growing to 15-30 m tall growing in areas of well-drained, rich soil and high ground water (Mbuya *et al.*, 1994). The timber from this tree is used for a variety of purposes including timber for furniture, boats, poles and tool handles. According to official records, this species has recently entered trade with the first harvest licences issued in 1998 (Figure 42). Similar to *Hymenaea verrucosa*, this is another species that is harvested in relatively high volumes (20% of all licences during 2000-2001) and has witnessed increases in its overall composition in harvest levels between 2000 and 2001 (13% increase). Again similar to *H. verrucosa*, all harvest licences issued in the study area were for Rufiji District, and Ngumburuni Forest Reserve was listed as a major source of timber (Figure 42). The recent increases in volumes recorded may be attributed partly due to declines in other timber species, and partly to misclassification to avoid royalties.

Figure 42

Rufiji District harvest areas and volumes (m^3) for *Trichilia emetica*



Sources: District timber harvest licence records, 2001; Kibiti checkpoint statistics, 1992-2001.

Dalbergia melanoxylon *(African blackwood, Mpingo) - Class I*

Dalbergia melanoxylon is a small tree found in low-altitude (0-1,300 m) savannah or woodland (Mbuya *et al*., 1994). The tree is well branched and slow growing, to around seven m tall with a diameter of no more than 20-30 cm. The very hard, durable, termite-resistant, purple-black heartwood is used for carvings and exports to make valuable musical instruments. It is the only Class I species harvested in significant volumes from the study area.

An average of 42 m^3 was exported during 1980-1991, increasing to an annual average of 74 m^3 over the next ten years (Marshall, 1996; Jenkins *et al.,* 2002). Moore *et al.* (1987) estimated a total of 1500 carvers in Tanzania and 1500 m^3 used annually, with illegal felling accounting for one-half of all harvesting (Gregory *et al.*, 1999). Jenkins *et al.* (2001) estimated that approximately 100-200 m^3 are currently exported as billets each year. This closely matches government records, with an average of 102 m^3 recorded between 1998 and 2000. Official exports of carvings totalled around 170 000 pieces in 1999-2000 (Jenkins *et al.,* 2002).

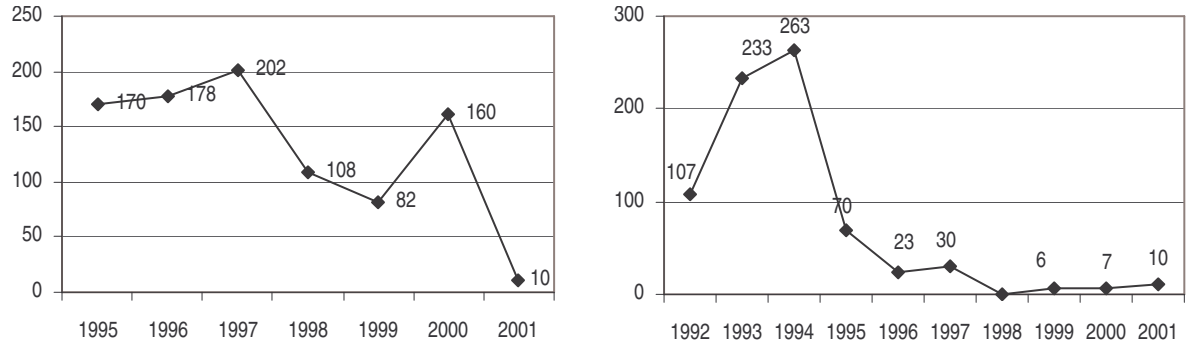
Two sawmills specializing in *Dalbergia melanoxylon* operate in the study area, in Lindi and Ikwiriri towns (Jenkins *et al.*, 2001). Volumes of *D. melanoxylon* harvested from the study area demonstrate a continuing pattern of decline due to overharvesting. Figure 43 shows how harvest volumes from Rufiji District started to decline in 1994 following overexploitation, after which harvests increased in neighbouring Kilwa District. However, harvest volumes subsequently began to decline from Kilwa District from 1997, dropping sharply in 2000 following a brief rise in harvests.

Individual licences show how areas harvested in 1997 (Nandera, Kikole, Chumo, Nanjirinji and Mingumbi) were no longer harvested in 2000. As demand continues to drive the search for viable stands southwards, Nachingwea is currently the major source of *D. melanoxylon* although it is uncertain how long this source will stay commercially viable (Figure 44). Jenkins *et al.* (2001) reported that Liwale, Rwangwa and Nachingwea Districts were currently the main sources of *D. melanoxylon* in Tanzania, especially from Lionja Forest Reserve in Nachingwea District.

Figure 43

Volumes (m^3) of *Dalbergia melanoxylon* harvest licences issued for Kilwa and Rufiji Districts

(a) Kilwa District ***(b) Rufiji District***

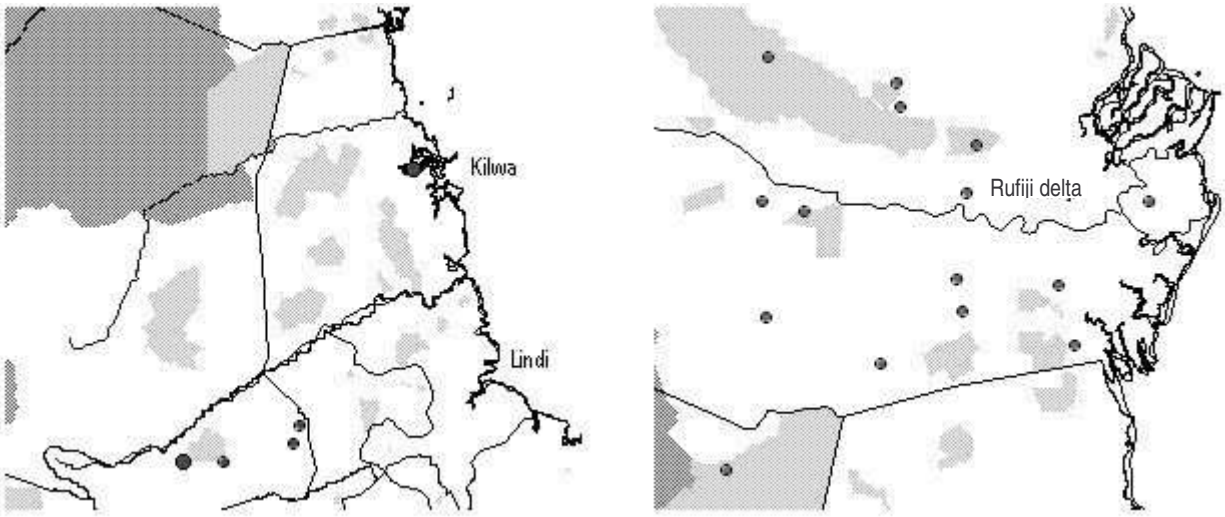


Sources: Kilwa District timber harvest licence statistics, 1995-2001; Kibiti checkpoint statistics, 1992-2001.

Figure 44

Harvest areas for *Dalbergia melanoxylon* showing major rivers, district and protected areas

(a) Lindi Region ***(b) Rufiji District***



Sources: District timber harvest licence records, 2001; Kibiti checkpoint records, 2001.

TRADE IN CHARCOAL AND OTHER TIMBER PRODUCTS

Introduction

Charcoal is widely used as a source of domestic energy in Tanzania, particularly in urban areas. Driven by low incomes amongst the majority of charcoal users and the lack of affordable alternative energy sources, the majority of medium to low-income families in urban areas rely heavily upon charcoal as their principle source of domestic energy (Jambiya, 1999). Charcoal production near a growing city such as Dar es Salaam promotes a lucrative business for many households, but this is often realised at the expense

of environmental protection (Monela *et al*., 1993). However, the capacity of the government to keep accurate records of charcoal production is low.

Volumes of charcoal traded

According to district licence statistics, 181 126 bags of charcoal were produced and recorded in the study area during 2000 and 2001 (Table 28). The majority (108 338) was produced in 2001, an increase of 49% from the previous year.

In the study area, simple earth kilns with low charcoal conversion efficiency are used for charcoal production. One cubic metre of round wood produces on average two to three bags of charcoal (Anon., 2001c). However, measured weights of charcoal bags in the study area varied from 30-38 kg per bag, higher than the national average of 28 kg (Anon., 2000a). Bags used for selling charcoal were not uniform in size, accounting for the variance in weight. However, based on the assumption that two to three bags of charcoal are produced from once cubic metre of round wood, an estimated total of 60 375 to 90 563 m^3 of round wood were used to produce the 181 126 bags of charcoal recorded in the study area during 2000 and 2001.

Table 28

Number of charcoal bags produced in study area, 2000-2001

District	2000	2001	Total
Lindi	493		493
Nachingwea	246	55	301
Rufiji	72 049	108 283	180 332
Total	**72 788**	**108 338**	**181 126**

Source: District licence statistics, 2000-2001.
Note: No data was collected from Kilwa and Ruangwa Districts.

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Charcoal kiln and bags in transport, Rufiji District.

Large-scale clearance of one hectare of miombo woodland provides on average 35 m^3 of round wood for charcoal production (Anon., 2001c). Thus, an equivalent of almost 1725 to 2588 ha of woodlands could have been cleared during the same two-year period although this is believed to be a large underestimate due to illegal production. This figure is substantially lower than the estimated 4354 ha of miombo cleared per year to produce the charcoal transported to Dar es Salaam along the Morogoro road in the early 1990s (Monela *et al.,* 1993).

Monela *et al.* (1999) reported that the demand for charcoal was increasing in Dar es Salaam and other urban areas of Tanzania since the majority of the population lack access to, or are unable to afford, electricity for cooking. Further, research in miombo regions of Coast Region showed that the number of people seeking income generation and employment opportunities through charcoal production was increasing rapidly, consequently increasing pressure on natural woodlands. Besides local villagers, immigrants from other regions are also involved in charcoal production. Low agricultural production is also forcing local people to find alternatives for income generation through charcoal production (Monela *et al.*, 1999).

Charcoal shipments

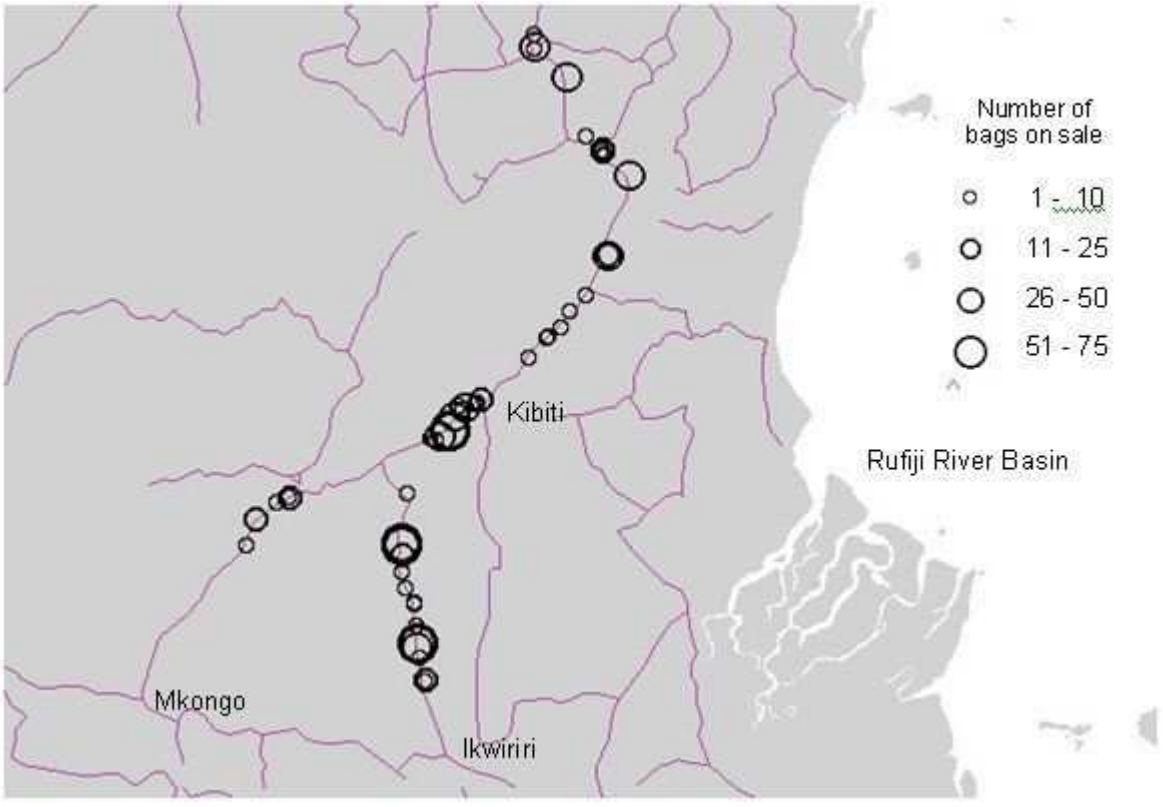
Official data on charcoal shipped from the study area to Zanzibar were not available. However, observations and reports from villagers showed that a substantial amount of charcoal was shipped to Zanzibar illegally using dhows, especially from small ports in Kilwa District. The demand for charcoal in Zanzibar is reported to be high in the face of declining natural forests on the island (Mwampamba, 2002). In 1989, charcoal consumption in Zanzibar was estimated to be 7460 t per year, but by 1999 the consumption had increased to 40 640 t per year. Sustainability of charcoal production in Zanzibar from natural forests and trees in farmland (e.g. old mango trees) is reported to be low, driving increased demand for charcoal from the mainland, most of which is delivered through informal channels.

Sources, trade routes and markets for charcoal

Charcoal production in the study areas was mainly taking place in Rufiji District, accounting for over 98% of the total charcoal produced and recorded by district authorities. The high level of charcoal production in Rufiji District is heavily influenced by the high demand in Dar es Salaam, where 65% of households use charcoal (Jambiya, 1999). Visual observations and GIS mapping showed that within Rufiji District, the Rufiji River strongly demarcated where charcoal production and trade was taking place. The majority of charcoal production is currently taking place on the northern side of river although this is expected to change after completion of the bridge (Figure 45).

Figure 45

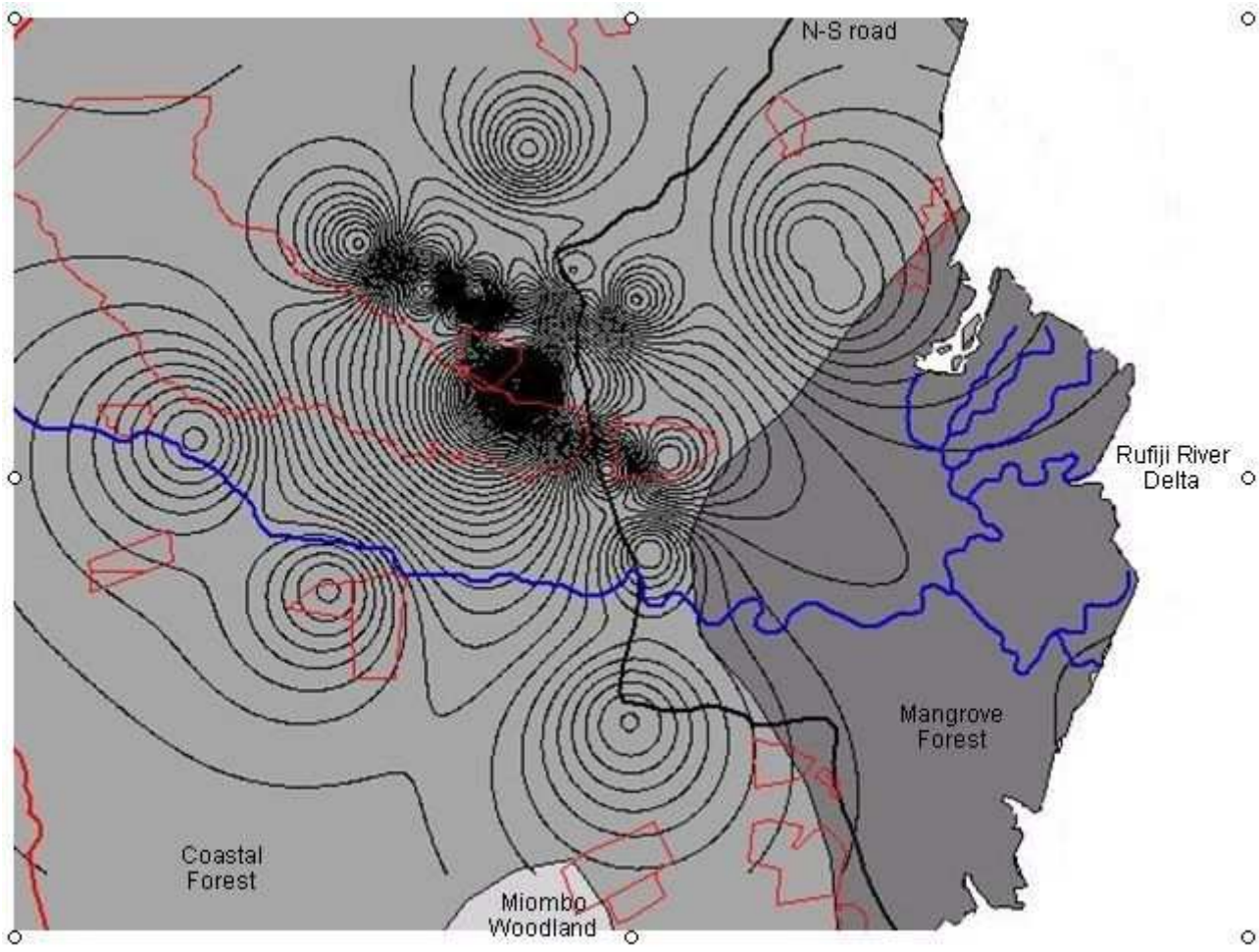
Location and relative size of charcoal retail outlets north of the Rufiji River, October 2001



According to Kibiti natural resource checkpoint records, the main charcoal production areas in Rufiji District include Ngulakula, Mng'aru, Ngumburuni Forest Reserve, Kimbuga and Mkupuka (Figure 46). However, smaller quantities of charcoal were also reported to have originated from Nachingwea, Kilwa, Lindi and Mtwara Districts. Charcoal retail outlets were also recorded on the outskirts of Lindi town during October 2001. Despite the ban on charcoal production in Forest Reserves within Rufiji District, charcoal production is still continuing.

Figure 46

Main source areas for charcoal in Rufiji District, 2001

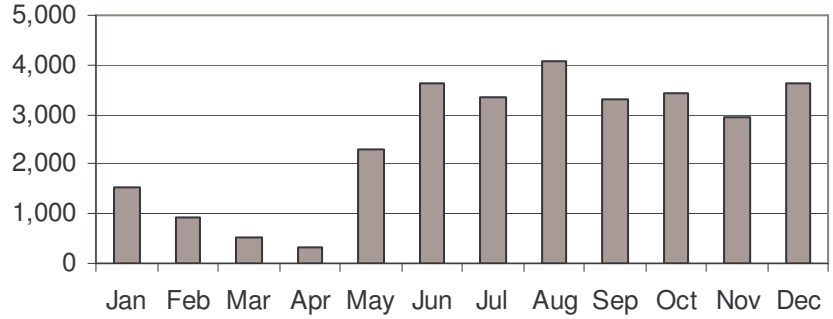


Note: Number of neighbours = 20; power = 2; contour interval = 100.

Normally, 7-10 t trucks carry between 100 and 120 charcoal bags. Records from Kibiti checkpoint also revealed that charcoal production and sale was most active during the dry months between May and December (Figure 47).

Figure 47

Quantities of charcoal (bags) recorded at Kibiti checkpoint, 2001



Source: Kibiti checkpoint records, 2001.

Other forest products in trade

There is a dearth of data on forest products other than timber and charcoal traded from the study area. This study focused on the most common forest products traded. According to district licence records, a significant quantity of poles was harvested, mostly coming from the mangrove forests of Rufiji District. Rufiji District recorded a total of 16 600 and 13 960 poles traded in 2000 and 2001 respectively (Table 29).

Table 29

Quantities of forest products other than timber and charcoal harvested in the study area by district, 2000-2001

Product	District	2000	2001
Firewood	Nachingwea	1 head load	7 m^3
	Ruangwa		13 m^3
Medicinal plants	Nachingwea		2 kg and 2 m^3
Poles	Nachingwea	174 pieces and 10 scores	45 pieces
	Rufiji	16 600 pieces	13 960 pieces
Woven plate	Nachingwea	20 each	

Source: District licence statistics, 2000-2001.

Limited data on other products transported through the Kibiti natural resource checkpoint were available for 2001. These included carvings (*Dalbergia melanoxylon*), furniture, pallets and slabs (Table 30). A total of 3.0 and 4.7 t of carvings were shipped from Mtwara port during 2000 and 2001 respectively. Along with Bagamoyo, Mtwara, Tanga, Morogoro, Kibiti, Kisarawe and Chanika, Rufiji is an important source of *D. melanoxylon* for the Mwenge carving market, the largest outlet of in East Africa (Malugu *et al.*, 2002). Jenkins *et al.* (2001) speculated that volumes of wood used by carvers are of the same order of magnitude (approximately 2000-4000 m^3 annually) as are being processed by sawmills for export.

Table 30

Quantities of timber products recorded at Kibiti checkpoint, 2001

Description	Quantities and units
Planks	5 312.1 m^3
Logs, small	2 001.4 m^3
Logs, large	944.1 m^3
Logs	350.6 m^3
Charcoal	29 966 bags
Carvings	14 901 pieces + 0.2 m^3
Furniture pieces	319 pieces
Firewood	80 bundles + 46.6 m^3
Pallets	5 640 pieces and 1 610.1 m^3
Poles	1 850 pieces
Slabs	290 pieces and 60 m^3
Sleeper	362.8 m^3
Wood pieces	24 528 pieces + 92.3 m^3
Unspecified	17 190 pieces + 63.9 m^3

Source: Kibiti checkpoint records, 2001.

SOCIOLOGICAL ASPECTS OF TIMBER TRADE

Data recording at natural resource checkpoints has traditionally focused on product volumes, licence information and revenues. During October 2001 to January 2002, Kibiti checkpoint personnel started recording the gender, age and education of traders. The purpose of this trial exercise was to gain a better understanding of the contribution of trade in forest products to different sectors of society.

Gender of forest product traders

During the three-month period, sociological data covering a total of 631 people trading in 11 forest products were recorded (Table 31). The majority was transporting planks (35%), small logs (32%) and charcoal (24%). Women were by far the minority, accounting for only 10.6% (67) of all traders. Men most strongly dominated the trades in small and large logs, both in terms of numbers of people involved and volumes transported (Table 32).

Table 31

Number of men and women and volume of major wood products transported via Kibiti checkpoint

Gender	Description	Carvings	Charcoal	Firewood	Logs	Logs, large	Logs, small	Planks
Women	Number of people	0	24	1	0	2	7	33
	Volume of product	0	873 bags	5 m^3	0	23 m^3	27 m^3	338 m^3
	Volume per person	0	36 bags	5 m^3	0	12 m^3	4 m^3	10 m^3
Men	Number of people	3	125	3	11	31	198	188
	Volume of product	250 pcs	9 624 bags	10 m^3	38 m^3	315 m^3	1 198 m^3	1 633 m^3
	Volume per person	83 pcs	77 bags	3 m^3	3 m^3	10 m^3	10 m^3	9 m^3

Source: Kibiti checkpoint records, 2001-2002.

Table 32

Proportion of selected wood products recorded at Kibiti checkpoint by gender

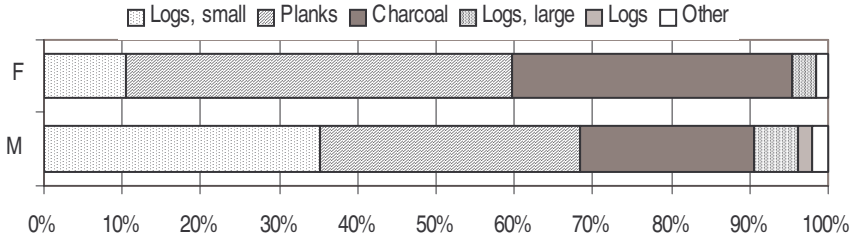
Wood product	Percentage by volume of product		Percentage by number of people	
	% women	% men	% women	% men
Charcoal	8	92	16	84
Large logs	7	93	6	94
Small logs	2	98	3	97
Planks	21	79	15	85

Source: Kibiti checkpoint records, 2001-2002.

In terms of the numbers of people involved, men and women vary in the proportion of timber products traded (Figure 48). In the case of men, over one-third traded in small logs, followed by planks (33%) and charcoal (22%). However, half of the women traded planks, followed by charcoal (36%) and small logs (10%). Table 31 also shows how on average women carry less charcoal, but more planks, per person than men.

Figure 48

Proportion of men and women transporting different timber products via Kibiti



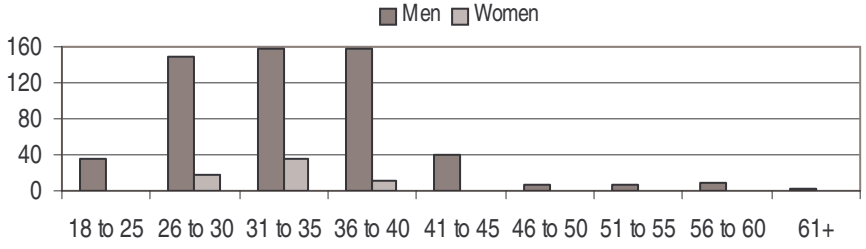
Source: Kibiti checkpoint records, 2001-2002.

Age of forest product traders

The age of timber product traders ranged from 18 years to 80 years old. Out of 629 traders, 528 (84%) were aged between 26 and 40 years old (Figure 49). Traders over 41 years of age were all men.

Figure 49

Age of traders transporting timber products via Kibiti checkpoint



Source: Kibiti checkpoint records, 2001-2002.

Education levels of forest product traders

Education levels of dealers in timber products ranged from primary school leavers to university degree holders. Out of 586 traders, the majority (93%) were primary school leavers with only five per cent having completed O-levels. The remaining 2% of the traders had A-levels, diplomas and university degrees. There were no traders lacking any education recorded during the monitoring period.

Eighty-one per cent of all traders educated beyond primary school were less than 40 years old. The more educated traders (i.e. O-level or above) were mostly engaged in selling planks (10% of all plank traders), followed by charcoal (seven per cent of all charcoal traders) (Table 33).

Table 33

Education levels of traders transporting different timber products via Kibiti checkpoint

Description	Primary	O level	A level	Diploma	Degree
Charcoal	124	8	2		
Logs	8	1			
Logs, large	28	3			
Logs, small	187	6			
Planks	184	14	3	5	1
Poles, firewood, slabs, pallets, carvings and wood pieces	12				
Total	**543**	**32**	**5**	**5**	**1**

Source: Kibiti checkpoint records, 2001-2002.

Education levels for women and men were similar, although women traders appeared to be slightly more educated, with 12% taking further education after primary school, compared to seven per cent for men (Table 34).

Table 34

Education levels, age ranges and gender of traders via Kibiti checkpoint

Age range	Primary			O level			A level			Diploma		Degree		Total
	F	M	Total	F	M	Total	F	M	Total	M	Total	M	Total	
18 to 25	1	29	30		3	3		1	1					34
26 to 30	15	132	147	1	5	6		2	2					155
31 to 35	30	137	167	4	6	10	1		1					178
36 to 40	11	135	146	1	6	7				3	3	1	1	157
41 to 45		33	33		2	2		1	1					36
46 to 50		4	4		2	2								6
51 to 55		6	6		1	1								7
56 to 60		7	7							2	2			9
61+	1	2	3											3
Total	**58**	**485**	**543**	**6**	**25**	**31**	**1**	**4**	**5**	**5**	**5**	**1**	**1**	**585**

Source: Kibiti checkpoint records, 2001-2002.

DISCUSSION

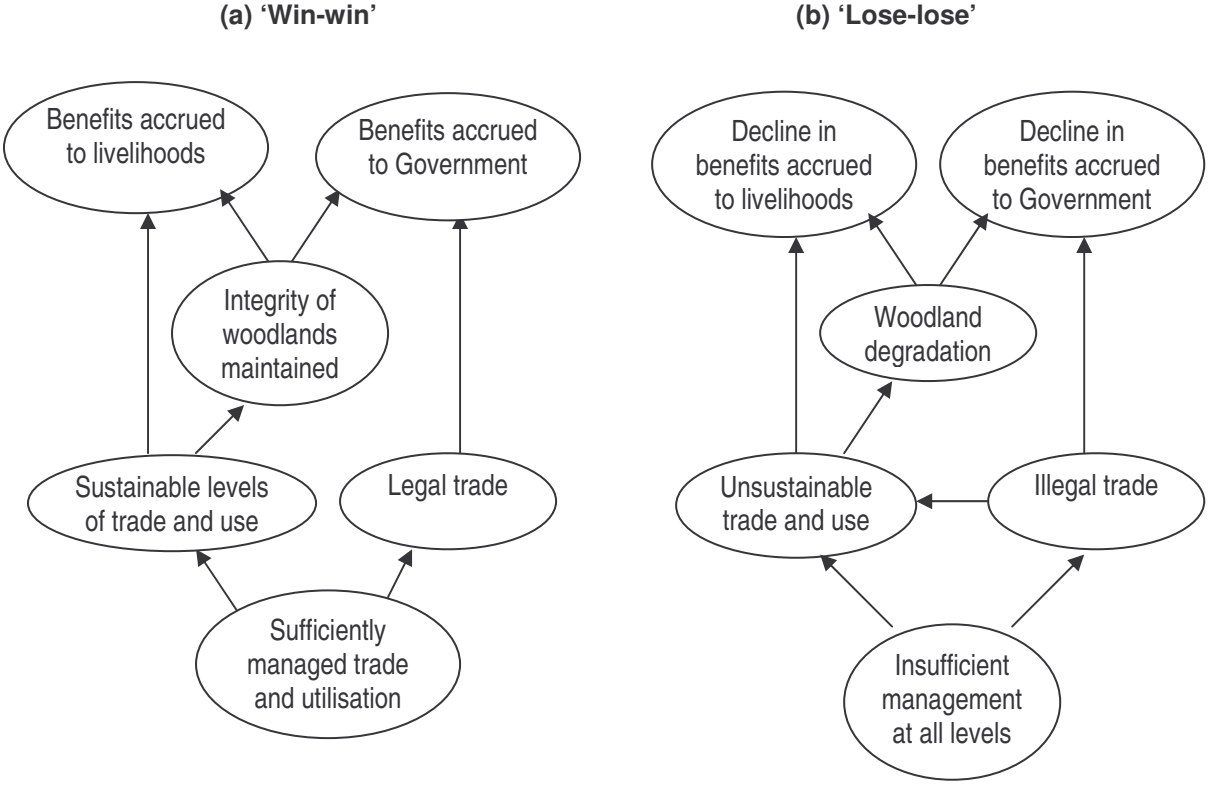
Evidence of linkages between poverty and quality of woodland/forest resources

Clear links between woodland utilization and livelihoods are evident in southern Tanzania. Understanding these linkages is important to, firstly, strengthen national efforts to eliminate poverty and, secondly, to mitigate adverse impacts on the environment that may exacerbate poverty. For example, low purchasing power has resulted in a high dependence on wood fuel for cooking, which has negative consequences on the environment and quality of life especially for the rural poor (Anon., 2001f). 'Win-win' scenarios and strategies need to be identified to ensure synergistic efforts to achieve both social development and conservation of miombo woodlands and coastal forests (Figure 50).

The study area contains some of the largest remaining wild stands of miombo woodland in Africa, with amongst the highest indices of forest density, quantities of forest per capita and unprotected woodland in the country. It also incorporates some of the most intact coastal forests with high species diversity and endemism. At the same time, this area represents one of the poorest in Tanzania, and most rural livelihoods are heavily dependent upon woodland and forest resources in the form of food, housing, fuel, medicines and income. For example, the value of miombo woodland products collected without any payment collected for direct use in Coast Region was valued at almost twice the average per capita income (Kaale *et al.,* 2002). The decline in supply of certain timber species has heavily impacted the ability of the Rufiji people to make durable canoes, an essential tool for transport and access to markets. Not only are woodland and forest products important to rural livelihoods, but their use also accounts for significant volumes of timber harvests. Fuel wood consumption in the study area per year was estimated at 2.1 million m^3.

Figure 50

Diagram showing different scenarios with regards to use/trade in woodland products



The high levels of dependence on the woodland/forest resources make rural communities in southern Tanzania particularly vulnerable to environmental degradation. On the other hand, there are opportunities to achieve woodland/forest-based poverty alleviation according to Sunderlin *et al.* (2003, by (i) preventing shrinkage of forest resources if they are necessary for maintaining well-being (*protecting the pie*); (ii) making forest resources accessible and redistributing resources and rents (*dividing the pie differently*); and (iii) increasing the production value (*enlarging the pie*).

This study has also revealed how major urban and export markets, local and central governments, also heavily benefit from trade in miombo timber products from southern Tanzania. For example, governments collected revenue on a total of 10 163 m^3 timber harvested from 27 species during 2001 and a further 5058 m^3 of round wood officially transported by sea from the study area during 2000-2001. A total of almost TZS 161 million (USD 155 000) was collected as revenue from timber products by the MNRT during 2000-2001.

In summary, the livelihoods of communities living adjacent to woodlands, local and central governments would be in a much worse situation in the absence of trade and utilization of miombo and coastal forest products.

Major challenges

This study revealed that a number of challenges remain with respect to ensuring that miombo woodlands retain their integrity and benefits continue to be accrued in the long term by stakeholders at all levels, especially the rural poor. Of particular concern is the evidence of woodland degradation in the study area due to agricultural expansion, commercial timber harvesting, fuel wood collection and charcoal production.

Insufficient management capacity and practices at all levels (including communities, local and central government) have led to lost revenues, poor forest management, and illegal and unsustainable trade. In turn, this threatens the integrity of miombo woodlands and seriously compromises prospects for poverty eradication in the area by degrading the services and products supporting rural livelihoods, urban markets, government and private sector economies. It is, therefore, important that not only are the challenges strategically addressed, but that relevant indicators are developed and continually monitored to measure the success of any interventions.

Management capacity and practices

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Checkpoint, Nachingwea district.

Extreme shortages of institutional capacity were recorded throughout the study area. A critical shortage of manpower was a common phenomenon in all the districts surveyed, with only five forestry staff available each in Kilwa and Rufiji Districts. Since at least two officials are stationed at licence offices or checkpoints, it is almost impossible to ensure implementation of existing forest laws and adequate monitoring of forest-related activities. For example, in 2002 there were only one or two qualified foresters for the entire Rufiji District, which has some 100 000 ha reserved forest and several hundred thousand hectares of unreserved woodland. As a result of a decline in field activities (e.g. identifying trees in forest, estimating standing volume to calculate licence

fees, applying 'minimum breath height' rules, and hammering), most of the evaluation of timber products is actually conducted at checkpoints.

In addition, most of the checkpoint officials were not trained in forestry and not conversant with timber identification, forest legislation and policy. Many checkpoint officials had problems in identifying forged documents and the trade in undersize or banned timber. Basic office facilities, poor equipment and long working hours all contribute to low morale amongst checkpoint personnel, and these factors were cited by forest officers as major reasons leading to corrupt practices. Mud and grass-thatched huts were used as checkpoint offices, in many cases without furniture or toilet facilities. With the exception of Kibiti, checkpoints had no means of transport to facilitate further investigation of dealers in forest products, especially those illegally transporting products by night using detours, reportedly a common phenomenon in Lindi and Coast Regions. Further, most checkpoints had a shortage of, or lacked, essential basic equipment to facilitate revenue collection, including pocket calculators, tables for calculating timber volumes, ledger books, measuring tapes, torches or weighing scales.

Most checkpoint officials are employees of village governments or district authorities, with fewer numbers of central government personnel. However, there is no clear memorandum of understanding on the sharing of responsibilities between the village/district employees and central government. In reality, differing objectives and poor linkages between different institutions are proving to be obstacles to effective management at checkpoints. For example, central government revenue collection is in general weak due to poor institutional linkages and a lack of trained manpower to implement the different forest rules regarding revenue collection.

Whilst the greatest emphasis on revenue collection at most checkpoints was on village and district authority revenue, minimal attention is placed on collecting information useful as secondary indicators of woodland status, for example data on species composition, harvest areas or other details. As a result, record keeping varied greatly between checkpoints.

Revenue collection

In general, timber revenue is only collected if harvesters and transporters of wood products happen to pass checkpoints. Since many traders bypass the checkpoints, a significant amount of revenue is lost. Potential revenues are further lost by the inability of some checkpoint staff to check consignments against accompanying documentation adequately or because of direct collusion between traders and checkpoint personnel. Common methods to avoid royalties include species misclassification, underdeclaration of volumes and transporting wood as planks or semi-processed furniture parts. The transport of so-called 'off-cuts' and wood pieces as furniture parts is an increasingly common practice in the study area, with both methods routinely used to reduce royalty payments.

Forest management

The large areas of ungazetted, open woodland in the study area imply that their future integrity is largely dependent upon management by surrounding communities. Ongoing efforts by central and local authorities to empower local communities to manage their natural resources through wise utilization is, therefore, a prerequisite for sustainable conservation of miombo woodlands in the study area. However, low awareness and acknowledgement of the contribution of forests to community livelihoods - by villagers and decision makers at all levels - is a major constraint to sustainable development. De Waal

(2001) claimed that limiting factors to achieving full community-based forest management in Liwale District include not only low community awareness, but also reluctance on the part of government officials to educate and empower villagers due to the fear of losing revenue.

Observations and discussions held with numerous stakeholders revealed that there is a serious lack of active forest management programmes, such as forest surveys, inventories and species harvest quotas. The most advanced work in the study area has been undertaken in Rufiji District, although this has yet to show tangible results in terms of successful, proactive forest management. In 2000, REMP conducted detailed inventories in five Forest Reserves in Rufiji District (Utete, Weme, Mtanza, Kichi and Mbunju) to provide data for enhancing sustainable utilization (Malimbwi, 2000). A total of 247 tree and shrub species were identified out of which 24 were potential timber species, constituting an average of about 55 m^3/ha or 24% of the total volume of 230m^3/ha in the surveyed Forest Reserves. Inventory results showed that all five Forest Reserves had very low harvestable timber stocks of commonly-used timber species, with some preferred species already exhausted. Species that did not qualify for further harvesting in Utete Forest Reserve include *Dalbergia melanoxylon, Hymenaea verrucosa, Julbernardia globiflora, Kigelia africana, Markhamia lutea, Newtonia buchananii, Sclerocarya birrea* and *Vitex domiana.* Harvestable species (diameter at breast height above 40 cm) also of concern included *Swartzia madagascariensis, Afzelia quanzensis, Tamarindus indica, Xeroderris stuhlmannii, Pterocarpus angolensis, Lonchocarpus capassa, Pseudolachnostylis maprouneifolia, Brachystegia speciformis* and *Brachystegia bussei* (Malimbwi, 2000). REMP are currently attempting to implement a forest action plan (Anon., 2002f). Limited work has also been undertaken in Lindi and Kilwa Districts with the financial assistance of the Finnish International Development Agency (FINNIDA) and DANIDA.

In Rufiji District, only two reserves, Kiwengoma and Namakutwa, currently have a management plan, and are theoretically closed to harvesting. In terms of effectiveness, the management of catchment Forest Reserves is considerably higher than most Forest Reserves found throughout the study area, but otherwise there seems to be little difference between harvest practices in protected (gazetted) Forest Reserves (under central or local government management) and public land within the study area. Traders were observed collecting forest products freely in all forested areas. REMP identified Ngumburuni Forest Reserve as of particular concern, with approximately one-third of the 3000 ha reserve being cleared for cultivation, and/or exploited as a local government Forest Reserve with unmarked boundaries and without a management plan (Anon., 2002h). Minimum harvestable sizes are not respected, no species-specific, spatial or temporal quotas or management regimes have been set for any of the hardwood species in the study area despite evidence of decline.

Due to a shortage of skilled personnel, all central and district authority Forest Reserves in the study area other than Kiwengoma and Namakutwa lacked management plans and their boundaries are not properly demarcated. Maps of most of the Forest Reserves are also not available at district offices. Growth and regeneration characteristics in the Forest Reserves are poorly understood, hence district officials are unable to provide data on sustainable harvesting and management of the forests. In many cases, government officials are unaware of what harvests are actually taking place deep within the reserves.

The general trend is that most of the central and district authority Forest Reserves in the study area were overexploited and encroached. Exploitation of protected species has continued virtually unhampered over the entire area, characterised by initial exploitation of large trees by organised loggers (normally

saw millers and traders from Dar es Salaam and Zanzibar), followed by forest colonisation by pit sawers (initially using trucks and later transporting by bicycle or foot).

Pitsawing is widespread in the study area and has flourished due to the favourable economic returns, low investment costs, low chances of apprehending illegal pitsawyers, poor patrolling and low penalties. Monela and Solberg (1998) noted that while pitsawyers may pose less of an environmental concern than mechanical logging, pitsawyers threaten sustainable forest management through indiscriminate cutting of trees, construction of dwelling huts, setting bush fires, littering and other undesirable practices causing costs to the forest owner and society. As tree stocks decline and pit sawyers move elsewhere, intensive harvesting of smaller trees for poles and firewood ensues, followed by traders returning to previously logged areas to recover small logs.

Evidence of unsustainable timber trade

This study has confirmed expectations that degradation of miombo woodlands is occurring in the study area. Unfortunately, few studies have been conducted to measure the growing stock in reserved and unreserved areas. During surveys of five Forest Reserves in Rufiji District, Malimbwi (2000) concluded that all the surveyed Forest Reserves were under harvesting pressure, with current unsustainable harvesting levels leading to deterioration of the woodlands. Negative environmental impacts resulting from fuel wood extraction, identified as a problem in the National Energy Policy of Tanzania, are relatively low when compared to land clearance for agricultural expansion. Clearance of land in Liwale District for agricultural expansion was equated to TZS 4 million (almost USD 4000) per ha equivalent in lost charcoal and sawn wood production (Kaale, 2000).

Whilst periodic surveys have not been conducted in the study area to determine precise changes in miombo woodland coverage and integrity, several secondary factors indicate signs of overharvesting and unsustainable trade levels:

Change in harvest areas

Traders reported declines in the most preferred species in Rufiji District, resulting in many traders harvesting in Lindi Region. Perhaps the clearest evidence of spatial decline is for *Dalbergia melanoxylon*, whose systematic clearance of export-quality trees has driven harvesting progressively southwards since the mid-1990s. All traders also reported travelling significantly further to get timber.

Increasing quantity of lower quality species harvested

Whilst tax avoidance may affect the quality of data (due to misclassification of harvested timber on licences), the increasing scarcity of valuable Class II hardwood species in Rufiji District has led to a higher proportion of Class V species being harvested. Moving southwards, there is an increasing proportion of Class I and II timber being harvested. Malimbwi (2000) and Kaale *et. al.* (2000) report that *Afzelia quanzensis, Millettia stuhlmannii* and *Swartzia madagascarensis* are likely to join the list of other timber species that have become commercially extinct in Rufiji District since the 1970s, namely *Dalbergia melanoxylon, Khaya anthotheca, Milicia exelsa, Newtonia* spp. and *Pterocarpus angolensis*.

Fewer large trees remaining

According to interviews with numerous stakeholders and field observations, some traders were returning to previously harvested areas to collect smaller logs. This practice was deemed profitable in light of depleted viable live stands of valuable species such as *Hymenaea verrucosa* and *Pterocarpus angolensis*.

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Traders returning to previously felled trees to collect smaller logs, Kilwa.

Harvesting of undersize trees

Stump surveys conducted by REMP in selected Forest Reserves in Rufiji District support field observations over a larger area that undersize harvesting continues. In particular, the average stump diameter of *Pterocarpus angolensis* harvested around Ruhoi Forest Reserve in 2000 was half the recommended minimum for sustainable management practices. Harvesting of smaller trees as 'off-cuts', for poles and firewood is also taking place in the forests, consequently leading to severe loss of species biodiversity. Due to a lack of management and control, even valuable species such as *Dalbergia melanoxylon* are being harvested for charcoal production. Regeneration of the most valuable commercial trees was observed to be low, due to a lack of seed mother trees in most of the forests.

Declining plank sizes

Similarly, data from sawmills and field observations supported reports from traders that the average plank size was declining for the more valuable species. For example, *Pterocarpus angolensis* planks measuring only 6-7 feet are now commonly traded, almost half the preferred length of 12 feet.

Large-scale, illegal trade

This study documented large-scale, illegal trade in timber products flourishing throughout the study area. Illegal and informal activities take a number of different forms, although the relative importance of each was not ascertained during this study. Concealment and evasion were amongst the most common techniques to avoid payment of royalties. The most common practices involved the utilisation of off-road truck routes to avoid official checkpoints, travelling at night, locking trucks to avoid inspection, and hiding timber under other products (e.g. salt).

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Truck delivering logs to woodland clearing, Lindi district.

In many circumstances, official harvest documentation has been obtained, but traders chose to underdeclare or misdeclare the goods. Timber traders may quote lower classes of tree species in their licences in order to pay low royalty rates. For example, whilst Class II species may actually be harvested (TZS 40 000 (USD 39.02) per m^3), the licence quotes less valuable, Class V timber species (TZS 10 000 (USD 9.76) per m^3).

The precise origin of timber is rarely checked in the field and many traders harvest timber in areas not specified on the harvest licence. In some cases, the wrong districts, let alone the wrong harvesting areas,

are indicated on the licences. For example, wood harvested in Rufiji District is commonly recorded as harvested in Mkuranga District whilst many traders claiming to harvest in Rufiji District are in reality harvesting from Kilwa and Liwale Districts. In some cases, harvest licences are prepared after the trader has harvested and transported the products to a checkpoint of the trader's choice.

Large volumes of timber are felled without any licence. Indeed, *none* of the traders encountered during this survey were carrying the necessary documentation. Research conducted in Rufiji District also noted that none of the operators encountered during forest surveys were in possession of a valid licence (Anon., 2002f). At Ikwiriri, it was noted that collectors of fuel wood and producers of charcoal from miombo woodlands were not paying any royalties to the district or central government.

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Abandoned logging camp, Liwale district.

Large-scale, illegal trade has resulted in large discrepancies between government records and actual trade levels. For example, official harvest records barely matched the volume of timber recorded leaving the study area, let alone products that left unrecorded or those used within the study area. During 2001, a total 10 163 m^3 round wood was issued on harvest licences in the study area, matching fairly closely the official figure of 11 228 m^3 timber known to have left the study area. This included a total of 2420 m^3 round wood equivalent logs and planks reported as shipments from Kilwa, Lindi and Mtwara ports during 2001, and 8808 m^3 round wood equivalent recorded moving through Kibiti natural resources checkpoint, en route to Dar es Salaam. However, these figures are a vast underestimate since they do not include subsistence use of timber products, urban sales of timber in southern Tanzania, illegal harvesting and trade in timber. Field research reliably estimated that five times as much timber passed north through Kibiti than was officially recorded and significant quantities also leave the mainland unrecorded by sea.

Levels of illegal trade are significantly higher than estimates by forest officers working in the study area. This level of undetected, illegal trade (77%) is close to the figure of 85% documented in Mwanza (Wells *et al.*, 2000). Hamerlynck (2003) estimated that government records from Rufiji District reflected a maximum of 20-30% of the actual offtake.

Several important driving forces affect illegal activities in the study area, most importantly profit margins and enforcement levels. Besides the various taxes required at local and central government levels, operational costs in the timber business include transport, logging and sawing costs. Calculations made in Rufiji District have shown that in general the timber trade is not profitable if one actually paid all the desired royalties, taxes and environmental fees (Anon., 2002f). Calculations showed that transport costs account for 40-50% of the total cost, while taxes account for 34-44 % and logging and sawing account for 13-15%. To remain in business, a trader must explore opportunities of minimising the payment of royalties and taxes. In reality, this is a relatively simple procedure due to the inefficient government system of collecting forest revenue and enforcing forest legislation, in turn due to capacity deficiencies. In particular, capacity is deficient in the areas of staffing levels, staffing expertise, equipment, morale and operating budgets. Whilst enforcement levels are generally low and many traders operate illegally with relative impunity in the study area, such activities may occur in collaboration with corrupt officials. Enforcement efficiency is reduced further in some areas due to the informal nature of harvesting and trade. For example, the widespread use of bicycles to transport planks south of the Rufiji River from pitsawyers to the coast poses enormous challenges for law enforcement

since they are difficult to monitor. Almost all shipments in this manner are conducted illegally and present large revenue losses to local and central governments.

The main implications of these illegal activities are huge revenue losses, and the degradation of woodland and forests that will result in negative social impacts on rural communities. For example, around 80% potential revenue is currently being lost at Kibiti checkpoint, thereby reducing income to central and district governments. It can be argued that small-scale traders may actually benefit more through illegal trade since they receive negligible, tangible benefits in return from the current redistribution levels of forest-derived government revenue. However, increasing numbers of larger-scale traders, who tend to come from outside the study area, results in a 'lose-lose' scenario in terms of revenue returns and distribution at the local level. The profit margins available through illegal trade are a major force driving the increase in illegal timber trade activities in parts of the study area. In this way, illegal trade can lead to serious woodland degradation.

Wastage

Observations during this study revealed low conversion rates for producing sawn wood and charcoal in the study area, resulting in wastage and lost revenue. Timber producers only use a small proportion of a felled tree log for sawn wood, leaving large quantities of valuable wood in the forest. This wastage has been partly driven by royalty calculations being based on the volume of logs collected instead of the volume of wood felled. Similarly, very low conversion rates in charcoal production were recorded using traditional earth kilns, with a recovery rate of between 8-15% on weight basis (Monela *et* al., 1999; Kaale *et* al., 2000). This compares to the potential 25% through proper selection and treatment of fuel wood and management of the kiln during carbonisation (Kaale *et* al., 2000).

Further, high wastage was observed at the Ikwiriri sawmill specialising in *Dalbergia melanoxylon*. Relatively little is resold or reused, with small quantities used by carvers. Jenkins *et al.* (2001) estimated that the overall recovery rate from round wood to exported billet is 5-10%.

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Wastage at sawmill, Kilwa Masoko.

Fire

Fire is a natural part of the miombo ecosystem although human-induced fires are often more destructive than naturally acurring ones. Excessive timber trade may also exacerbate damage caused by fire. As large trees are removed, the forest canopy becomes progressively more open allowing grasses to colonise (Anon., 2002f). This greatly increases the risk of more intense, late dry-season fires that affect forest regeneration in particular fire-sensitive species such as *Dalbergia melanoxylon*. The disappearance of certain species and general thinning out of forests can lead to a reduction in other forest-dependent species, particularly primates, shade-dependant plants, forest birds and invertebrates.

RECOMMENDATIONS

Costs of not taking action and benefits of taking action

This study has clearly presented evidence of overharvesting leading to lost revenues, malpractices and forest degradation. The threats to long-term sustainability of timber trade are likely to be exacerbated following increased access to harvest areas, unfettered crossing of the Rufiji River and a rise in development in southern Tanzania following completion of the bridge. Given its proximity to the bridge, it is expected that the study area is most likely to be affected in terms of increased exploitation by outsiders and lost incomes from trade in timber products by both community and government sectors.

Failure to counteract these trends will result in continued forest degradation, serious deleterious consequences to local communities' livelihoods and revenue losses at all levels. Ongoing monitoring is necessary to assess timber extraction and assess sustainable utilization levels.

On the other hand, there are opportunities to directly influence efforts to achieve not just sustainable utilization from the largest remaining wild stands of miombo in Tanzania, but also poverty alleviation in one of the poorest regions most dependent upon natural resources. Improved forest/woodland management and socially equitable access, use and trade of forest and woodland resources could drastically increase long-term benefits to rural communities – at the very least helping to mitigate further poverty, but at the very best contributing towards poverty alleviation. Indeed, a significant number of key stakeholders and partners support the implementation of various capacity-building activities and the need for a sustained effort to monitor the impact of the Mkapa Bridge on timber trade from southern Tanzania and development. Further, this project provides a unique opportunity to study the relationships between development and the environment, beneficial to further development of the PRSP.

Ongoing monitoring of the timber trade

The impact of the Mkapa Bridge (*and* subsequent improvements to other infrastructure, such as roads) on timber trade and social development in southern Tanzania can only be measured by comparing data collected periodically after completion of the bridge with the baseline data presented in this report. In the process of collecting information during this study, potential indicators for ongoing monitoring were identified. Based on results gathered during this study, it is predicted that numerous changes in timber trade dynamics will take place following completion of the bridge, due to increased access to harvest areas south of Rufiji River and social development in the region.

Credit: Simon Milledge/ TRAFFIC East/Southern Africa

Rufiji River bridge under development, October 2001.

Indicators were chosen to enable monitoring of the following predicted changes:

- increased magnitude or volume in timber trade overall;
- increased proportion of timber coming from south of Rufiji River;
- increased proportion of illegally harvested and transported timber in transit;
- changes in harvest areas due to overexploitation and access to previously less exploited areas;

- changes in trade routes according to changes in harvest areas, and a greater proportion of timber transported by land than sea;
- changes in class and species composition due to misclassification and overexploitation with a higher percentage of lower value species harvested moving southwards;
- changes in product composition with higher numbers of planks and smaller logs;
- higher proportion of larger trucks moving across the Rufiji River transporting timber;
- higher percentage of vehicles moving across the Rufiji River involved in timber trade;
- decline in the average size of logs and sawn wood due to overexploitation; and
- reduction in seasonality in trade.

Whilst some indicators will need to be refined, replaced or added (especially to encapsulate environment-poverty linkages) over time, a total of 58 general indicators and a further five species-specific indicators were identified during this preliminary study (Table 35). Table 35 includes the source of data collected during this study, prospects for future data collection, and level of priority for future collection. As a minimum, future data collection efforts should aim to ensure collection of all high priority indicators. Greater efforts are required to develop strategies of detecting and monitoring quantities of sawn timber transported by bicycles, dhows and closed lorries.

It is further envisaged that lessons learnt from the ongoing monitoring of these indicators will assist the Government of Tanzania refine national-level monitoring of environment-poverty linkages and poverty reduction efforts. As stated in the PRSP (Anon., 2000d): '*Future iterations of the PRSP …. will capture more fully these linkages and help define a more consistent framework for managing activities aimed at protecting the environment*.'

Capacity building

A lack of management capacity at all levels was identified as a major causal factor for current alarming trends in forest degradation that will ultimately lead to negative livelihood and economic impacts. Highest priorities include the strengthening of Kibiti checkpoint, the first official checkpoint north of Rufiji River located in a strategic position to capture most of the wood products moving across the Rufiji River north towards Dar es Salaam. Capacity building should be intensified by the central government (FBD) in collaboration with district authorities throughout the study area, including the enhancement of existing checkpoint facilities, development of monitoring tools, skills training in forest products, standardised data collection and improved liasons and co-ordination between different bodies. The need to build capacity at local government level was prioritised during the Meeting of Directors of Conservation and Economic Planning, held in February 2002 in Kenya (Mariki *et al*., 2003).

Low wages and incentives are believed to be one reason why some government staff and even police officers become involved in the untrustful control of illegal harvesting and trade in timber products (Anon., 2002c). It is therefore imperative that existing salary structures and working conditions are reviewed and increased, something that should be justifiable considering the high percentage of revenues coming from sale of forest products.

Table 35. Monitoring indicators including baseline data

DESCRIPTION OF INDICATOR	BASELINE DATA	TIME	FUTURE DATA COLLECTION	PRIORITY
1. Volumes of Timber in Trade				
1.1 Official total volume of round wood harvested in study area	10 163 m3	2001	Data readily available – District forest offices compile harvest licences monthly and annually	High
1.2 Official ratio of round wood harvested from different districts	85% Rufiji (8505 m3) 10% Kilwa (976 m3) 2% Nachingwea (163 m3) 2% Lindi (172 m3) 1% Ruangwa (123 m3) 1% Liwale (119 m3)	2001		High
1.3 Official total log and timber shipments from three ports	7,357 m3	2000-2001	Data readily available – Tanzania Harbours Authority compile data annually	High
1.4 Ratio of shipments from three ports	56% Kilwa: 31% Mtwara: 13% Lindi			Low
1.5 Estimated total volume leaving study area by sea unofficially	Not recorded	-	Data would only become available from appropriate field research (currently being researched by TRAFFIC)	Medium
1.6 Estimated ratio of official shipments to unrecorded sea shipments	Not recorded	-		Medium
1.7 Estimated volume crossing Rufiji River from south	40 400 m3	2001	Data was collected during field research, and only available in future if vehicles can be stopped near river for adequate covert inspection	High
1.8 Estimated total volume entering sawmills in Ikwiriri	4112 m3	2001	Data available from sawmill records, interviews and observations	Medium
1.9 Official volume passing north through Kibiti checkpoint	8608 m3	2001	Data not currently analysed but are available from Kibiti checkpoint records	Medium
1.10 Percentage volume round wood passing north of Rufiji River recorded at Kibiti checkpoint (degree of accuracy)	23%	2001	Data calculated from above indicators (see section on *Total Volume of Timber Moving North of Rufiji River*)	High
2. Timber Harvest Areas				
2.1 Main harvest areas in Rufiji District	Ngumburuni, Ruhoi, Ikwiriri, Nyamwage; see also map	2001	Data not currently analysed by district authorities but are available from Kibiti checkpoint records	High
	Ruhoi; see also map	2001	Data available from mapping of logging roads in study area	High
2.2 Main harvest areas in Lindi Region	Nainokwe-Zinga-Likawage-Liwiti; see also map	2001	Data not currently analysed but are available from district forest offices which compile harvest licences monthly and annually	High

DESCRIPTION OF INDICATOR	BASELINE DATA	TIME	FUTURE DATA COLLECTION	PRIORITY
3. Key Species of Round Wood in Trade				
3.1 Number of species officially harvested from study area	24 species	2001	Data readily available – district forest offices compile harvest licences monthly and annually	Low
3.2 Main species in trade	*Hymenaea verrucosa* – 41%; 53% *Trichilia emetica* – 21%; 13%; 5% *Pterocarpus angolensis* – 11%; 15% *Swartzia madagascarensis* – 7%; 5% *Afzelia quanzensis* – 7%; 5%	2001	Data available from district harvest licences; whilst not currently analysed, data also available from Kibiti checkpoint records; additional data could be collected in the future from systematic field surveys of fresh stumps	High
3.3 Total volume of top five species	87%; 90%	2001		Medium
3.4 Species whose proportion in trade decreased markedly over past year	*Pterocarpus angolensis* – 12% *Afzelia quanzensis* – 4%	2000-2001	Data not routinely analysed by government authorities but are available from district harvest licences, monthly and annual reports	High
3.5 Species whose proportion in trade increased markedly over past year	*Hymenaea verrucosa* – 10% *Trichilia emetica* – 13%	2000-2001		High
3.6 Proportion of difference classes in trade	66% Class V, 4% IV; 1% III; 28% II; 1% I	2001		High
3.7 Changes in class composition over past year	Class I decreased from 3% to 1% Class II decreased from 44% to 28% Class V increased from 46% to 66%	2000-2001		High
3.8 Origin of Class II	47% Class II licences from Lindi Region 53% Class II licences from Rufiji District	2001		Medium
3.9 Origin of Class V	0% Class V licences from Lindi Region 100% Class V licences from Rufiji District	2001		Medium
3.10 Proportion of Class II and V in Lindi Region	85% Lindi Region licences Class II 0% Lindi Region licences Class V	2001		High
3.11 Proportion of Class II and V in Rufiji District	17% Rufiji District licences Class II 77% Rufiji District licences Class V	2001		High
4. Timber Products				
4.1 Ratio of logs : planks crossing Rufiji River	1 : 5.8	2001	Data collected during field research and only available in future if vehicles can be stopped near river for adequate covert inspection	High
4.2 Ratio of logs : planks recorded at Kibiti checkpoint	1 : 1.6	2001	Data not currently analysed by government authorities but are available from Kibiti checkpoint records	High
4.3 Main species transported as small logs	82% *Hymenaea verrucosa*	2001		High
4.4 Main species transported as large logs	57% *Swartzia madagascarensis*	2001		High
4.5 Main species transported as planks	92% 4 spp - *H. verrucosa, P. angolensis, T. emetica, A.* quanzensis	2001		High

DESCRIPTION OF INDICATOR	BASELINE DATA												TIME	FUTURE DATA COLLECTION	PRIORITY
5. Transport Across Rufiji River															
5.1 Most common vehicles carrying timber products	Isuzu and Benz												2001	Data collected during field research and only available in future if vehicles can be stopped near river for adequate covert inspection	Low
5.2 Proportion of vehicle tonnages carrying timber products north across Rufiji River (by volume)	0.3% <3t; 41.2% 3-7t; 56.9% 8-14t; 1.6% 15+ t												2001		Medium
5.3 Proportion of vehicle tonnages carrying logs north across Rufiji River	80% 8-14t; 20% 3-7 t												2001		Medium
5.4 Estimated % vehicles crossing Rufiji River carrying timber products	27%												2001		Medium
6. Sizes of Logs and Planks															
6.1 Average length of logs	3.3m (ranging 2.3-3.8m)												2001	Data collected from PIC Ltd. although future collection depends on willingness to disclose information and format of record keeping	Medium
6.2 Average girth of logs	1.8m (ranging 1.1-2.1m)												2001		High
6.3 Average volume of logs	1m3 (ranging 0.3-1.4 m3)												2001		Medium
6.4 Relationships between log dimensions	Volume = (0.93 x girth) – 0.82												2001		Medium
6.5 Percentage of logs measuring 3.66 m (12 feet) long	22%												2001		High
6.6 Percentage of logs measuring between 3.35 and 3.6 m length	67%												2001		Low
6.7 Average volume of sawn wood (round wood equivalent)	0.05 m3 (18.41 planks/m3)												2001	Data not currently analysed but are available from Kibiti checkpoint records	High
7. Seasonality in Timber Trade	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**			
7.1 Peak in transport over Rufiji River, 2001		x					x	x	x	x	x	x	2001	Data not currently analysed but are available from Tanzania Harbours Authority, Kibiti checkpoint records, PIC Ltd. and district timber harvest licences	Low
7.2 Peak in transport north via Kibiti checkpoint							x	x	x	x	x	x	2001		Low
7.3 Peak in wood purchases by Ikwiriri sawmills								x	x	x	x		2001		Low
7.4 Peak in harvest licences from Lindi Region						x	x	x	x				2001		Low
7.5 Peak in harvest licences from Rufiji District	No peaks												2001		Low

DESCRIPTION OF INDICATOR	BASELINE DATA	TIME	FUTURE DATA COLLECTION	PRIORITY
8. Species-Specific Indicators				
8.1 *Hymenaea verrucosa* Class V	41% all harvest licences in study area; 53% all timber recorded at Kibiti checkpoint 3% large logs; 54% small logs; 43% planks recorded at Kibiti checkpoint 65% increase in licence volumes; 10% increase in overall species composition	2001 2001 2000-2001	Data not currently analysed by government authorities but are available from district harvest licences and checkpoint records	High
8.2 *Trichilia emetica* Class V	21% all harvest licences in study area; 13% all timber recorded at Kibiti checkpoint 1% large logs; 20% small logs; 79% planks recorded at Kibiti checkpoint 238% increase in licence volumes; 13% increase in overall species composition			
8.3 *Pterocarpus angolensis* Class II	11% all harvest licences in study area; 15% all timber recorded at Kibiti checkpoint 0% large logs; 5% small logs; 95% planks recorded at Kibiti checkpoint 41% decrease in harvest licences; 12% decrease in overall species composition			
8.4 *Swartzia madagascarensis* Class II	7% all harvest licences in study area; 5% all timber recorded at Kibiti checkpoint 100% large logs; 0% small logs; 0% planks recorded at Kibiti checkpoint 17% increase in harvest licences; Negligible change in species composition			
8.5 *Afzelia quanzensis* Class II	7% all harvest licences in study area; 5% all timber recorded at Kibiti checkpoint 7% large logs; 19% small logs; 74% planks recorded at Kibiti checkpoint 21% decrease in harvest licences; 4% decrease in overall species composition			
8.6 *Millettia stuhlmannii* Class II	3% all harvest licences in study area; 1% all timber recorded at Kibiti checkpoint 47% large logs; 0% small logs; 53% planks recorded at Kibiti checkpoint 15% increase in harvest licences; Negligible change in species composition			
8.7 *Afrormosia angolensis* Class V	3% all harvest licences in study area; 2% all timber recorded at Kibiti checkpoint 100% large logs; 0% small logs; 0% planks recorded at Kibiti checkpoint 17% decrease in harvest licences; 1% decrease in overall species composition			
8.8 *Erythrophleum africanum* Class IV	3% all harvest licences in study area; 0.2% all timber recorded at Kibiti checkpoint 0% large logs; 0% small logs; 100% planks recorded at Kibiti checkpoint 408% increase in harvest licences; 2% increase in overall species composition			
8.9 *Milicia exelsa* Class II	1% all harvest licences in study area; 0% all timber recorded at Kibiti checkpoint 0% large logs; 0% small logs; 0% planks recorded at Kibiti checkpoint 15% increase in harvest licences; Negligible change in species composition			
8.10 *Dalbergia melanoxylon* Class I	1% all harvest licences in study area; 0.4% all timber recorded at Kibiti checkpoint Carvings and 'firewood' recorded at Kibiti checkpoint 47% decrease in harvest licences; 2% decrease in overall species composition			

DESCRIPTION OF INDICATOR	BASELINE DATA	TIME	FUTURE DATA COLLECTION	PRIORITY
9. Trade in Charcoal				
9.1 Number of bags officially harvested from study area	108 338	2001	Data readily available – district forest offices compile harvest licences monthly and annually	High
9.2 Proportion of charcoal harvested from Rufiji District compared to the rest of the study area	98%	2001	Data available from district harvest licences although not currently analysed	High
9.3 Major source areas of charcoal in Rufiji District	Ngulakula, Mng'aru, Ngumburuni Forest Reserve, Kimbuga, Mkupuka; see also map	2001	Data available from district harvest licences; whilst not currently analysed, data also available from Kibiti checkpoint records;	High
9.4 Major source areas of charcoal in Lindi Region	Minimal official	n/a	Data available from district harvest licences although not currently analysed	High
10. Sociological Indicators				
10.1 Percentage women traders	10.6%	2001	Data collected from modified checkpoint record books	Medium
10.2 Percentage different products transported by men	35% small logs, 33% planks, 22% charcoal			
10.3 Percentage different products transported by women	49% planks, 36% charcoal, 10% small logs			
10.4 Percentage charcoal transported by women	8% by volume, 16% by number of people			
10.5 Percentage large logs transported by women	7% by volume, 6% by number of people			
10.6 Percentage small logs transported by women	2% by volume, 3% by number of people			
10.7 Percentage planks transported by women	21% by volume, 15% by number of people			
10.8 Percentage aged 26-40 years	84%			
10.9 Percentage primary school leavers	93%			
10.10 Products transported by most educated	Planks			

Empowerment of the local communities

Large areas of unreserved woodland and evidence of degradation highlights the need to increase empowerment of local communities in managing their natural resources, specifically through community-based forest management and wildlife management areas. Concerted multi-sectoral efforts are required to educate villagers on existing national policies, strategies and legislation that support participatory community management of natural resources for poverty alleviation. In particular, how the sustainable conservation of natural resources will also contribute positively to development of priority sectors, mainly agriculture, education, health, transport and judiciary. Specific assistance is required in developing land use plans and by laws. Empowerment of local communities holds good potential for exerting greater control over the informal transport routes using bicycles, and village institutions could take over monitoring of the movement of products.

It is important that standardised data collection at checkpoints includes social data on traders in forest products. Such information would be useful in the facilitation of awareness raising campaigns and the provision of technical assistance to traders to improve trading practices and their livelihoods.

Hamerlynck (2003) noted that in order to prevent the same deprivation of natural resources vital to local livelihoods (canoes) from occurring south of the Rufiji River, it would seem necessary to facilitate the empowerment of local communities in the designation and management of Village Forest Reserves and Joint Forest Management Plans. Experience from Rufiji shows that it is essential that communities are aware of their rights under the new laws and to facilitate the registration procedures.

Participants at a workshop on community-based natural resources management in Rufiji District, held in June 2002, agreed to three key principles. These should be applied to the entire study area:

- participation of all stakeholders with regard to natural resources management now is a prerequisite since the current policy and law allows the community to manage and own natural resources;
- each village should have a village environment management plan; and
- during preparation of conservation and wise use plans, it is very important to involve all stakeholders, as their participation will help to prevent potential conflicts.

Improving forest management plans

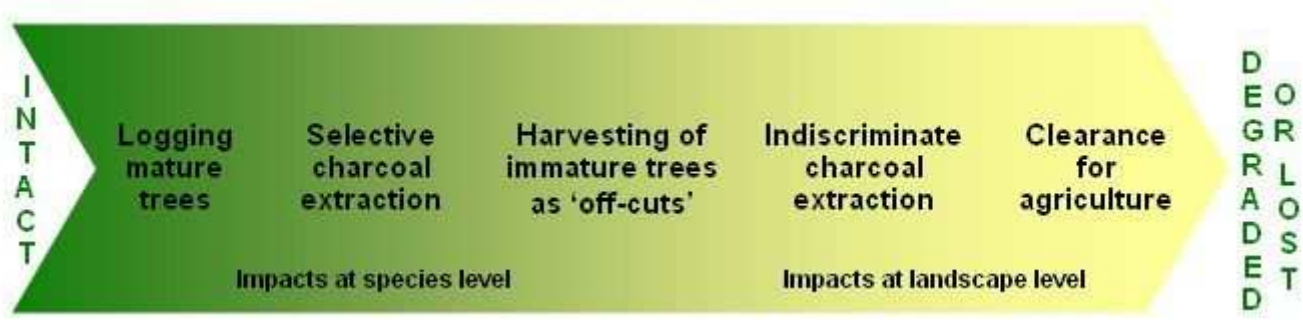
Effective management is seriously hindered by poor knowledge regarding timber stocks and trade dynamics, and the lack of forest management plans in the study area. Efforts are required in all central and district authority Forest Reserves in the study area to ensure that boundaries are properly demarcated; maps available and management plans are prepared. Further, structured field surveys are required, initially in areas under highest harvest pressure, to establish species distribution, abundance, growth, harvesting and regeneration characteristics. Zoning and harvesting plans should be introduced, based on scientific, inventory data and socio-economic analyses of the surrounding communities. It is imperative that revenue district targets do not primarily determine offtake levels since this is proving unsustainable. It is recommended that these harvesting plans include pro-active measures such as the promotion of less-used species, diversification of products, improvements to tools and technologies, and the use of concessions.

It is further recommended that the harvesting and trade in Class I and II species should be more strictly regulated since evidence shows that their supply potential is declining rapidly. Following impacts at the species level, there is a rapid succession of indiscriminate clearance of land for charcoal and agriculture

(Figure 51). Regulatory options to be explored may be specific to certain species, wood products, geographical areas and/or seasons. For example, logging and/or charcoal bans may be necessary in key areas, and efforts are required to control the trade in small logs ('off-cuts') to minimize harvesting of immature trees. Similarly, greater attention needs to be paid to areas under highest harvest pressure, such as Ngumburuni Forest Reserve, and the following species: *Dalbergia melanoxylon, Khaya anthotheca, Milicia exelsa, Pterocarpus angolensis*, *Afzelia quanzensis, Millettia stuhlmannii* and *Swartzia madagascarensis*. Further, the degree of regulation may range from a total moratorium to ongoing monitoring through licences and permits. The National Forest Policy (1998), Policy Statement (14) supports this recommendation, stating: '*Internal trade and exports of forest produce, excluding those regulated by international agreements of which Tanzania is a party, will be promoted. To prevent forest destruction and degradation through commercial exploitation, trade of certain forest products may be regulated*.'

Figure 51

Diagram illustrating the successive exploitation practices leading to woodland degradation.



A number of other regulatory tools should be explored to assist with exports of woodland/forest products. These include the use of export quotas, piloting forest product certification mechanisms (minimum biological, social and economic standards in Tanzania) and gaining further assistance of the international community. The potential for CITES to help in achieving sustainable international trade in timber products is becoming increasingly accepted, as it represents an established, global, mandatory and co-ordinated system to help verify source, trade levels, legality and sustainability (Keong, 2002; Milledge, 2003b). Options for listing species such as *Dalbergia melanoxylon* on CITES should be explored.

It is important to ensure that regulatory interventions constitute socially acceptable and responsible conservation as otherwise negative impacts of regulations on livelihoods may inadvertantly undermine the original environmental management objectives (Roe *et al*., 2002; Milledge, 2003a,c).

Greater effort should be made to utilise the available information on harvest areas, which up until this study has not been analysed. Further, it is important that forest officials certify the origin of wood products in the field and not at checkpoints to minimise incorrect recording of harvest areas.

The specific recommendations arising from the Rufiji District Forest Action Plan are also supported by the results of this study (Anon., 2002g; John *et al.*, 2003).

- Demarkation of forest boundaries and definition of management responsibility and legal status
- Adoption of zoning and harvesting plans
- Defining and controlling charcoal production areas
- Revitalizing and initiating collaborative forest management arrangements
- Effective law enforcement and revenue collection
- Consolidating the "whole tree" licensing system in the district
- Adopting a moratorium on *Afzelia quanzensis* harvesting and other depleted species
- Promotion of *Afrormosia angolensis* from Class V to Class II.
- Improving the revenue retention scheme at district level
- Revenue generation from tree seeds
- Promoting the planting of indigenous tree seeds
- Development of guidelines for sustainable agriculture in Rufiji
- Awareness raising and cooperation with forest products traders
- Implementing a monitoring system which includes the harvesting area

Additional recommendations

Checkpoint records

Record keeping and analysis are vital prerequisites for management, and actions need to be taken to improve the uniformity and content of records kept at checkpoints. Existing records vary considerably for reasons discussed earlier, and the information is not used in a consolidated manner despite great potential to assist management efforts. In the interest of making the most efficient use of available time and resources, it is recommended that one format be used for all checkpoints throughout the country. A recommended format is given in Annex 5. It is also necessary to instigate formal procedures for collecting and consolidating this information between different levels of government.

Law enforcement assistance

In order to reduce the scale of illegal activities and associated losses of revenue, it is recommended to instigate training activities aimed at increasing knowledge of forest laws, improving inter-agency co-ordination and revenue tracking. This training needs to be continuous and involve relevant stakeholders from both Tanzania mainland and Zanzibar, with an emphasis on informal ports. In the short-term, it is advised that greater law enforcement effort be placed on discouraging the harvest and trade in small-sized timber.

Reducing wastage

Efforts should be made to improve conversion rates for producing sawn wood and charcoal in the study area, which currently results in considerable wastage and lost revenue.

Alternative energy sources

Accounting for around 92% of the country's energy use and around 95% of the total wood products consumed in the country, unsustainable consumption of fuel wood is having a serious impact on unreserved woodland in particular. Development of affordable alternative sources of energy needs to be prioritised at the national level if current deforestation trends are to be reversed, as recognized by the national energy policy (Anon., 2001f; Monela *et al.*, 1999).

The close proximity of the study area to valuable gas deposits near Songo Songo presents some potential to alleviate the dependence on wood fuels, although economic accessibility by the majority of households remains doubtful. Biomass substitutes to charcoal hold potential for producing a cheaper alternative in certain localities, although efforts to produce such substitutes have suffered from the lack of private sector buy-in.

Plantations

Very little wood originates from plantations (soft and hard woods) in the study area, unlike other areas of Tanzania despite their huge potential to supply wood for construction markets (Wells *et al*., 2000). Options for increasing the number and size of plantations under private and government ownership should be explored in southern Tanzania, with attention paid to balancing the successful management of existing wild forests against the clearing of land for fast-growing plantation species.

Further research

In addition to specific research into the illegal and informal trade dynamics mentioned above, further research on influential market forces (such as Zanzibar) should be initiated by the FBD in collaboration with other institutions dealing with poverty reduction and trade in natural resources. Management would benefit from more knowledge covering the movement of natural resource products in Zanzibar ports and urban market surveys on the Tanzania mainland. Management effectiveness would also benefit from more silvicultural research in the area, especially species' ecological requirements and tending practices.

Many factors affect the species composition of wood purchased, primarily market preferences and availability of the timber resource. However, sawmills tend to differ from small-scale timber merchants in that they are less compromised by budgetary constraints and, therefore, more capable of dealing in high value species. However, on the other hand, the distance and accessibility of suitable species tends to be a limiting factor for sawmills. These factors may affect the proportions of different species used by sawmills and individuals. However, little knowledge is available regarding the differences in species selection and trends between the two sectors, an important factor to consider since it has important implications on markets and thus potential management interventions. In this respect, it would also be advantageous for future monitoring to mark harvest licences differently for sawmills and individuals. This would allow for a comparison between the two sectors.

Further research is required to clarify the relative impacts of trades in different timber products on livelihoods. In this respect, it is important to investigate the relative costs and benefits to rural people of converting forest and woodland to agricultural land as depicted in Figure 51. This is important as without understanding the incentives and challenges faced by rural communities, it is more difficult to find socially acceptable and equitable solutions to environmental degradation.

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ANNEXES

Annex 1 Tanzania industrial plantations, 2001

Plantation	Region	Area ha	Main species planted
Meru/Usa	Arusha	6 884.9	*Cupressus lusitanica, Pinus elliotie, P. Caribeae, Eucalyptus saligna, E. maidenii*
Ruvu woodfuel	Coast	633.0	*Pinus caribeae, Eucalyptus saligna, E. tereticornis, Senna siamea*
Sao hill forest	Iringa	40 041.3	*Pinus patula, P. elliotie, P. caribaea, Eucalyptus saligna, Eucalyptus maidenii*
Rubare	Kagera	285.1	*Pinus caribaea*
N. Kilimanjaro	Kilimanjaro	6 478.5	*Cupressus lusitanica, Pinus patula, Grevillea robusta*
W. Kilimanjaro	Kilimanjaro	3 487.7	*Cupressus lusitanica, Pinus patula, Grevillea robusta*
Rondo	Lindi	2 598.7	*P. caribaea, Milicia excelsa, Tectonia grandis, P. angolensis, Dalbergia melanoxylon*
Kawetire	Mbeya	1 700.0	*Cupressus lusitanica, Pinus patula, Eucalyptus maidenii*
Kiwira	Mbeya	2 637.4	*Pinus patula*
Mtibwa	Morogoro	1 408.5	*Tectonia grandis, Cedrela mexicana*
Ukaguru	Morogoro	1 699.0	*Cupressus lustanica, Pinus patula, Pinus elliottii, Pinus caribaea*
Rubya	Mwanza	1 816.0	*Pinus caribaea, Pinus patula*
Buhindi	Mwanza	3 210.0	*Pinus caribaea*
Matogoro	Ruvuma	868.2	*Pinus patula, Pinus elliotii*
Shume/Magamba	Tanga	3 803.9	*Cupressus lusitanica, Pinus patula, Grevillea robusta*
Longuza	Tanga	2 449.4	*Tectonia grandis, Terminalia ivorensis, Maesopsis eminii, Cephalosphera usambarensis*

Source: Anon. (2001b).

Annex 2 Regulatory and institutional framework of the forestry sector

Over the past five years, Tanzania has initiated a thorough revision of national policies and strategies with the aim of realising a 50% reduction in abject poverty by 2010 and total eradication by 2025. These include the National Development Vision 2025, National Poverty Eradication Strategy (NPES), Poverty Reduction Strategic Paper (PRSP), Rural Development Strategy, and Tanzania Assistance Strategy (Anon., 1999a; Anon., 2000d). In recognition of the Rio Declaration on Environment and Development, Tanzania has also committed to implementing Agenda 21 through the review and development of appropriate policies, agendas and strategies.

At the sectoral level, five policies have been recently revised: National Environmental Policy (Anon., 1997b), National Fisheries Sector Policy (Anon., 1997e), National Forest Policy (Anon., 1998a), National Beekeeping Policy (Anon., 1998b) and Wildlife Policy of Tanzania (Anon., 1998c). Other relevant policies include the Tourism Policy (Anon., 1999e), Land Policy (Anon., 1997d), and Mineral Policy (Anon., 1997c). Tanzania established three biodiversity planning tools within the provisions of the Convention of Biological Diversity, the National Biodiversity Country Study (Anon., 1997a), National Biodiversity Strategy and Action Plan (1999) (Mgoo *et al.,* 2000; Anon., 1999i).

Mainstreaming gender, environmental conservation, involvement of local communities and multi-sectoral co-operation are generic components that are considered in policies at all levels. Revision of

policies and national strategies in Tanzania from 1996 onwards is based on learning from best practices and use of appropriate and efficient technologies of natural resource utilisation (Anon., 1996; 1999e; 2001a,b). Tanzania has recognised the importance of creating an enabling environment for the local community to participate effectively in national development programmes. Empowerment of grass root institutions and communities is taken as an important policy issue for promoting democratic systems and economic development. While gross economic growth is necessary, it is important to ensure that it is broad-based and centred on improving the livelihoods of the poor. The revised National Forest Policy and Tanzania Wildlife Policy proffer radical changes, including the empowerment of the local communities to manage forest and wildlife resources in collaboration with government officials and other stakeholders (Anon., 1998a,c).

The eradication of poverty and sound environmental conservation to enhance livelihoods are the main national development priorities in the short and medium term. At policy level, it is acknowledged that, the majority of Tanzanian livelihoods depend on natural resources (Anon., 2001b; Anon., 2000e). However, proven experience has shown that the quality and quantity of natural resources, in particular forests, is dwindling, consequently threatening living standards. At the same time, rural populations may have a strong and positive role to play in environmental management (Anon., 2001h). The National Environmental Action Plan (1994) and the National Environmental Policy (Anon., 1997b) identify six categories of priority environmental problems in Tanzania: land degradation; lack of accessible good quality water; environmental pollution; loss of wildlife habitats and biodiversity; deterioration of aquatic systems; and deforestation. Efforts are ongoing to ensure that activities to address these environmental concerns are also addressing the main focus of the PRSP (Anon., 2001h).

Recently revised legislation regarding land acquisition, ownership and utilisation have impacts on the environment, natural resource conservation and wise use of forest products. *Land Act No 4 of 1999* defines land tenure structure in Tanzania (Anon., 1999c). It is the main implementation legal instrument for the Land Policy of 1995. *Land Act* (1999) Part III, subsection 7 gives declaration to hazardous land that provides opportunities for natural resource conservation. The main contribution of the *Land Act* to management of natural resources is the definition of land tenure systems in Tanzania. However, the majority of local communities in Tanzania are not aware of the *Land Act* of 1999 and how it affects their livelihoods.

Village Land Act No. 5 of 1999 is complimentary to the *Land Act No. 4 of 1999*. The *Village Land Act* empowers the Village Council to manage all village lands in accordance with the principles of a trustee with the villagers being the beneficiaries (Anon., 1999d). The *Village Land Act* is very important to the sustainable management of forest resources since around two-thirds of the total forest land in Tanzania is unreserved, village land (Anon., 1998a). The Act supports wise use of village land, including the sustainable management of natural resources. The Act also encourages a group of villages to manage village land jointly to enhance the conservation of natural resources on a landscape level, for example the joint management of water catchment forests or biodiversity conservation.

Whilst still in operation, the *Forest Ordinance Cap. 389 of 1957*, *Grass Fire Control Ordinance of 1943* and *Export of Timber Ordinance of 1953* are replaced by the *Forest Act of 2002* (passed by Parliament in April 2002). The latter will become fully operational once regulations are approved. The *Forest Act of 2002* and the National Forest Programme (2001-2010) are the main instruments to implement the National Forest Policy (Anon., 1998a).

However, forests outside Forest Reserves may be covered by other legislation listed above such as the *Wildlife Act No.12 (1974)*, *Ngorongoro Conservation Area Authority Cap. 413 Ordinance (1959)* and *National Park Ordinance Cap. 412, Supp. 59 (1959)*. These legal instruments cover the creation and declaration of protected areas and species, permit and licence requirements, royalties and penalties. Of particular importance is the *Wildlife Conservation Act (1974*), which governs the protection, conservation, development, regulation and control of fauna and fauna products in Game Reserves and game controlled areas. The WCA overlap with the *Forest Ordinance Cap. 389* on issues related to hunting of wildlife in Forest Reserves and harvesting of forest products in Game Reserves and game controlled areas whose management does not prohibit consumptive uses of wildlife and forest products.

The *Plant Protection Act No. 13 of 1997* provides for regulation of plants and plant protection substances and the protection of natural environment against plant protection substances. According to the Act, natural environment include its components soil, water, air, species or wild flora and fauna, as well as interaction between them. Effective implementation of the *Plant Protection Act* will contribute to conservation and management of forest resources by regulating importation of undesirable exotic trees and other plant species into Tanzania.

Tanzania is a signatory to various international and regional conventions related to forestry, biodiversity and environmental conservation. Implementation of these conventions has necessitated revision of policies including those used for the forestry sector. The UN Conference on Environment and Development (UNCED), in 1992, adopted globally authoritative Forest Principles and cross-sectoral recommendations on forest conservation (Chapter 11 of Agenda 21). These principles encompassed holistic and cross-sectoral approaches and stressed the sovereign right of individual countries towards sustainable forest management. Relevant international conventions and agreements of which Tanzania is a member include the Convention on Biodiversity (CBD), Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), Convention to Combat Desertification (CCD), Convention Concerning the Protection of the World Cultural and Natural Heritage, Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), Convention on Wetlands of International Importance (Ramsar Convention), United Nations Forum on Forests (UNFF), United Nations Framework Convention on Climate Change (UNFCCC and the Kyoto Protocol).

The conservation and utilisation of wildlife in Tanzania is largely based on categorisation of areas and species according to their degree of protection. The protected area network now covers 38% of the total land area and incorporates 12 National Parks, the Ngorongoro Conservation Area, 28 Game Reserves, 38 Game Controlled Areas and 540 Forest Reserves. In addition, seven Marine Reserves and one Marine Park have been established. The 540 Forest Reserves cover approximately 132 000 km^2 (15%) of Tanzania's surface area, of which three per cent overlap with Wildlife Protected Areas. Human settlement is prohibited within Forest Reserves, although utilisation of the natural resources varies depending on whether they are a Protected or Productive Forest Reserve (Roe *et al.*, 2002).

The overall policy, institutional and legal framework for environmental management consists of the Vice President's Office, National Environmental Management Council (NEMC), sectoral/line ministries and local government authorities (Anon., 2002a; Anon., 2001h). The Vice President's Office is responsible for overall policy-making, co-ordination and planning with respect to the environment. NEMC, established under the *National Environment Management Council Act No. 19 (1983)*, is a national advisory body to the Vice President's Office on environmental issues. The Ministry of Natural Resources and Tourism contains four divisions, namely Wildlife, Fisheries, Forestry and Beekeeping,

and Tourism. The Ministry of Natural Resources and Tourism also supervises five parastatal wildlife organizations, Tanzania National Parks (TANAPA), Tanzania Wildlife Research Institute (TAWIRI), Ngorongoro Conservation Area Authority (NCAA), College of African Wildlife Management (CAWM), and Tanzania Wildlife Corporation (TAWICO). The local government structure also includes wildlife, fisheries, forestry and beekeeping officers whose mandate covers the management of natural resources within every district or division.

Before the mid-1980s, the government (through the Forest Division) managed forests whilst the Tanzania Wood Industries Corporation (TWICO) controlled wood-based industries. However, the large area of forests on open land under public control and the limited resources available for the designated Forest Reserves resulted in poor management. Liberalisation of the forest sector since the mid-1980s has included decentralisation and joint forest management with local communities. The government's role on natural resource management has also changed from that of control and policing to that of providing an enabling environment to the private and business sector to manage natural resources (Anon., 2001a,b; Anon., 2000e). The FBD provides overall policy guidance for the forestry sector although a new executive agency to manage forest resources on behalf of the country is being established under the recently launched Tanzania Forest Conservation and Management Project (TFCMP). Management and protection of the Forest Reserves has been highly decentralised under district administration with the exception of major catchment forests.

According to existing forest legislation, licences and permits are required for the legal harvest, transport, sale and export of timber and timber products. Harvest licences must accompany all timber harvested from reserved and unreserved land, and appropriate harvest fees need to be paid according to the product and species in question. The harvest licences are used to compile monthly, biannual and annual reports to local and central government authorities, summarising the revenue earned and trade volumes by product and/or species. In 2002, the respective annual registration fees for all forest produce dealers and traders were:

Dealers in sawmills, chipboard, plywood and pulp mills	TZS 200 000	(USD 195.12)
Dealers in timber, logs and poles, and curio shops	TZS 100 000	(USD 97.56)
Dealers in charcoal and firewood	TZS 50 000	(USD 48.78)
Dealers in wood furniture	TZS 50 000	(USD 48.78)
Dealers in bee products for export	TZS 30 000	(USD 29.27)
Dealers in other forest products	TZS 20 000	(USD 19.51)

Timber harvest licences are valid for 30 days. Trees should initially be identified in the forest, and the estimated standing volume used to caculate the licence fee. Different minimum breast height (MBH) diameters apply to different species. After felling, the volume of cut logs should be verified against the licence and the logs punched with an official hammer. The logs may then be cut into sawn wood and transported with a Transit Pass.

Forestry levies are set according to the *Forests (Amendment) Rules* (Anon., 2001i) and form the dominant source of local revenue for many districts in the study area. Fees payable on non-plantation forest produce vary according to the product and species. Log fees have gradually increased since 1997 and, in 2002, were TZS 10 000-70 000/m^3 (USD 9.76-68.29/m^3) depending on the timber class, with the more valuable species having the highest fees (Table 36).

Other fees include poles at TZS 200-250 (USD 0.20-0.24) each, withies at TZS 1500 (USD 1.46) per 30, firewood at TZS 3000 (USD 2.93) per m^3, charcoal at TZS 400 (USD 0.39) per 28kg bag, medicinal

barks at TZS 2000 (USD 1.95) per kg and medical plants at TZS 500 (USD 0.49) per kg. These fees are payable for all timber and products harvested from Forest Reserves. In open land, fees are only payable for 24 of the most threatened tree species.

Table 36

Forestry levies paid for timber in Tanzania, 1997-2002 (TZS per m^3)

Class	Before 1997	5/1997 to 6/2000	7/2000 to 2/2001	3/2001 to 5/2002
I	50 000	60 000	70 000	70 000
II	20 000	25 000	50 000	40 000
III	10 000	15 000	30 000	30 000
IV	7 500	7 500	15 000	15 000
V	3 000	3 000	10 000	10 000

Source: Anon. (2002f).

Fees from plantations are lower with log fees for wood at TZS 1500-12 000 (USD 1.46-11.71) per m^3 (except *Tectona grandis* and *Juniperus procera* which cost up to TZS 50 000 (USD 48.78) per m^3), firewood at TZS 500-1000 (USD 0.49-0.98) per m^3 and poles at TZS 200-300 (USD 0.20-0.29) per m^3.

Royalties, according to the *Forests (Amendment) Rules* (Anon., 2001i), for wood harvested from central government Forest Reserves are sent to the Forest and Beekeeping Division headquarters in Dar es Salaam. District authorities retain royalties collected from wood harvested in district authority Forest reserves according to their by-laws. For example, district council levies paid at Kibiti checkpoint (Rufiji District) include TZS 150 (USD 0.15) per piece of sawn wood (12'x1'x1"), TZS 1,000 (USD 0.98) per piece of furniture, TZS 30 (USD 0.03) per bag of charcoal, and a 50% levy on central government royalties paid on all logs.

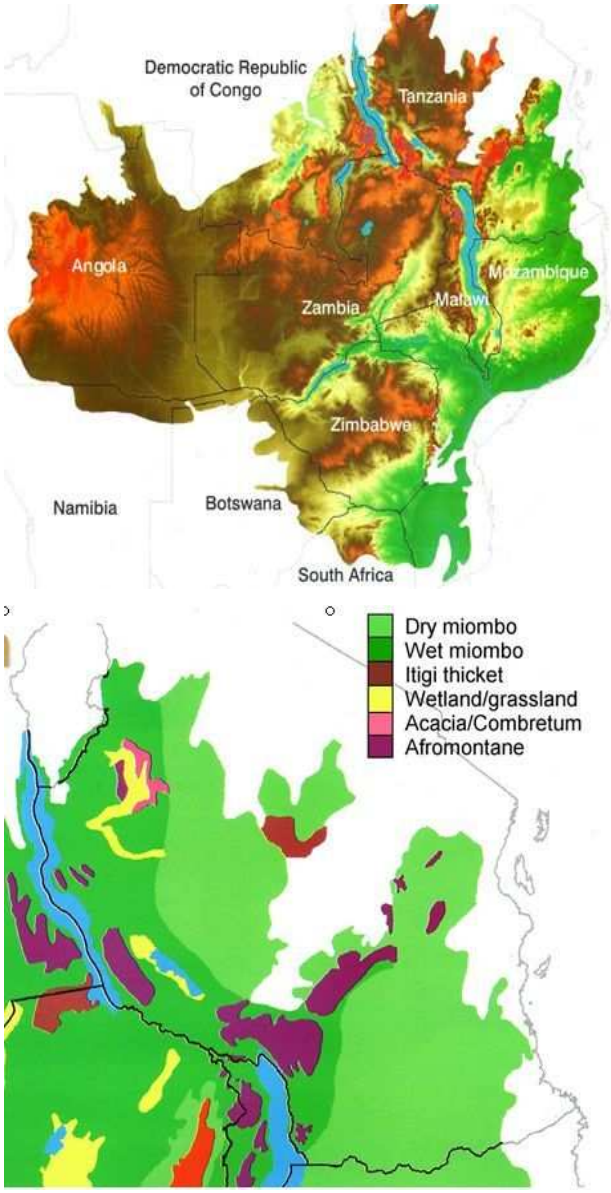
Checkpoints are normally stationed at administrative boundaries for the purpose of monitoring and collecting harvest revenues on specified agricultural products and natural resources. In the case of forest products, officers are supposed to ensure that the transported products match the accompanying harvest licence(s). Considerable variation exists between checkpoints in terms of their mandate, manpower and capacity. For example, checkpoints may be under the auspice of the central government, regional government, district government, village government, or a combination of the above. Checkpoints tend to specialize in collecting revenue for specific products, often from only one direction. In the case of forest products, very few checkpoints are staffed by skilled forestry officers. These factors contribute to losses of government revenue, as well as contribute to the high variation in the quality of records kept.

According to the *Forest Act of 2002*, maximum penalties for offences in forest reserves include a TZS one million fine and/or two years imprisonment. Penalties are compoundable but may not exceed five times the maximum fine. In Rufiji District, fines for defaulters on forest royalty payments are set at five times the official value of the forest produce (Anon., 2002f).

Annex 3 Miombo woodlands of Tanzania

Miombo woodlands span ten countries from the Congo Basin and eastern African savannas west to Angola, covering a total area of approximately 3.6 million km^2 (Figure 54). They can be defined by the dominance or high frequency of trees belonging to the legume sub-family *Caesalpinioideae*, such as *Brachystegia, Julbernardia, Isoberlinia, Baikiaea, Cryptosepalum, Burkea* and *Colophospermum* (Kojwang, 2001). Mature, relatively undisturbed stands typically comprise a 10-20 m high, single storey, partly closed canopy of mostly pinnate-leafed trees; a discontinued under-storey of broad-leafed shrubs; and an often sparse but continuous herbaceous layer of forbs, small sedges and C4 grasses (Chidumayo, 1997; Kojwang, 2001). The majority of miombo woodlands are briefly deciduous, many of the dominant tree species only losing their leaves for a short period of the late dry season. In drier areas, miombo woodlands may be completely deciduous while in moister areas they may be virtually evergreen. There are six key biophysical determinants that pattern miombo woodlands: long-term geological stability; long dry season climate lasting over five months; flat topography and relatively poor drainage; old, nutrient-poor soils; low levels of large mammal herbivory with episodic high levels of insect and small mammal herbivory; and frequent fires (Kojwang, 2001).

Figure 54
Extent of miombo woodland in southern Africa and Tanzania



Source: Kojwang (2001).

In Tanzania, *Brachystegia – Julbernardia* savanna woodland covers almost two-thirds of the forested land (Mgoo *et al.*, 2000). The flora in the miombo woodlands of Tanzania is estimated at around 8500 species (Anon., 2000a; Anon., 1999i). Gardiner *et al.* (1990) documented 106 tree and shrub miombo species in Ihowanza, Iringa Region, while Malimbwi *et al*. (1998) recorded 91 species in Morogoro District. Wildlife protected areas constitute 47% (96 000 km^2) of this zone in Tanzania (Mgoo *et al.*, 2000). According to Kojwang (2001), four major vegetation types occur within miombo in Tanzania, namely dry miombo, wet miombo, Itigi thicket and wetland/grassland (Figure 54).

Dry miombo is the dominant woodland type in Tanzania found in most regions. It is floristically poorer than wet miombo with *Brachystegia speciformis, B. boehmii* and *Julbernardia globiflora* dominating. The canopy is generally less than 15 m in height and trees are deciduous for a month or more during the dry season. Species of *Acacia* are found on clay soils in drainage lines. Annual rainfall is less than 1000

mm and relatively unreliable. The herbaceous layer consists of medium to tall C4 grasses. In drier areas, *Julbernardia and Combretum* species become dominant.

Wet miombo is mainly found in west and south-west Tanzania. These are floristically rich woodlands, often dense with a canopy usually greater than 15 m high with *Brachystegia* species being dominant. Annual rainfall is usually more than 1000 mm. The herbaceous layer comprises tall grasses such as *Hyparrhenia*. In the wettest areas the dominant trees are only briefly deciduous, the canopy is almost closed and shade tolerant species such as *Rubiaceae* are found in the understorey.

Itigi thicket is mainly found in Singida Region. It consists of dry deciduous forests dominated by *Baphia* and *Combretum* species and *Bussea massaiensis*. Edaphic grasslands, floodplains and wetlands that are included in miombo woodland vegetation cover are found in Rukwa, Tabora, Kigoma and Shinyanga Regions. In addition, Afromontane vegetation, consisting of a mosaic of moist evergreen forest and grasslands, is found within miombo woodlands. In Tanzania, Afromontane vegetation is found in mountainous areas in Morogoro, Iringa, Mbeya, Rukwa, Kigoma and Kagera Regions. Miombo woodlands also merge with *Acacia*-savanna grasslands, *Acacia-Commiphora* thornbush and coastal thickets (Holmes, 1995; Kojwang, 2001; Anon., 2000b).

Annex 4. Description of study area

Coast Region

Coast Region covers an area of 33 539 km^2 with two-thirds defined as public land (Table 37). Coast Region is divided into six districts, namely Bagamoyo, Kibaha, Kisarawe, Mkuranga, Rufiji and Mafia. Based on the 1988 population census, Coast Region has a population of over 820 000 people with an average density of 24.6 people per km^2. The average household size in the region is 4.86 (Anon., 1997f). Rufiji District, the only district in Coast Region in the study area, covers a total of 14 471 km^2 (including 1,132 km^2 covered by the Rufiji River with its large flood plain and delta, the most extensive in the country). It is composed of six divisions, 19 wards and 94 villages and 385 hamlets (Mwageni *et al.,* 2002; Table 38). Rufiji District had an estimated population of 182 000 in 2002, equivalent to 12.6 people per km^2 (Mwageni *et al*., 2002).

Table 37

Land use in Coast Region

Land use	Estimated area (km^2)	% total land area
Public land (mostly open forests, shrubs and bushes with no defined owner)	22 642	67.5
Forest reserves	3 013	9.0
Crop land (land under cultivation for food and cash crops)	2 991	8.9
Grazing land (land suitable for grazing)	2 147	6.4
Water area (land under water)	1 132	3.4
State farms (land allocated for diary cattle farming, ranches and plantations)	1 021	3.0
Settlements (land used for human settlements)	593	1.8
Total	**33 539**	**100**

Source: Anon. (1997f).

Table 38

Demographic information for districts in Coast Region

District	Area km^2	Population 1988 census	Annual population growth rate % 1988	Population 2000 projections	Administrative Units		
					Divisions	Wards	Villages
Bagamoyo	9 842	171 918	2.4	231 177	6	16	78
Kibaha	1 812	83 018	2.3	257 110	3	8	39
Kisarawe	4 464	195 709	1.8	102 826	4	11	52
Mkuranga	2 432				4	10	97
Rufiji	14 471	152 316	2.3 *	182 000 *	6	19	94 *
Mafia	518	33 054	3.6	50 529	2	7	20
Total	**33 539**		**2.1**	**823 642**	**25**	**71**	**380**

Note: Mkuranga was part of Kisarawe District during the1988 population census.
Source: Anon. (1997f); Mwageni *et al*. (2002).

In 1996, Coast Region had a total of 391 primary schools, 27 secondary schools, of which 95 and seven respectively, were located in Rufiji District (Anon., 1997f). According to the 1988 population census results, males were more literate (66%) than females (34%) in the district (Mwageni *et al.,* 2002). Rufiji District had the highest number of medical facilities in the region (Table 39).

Table 39

Education and health facilities in Coast Region, 1996

Facilities	DISTRICTS						Total
	Kisarawe	Mkuranga	Rufiji	Kibaha	Bagamoyo	Mafia	
Primary Schools	140	*	95	45	93	18	391
Secondary Schools	4	3	7	5	7	1	27
Vocational training	1	*	1	3	5	0	10
Hospitals	1	0	2	1	1	1	6
Rural Health Centre	2	2	4	2	4	0	14
Dispensaries	14	13	49	25	29	10	140

Source: Anon. (1997f).

Coast Region experiences a typical tropical climate with an average temperature of 28^{o} C. There are two rainy seasons with an average rainfall of about 800 to 1000 mm per year. The main wet season occurs between March to June. Agriculture, the main economic activity in Coast Region, employs over 90% of the population, although agricultural production and income is relatively low. The main food crops cultivated in Coast Region are rice, maize, cassava, sorghum and cowpeas. In 1997, none of the districts in the region produced the annual food requirements to feed its population (Anon., 1997f). Cash crops produced in Coast Region include cashew nuts, coconuts, cotton, sesame and fruits (oranges, pineapples, mangoes and papaws). Cashew nut is the major cash crop in Coast Region that contributes more than 30% of the total regional income. Cotton is mainly grown in Bagamoyo and Rufiji Districts, although favourable soils for cotton growing exist in many parts of Coast Region.

Coast Region has a total forest area of 2 436 839 ha out of which 330 144 ha are reserved and the remaining 2 106 695 ha fall under open public forests. The region has a total of 31 Forest Reserves, two Game Reserves and five Game Controlled Areas. Rufiji District contains 13 central government Forest Reserves and three of the region's local authority Forest Reserves (Table 40). Together, they total some 150 420 ha. Coast Region also includes the Rufiji Delta, which holds some 53 255 ha of mangrove forest, the largest such stand in East Africa (Semesi, 1992).

Development plans in the Coast Region acknowledge that forests have indirect and direct contributions to the society with strong linkages to community livelihoods. According to the Regional Commissioner's 1997 report, most of the forests in Coast Region - especially the open public forests - are in danger of being heavily depleted due to widespread deforestation, shifting agriculture and uncontrolled forest fires (Anon., 1997f).

Table 40

Distribution of Forest Reserves by district in Coast Region

District	Number of Forest Reserves			
	Owned by central govt.	Owned by local auth.	Total	Area (ha)
Bagamoyo	6	0	6	77 235
Kibaha	1	0	1	31 930
Kisarawe	4	0	4	67 559
Mkuranga	3	0	3	
Rufiji	13	3	16	150 420
Mafia	1	0	1	3 000
Total	**28**	**3**	**31**	**330 144**

Sources: Anon. (1998a); Anon. (2000a,b,c); Anon. (1997f).

In 1996, there were around 3200 local beekeepers in Coast Region who own more than 20 000 local or traditional beehives, and about 1379 modern or transitional beehives with a capacity of producing an average of 800 tonnes of honey and 80 tonnes of beeswax in one year (Anon., 1997f). The availability of forests and trees in farmland provide good beekeeping opportunities in the Coast Region. However, the real potential of beekeeping in the region has not been fully realized, with only around 29 000 kg honey and 1560 kg beeswax produced annually. Popular tourist attractions include game viewing, beach resorts, diving, sport hunting and historical sites.

Lindi Region

Lindi Region covers an area of 67 000 km^2 and is divided into six districts, 28 divisions, 116 wards and 365 villages (Table 41). In year 2000, the population of Lindi Region was projected to be around 803 938 people with an average density of 12 people per km^2. The average household size in the region is 4.7. In 1996, Lindi Region had a total of 340 primary schools and 15 secondary schools, mostly in Lindi (Table 42).

Table 41

Demographic information for districts in Lindi Region

District	Area km^2	Popn. 1988 census	Annual popn. growth rate % 1988	Population 2000 projections	Projected popn. density per km^2 in 2000	Administrative Units		
						Division	Ward	Village
Kilwa	13 920	150 212	1.4	177 485	12.8	6	21	74
Lindi Rural	7 538	197 917	0.7	215 198	28.5	10	28	121
Ruangwa	2 080	86 407	0.7	92 951	45.2	3	12	62
Nachingwea	7 070	118 017	2.1	151 445	21.4	5	27	65
Liwale	36 084	52 211	3.1	75 313	2.1	3	15	39
Lindi Urban	308	41 581	6.7	90 546	294.0	1	13	4
Total	**67 000**	**646 345**	**2.0**	**803 938**	**12.0**	**28**	**116**	**365**

Source: Anon. (1997g).

Table 42

Education and health facilities in Lindi Region, 1996

Facility	DISTRICT					Total
	Lindi (U)	Lindi (R) and Ruangwa	Nachingwea	Kilwa	Liwale	
Primary Schools	13	138	70	84	35	340
Secondary Schools	3	5	3	3	1	15
Hospitals	1	1	2	2	1	7
Rural Health Centre	0	7	1	4	0	12
Dispensaries	9	44	17	34	16	120

Source: Anon. (1997g).

Lindi Region experiences a hot and humid rainy season from November/December to April/May and a cool, less humid, dry season from June to October. The pattern of rainfall peaks in April with mean rainfall ranging from 774 mm to 1191 mm per year. Air temperatures are slightly higher along the coast than inland, with the monthly mean ranging from 27.7°C at Kilwa in March to 22.2°C at Nachingwea in July. Relative humidity is highest in the coastal area, averaging 87% in Lindi town during March and April (Anon., 1997g).

The main economic activity in the region is agriculture, which employs over 90% of the population. Subsistence agriculture contributes 60% of the GDP followed by natural resources, which contributes 27% (Table 43). The main food crops cultivated in Lindi Region are maize, sorghum, cassava and rice. In general, the region has not attained self-sufficiency in terms of its annual food requirements with noted deficiencies both in cereals and protein supply. Cashew nut and sunflower are the major cash crops grown in Lindi Region. Lindi Region commands the best production of sunflower in Tanzania (accounting for approximately 72%), and contributed 15% of the total cashew nut production in the country during 1996, ranking second to Mtwara. Livestock and industry are underdeveloped in the region. Due to low employment opportunities in the region, a high number of youth prefer to migrate from rural areas to towns as far away as Dar es Salaam (Milliken, 1999).

Table 43

Sectoral contribution to Lindi Region GDP

Sector	1992/93	1993/94	1994/95	1995/96
Agriculture	59.0%	61.0%	63.0%	66.0%
Natural resources	28.8%	29.0%	28.0%	27.0%
Livestock	5.4%	5.0%	5.0%	5.0%
Industries	1.4%	1.6%	1.6%	1.9%

Source: Anon. (1997g).

A total of 5893 km^2 of Lindi Region is covered by Forest Reserves, of which 87% are managed by central government and the remaining 27% by district authorities. The region has large areas of unreserved woodlands and grasslands that cover an estimated 43 410 km^2. In 1996, it was reported that Lindi Region was experiencing a high rate of deforestation due to uncontrolled cutting of trees for timber, firewood, charcoal and clearing of land for agriculture expansion (Anon., 1997g).

Miombo woodlands suitable for beekeeping cover about 40 200 km^2 of Lindi Region. Beekeeping is practiced mainly in Liwale and Kilwa Districts using traditional methods. A total of 18 000 km^2 of the Selous Game Reserve is in Liwale District. However, due to poor infrastructure the tourism industry is not yet well developed in the region.

Mtwara Region

Mtwara Region covers an area of 16 720 km^2 and is divided into five districts, 21 divisions, 98 wards and 554 villages (Table 44). In year 2000, the population of Mtwara Region was projected to be around 875 977 people with average annual growth rate of 1.4% and an average density of 53 people per km^2. Average household size in the region is 4.4.

Table 44

Demographic information for districts in Mtwara Region

District	Area km^2	Popn. 1988 census	Annual popn. growth rate % 1988	Population 2000 projections	Projected population density per km^2 in 2000	Administrative Units		
						Division	Wards	Villages
Mtwara/ Mikindani (U)	163	75 857	4.0	121 449	745.1	2	13	6
Mtwara Rural	3 597	168 189	1.6	203 480	56.6	6	17	101
Newala	2 126	301 247*	1.0	155 615	73.2	3	16	130
Tandahimba	1 894	*	1.0	183 824	97.1	3	22	103
Masasi	8 940	330 684	1.9	414 480	45.4	7	30	214
Total	**16 720**	**875 977**	**1.4**	**1 078 848**	**64.5**	**21**	**98**	**554**

Source: Anon. (1997h).
*Note: * Includes Tandahimba District*

The main occupation in Mtwara Region is agriculture, occupying around 92% of the population. Poor soils and climatic conditions typical of miombo woodlands limit agricultural potential. Food crops include cassava, millet, sorghum, cow peas, pigeon peas and maize. The major cash crop is cashew nuts, and Mtwara Region ranks first nationally, contributing about 50% of national cashew nut production. Other cash crops include groundnuts and sunflower.

Since 1995, sapphire, christalbella, alexandrite, tourmaline and rhodolite have been mined in Masasi District, providing hopes for boosting the region's economy through development of the mining industry. Similar to Lindi Region, a major capacity limitation in Mtwara Region is the negative net lifetime migration, losing people to other parts of the country, mainly to Dar es Salaam (Milliken, 1999).

Health facilities include 4 hospitals, 14 health centres, 126 dispensaries and 133 MCH clinics. Adult literacy in the region is estimated to be 57.1%, and education facilities include 493 primary schools and 13 secondary schools.

Mtwara Region has a total of 139 295 ha of forests accounting for 8.33% of the regional land. Of the total forest area, 130 545 ha (93.7%) are central government Forest Reserves and 8749 ha (6.3%) are local authority Forest Reserves (Anon., 1997h). The Regional Commissioner's Office reported in 1997 that uncontrolled harvesting of trees for timber, poles, charcoal and firewood exceeds the estimated annual yield from the forests, consequently leading to progressive degradation of the forests. Mtwara Region has a high potential for beekeeping utilising existing miombo woodlands and cashew nut trees. A total of 65 450 ha of Mtwara Region is designated as Game Reserves, although poor infrastructure has limited tourism development.

Annex 5. Sample checkpoint form for recording movement of timber products

KITUO CHA UKAGUZI:	WILAYA:	MKOA:	MWEZI:	MWAKA:

	MWENYE MAZAO				GARI			LESENI, TRANSIT PASI, ERV NA USHURU WA HALMASHAURII					MAZAO								MTOA LESENI	MALIPO TZS	MKAGUZI	
Tarehe	Jina	Jinsia	Umri	Elimu	Namba	Aina	Rangi	Namba ya leseni	Namba Transit pass	ERV Namba	Namba ya Ushuru wa Halmashauri	Namba ya Nyundo	Aina	Aina ya miti	Kiasi kwenye leseni	Kiasi halisi kilichobebwa	Ziada/pungufu	Yalikotoka	Aina ya msitu	Yanakopelekwa	Jina la Afisa aliyetoa leseni	Jumala ya malipo yaliyolipwa TZS	Jina la Afisa aliyekagua mazao	Sahihi ya Afisa aliyekagua

NB. Recommended format for register is A3 size paper.