ASSESSMENT OF THE IMPACTS OF COMMUNITY PARTICIPATION ON THE CONSERVATION OF MANGROVE RESOURCES: A CASE STUDY OF LINDI DISTRICT, TANZANIA.

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT FOR THE DEGREE OF MASTER OF SCIENCE IN MANAGEMENT OF NATURAL RESOURCES FOR SUSTAINABLE AGRICULTURE OF SOKOINE UNIVERSITY OF AGRICULTURE

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DECLARATION

I, Milali Ernest Machumu, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is a result of my own original work and it has never been submitted for degree award in any other university.

Signature: .....

Date: .....17/8/2001.....

DEDICATION

This dissertation is dedicated to my parents the late Milambo Mageye and Maria Nyakwesi Kasuguri, who tuned my youth in favour of education.

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LIST OF ABBREVIATIONS

CSA	–	Canadian Students Association
DBH	–	Diameter at Breast Height
FAO	–	Food and Agricultural Organisation of the United Nations
FBD	–	Forestry and Beekeeping Division
Ha	-	Hectare
ICD	-	Integrated Conservation Development
IUCN	-	International Union for Nature Conservation
ITCZ	-	Inter Tropical Convergence Zone
IFM	–	Joint Forest Management
MMP	–	Mangrove Management Project
MNRT	–	Ministry of Natural Resources and Tourism
NGO	–	Non-Governmental Organisation
NORAD	–	Norwegian Agency for Development Corporation
NTFP	–	Non Timber Forest Product
PRA	–	Participatory Rural Appraisal
SPSS	–	Statistical Package for Social Science
UNESCO	–	United Nations Education and Science Organization
UNDP	–	United Nations Development Programme
URT	–	United Republic of Tanzania
VNRC	–	Village Natural Resources Committee

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

1.1.1 Mangrove Resources

The word mangrove refers either to the plants of tropical intertidal forest communities or to the community itself (Semesi, 1991). Mangroves are trees and bushes growing below the high - water level of spring tides (FAO, 1982). "Mangrove" is a general term applied to an association of physiologically specialised plants inhabiting muddy swamps, creeks, deltas and sheltered sea coasts periodically inundated by tides (Banyikwa and Semesi, 1986). The trees are only one component of the complex mangrove ecosystem, which includes associated bodies of water, substrates as well as a variety of other plants, animals and micro-organisms (Semesi, 1986).

In Tanzania mangroves occur along the coastal area from Kenya boarder in the north to that of Mozambique in the south (Mbwana, 1986). The total length covered by mangrove ecosystem along the coastline is 800 km. The total area of mangrove forests in Tanzania mainland is estimated to be 115,500 hectares (Semesi, 1991). The largest area is found in Rufiji delta (53,255 ha). Fairly large areas are also found in Tanga (9,403 ha), Bagamoyo (5,636 ha) and Kilwa (22,429 ha) (Semesi, 1991).

All mangrove forests in Tanzania are gazetted as forest reserves. Laws and regulations governing mangrove forest reserves are included under forest ordinance of 1957, published in 1958, forest ordinance chapter 389 of the laws (Principal Legislation) Supplement 57 part V. In Kiswahili the mangrove forests are referred to as Kapa or Kokoni and the mangrove trees as mikoko (Semesi, 1991).

There are eight common mangrove species in Tanzania, though not all are found in every forest. The species are: *Rhizophora mucronata, Sonneratia alba, Ceriops tagal, Bruguiera gymnorhiza, Avicennia marina, Lumnitzera racemosa, Xyalocarpus granatum* and *Heritiera littoralis* (McCusker, 1971 cited by Semesi, 1986).

Records show that along with slaves and ivory, mangrove poles constituted a major regional trade by the 9th century (Semesi, 1991, cited by Kajembe *et.al*, in Press). The tree-less towns of South Western Arabia and the Persian Gulf, especially Oman, Siraf and Basra, all needed mangrove poles for construction. Somalian, Arabian, Persian and Indian traders exploited mangroves, and it was not until 1898 in Tanganyika (now Tanzania mainland) when the colonial German administration established an ordinance dealing with mangroves, especially those of Rufiji delta. On the basis of the legislation, merchants were allowed to purchase wood and related products. About 70-80 dhows from various ports called on to load mangroves from the Rufiji Delta. Following the end of German Administration, the British expanded the mangrove reserves, and after independence the reserves were continued to be maintained. The Tanzania government took little measures to manage and control over utilization of the mangroves by commercial pole traders (Semesi, 1993).

1.1.2 Traditional Forest Management Initiatives in Mangrove Conservation

Forestry and Bee-keeping Division (FBD) of the Ministry of Natural Resources and Tourism (MNRT) is responsible for the protection and management of the mangroves. For quite some time the management strategy was based on top-down approach. In the top-down management approach there is little control over the resource and invariably there is no multiple use policy incorporating commercial and traditional user interests. Due to the failure to control the resource, there was large commercial cutting of mangroves (Semesi, 1991). For many years the mangroves received insufficient attention with respect to both biological investigation and management (FAO, 1994). Thus, mangrove has been a forgotten ecosystem, neglected by scientists, undervalued by the governments and destroyed by developers (UNDP\UNESCO, 1991). According to Kajembe, (1997) the top-down management approach create a kind of institutional vacuum, which lead to open access regime. Under open access situation, degradation of forests is an expected outcome. In Tanzania, the mangrove resource has been over-exploited due to human population growth through the increase of settlements, agricultural activities, establishment of solar salt pans, fuel wood collection and over-cutting of valuable species for poles and withies which led to depletion and degradation of mangrove resources (Semesi, 1991). In 1994 FBD through the Norwegian Agency for International Development (NORAD) funding, established the Mangrove Management Project (MMP) in three zones namely: Northern zone, which include Tanga, Muheza and Pangani districts. Central zone which include Dar-es-Salaam region, Kisarawe, Mafia, and Rufiji districts. Southern zone which include Kilwa, Lindi and Mtwara districts.

1.1.3 Joint Forest Management (JFM) as a Management Strategy for the Mangrove Project

JFM is a management regime practised by MMP. The concept of joining forces with local communities in the conservation and management of forest resources is known as Joint Forest Management (JFM). It is a movement towards a more democratic management of forest resources. Joint Forest Management represents a fundamental shift in forestry management methods and conceptually envisages a movement from centralized to decentralized management. JFM is a 'new paradigm', which challenges the principle or premise of prior knowledge and previous forest policies. JFM is a type of forest management, which recognises the symbiotic relationship between the forest community and forests and hence treating people as 'partners'. The origin and evolution of JFM has been much influenced by the social forestry movement and practices (Mvena and Kajembe, 1997).

It might appear paradoxical that the effort to achieve effective decentralization is a pressing policy issue in all parts of the world (Agrawal, *et al.* 1999). In many aspects, the modern nation-state is proving to be both too small and too large. When it comes to a movement of goods and financial investments, national boundaries are becoming less and less important. On the other hand, when it comes to making wise decisions about the use of natural resources such as forests, a substantial body of research consistently establishes that very large-scale units of government are not effective.

Some scholarly articles about the "tragedy of the commons" recommended that the state should control most forest resources to prevent their destruction; others

recommend that privatising those resources will solve the problem. In Tanzania neither the state nor the market is uniformly successful in enabling individuals to sustain long-term productive use of forest resources (Kajembe and Kessy 1999).

Though Joint Forest Management seems to be accepted in Tanzania, progress towards this strategy has been slow. The reasons for the slow change are many: In some cases the foresters are threatened by the change that seems to be taking some of their powers. They perceive power as zero- sum commodity; what is given to others must first be taken away from them (Kajembe and Kessy, 1999). In other cases both local communities and foresters are not prepared to take on the type of responsibilities envisioned in joint forest management.

Besides of the slow change, the kind of experimentation going on in forestry sector in Tanzania since the mid 1990s is an exciting development for the future of forestry in the country. Both central and local governments capacity to protect forest reserves is declining, with declining budgets and retrenchment of manpower just as pressure is increasing, and as awareness of the importance of retaining natural forests for environmental stability and production purposes is growing (Wily, 1995).

Under right conditions, such as appropriate legal framework and right motivation it is the local people who may become the strongest and most effective guardians of natural forests and at very little cost. In the process, the burden of policing by government drops out and foresters are at last able to fulfil their preferred role as technical advisers (Wily, 1995). Thus, there is a need to reconcile the local community objectives and the state forest management objectives during decision-making. The state usually aims at large scale management objectives including

utilisation of forest to increase national income while, local communities are mostly interested in small-scale utilisation such as wood and non-wood exploitation (Kessy, 1998). It is not surprising that the current paradigm in natural forest management in Tanzania is looking more and more to local communities as the forest managers of the future (URT, 1998).

Involving the public in decision-making process is necessary to promote local support and acceptance for integrated forest management planning. Just as it will be the duty of the forest service to explain to the public the implications of various decisions, the greatest value of working with local communities will most likely be in using their knowledge of local conditions and needs. Customary rights should be respected where possible, decision-making should not marginalize the traditional incomes of local people nor their access to reasonable amount of forest products without offering practical and acceptable alternatives (FAO, 1994).

1.1.4 Management Objectives of the MMP

The main goal of MMP during phase I, which commenced in 1994, was to maintain the integrity of mangrove ecosystem. While in phase II which started in 1998, the project goal was socio-economic contribution of mangrove resources to the society on sustainable basis.

The specific objectives include:

- To enhance the contribution of the mangrove ecosystem to the local and national economy on sustainable management basis.
- To improve the management of mangrove ecosystems.

The management strategies to achieve the above mentioned objectives are geared towards institutional and operational levels (Semesi, 1991). Under institutional strengthening, MMP has the overall authority for the field staff and training in matters related to mangroves. While in operational levels, people through their Village Natural Resources Committees (VNRCs) participate in various conservation activities such as patrols to control illegal harvesting and planting of mangroves to fill the gaps. Also certain mangrove areas have been allocated to villagers living along the coast for their small-scale local uses, such as firewood and raw materials for handcrafts (Semesi, 1991). The by-laws guiding conservation proposed by village governments are waiting approval of District council on behalf of the Ministry of Local governemnt and the VNRCs have granted permission to confiscate mangrove resources harvested illegally and to levy fines upon offenders.

1.1.5 Zoning as Management Strategy

According to the existing literature and more particularly as reported by Semesi, (1991) mangrove forests in Tanzania have been categorised into four zones:

- Forests, which receives total protection. These are divided into three groups
  - Environmentally stressed mangroves;
  - Mangroves that maintain genetic resources; and
  - Protect flora and fauna.
- Forests, which are under production. These are ecologically stable areas with sufficient regeneration potential to permit sustainable harvesting.
- Degraded areas that have been closed from cutting for period of varying lengths to allow for recovery and rehabilitation.

- Areas that have been set-aside for development activities such as aquaculture and solar saltpans.

1.2 Problem Statement and Justification of the Study

Since colonial period, protection of forest reserves has been done by the state using the forest ordinance administered by the Forestry Division. This ordinance does not permit either entry into or free access to and utilisation of forest produce from the reserves by the general public for daily livelihood (Malimbwi and Sjoholm, 1994). Forestry-employed staff did all protection activities and operations and the public was involved only under special arrangements.

As a result, there has been little appreciation for the complexity and importance of these resources by the communities. Under such a situation, local people regarded the mangrove forest reserves as the government property without any direct benefit from them.

MMP as a project has involved communities in various activities such as mangrove planting and patrols. The involvement of the local people in the conservation helps in gaining information about people's views, values and priorities. This is contrary to conventional management approach whereby, rural people are rarely consulted in planning or given an active role in development activities. This is because the poor have no organisational structure to represent their interest (FAO, 1994).

Besides of all these positive efforts done by MMP, there is little information if any, on the impacts of community participation in mangrove conservation. Due to lack of impact assessment, there is no clear picture as to whether both the resource and people welfare have improved or not over the project period. This study aimed at assessing the impact of Joint Forest Management strategy on the conservation of mangrove resources.

1.3 Objectives of the Study

1.3.1 Overall Objective

The overall objective of this study is to assess the impacts, effectiveness and sustainability of community participation approach in the management of mangrove forest resource.

1.3.2 Specific Objectives:

Specifically the study intended to:

1. Assess the status of mangrove resource in the study area.
2. Assess the impact of community participation in the conservation of mangrove resources in terms of decision making, implementation, benefit sharing and evaluation; and
3. Identify socio-economic factors, which enable or constrain community participation in mangrove conservation.

1.4 Research Questions

1. What is the current status of mangrove resources?
2. What are the major uses of mangroves?
3. To what extent mangrove resources have been improved or degraded under community participation approach?
4. Are the local people involved in decision-making, implementation, evaluation and benefit sharing?
5. What are the socio-economic factors, which enable or constrain community participation in conservation?

1.5 Conceptual Framework

Without theoretical framework to bind facts together, knowledge is fragmented into discrete segments. Research performed without the guidance of theoretical framework is usually sterile for the reason that the researcher does not know quite well what data to collect and when he or she has them, he or she can not put them to use (Kajembe, 1994).

In this study it was postulated that the mangrove resources and the community are influenced by both endogenous and exogenous socio-economic factors. Endogenous changes relate to the way the society is internally organized and linked to natural events such as migration, drought and internal conflicts. Exogenous change relate to those forces that are external to the community and simultaneously affect the

functions of those communities and consequently their natural resources. Such forces include: state policies and economic reforms (Kajembe and Kessy, 1999).

In order to attain sustainable management, there must be an equilibrium between mangrove resources and the surrounding communities. This occurs when the resource meets the needs of people without itself being degraded. The conceptual framework is depicted in Figure 1.

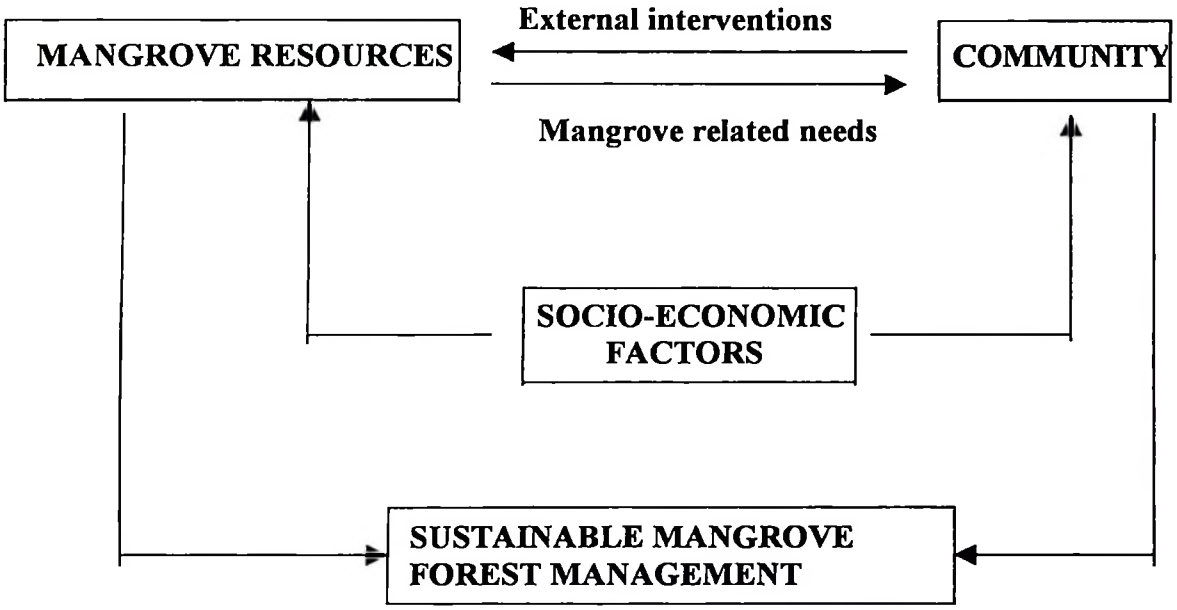


Figure 1: Conceptual frame work of the study

1.6 Study Limitations

Some limitations were encountered during the study. These include:

1.6.1 Specification Error

When deciding on variables to be incorporated in the multiple regression model, there is always a possibility of omitting important variables from the model or selecting irrelevant variables (Gujarat, 1995). In practice one rarely knows the correct variables to include in the model. To some extent, there is some trial and error involved in choosing the right model for empirical analysis. In this study, the coefficient of determination (R^2), for mangrove trees planted is 0.14, which is rather low. This suggests that there are other independent variables, which could explain the variation in the dependent variable, which were not specified in the model. Therefore, for any further empirical studies on the subject matter, the researcher is deemed to accommodate more refined variables to arrive a more conformable multiple regression model.

1.6.2 Measuring Error

Some parameters particularly height and diameter of mangrove trees might have been underestimated or overestimated. This was due to canopy closure, which caused some difficulties during sighting the tree tops.

1.6.3 The Problem of Recall Data

Quantitative variables in the participatory rural appraisal exercises and questionnaires surveys were based on estimates and memories. For example, it was difficult for a farmer to estimate the land used in agricultural activities, distance from the homestead to the mangrove forest reserve and consumption data such as fuel wood used per week.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Ecological Characteristics of Mangrove Resources.

The intertidal zone consists of a great variety of diverse habitats including mangrove swamps, rocky, sand and muddy shores and estuaries. Mangroves are a group of higher plants, generally common in sheltered tropical shores in the intertidal zone. They are also found in estuaries and in deltas influenced by tides where there is a high variability in salinity (Mac-Nae, 1968). The intertidal zones are the areas covered and uncovered by water during high and low tides. They are characterised by both terrestrial and marine conditions. That is why sometimes they are called transitional zone between terrestrial and marine life (Wolf, 1987).

Mangrove resources occur in more or less pure stands. The zonation is quite sharp and the species composition can change within little distance (Semesi, 1993). In areas where less water reaches, the mangrove trees tend to be shorter, open and are dominated by stunted *Avicennia marina* and *Ceriops tagal.* The driest parts do not support mangrove tree growth (Banyikwa & Semesi, 1986).

2.2 Regeneration

2.2.1 Natural Regeneration

Natural and artificial regeneration of mangroves do not take place in most abandoned rice farms and solar saltpans, and other impoundments such as shrimp farms and fish ponds is generally hampered because of man-made alterations to the hydrology imposed by the dykes and bunds surrounding them. If such hydrological conditions that existed prior to the impoundment, natural regeneration is usually rapid and successful (FAO, 1994). In Tanzania rice farms are overgrown by grasses and sedges and solar saltpans have got high concentration of salts that hinder both natural and artificial regeneration (Semesi, 1991). However, due to the ability of the mangrove species particularly the *Rhizophora* species, to regenerate naturally through viviparous seeds, a method similar to the tropical shelter wood system can be adopted (Nwoboshi, 1992). This involves a gradual opening of the forest canopy to induce regeneration. In Tanzania, site protected by breakwater and subjected to little wave action were found to develop mangroves from natural seedlings (Mkomwa, 1992). *A.marina* and *S. alba* have been recorded to colonise newly formed silt banks, under the assumption that their peg roots can stabilize them. Presumably in the succession are *R. mucronata* and *B.gymnorhiza,* which can grow in stabilized substrate, and they are normally replaced by *A. marina* and *C.tagal* (Mkomwa, 1992).

2.2.2 Artificial Regeneration

Artificial regeneration involves employing silvicultural techniques in raising the seedlings, planting, and then tending the established plantations (Nwoboshi, 1992; FAO, 1994). Although this system is more expensive than the natural regeneration method, it is more effective (Adegbehin *et al.*, 1991). The Germans tried artificial regeneration in Tanzania and later the British before it was abandoned in 1937.

2.3 Socio-economic Activities

2.3.1 An Overview

In Tanzania clearance of mangroves for rice farms takes place only in Rufiji delta. It began in the early 1960s. Now it has stopped as a result of FBD stopping socio-economic activities in the mangroves. The clearance of mangroves for rice farming in the Rufiji Delta has by no means stopped Mangrove being forest reserves, are protected from human encroachment however, the laxity in law reinforcement has changed the attitude of the villagers towards the resource. They believe that they have the right to clear and cultivate in the mangrove areas.

The mangrove areas most affected by the establishment of solar saltpans are those in Lindi, Mtwara, Tanga and Bagamoyo. Records show that saltpans were started in the early 1930s. Salt works have expanded to 3,100 ha of solar saltpans in the mangrove areas by 1939. The majority of the pans were not properly sited or constructed due to lack of knowledge and capital (Sutton, 1973).

Currently the permission granted to the African Fishing Company by the government to establish prawn farms in the Rufiji delta has been stopped. This was due to environmental hazardous which could be caused by establishing of prawn farms (Aquaculture) including cutting of mangrove trees, toxication of marine organisms from chemicals and feeds, extinction of natural prawns caused by diseases brought by imported prawns and human being side effects. All these effects are experienced in countries that are practicing prawn farming like Thailand, Indonesia, Malaysia and Japan. Also scientists from local institutions and international organizations have given recommendations about prawn farming and their effects to the government (Dallu, personal communication). For the time being no minerals or drilling for oil, which is taking place in mangrove areas in the country.

2.3.2 Threats to Mangroves

In the Lindi District and else where in Tanzania mangroves are under threat due to exploitation as a result of rapid increase of human population and poor management strategies. Clear felling of mangrove for solar saltpans establishment is among ecologically unsound practices. The use of DDT and other pesticides on upland farms, construction of dams or major irrigation schemes may pose a threat. Semesi (1993) pointed out that mangroves are endangered by oil, industrial pollution, and house construction around towns particularly in Dar es Salaam.

In Tanzania though the main threats to mangrove come from human activities, there are also natural factors that affects this dynamic and constantly changing ecosystem. The natural factors include river floods, sea level rise and sand deposition.

The consequences of mangrove destruction includes:

- Decrease of fauna and flora associated with or dependent upon mangrove forests e.g. fish and prawns.
- Increase of siltation, which can cause corals death hence, reduction in production of fish and tourism.
- Increase of coastal erosion, which may have very negative effects on the environment.
- Decrease in production of mangrove products such as poles and firewood.
- Reduction in the amount of revenue paid to the government from royalties.

Women are the most affected group when the nearby mangrove resource no longer suffices for the needs of the community. They must go longer distances in search of firewood and spend more time searching for crabs, molluscs and prawns for their families (Semesi, 1993).

2.3.3 Externalities of Mangrove Forests

One of the major causes of resource degradation is an external effect (externality), it happens when tangible and intangible benefits from mangrove resources go far to other inland communities. For instance mangrove poles and withies (tangible goods) from Lindi are used for construction in Masasi and Nachingwea Districts. Other

effects (intangible) include windbreak, provision of breeding nurseries, trapping of sediments and toxic materials from uplands, controlling of soil erosion and climate amelioration. However, the costs of protection remain only to the people living close to the forests (Pereira, 1986). According to Hufschimidt *et al.*, (1983), an external effect emerges if production of other producers and the effect is unpriced or uncompensated. A large part of costs of conserving biological diversity are therefore being borne by those least able to pay, even though the benefits are increasingly recognized as global (Wells *et. al.*, 1992). When common poor resources are exploited by individuals maximizing their private utility, the resource will inevitably be over used because the costs of overuse will be shared collectively, while all the profit will be privately appropriated (Hardin, 1968).

2.4 Mangrove Products and Services

The use and values of the products obtainable from mangroves are many and important. To illustrate the use value of mangrove, Apan (1992), cited by Wouters (1993), listed the tangible and intangible products, which can be harvested from the mangrove.

2.4.1 Tangible Benefits

Mangroves contribute both tangible and intangible benefits to the economy. Tangible benefits are quantifiable whereas intangible benefit are difficult to quantify. For the purpose of this study, tangible benefits embrace timber, woodfuel, tannin and pulp.

2.4.2.1 Timber

The *Rhizophora* has desirable qualities (for example, high density and durability), which are comparable to many commercial species used as building material (Choong *et al.*, 1990). They are however not valuable as timber because of their tendency to split and warp when dried (FAO, 1994). Possible uses of the wood include making of agricultural implements, boat construction (knees and ribs), heavy construction such as rafters, beams, joints, fence posts and poles (FAO, 1994). As pointed out by Banyikwa (1986) and Chakrabarti (1987) the best mangrove timber comes from *Heritiera* species, one of the species growing to large dimensions. *Bruguiera* timber is used for construction, as rafters, beams and poles. Creosoted *B. gymnorrhiza* transmission and telegraphic poles were used in Andaman Island (FAO, 1994).

2.4.2.2 Wood Fuel

2.4.2.2.1 Firewood

Practically all mangrove species are used as firewood, but their properties differ. *Rhizophora* is especially popular as the wood is heavy and burns with an even heat. The wood is clean with little smoke, ignites easily when partially dry and is easy to cleave (Watscon, 1928), cited by FAO (1982). *Rhizophora* has high value as fuelwood, which is primarily due to high wood density. Moreover, it is in great demand for smoking fish, due to abundant smokes and peculiar smell produced by combustion, which confers a special taste on the fish. *L. racemosa* is favoured as fuel

for domestic purposes and is commercially harvested as in the case of Matang in Malaysia, or collected by fishermen (FAO, 1994). *Xylocarpus* species burn very fast but do not emit even heat. *Avicennia* species have lightwood of low calorific value but its clean white smoke is suitable for smoking fish (FAO, 1992).

2.4.2.2.2 Charcoal

Rhizophora species make charcoal of excellent quality. Other mangrove species such as *B. gymnorhiza* and *Ceriops* species are also used but are quantitatively less important. Mangrove charcoal is the main forest product from mangroves in Thailand and West Malaysia, Also in Indonesia and Vietnam as well (FAO, 1982). The charcoal is mainly used for cooking.

2.4.2.3 Tannin

Wood extract such as cutch (crude tannin) and dyes can be obtained from the mangrove species in commercial quantities. Tannin popularly used in the leather industry accounts for 15% of the weight of under barked mangrove log and obtained largely from the bark (Adegbehin *et al.*, 1991). *Rhizophora* and *Lumnitzera* species provide tannin, which is good for colouring fishnets. Tannin is used in the leather industries and for dying clothes and mats (Kai *et al.*, 1974; Wouters, 1993). *Rhizophora* bark produces very fine tannin of the phlobaphene yielding catechol group, which is not broken down by ferments, and it is thus very suitable for leather work (FAO, 1994). The amount of tannin varies some how with bark thickness, position of a tree stem, location of tree, dryness of the bark, as well as between species (FAO, 1994).

2.4.2.4 Pulp

The African species of *R. racemosa* is reported to be suitable for making dissolved pulp although some problems exist due to the inorganic crystals present in the wood (Sugden and Von cube, 1978). FAO (1982) pointed out that mangroves might be used as fodder for cattle and camel, honey and beeswax collection, and oil extraction. Oil extracted from the seeds of *Cerbera* is used medically, and oil from *Xylocarpus* seed is used for burning and hairdressing.

2.4.2 Intangible Benefits

According to choong *et. al*, (1990) and FAO, (1994) 'intangible' benefits accruing from mangroves are:

a) Coastal protection against wave and wind erosion; (b) moderating the effects of coastal storms and cyclones; (c) shelter habitat for diverse wildlife, particularly avifauna: (d) nutrient sink-effect and reduction in excessive amounts of pollutants, and (e) trapment of upland runoff sediments, thus protecting near shore reefs and reducing water turbidity. Mangroves also provide opportunities for education, scientific research, recreation and eco-tourism.

Fishery is another important product obtained from mangrove swamps. Mangrove swamps provide a rich source of food for coastal and offshore marine communities (Choong *et al.*, 1990; Raymond and Johnson, 1993). They serve as feeding, breeding, spawning and nursery grounds for many marine organisms. The tidal characteristics of the mangrove swamps provide an ecosystem, which offers great productivity

potential for marine biota, and specifically are well suited for fish and shrimp production (Choong *et al.*, 1990)

From the economic point of view, mangroves are more important for the aquatic production. Kapetsky (1985), cited by FAO (1994), estimated that the average yield of fish and shellfish in mangrove area is about 90 kg ha -1, with maximum yield being up to 225 kg ha-1.

2.5 Forest Management Systems and Their Evolution

2.5.1 State Forestry

State forestry under German rule began slowly in 1892, gaining momentum in 1903 with the appointment of the first full time professionals and subsequently the establishment of the forest conservation management a year later (Neumann, 1997). Upon taking control of German East Africa, the British administration closely followed the Germans' forest regulations. The legal framework for administering the territory's forests was established by the 1921 forest ordinance, which incorporated all the previously designated German Forest Reserves. When Tanganyika gained independence in 1961 she inherited almost the same colonial legal framework for administering forest resources. It became almost commonly accepted doctrine that proper forest management was best assured through the creation of legally gazetted forest reserves, which were to be managed by "professional" forest services (Kajembe, 1994).

The establishment of state forests paved the way for the creation of forest reserves, which were gazetted by the government to give them a legal status. In most of the localities, forestlands were either previously occupied by rural people or they were a source of supply of forest produce such as firewood, constructional poles, edible fruits and traditional medicines. The gazettement of such forest lands embraced evacuating the local people followed by legal restrictions both in accessibility and procurement of forest produce. In such exercises no alternatives for the rural communities in meeting their forest-based basic needs were provided. Consequently such rural people became worse off as the forest resources which formerly supplied their forest-based basic needs became managed almost exclusively for the far distant consumers with hardly any trickle down effect (Mgeni and Solberg, 1995). Professional forestry in many third world countries including Tanzania developed in isolation from rural people. One of the strategies adopted by foresters was the protection of the forest reserves from the rural communities by policing. This included the enforcement of the punitive laws stipulated in the forest ordinances of many third world countries. This role of foresters created suspicious and mistrust with the rural masses (Mgeni and Solberg, 1995).

State forestry programmes also had the effect of extending state authorities into the most remote areas. Through road building, surveying and the construction of field stations, forest management activities dramatically increased the level of surveillance and control over rural societies and helped to secure territorial dominion (Neumann, 1997).

Despite of the gloomy picture accounted above on the relationship between forest service and rural communities, some rural members benefited from state forestry through the provision of employment in both forestry and forest based industries. In addition some countries have accommodated customary or traditional user rights which enable rural communities to acquire some specified forest produce from the forest reserve for household consumption.

2.5.2 Community Forestry

By the mid of 1970s, it had become apparent that industry -led theories and programmes were not pragmatic for many nations. Even in situations where there was a success, the achievements were highly localised and too often insignificantly contributing to the people's total basic needs. Consequently development-thinking practice in forestry started shifting towards rural led focus (Mgeni and Solberg, 1995). With varying names such as social forestry, forestry in rural development and community forestry. In this study the term community forestry is adapted.

There is an interest in reorienting management practices from the conventional approach based on the state control and professional management by the foresters to community forest management. This approach aims at meeting a multiplicity of local needs and devolving responsibility for forest management to local institutions (Dewees, 1996). Professional forestry management refers to activities carried out by specifically trained people, normally employed by state or other public organizations with specific forest management objectives. Decisions taken by these professionals are often primarily based on national and long-term interests or commercial

intentions (Kajembe, 1994). If forestry is to take its rightfully place in local community development, the active interest and involvement of rural population in forestry programmes right through from the designing stage will be essential, followed by a continuous communication between the people and various government agencies (FAO, 1978). The most important requirement for supporting and building on existing practices is the existence of national policies and legislation which create an "enabling environment" for community based natural resources management (Clarke, 1994). Kajembe (1994) argued that there are three key actors in community forestry development: Farmers, extensionists and professional foresters. This triangle of relationship constitutes social arena marking the actual locale of community forestry in Tanzania.

Before mid 1970s, rural development was generally considered from the perspective of food and agricultural production while the forest sector was regarded as being peripheral. However, in the mid 1970s, a number of events manifested the importance of forest resources to rural people and rural development in general. Crystallisation included the dependence of rural people on forest resources, trees and shrubs. Simultaneously the 1973 jump in fossil energy prices drew the attention to the fact that rural people in the third world countries will continue to depend on wood as their main fuel for cooking and other household uses for the foreseeable future. This was perceived to be quite critical to the extent that it was labelled as the "wood fuel crisis" (Leach and Mearns, 1988).

Deforestation due to wood fuel acquisition and agricultural expansion was linked to declining productivity of food production systems and land use deterioration.

Drought in Africa and flooding in South Asia during the mid 1970s, underpinned the impact of deforestation and degradation of woody vegetation cover augmented the thinking on the subject of forestry in rural development (Arnold, 1991). The need for rural - focused forestry emerged as a result.

Community forestry in this study is defined as "any situation which intimately involves local people in a forestry activity. It embraces a spectrum of situations ranging from woodlots in areas which are short of wood and other forest products for local needs, through growing trees at farm level to provide cash crops and the processing of forest product at the household, artisan or small industry level to generate income, to the activities of forest dwelling communities" (FAO, 1978). The main objectives of community forestry are meeting fuel and other forest - based basic needs at both rural household and community levels; providing food and stabilization of the supporting environment for sustainable food production; and the creation of opportunities for income earning and employment within rural areas (FAO, 1978).

Conceptually, community forestry was visualized to be participatory bottom- up approach addressing rural needs with the external assistance being of supportive role. A number of initiatives at both national and international levels were designed to satisfy the perceived rural needs for firewood and other forest- based products as a matter of urgency. One of the early initiatives perceived to be of particular importance was wood fuel shortage (Arnold and Jongma, 1978). From the analysis it was found that existing woody resources were being overcut to meet fuelwood demand. With a thrust on increasing wood fuel supplies, a very large portion of the initial investments in community forestry was in the mode of afforestation

programmes. Another emphasis was on organizing community forestry at community level like the village woodlots in Tanzania. Much emphasis was also put on establishment of new plantations rather than on management existing of forest resources.

2.5.3 Top-down Versus Bottom-up Management Approach

In the implementation of top-down programmes, there are always problems particularly with regards to technical solutions identified by the specialists who do not fit with the culture of the local people. Moreover, part of beneficiaries become unwilling to participate because they do not understand how the programme works; the list of identified needs for local people is always incomplete; and the order of priorities of problems do not accord with that of local people themselves (Shaxon, 1989 and Rist, 1991). Due to these problems, rural development is not successful and not sustained. Externally sponsored management plans, which do not incorporate local institutions, normally get less support from the people (Kajembe, 1994).

Contrary to top-down approach, for rural development to be successful and sustainable, the inherent enthusiasm of the beneficiaries must be unlocked (Shaxon, 1989). Participation of the beneficiaries can be obtained by accomplishing certain procedures. Such as understanding the local community structures and needs; communicating with the community about the techniques to be used; explaining the meaning of the programme and the way it will deal with the community problems and; obtaining the community approval to the program (Noronha and Spear, 1985).

2.6 Peoples' Participation

"Participation" has become an accepted term in development vocabulary. It is however, a difficult term to define as different people interpret it differently. There are those who see participation as a continuum to illustrate the direct relationship between interpretation and development analysis (Oakley, 1987). Interpretation of participation on a development continuum include:

a) Community participation

b) Rural development and

c) Organised efforts to increase control over resources (Oakley, 1987).

Community participation is viewed as a process whereby beneficiaries or clients influence the direction and execution of a development project. Participation in this sense occurs in the form of input or contribution towards a project in order to increase chances of success and, correspondingly, personal economic benefit. In rural development, participation includes peoples involvement in decision making process, in implementing programmes, their sharing in the benefits of development programmes and their involvement in efforts to evaluate such programmes (Cohen and Uphoff, 1979). According to Oakley (1987) decision-making, implementation, benefits and evaluation are key elements in the process of participation in rural development.

Pears and Stiefel (1980), as cited by Oakley (1987), report that the other aspect is where participation is regarded as the organized efforts to increase control over resources and regulative institutions in given social situations on the part of groups and movements of those hitherto excluded from such control. This aspect is particularly held among non-

governmental organizations (NGOs), whose approach has been less tied to the notion of immediate economic benefit (Oakley, 1987).

Clark and Thomas (1987), also tried to elaborate on different terms used to describe participation. They viewed participation as animation, conscietization, facilitation, participatory rural development and self-reliance. They defined these labels as follows:

i) Animation means assisting people to think, reflect and act autonomously by helping to build up their intellectual knowledge base.

ii) Conscietization is a process in which people achieve a deepening awareness of the reality, which shapes their capacity to transform that reality.

iii) Facilitation is assisting people to acquire practical skills, to improve their access to material resources, and to undertake actions.

iv) Participatory rural development is a process of creative change initiated by organized, self-conscious rural people acting in response to their own deprivation.

v) Self-reliance is an expression of a person's faith in his/her own abilities; delineation and regeneration of powers lost through dependence and exploitation.

These labels tend to define participation by way of two broad categories: Participation as a means and as an end (Oakley, 1987).

2.6.1 Participation as a Means

When participation is viewed as a means, it is used to achieve some predetermined goal or objective. Through it, the existing physical, economic and social resources of rural people are harnessed in order to achieve the objectives of development programmes and projects. It stresses the results of participation; in this form the achievement of predetermined targets is more important than the act of participation. Governments and development agencies use participation as a means to improving the delivery systems of the projects they seek to implement. In such a situation the local population is mobilized, there is a direct involvement in the task at hand and the participation ceases once the task is completed. This type of participation is considered to be passive.

2.6.2 Participation as An End

Participation as an end aims at developing and strengthening the capabilities of rural people to intervene more directly in development initiatives. This process unfolds overtime and may not necessarily have predetermined measurable objectives or even direction. As an end, participation is an intrinsic part, which grows and strengthens as the project develops. It is an active and dynamic form enabling people to pay an increasing role in development activities. It should also be a permanent feature of any project.

Besides participation being seen as a means or an end, it can be examined in terms of how it is initiated, that is spontaneous, induced and coerced forms of participation. The spontaneous participation is the authentic emergence of locally based initiative for

participation with little or no external support. Such participation has a high chance of being self- sustaining. On the other hand, induced participation (pseudo - participation) refers to the participation as a result of external initiatives in terms of seeking support endorsement (ratification) for external plans or projects. In the case of coerced participation, people are involuntarily mobilized or organized to undertake activities over which they have had neither any say or controls as exemplified by participation in some conservation programmes.

The concept of participation in development is a complex process. It is both subjected to a range of different interpretations and also influenced by a number or different factors. If a project or programme wants to use participation as management tool, it has to be open-ended, flexible, responsive, enabling, listening and learning, situation and contextual (Vonk, 1987).

Most of developing countries, including Tanzania had already realised the importance of people's participation in forest management, and because of this fact, current National Forest Policy recognise and duly support local peoples' identity, interests and culture to enable their effective participation in order to achieve sustainable management goals (URT, 1998).

2.7 Sustainable Forest Management

Canadian Students Association (CSA) in 1996 defined sustainable forest management as "Management to maintain and enhance the long term health of forest ecosystems while providing ecological, economic, social and cultural opportunities

for the benefit of the present and future generations''. In short, sustainable forest management should balance the needs of people and communities with the ecological values. The concept of sustainable forest management includes an environmental dimension that aim at perpetual maintenance of the resources; an economic dimension that includes the production of commodities and services; and a social dimension that involves people in decision-making process concerning forest management and the distribution of forest benefits (Hachrik, 1997).

The role of forestry service in sustainable management involves establishment of an appropriate policy framework across natural resources sectors. This is of paramount importance in achieving sustainability objectives, but most of the concrete action to be taken for operational implementation is the responsibility of specific sectors, of the institutions dealing with these sectors in particular, and of the communities and individuals actually involved in these branches of the economy. It is therefore essential that each sector determine its role (FAO, 1992).

2.7.1 Resources Conservation

Conservation is defined as the management of human use of the biosphere (all living things) so that it may lead to the greatest sustainable benefit to the present generations while maintaining its potentials to meet the needs and aspiration of future generation (IUCN, 1980). In short, conservation means the maintenance of all resources. Once conservation is recognised as maintenance of the means of development, then with proper planning, it becomes possible to integrate the two processes, maintenance and utilisation and hence to make development sustainable.

Integration, however, depends first on recognising the role the ecosystem play in human economics (FAO, 1994).

The international debate over conservation strategies has often become an opposition between nature and people orientated conservation (Peres, 1994). A response to alarming habitat and species losses has been tripling in both, area and number of protected areas. Communities adjacent to parks or reserves have suffered from protectionists' measures (West and Brechin, 1991). Local communities have often been hostile to conservation efforts, particularly when such activities result in reduced access to resources, employment and income. In many cases they have been evicted from their own lands with considerable social disruption. Communities occupying areas adjacent to forest reserves boundaries frequently bear substantial costs as a result of lost access, while receiving few benefits in return. People in these communities tend to be poor, they lack political influence and they receive few government services (Mvena and Kajembe, 1997).

Gradually however, conservation organizations are acknowledging these problems and trying to become more socially responsive (Kamstra, 1994). Integrated Conservation and Development (ICD) has been suggested as a way of reducing the burden of conservation on local communities, which include: revenue sharing, tourism -related enterprises, agroforestry, improved agricultural practices, rural development and conservation education.

Recently, approaches to community involvement have evolved which encourage community participation and valuing indigenous knowledge (FAO, 1989, Chambers,

1992, Kajembe and Rutatora 2000). Though local participation in conservation is now part of most conservation plans, the actual methods of achieving this are not well developed.

2.7.2 Conservation Alternatives and Reconciliation

Sustainable conservation of forest resources requires initiatives geared towards identifying alternative sources of forest products outside conservation areas. Often the demand for forest products is so high as to defeat sustainable utilization of forest resources in the conservation areas no matter how stakeholders try to reconcile their interests (Kessy, 1998). For example, there might be a demand of forest products such as building poles in areas with large human populations. Under such condition the reconciliation process should also attempt to elicit ideas about how population growth trends can be mitigated to achieve better balance on forest products.

2.8 Forest Resources Assessment

Resource assessment can be done at different scales, from country level to that of the forest management unit. Thus, the required standard at each scale would differ. The most reliable one would be used by the forest management unit, and progress up from there (Appanah and Thang, 1996). Forest inventory is the procedure for obtaining information on the quantity and quality of the forest resources and other characteristics of the land on which the trees are growing. Traditionally forest inventory refers to timber estimates. It is however, realized that non-timber forest products (NTFP) are equally important. These include information on wildlife, water

catchments, beekeeping, biodiversity, medicinal values, edible fruits, local and global environmental protection and a host of other NFTP (Malimbwi, 1997). The context of such an inventory falls under multiresource forest inventory, which requires multidisplinary approach and hence considerably high input (Malimbwi and Mgeni, 1990). This information is vital for planning purposes and also for guiding forestry policies (Shaba, 1994; Rodgers, 1994). Rational decisions in management of natural forest depend on information available on the growing stock. Acquisition of inventory information is pre-requisite to any forest management system (Mgeni and Malimbwi, 1990). Forest inventories are concerned with more detailed and accurate estimates of especially the standing volume of wood. As such, they provide valuable information needed in the preparation of forest management plans and in preparation and execution of operational plans. Such as, harvesting plans. What is generally desired is a very detailed knowledge about the quantity and quality of the resource available, and a reliable estimate of the size of the area where harvesting operations will take place (FAO, 1994).

2.9 Forest Policy

The new Tanzania forest policy (URT, 1998) realizes the core problems in the management of both central and local government forest reserves. The main problem is low capability of the government institutions to manage the resources to meet the growing demands for forest products and services. As a consequence, the forest cover is being reduced due to the prevailing trends of forest destruction and degradation as well as the unsustainable conversion of forest to other land use. As a strategy to overcome the problems which are existing, Forest policy states that; "In

order to improve forest conservation and management and to ensure equitable sharing of benefits amongst all stakeholders, joint management agreements between the central government, specialized executive agencies, private sector or local governments, as appropriate in each case, and organised local communities or other organisations of people living adjacent to the forest, will be promoted. The local communities will be granted appropriate user rights for forest produce and forests will be managed in accordance with approved management plans.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

3.1.1 Location

The study was carried out in Lindi district, which is the headquarters of MMP southern zone. The district is on the southern coast of Tanzania and is separated from Kilwa district to the north by the Mbwemkuru River and from Mtwara district to the south by a channel at Sudi bay. Lindi region lies between longitude 36°50' and 40° E and latitude 7°55' and 10° 55'S with an area of 66,950km² (Fig.2). Lindi rural and urban district in this study are considered together and are simply referred to as Lindi district. Mangroves are largely found in Lindi rural.

3.1.2 Climate

There are two main seasons: dry and wet season. The area receives low rainfall, mostly less than 1,000 mm and 85% of it occurs between November and May when the northeast monsoon wind predominates. There is also high annual variability in rainfall. The cooler dry season is from June to October when the southeast monsoon winds prevail. Average temperatures are relatively high ranges between 28-300C with little variation between mean monthly temperatures or day and night temperatures. Wind strengths are normally higher and more during the southeast

monsoon period. The apparent movement of the sun controls the rains. The area is characterized by high temperature and therefore lowest pressure occurs where the sun is approximately overhead and this is known as heat trough or equatorial trough or Inter Tropical Convergence Zone (ITCZ).

3.1.3 Soil and Physical Features

The soils are generally well drained, red in colour and differ in depth from very deep to shallow. Along river valleys soils are fertile and seasonally flooded. The coastline of Lindi district is approximately 130 km long. Along most of it there is a narrow fringing reef about one to two km off shore with a steep slope, which drop to a depth of about 500 m. The coastal area is predominantly marine limestone and muddy in few areas.

3.1.4 Vegetation

Three types of forests characterize Lindi District. Namely high forests, which surround the villages in the study area and mangrove forests, which broadly occur along the coast. The high forests are extensively diminishing as a result of shifting cultivation. The district is also dominated by coastal forests, which are believed to be rich in biodiversity (both flora and fauna). Some coastal forests include Dimba forest reserve, which is adjacent to mangrove forest reserve of Sudi. Others are Rondo, Chitoa, Ruawa, Matapwa and Mkangala.

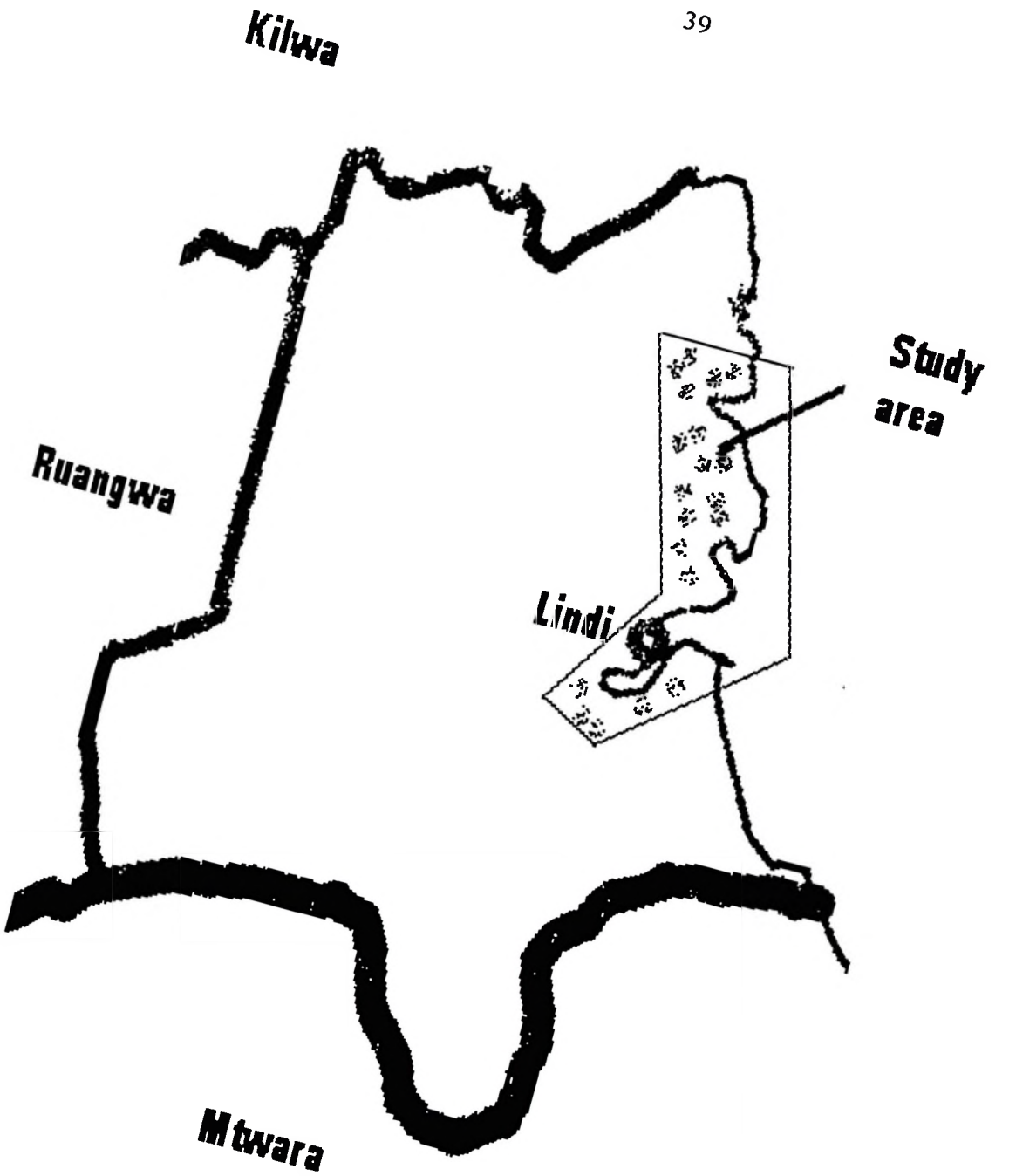


Figure 2: A sketch map of Lindi District and location of the study area

3.1.5 Communication

Communication in the district is a big problem. The main road to the rest of the country is the Lindi - Dar es Salaam road whose stretch of Kibiti to Lindi is not tarmac. It is impassable during rainy seasons. The alternative means of transport to the district is the ocean and airways. But this is also hampered by insufficient number of ships plying between Lindi and Dar es Salaam. The ships do not meet the demands, but the harbour facilities are also not good. In the case of aeroplanes, fare is rather high and only few people can afford it. Transport problems affect both raw material supply and products distribution.

3.1.6 Population and Socio-economic activities

3.1.6.1 Population

The main tribes in Lindi district are Wamwera, Wamachinga, Wayao and Wamakonde. In 1988 census, Lindi urban was found to have a population of 41,587 composed of 20,834 males and 20,753 female. Lindi rural district had a total population of 284,523 of which 136,207 are males and 148,316 are females (URT, 1988). The population increases by 2.6% for Lindi region, which is lower than 2.8% of the national average. This is thought to be due to lower fertility and high infant mortality rates. But it is also most likely due to out migration of people to other parts of the country, particularly to Dar es Salaam where a big number of youths from southern regions including Lindi make petty businesses, and are popularly known as 'Wamachinga'.

3.1.6.2 Agriculture

Small scale farmers provide 90 percent of the total district agricultural production. Virtually all the land is hand tilled. As a result only limited areas are being cultivated. The main food crops grown are: rice, sorghum, maize, cassava, cowpeas and pigeon peas. Cash crops include: cashew nuts, groundnuts and sesame. Most of the land is under private ownership.

3.1.6.3 Fisheries

Fishing provides the main source of protein, but not every household has a fisherman. Fishing is also a seasonal activity; maximum abundance of fish broadly speaking coincides with that of the northwest monsoon winds while minimum fish abundance with southeast monsoon. The boats engaged in fishing are traditional canoes with poor fishing gears.

3.1.6.4 Salt Production

Lindi district is the best area along Tanzanian coast for solar salt production, because of its long dry season and the relatively low rainfall. Only few people are engaged in this business due to high investment costs required for production

3.2 Methods

3.2.1 Data Collection

The study was carried out under three phases. Phase one of the study involved Participatory Rural Appraisal (PRA) techniques. The second phase of the study involved questionnaire surveys as a major tool for data collection. Other tools include: checklists and participant observations. The third phase of the study involved carrying the inventory of mangrove forests. The study was carried out in the three pilot villages of the MMP project namely: Sudi, Mkwaya and Mchinga II. Prior to the actual data collection, a reconnaissance survey was done to determine the total number of villages and households required for the study based on the variability of the area. The questionnaire was pre-tested in order to ensure validity and reliability of the questionnaire items. As argued by Mettrick (1993), pre-testing is essential before beginning any survey.

3.2.1.1 Socio-economic data

3.2.1.1.1 Participatory Rural Appraisal (PRA)

PRA is based on interactive learning, shared knowledge and flexible, yet structured analysis (Devavaram and Johansson, 1993). The methods applied were designed in such a way that they quickly generated information about local conditions, livelihoods and social formations around mangrove forests. The techniques involved self-critical awareness of the attitudes and behaviour on the part of the researcher

towards the people with whom he worked with. It is this relaxed rapport, open dialogue and mutual sharing that made the methods effective.

In each study village, participants in the PRA exercises were in four categories each comprising six participants namely: women, youth, village elders and village leaders. Participants went through the following exercises:

- Resource mapping in relation to the village set-up. The maps showed the village and sub-village boundaries, major infrastructure and location of the mangrove forest reserves. The maps drew people into intense agreements and disagreements until a compromise was reached in relation to the items on the maps.
- Historical changes in relation to mangrove ecosystem and factors influencing the changes for a period of approximately fifty years were discussed.
- Listing and ranking the benefits of mangrove forest resources by using a pair wise ranking method.

During PRA exercises, Kiswahili was used as a medium of communication. Data collected through PRA were analysed with the help of participants and the results were given back to them for verifying and retention. As a result in this study local people were not regarded as clients or beneficiaries but as partners.

3.2.1.1.2 Structured Questionnaire

- **Questionnaire design**

The structured questionnaire was designed based on the specific objectives and research questions (Appendix 1). Both open and close-ended questions were used to collect socio-economic data, mangrove forest products utilization trends and local

people's perceptions of a variety of conservation and development aspects in the study villages. In close-ended questions, a number of alternative answers were provided while in the open-ended questions respondents were free to give their own answers. As pointed out by Richards (1980); cited by Kessy (1998), open- ended interviews serve the purpose of disclosing the system of knowledge and structuring of ideas central to the respondent's own views of the world.

- **The sampling procedure and intensity for households surveys**

A simple random sampling method was used in selecting households for the interviews. A random error (intensity) of 5% was used to determine the sample size as described by Boyd *et al* (1981) as stipulated in Table 1. The heads of households were the main respondents; however, other members of household were encouraged to attend so as to supplement information.

3.2.1.1.3 Checklist

Checklist was designed to collect information from key informants. A key informant is an individual who is accessible, willing to talk and has a great depth of knowledge about issues in question. Key informants are not only members of clientele, but most often are informed outsiders (Mettrick, 1993). The key informants in this respect included MMP staff, natural resources officers, village leaders and ward executive officers (Appendix 2).

Table 1: Sampling intensity adopted in socio-economic survey in Lindi district

Village	Number of Households (N)	Sample size (n)	%sampling fraction (n/N)	% of total sample
Sudi	522	26	5.0	31.0
Mkwaya	454	23	5.0	27.3
Mchinga II	702	35	5.0	41.7
Total	1 678	84	15.0	100.0

3.2.1.1.4 Participant Observation

Participant observation is a technique we all use as soon we set foot in a community, which is not our own to overcome feelings of alienation. Participant observation as the name implies, is distinguished by the fact that the observer himself or herself forms a part of the situation he or she is studying. Much information can be obtained simply by observing what goes on. This was a very useful method for counterchecking information from the surveys especially on those aspects of village life, which most villagers would avoid to discuss openly in an interview or a village meeting. For example, encroachment in the mangrove forest reserves to collect building materials. During the fieldwork, constant interactions with the villagers were part of the information collection process. The researcher developed collegial relationships with villagers while trying to study their way of life, making sense out of their interactions with the mangrove forests in their daily tasks.

3.2.1.2 Inventory Data

3.2.1.2.1 Sampling Design

The stratified random design that divides a population into homogenous sampling units called strata was adopted to cover a representative area. The transect line method for studying plant community was adopted (Malimbwi *et al.*, 1994). Sample plots laid out in different compartments and in three pilot villages of MMP in Lindi district namely: Mkwaya, Mchinga II and Sudi. The distance between transects and plots varied due to difficult accessibility in the muddy soils and it ranged between 750 and 1500 m.

3.2.1.2.2 Sampling Intensity

As recommended by Synnot, (1979) for the case of tropical inventories, a sample size of 0.5 to 0.7 percent of the total area is supposed to be used. The total area of the studied forest was 1061 ha. Then 0.5 percent to 0.7 percent is 5.3 to 7.4 ha.equivalent to 600 to 680 plots.Due to time and financial constraints, only 5% of the total number of recommended plots were sampled (Synnot, 1979). In this study only thirty-two sample plots were inventoried.

3.2.1.2.3 Shape and Size of Plots

The plots for this study were square measuring 10x10 m, 5x5m and 1x1m. Square or rectangular plots for inventory in mangrove forest are more appropriate (FAO, 1994). This is because they are easier to demarcate and relocate (Appendix 3).

3.2.1.2.4 Tree Measurement

Inventory data were collected in order to know the status of mangrove resources. Diameter at Breast Height (dbh) and height of trees were measured by using caliper and suunto-hypsometer respectively. The tree measurements were in three categories as follows: Tree with dbh $\geq$ 5cm, tree with dbh $\leq$ 5, and total heights.

Tree with dbh $\geq$ 5cm

Within the 10 × 10m plot, trees equal to or larger than 5 cm in diameter at 20 cm above root collar for *Rhizophora mucronata* (with prop roots), and at dbh (1.3m above ground level) for other species were recorded. Species name (local and botanical) and dbh of all measured trees were recorded. The number of stems was determined from the dbh tally.

Data collected through questionnaire surveys in phase two were coded. The coding involved structuring the responses from the open -ended questionnaire and assigning them nominal value for analytical purposes. The quantitative data were fed in the computer and analysed using the Statistical Package for Social Sciences (SPSS) computer programme. Both descriptive and inferential statistical analysis was carried out. Descriptive statistics mainly measures of central tendencies and dispersion, while Inferential statistics provide an idea about whether the patterns described in samples were likely to apply in the population from which the samples were drawn (De vaus, 1986). A multiple regression equation was developed to show the relationship between socio- economic factors as independent variables and number of mangrove trees planted as dependent variable. The number of "mangrove trees planted" was chosen as the only dependent variable indicating the level of community participation because it is quantifiable compared to other indicators of participation.

The statistical model used was:

$$Yj = a + b1x1 + b2x2 + \ldots\ldots\ldots\ldots + bixi + ei$$

Where:

Yj: The jth observed value of the dependent variable, that is, number of mangrove trees planted.

x1 to xi: independent variables which includes: household income, education, distance to mangrove forests, sex, household labour, residence duration and age.

trees with dbh < 5 for example, *R. mucronata*. This characteristic is not uncommon with such a model (Phillip, 1994). For this reason this model was adopted only where all other models proved to be biased. Also there was no equation developed to estimate volume of *L. racemosa*.

3.2.2.2.3 Basal Area

The mean basal area per hectare (m^2 ha^{-1}) was estimated as the summation per plot cross sectional area of all trees estimated at dbh using the formula:

$$G = (1/n)\ (\Sigma\ gi)/a$$

Where $gi = (\pi/4)/\ di2$

a and di are sample plot area (ha) and diameter of the ith stem in the plot respectively for n plots.

3.2.2.2.4 Stem Density

The DBH tally was used to determine the average stem density for mangrove species such that;

$$N = (1/n)\ \Sigma(xj/aj)$$

where;

N = average number of stems per hectare;

n = number of plots;

xj =number of stems in plot j;

aj =area of plot j;

3.2.2.2.5 Annual Coupes

An annual coupe was calculated in order to developed a harvesting plan of mangrove poles using the following formula:

AC = Area (ha)/rotational age

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Status of the Mangrove Resources

4.1.1 Local People Perceptions

During discussion with villagers in the study area, 85% of the interviewees revealed that mangrove trees have increased as a result of the increasing of the volume of seawater, which led to some of the people who were living at the lower intertidal zones to shift to the upper areas and most of the shifted areas are currently covered by mangroves. This means that increasing of the seawater volume provides the favourable conditions for the growth of different mangrove species. Also most of the areas, which were degraded in the past are now covered by mangroves. Sedimentation process performed by mangrove roots also create conducive site for their regeneration.

The local people perceptions of the increase of mangrove resources in the study area were similar. During colonial period people were not harvesting mangrove. Also population by that time was small and sparse. The community lived in balance harmony with nature. Consequently, forests were utilized at minimal. All mangrove forests in Tanganyika (Tanzania mainland) were gazetted as forest reserves. Legislation governing mangroves forest reserves is included under forest ordinance of 1957 (Semesi, 1991). After independence management became poor, the harmony

was disrupted, it led to disequilibria and hence degradation. A range of factors may be called to account, including: break down of traditional authority; social change; urban aspirations and the intrusion of inappropriate state policies. This situation created loopholes for local people to utilize mangrove forests illegally for various needs such as poles for house building and clearing land for establishment of solar saltpans. In 1990s, the government took effective measures towards conservation and control of illegal harvesting. This at least has reduced the destruction of mangrove resources. In 1995 the government established mangrove management project (MMP) with community participation as a management approach. The awareness of local people towards the conservation of mangrove resources has been raised. They now regard mangroves as shared property and no longer as solely a government property. According to local people views; under this programme, mangrove forests have increased in terms of area and quality. High pressure of cutting has shifted to general land because of strict control on mangrove forest resources.

4.1.2 Height / Diameter Equation

As explained in section 3.2.2 .2.1 single tree volume estimation needs both dbh and height. The height\diameter equation selected after analysis of inventory data to estimate the height of trees which were not measured for Lindi mangrove forests was:

$H = 0.656226 + 0.6597 \ln D$: $R^2 = 0.89$, DF = 95, S.E =018, n = 96

Where, H = Total tree height

D = Diameter at breast height (cm)

ln = Natural logarithm

R^2 = Cofficient of determination

DF = Degree of freedom

S.E = Standard error

n = Number of observations

4.1.3 Wood Volume

The mean estimated wood volume was 32.4 m^3ha^{-1}. The mean volume was distributed as follows, 5.4 m^3 ha^{-1} in diameter class 1, 12.6 m^3 ha^{-1} in diameter class 2, 8.8 m^3 ha^{-1} in diameter class 3, 5.5 m^3 ha^{-1} in diameter class 4 and 3.2 m^3ha^{-1} in diameter class 5 (Figure 3). The mean volume obtained in the study area as stipulated in Table 2 and Appendix 4, is comformable to 42.8 m^3 ha^{-1} from 29 compartments for Lindi reported by Semesi (1991). However, its quite low compared to 127 m^3 ha^{-1} and 268 m^3 ha^{-1} for Rufiji as reported by Semesi (1991) and Mattia (1998) respectively. In Thailand 226 m^3 ha^{-1} of mangrove volume had been reported (FAO, 1994), while, 650 m^3 ha^{-1} were documented in Philippines (FAO, 1982). The available volume shows that there is a problem with mangrove quantity in Lindi district. This can be attributed to over exploitation and mismanagement. Also this indicated that the forest is not ecologically stable since the volume of trees decreases tremendously in higher diameter classes. The forest, which is ecologically stable comprising different sizes and ages of trees, such type of forest is known as normal forest. The estimated wood volume gives a real picture that trees with small age and sizes dominate the mangrove forest in Lindi district, small sizes can also be contributed by environmental factors leading to stunted growth. Semesi (1991), reported that 907.3 ha of mangroves in Lindi are environmentally stressed, those

trees do not exceed 5m (shrubs in form and size) need complete protection from cutting. Another 926.3 ha are the mangrove forests requiring recovery and regeneration in degraded areas. The results on wood volume, basal area and stem density are presented in Table 2.

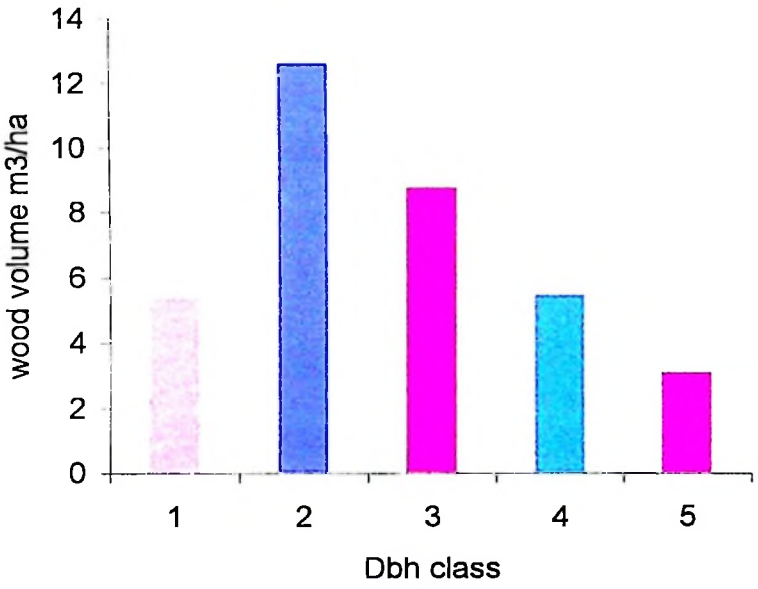


Figure 3: Distribution of mangrove wood volume at Lindi

R. mucronata is the most extensively occurring species. It contributed the highest wood volume (47%), followed by *C. tagal* (20%). *B. gymnorhiza* contributed the least wood volume (0.1%) which estimated to be negligible as it appears in Figure 4. The proportion of wood volume produced by each species is shown in Figure 4. The volumes contributed by each species at the respective diameter classes are shown in Table 3.

Table 2: Summary of wood volume, basal area and stem density

Parameters	Diameter classes					
	1	2	3	4	5	Total
Wood volume (m^3/ha)	5.4	12.6	8.8	2.3	3.2	32.4
Basal area (m^3/ha)	1.9	2.7	1.5	0.3	0.4	6.8
Stocking (stems/ha)	6544	1288	156	22	9	8019

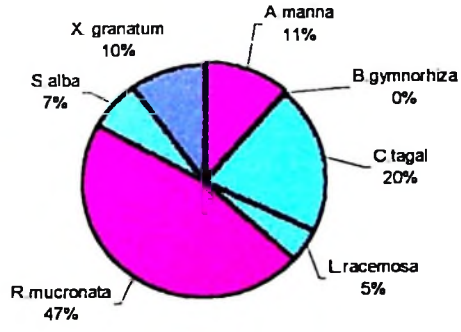


Figure 4: proportions of wood volume by mangrove species

Table 3: Volume contributed by species ($m^3 ha^{-1}$)

Species	* Diameter class					
	1	2	3	4	5	Total
A. marina	0.36	0.94	1.63			3.68
B.gymnorhiza	0.01	0.03				0.04
C. tagal	1.89	2.91	1.79			6.59
L.racemosa	0.39	0.69	0.52			1.60
R. mucronata	1.65	5.55	3.03	0.76	3.15	14.96
S.alba	0.57	0.99	0.69	1.58		2.26
X. granatum	0.53	1.51	1.18			3.22
Total	5.40	12.63	8.84	2.34	3.15	32.4

*Diameter class limits are as explained in section 3.2.2.2.1

4.1.4 Basal Area

From the study the mean basal area per ha was found to be 6.8 $m^2 ha^{-1}$ distributed in five diameter classes as 1.9 $m^2 ha^{-1}$, 2.7 $m^2 ha^{-1}$, 1.5 $m^2 ha^{-1}$, 0.3 $m^2 ha^{-1}$ and 0.4 $m^2 ha^{-1}$ in dbh class 1, 2, 3, 4 and 5 respectively as indicated in Figure 5 and Table 4. Dbh class 2 contributed the highest (40.6 %) to the mean basal area while the least was contributed by dbh class 4 and 5 with 4.8% and 6% respectively (Table 4). As in the case of wood volume *R. mucronata* contributed the highest percentage of basal area (42%) and the least (0.15%) was by *B. gymnorhiza* (Figure 6). The results show that basal area is relatively smaller than that found at Rufiji Delta, which is 28 $m^2 ha^{-}$

(Mattia, 1998). Philip (1983) showed an average of 35 m^2 ha^{-1} for a natural forest. Malimbwi (1997), argued that basal area normally ranges from 10 - 20 m^2 ha^{-1}, rising to 60 m^2 ha^{-1}. The smaller basal area obtained in the study area suggests that the diameter of trees found in Lindi is smaller than those in Rufiji Delta, also it is an indication of less potential site for the big mangrove trees. This could also be attributed to the fact that in the past the exploitation of bigger trees was high, people were regarded mangrove forests as the government property. The summary of proportions of basal area by plots and by species is shown in Appendix 4.

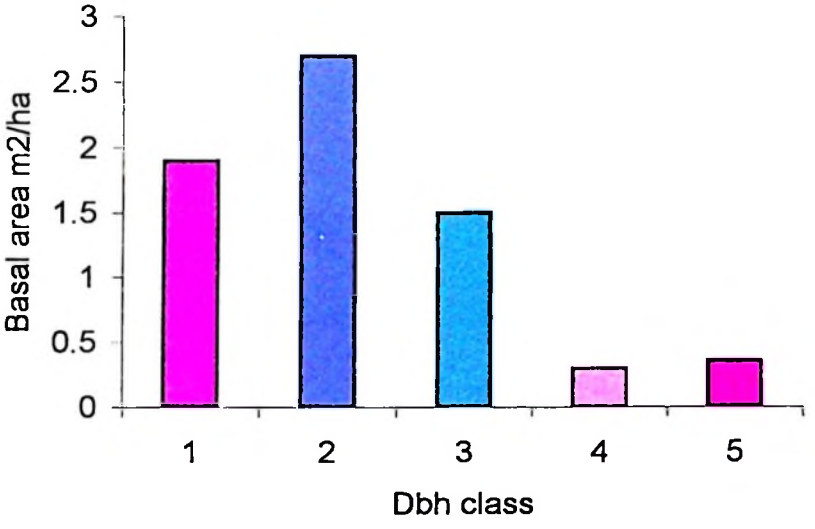


Figure 5: Distribution of mangrove basal area at Lindi

Table 4: Basal area contributed by species (m^2 ha^{-1})

Species	Diameter class					
	1	2	3	4	5	Total
A.marina	0.17	0.25	0.31			0.86
B.gymnorhiza	0.00	0.01				0.01
C.tagal	0.66	0.65	0.30			1.61
L.racemosa	0.13	0.15	0.08			0.36
R.mucronata	0.60	1.19	0.50	0.13	0.36	2.86
S.alba	0.2	0.21	0.11	0.20		0.52
X. granatum	0.12	0.25	0.16			0.53
Total	1.91	2.7	1.46	0.33	0.36	6.8

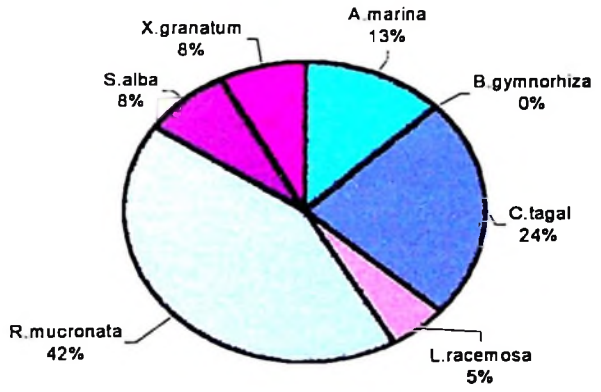


Figure 6: proportions of basal area by mangrove species.

4.1.5 Stem Density

The total of 8019 stems ha^{-1} of mangrove trees were found in Lindi district, comprising seven species. Among these, 6544 stems were in diameter class 1, 1288 stems in diameter class 2, 156 stems in diameter class 3, 21 stems in diameter class 4 and 9 stems in diameter class 5. Figure 7 and Table 5 shows diameter distribution by classes. The number of stems in the study area was found to be larger compared to 1488 of mangrove stems recorded in Rufiji delta (Mattia, 1998). These results are not similar to what was established in mangrove forests in Thailand and Senegal whereby, 3400 and 1343 stems ha^{-1} were found respectively as reported by (FAO, 1994) and (Diop and Ba, 1993). This may be due to small stem diameter of mangroves found in Lindi. The size of stems is inversely proportional to the number of trees. The bigger the size of trees the smaller the number of stems and vice versa (Table 5).

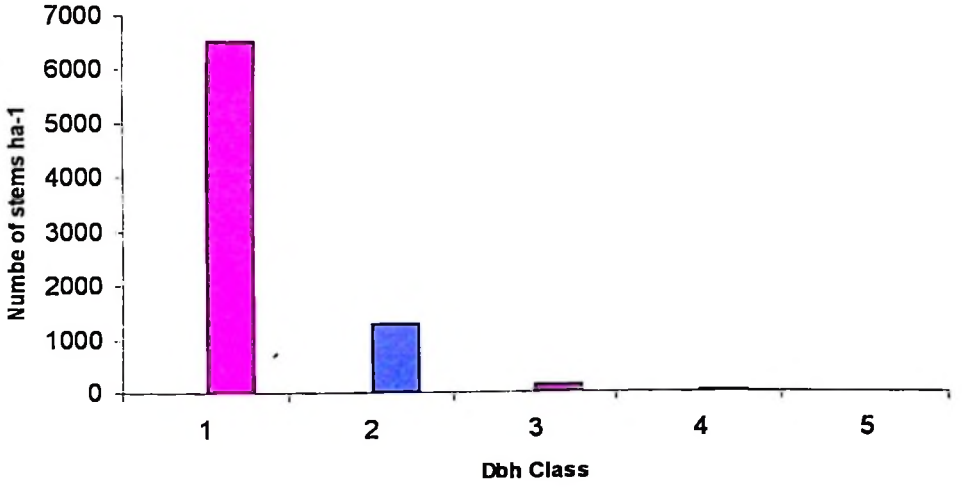


Figure 7: Distribution of mangrove stems per ha in Lindi district.

The mangrove trees in the study area in most cases were found to occur in pure stands. Sometimes the stand of mixed species occurred, but one species tended to dominate.

R. mucronata is represented in the all diameter classes consisting 35% of the total stems ha^{-1}. While *B. gymnorhiza* hardly possess the least number of stems ha^{-1} about 1% (Figure 8). The species seems to be endangered in the study area may be due to over cutting or unfavourable conditions. The distribution of mangrove stems per ha from this study was found to follow the usual reversed J-shape (Figure 7). This is an indication of good regeneration in the natural forest (Nduwamungu, 1996). Hence, sustainability of the mangrove forests. Also the high percentage of trees with small diameter indicates overharvesting which is also known to stimulate regeration (Zahabu, 2001).

Table 5:Stem density per ha of mangroves by species in Lindi district.

Species	Diameter class*					Total
	1	2	3	4	5	
Avicennia marina	431	122	22	13	0	588
Bruguiera gymnorhiza	50	16	0	0	0	66
Ceriops tagal	2 438	331	28	0	0	2 797
Lumnitzera racemosa	328	56	6	0	0	390
Rhizophora mucronata	2 209	522	69	9	9	2 818
Sonneratia alba	766	141	19	0	0	926
Xyalocarpus granatum	322	100	12	0	0	434
Total	6 544	1 288	156	22	9	8 019

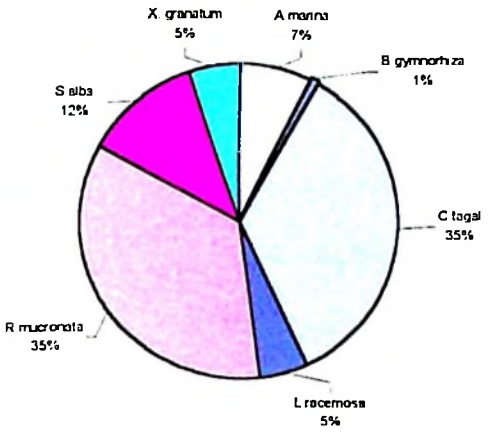


Figure 8:Proportions of mangrove trees per ha by species

4.1.6 Species Composition

4.1.6.1Mangrove Species at Lindi District

The mangrove species, which were found in the study area are shown; *A. marina, B. gymnorrhiza, C. tagal, L. racemosa, R. mucronata, S. alba and X. granatum.*

4.1.6.2 Species dominance

The results revealed that all mangrove species found in Lindi reflects the highest number of stems in dbh class 1. However, each species differ from one another (Figure 9a to g). *C. tagal* contributed the highest number of stems in dbh class 1, followed by *R. mucronata* with 2238 and 2209 stems respectively. The next species in abundance was *S. alba* with 766 stems. The other species are ranging between 200 to 450 stems, except *B.gymnorhiza* with 50 stems only. Both *C. tagal* and *R.*

mucronata grow well in mud substratum at the middle intertidal zone of sea shore, also are characterized with high fecundity due to their adaptation features such as propagules with sharp end points which facilitate their germination and vivipary germination. *S. alba* grows well on the hard or rocky substratum, they tend to be scattered from each other. While *X.granatum, B. gymnorhiza* and *L. racemosa* species dominate sandy-mud substratum, except *A. marina*, which prefers sands of the upper intertidal zones. All these were ecological features observed in the field. There was a big number of mangrove species in diameter class 1 and 2. In the case of diameter classes 3, 4 and 5, the number of mangrove stems is rather low with 156, 22 and 9 stems/ha respectively. This may be due to over exploitation; since mangrove stands with less trees are close to human settlement compared to mangrove stands with many trees.

4.1.7 Annual coupes

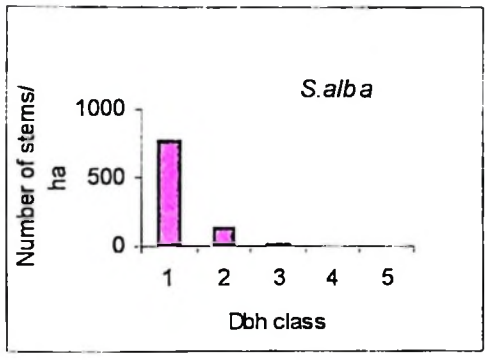
Mangrove forest of Lindi like other many forests have no growth and yield data, it is a convenient to develop a harvesting plan by annual coupes using area control. The rotational age of mangroves for the production of poles and firewood is 10 years (Semesi, (1991). According to FAO (1994), it was noted that there is much longer rotation cycles for other uses of mangrove wood. Such as; 12-30 years for charcoal and above 40 year for barks. Even the world famous mangrove plantation in Matang-Malaysia follows a 30 year cycle. For the Lindi case a 10 years felling cycle would mean that some mature mangrove trees at preset will have to wait for 10 years before they are harvested for building poles and fire wood. The resulting annual coupes are shown in Table 6.

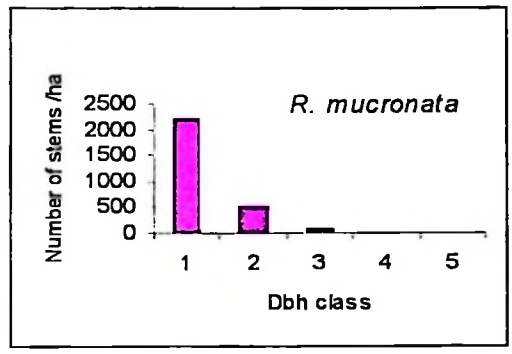
4.1.7.1 Harvesting Plan

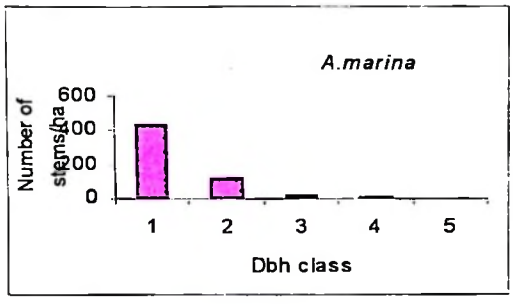
By knowing the key species for poles, and their size distribution and size of the area to be harvested annually, a harvested plan can be prepared. Table 7 shows the proposed harvesting levels and the expected yield of different species in the study area.

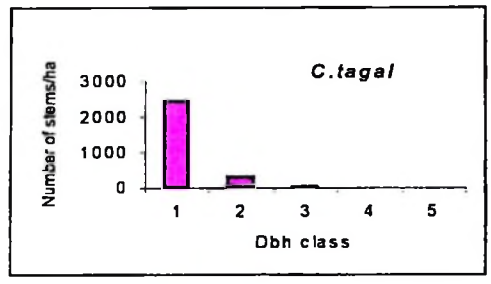
Table 6: Annual harvesting coupes for Lindi mangrove forest reserve

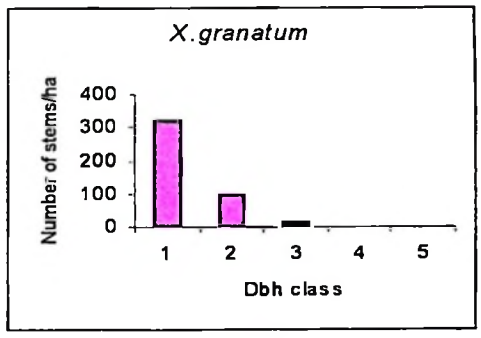
Forest type	Area (ha)	Felling cycle (yrs)	Annual coupe (ha)
Mangrove	4546.5	10	455

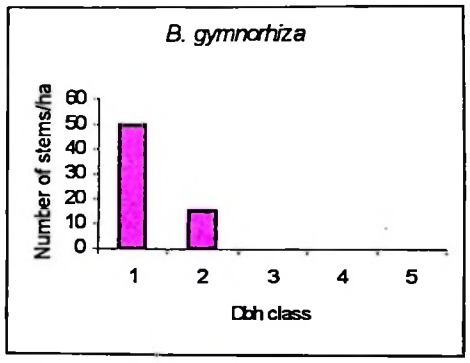












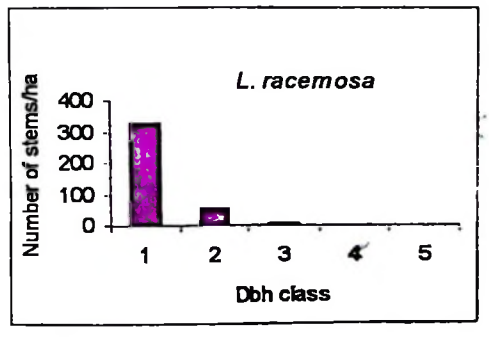


Figure 9: Distribution of species by stems per diameter

Table 7 Harvesting plan for poles in Lindi mangrove forests

Species	Area (ha/yr^{-1})	Removals				
		Stem/ha	Volume (m^3/ha)	Dbh class	7Total/year	
					Stems	Vol (m^3/ha^{-1})
A.marina	455	157	3.32	2 - 5	71435	1510.6
B.gymnorhiza	455	16	0.03	2 - 5	7280	13.7
C.tagal	455	359	4.7	2 - 5	163345	2138.5
L.racemosa	455	62	1.21	2 - 5	28210	550.5
R. mucronata	455	609	13.31	2 - 5	277095	5584
S.alba	455	160	1.69	2 - 5	72800	768.9
X.granatum	455	112	2.69	2 - 5	50960	1223.9

4.1.7.2 Applicability of the Plan

The implication of the plan requires that annual coupe of 455 ha in mangrove of Lindi should be harvested. An annual coupe will be visited again after 10 years. In this study about 277,095 stems (dbh > 5) of *R. mucronata* the most preferred species for poles can be harvested. Malimbwi (2000), argues that to avoid loss due to over maturity it's recommended to harvest mangrove trees which are over mature even if they are outside the annual coupe. The potentiality of this forest can sustainable if

only; the management objectives and strategies including harvesting plan and zonation will be achieved.

4.1.8 Natural Regeneration

Natural regeneration of mangroves in the study area is quite good for most of the species throughout the forests. The study indicates that the densities of mangroves with dbh ≤ 5 are very high with average values of 6544 stems ha^{-1}. Those plant densities are similar to those obtained in Rufiji with average values of 6441 stems ha^{-1} (Mattia, 1998), as well as 4263 stems ha^{-1} recorded in Thailand (Aksornkoae *et al.*, 1988). Young tree species of *B. gymnorhiza, C. tagal* and *R. mucronata* were abundant in Lindi district. However, natural regeneration of *S. alba* and *A. marina* seems to be endangered in the study area. Regeneration trend to some extent indicates that mangrove resources available can sustain and meet people's requirement in future if managed properly.

4.1.9 Uses and Species Preference

Mangrove trees have been used for various purposes in the study area. Coastal communities use mangrove on a small scale to supply local needs such as: fuel wood, fences, house construction, boat building and medicine. Some of the uses extended even beyond the coastal communities boundaries to nearby urban centres of Lindi, Nachingwea, Ruangwa, Newala and Masasi. The most preferred species is *R. mucronata* 87%, followed by *A. marina* 60% and least one is *L. racemosa* 34% which is said to be inferior mangrove tree in the study area due to its low calorific

value and it is not durable. *R. mucronata* is preferred due to its desirable qualities such as high density and durability (Choong *et al.*, 1990). However, not valuable as timber because of their tendency to split or warp when dried (FAO, 1990). In Lindi timber is not produced from mangroves probably due to the absence of the species growing in large dimensions such as *Heritiera littoralis*, but also due to presence of high quality timber trees like *Pterocarpus angolensis*. Mangrove species uses and their preferences are shown in Table 8.

Table 8: Mangrove tree uses in Lindi district.

Species	Local name	Uses	Preference %
Avicennia marina	Mchu	FS, BC, AF	60
Bruguiera gymnorhiza	Mshinzi	FW, P, FS	49
Ceriops tagal	Mkandaa	FP, FW, FS, P	72
Lumnitzera racemosa	Mkandaa dume	FW	34
Rhizophora mucronata	Mkoko	P, FP, FS	87
Sonneratia alba	Mlilana	FW, FNF, BB	56
Xyalocarpus granatum	Mkomafi	FW, FS, BB, F, MD	34.

Key:

FW = Firewood; FNF = Fish net floats; BB = Boat building; P = Poles; FP = Fence post; FS = Fishing stakes; MD =Medicine; AF =Animal fodder; BC = Burning charcoal.

During this study it was revealed that, most of the villagers use mangroves for various purposes. Among 84 respondents who have been interviewed in three pilot villages for the project 95.2 % use mangroves, only 4.8 % do not use as shown in Table 9.

Table 9:Responce of villagers on the use of mangroves in Lindi district

Response	Sudi n=26 %	Mkwaya n=23 %	Mchinga II n=35 %	Total N=84 %
Yes	96.2	91.3	97.1	95.2
No	3.8	8.7	2.9	4.8
Total	100.0	100.0	100.0	100.0

4.1.9.1 Fuelwood

In Tanzania more than 80% of people use firewood as the main source of fuel energy (URT, 1995). The study revealed that 100% of the respondents use firewood as a source of energy for cooking. Among those, 77.4% of the respondents obtain firewood from public land, 17.9% from both mangrove forest reserves and public land; and 4.8 % from mangrove forest reserves only. Table 10 shows fuel wood consumption in the study area. It was observed that 92 % of the respondents in the

study area were consuming between 1- 4 head loads and the rest 8% were consuming 5 - 8 head loads per week. The head loads volume range within 0.015 to 0.04 m^3.

Table 10: Number of head loads of fuel wood consumed per week in Lindi district.

Villages	Sudi	Mkwaya	Mchinga II	Total
Head loads	n=26	n=23	n=35	N=84
	%	%	%	%
1-4	96.2	82.6	94.3	91.7
5-8	3.8	17.4	5.7	8.3
Total	100.0	100.0	100.0	100.0

Local people in the study area are totally dependent on natural forests, which include mangroves and inland forests. This may be due to scarcity of exotic species so they have no other alternative.

4.1.9.2 Poles and Withies

About 78% of the respondents in the study area use mangrove poles and withies for construction and roofing of their houses. While about 22% of the respondents use poles and withies from inland forests. These data indicates that coastal communities, particularly those of Lindi depend mainly on mangroves as a source of raw materials for house construction.

4.2 Impacts of Community Participation in the Conservation of Mangrove and Inland Forest Resources

Community participatory approach is a process of involving people in decision-making, implementation of various activities, benefit sharing and evaluation (Kajembe, 1994). During this study, it was revealed that traditional methods were rarely used to tend mangroves. This is because since pre- independence period, protection of mangroves has been done by the state. The ordinance was not permitting free access and utilisation of forest produce from the forest reserves by local people for daily livelihood (Malimbwi and Sjoholm, 1994). The study also revealed that only 5 households out of 84, which were, interviewed plant trees around their houses. The remaining 79 households have different reasons why they don't plant trees as shown in Table 11. The main reason given by respondents was that the area is surrounded by natural forests, which meet their forest based needs. This statement gives a real picture which calls for the need to enhance people's awareness regarding the values, benefits and functions of mangroves and the possibilities for replanting them.

This situation caused many areas covered by mangroves to be degraded. Under MMP, local people participate fully in various activities related to conservation and sustainable management through their village Natural Resources Committees (VNRC). The extent of participation differs from one person to another depending on various factors, including knowledge about conservation of mangroves.

Table 11: Local people's response for not planting trees

Reasons	Sudi n=26 %	Mkwaya n=23 %	Mchinga II n=32 %	Total N=79 %
No seedlings	50.0	28.6	34.4	38.0
No need	34.6	47.6	62.5	49.3
No land to plant	15.4	23.8	3.1	12.7
Total	100.0	100.0	100.0	100.0

4.2.1 Decision Making

The results showed that about 30 % of the respondents revealed that decision making process was satisfactory, because villagers are involved in decisions of various issues related to conservation of mangroves. However, about 45 % of the households indicates that the decision making process on how to protect and conserve mangrove forests was presumed to be only satisfactory. Whereas 15.5 % of respondents revealed that the process of decision making was unsatisfactory, only members of VNRC and village leaders were involved in the decision making and not all villagers. It should also be noted that about 13 % of the respondents had no opinions about the decision making process on mangrove forest conservation. Even though women are given the opportunity to participate in decision making process, the workload and social norms, make it difficult for women to speak up in the public meeting and in the presence of men. Hence most of decisions are made by men (Table 12).

Table 12: Response of local people on decision making in Lindi district.

Efficiency	Sudi n=26 %	Mkwaya n=23 %	Mchinga II n=35 %	Total N=84 %
Very satisfactory	30.8	17.4	28.6	26.6
Satisfactory	26.9	60.9	48.6	45.2
No opinions	7.7	13.0	17.1	13.1
Unsatisfactory	34.6	8.7	5.7	15.5
Total	100.0	100.0	100.0	100.0

4.2.2 Implementation of Various Activities

People around the mangrove forests participate in various activities related to conservation and management of mangrove resources. Villagers in their respective areas under supervision of VNRC carry out regular patrols in order to control illegal harvesting. Patrols involved both males and females, normally females are informers. Severe measures are taken against culprits these measures include fine and confiscation of mangrove poles harvested illegally.

In the case of mangrove planting, only few people are planting mangroves voluntarily. The rest are employed as casual labourers to fill gaps in degraded areas. Among the people interviewed in the study area 88.1 % have not planted mangroves in their lifetime, 4.8 % planted between one and fifty mangroves and 7.1 % planted

above fifty mangroves. Before the establishment of MMP most of the people were not aware if mangroves could be planted, they thought that mangroves are only regenerate naturally. Although mangroves can be directly planted, they have so many complications in germination due to the unique and difficult environment for them to adapt such as: nature of substratum and salinity tolerance. This is one of the reasons which discourage people to participate in planting. Also some people are still regarding mangrove planting as a research performed by the project but not as an actual thing.

Another activity performed is demolishing solar salt pans to allow natural regeneration to take place. Solar saltpans edges limit seawater and propagules (mangrove seeds) to get in the degraded areas during high water tides. In addition, MMP staff in collaboration with natural resources officers give extension services to raise people awareness about the resource. The activities monitored by the project include rate of illegal harvesting, patrols and other activities related to conservation, also perception of local people towards the mangrove resources. Generally, regular meetings between project staff and local communities are conducted to discuss project progress and initiatives. The study indicated that about 30 % of respondents said that implementation of various activities in the mangroves is very satisfactory, 39.3 % satisfactory, 14.3 % unsatisfactory, while 16.7 % had no opinions. Among all activities measured only patrols are voluntarily, the rest are done by hired labourers. Table 13 shows how implementation of various activities takes place in the mangrove forests.

Table 13: Response on implementation of various activities related to mangrove in Lindi district.

Efficiency	Sudi N=26 %	Mkwaya n=23 %	Mchinga II n=35 %	Total N=84 %
Very satisfactory	46.2	21.7	22.9	29.8
Satisfactory	19.3	39.1	54.3	39.3
No opinions	11.5	26.1	14.3	16.7
Unsatisfactory	23.1	13.0	8.6	14.3
Total	100.0	100.0	100.0	100.0

4.2.3 Benefit Sharing

During the study it was noted that 10 % of the total revenue obtained from selling harvested mangroves is given to the concerned villages. The contribution of revenue to the local people's economy seemed to be negligible because it doesn't make a significant difference in relation to their other sources of income. Local people along the coast also benefit from mangrove poles, firewood, withies, animal fodder and medicine. Mangrove poles and withies are sold at reasonable and affordable price (Table14). The study showed that 19 % of the respondents were very satisfactory with the level of benefit sharing, 30 % were satisfactory, 19 % unsatisfactory and 26 % had no opinions (Table 15). Disabled people are given poles and withies free of

charge after recommendations from village governments. Other mangrove resources like fruits, firewood from dry mangroves and medicine are offered free of charge.

Table 14: Mangrove poles price per score

Class	Poles diameter (cm)	T shs
1	≥ 20	600
2	15 - 19.9	400
3	10 - 14.9	320
4	5 – 9.9	180
5	≤ 4	80

Key: 1 score = 20 poles

Source: Management plan for the mangrove ecosystem of mainland Tanzania, (1991).

Table 15: Response on benefit sharing accruing from mangrove resources in Lindi district.

Efficiency	Sudi n=26 %	Mkwaya n=23 %	Mchinga II n=35 %	Total N=84 %
Very satisfactory	26.9	0	25.7	19
Satisfactory	23.1	52.2	34.3	35.7
No opinions	19.2	34.8	25.7	26.2
Unsatisfactory	30.8	13.0	14.3	19.1
Total	100.0	100.0	100.0	100.0

4.2.4 Evaluation

Evaluation is the periodic assessment and review of the extent to which goals and objectives of an activity have been accomplished. The role of evaluation is to attempt to portray the performance of the project in line with the stated objectives, based on expected output and any resulting externalities. The results revealed that 39 % of the respondents confirmed that the evaluation process was done unsatisfactory, whereas about 7 % rated the evaluation process as being very satisfactory. Probably many respondents claimed evaluation to be unsatisfactory because since the project established no concrete evaluation mission has been carried out However, different visitors including MMP staff have been visiting mangrove areas to see the progress. The fact that over 30% of the respondents were satisfied to very satisfied with the

evaluation process of the MMP, even though there never has been any form of evaluation carried out was based on PRA exercises which have been conducted by project staff in the villages surrounded by mangroves and not actual evaluation mission. The results have been presented in Table 16.

Table 16: Response on evaluation process of the MMP project.

Efficiency	Sudi n=26 %	Mkwaya n=23 %	Mchinga II n=35 %	Total N=84 %
Very satisfactory	7.8	0	11.4	7.1
Satisfactory	11.5	39.1	22.9	23.8
No opinions	19.2	43.5	28.6	29.8
Unsatisfactory	61.5	17.4	37.1	39.3
Total	100.0	100.0	100.0	100.0

4.3 Socio - economic Factors Influencing Mangrove Tree Planting

The participation of the local community in planting mangrove trees plus their efforts in conserving them, have to some extent been influenced by a variety of socio-economic factors which either enable or constrain the mangrove planting efforts. In order to ascertain or predict the relationship between selected socio-economic factors to mangrove tree planting efforts, a multiple regression model was developed. The model results revealed significance correlation between the number of mangrove

trees planted with household income, and positive correlation though not significant with education and residence duration. The results showed a negative correlation between distance to mangrove, sex, household size and age. The results have been summarized in Table 17.

Table 17: The relationship between mangrove trees planted and socio- economic factors in Lindi district (n =84)

Xi	Y . $R^2 = 0.14$	T	Significant
Variable(s)	b*		
Household income	0.326	2.983	0.004*
Education .	0.104	0.885	0.3799 (NS)
Distance to mangrove	-0.056	-0.513	0.609 (NS)
Sex	-0.044	-0.378	0.707 (NS)
Household size	-0.018	-0.161	0.872 (NS)
Residence duration	0.151	0.954	0.343 (NS)
Age	-0.102	-0.606	0.546 (NS)
Constant		-0.467	0.642(NS)

Key:

Xi = All independent variables referring to household

Y = Dependent variable (Number of planted trees)

R^2 = Coefficient of determination

* = Significant at 0.05 level

NS = Indicate non –significant at 0.05 level

b* = Beta weight

The overall coefficient of determination (R^2) was 0.14 implying that independent variables were only able to explain about 14 % of the variation. This is a relatively weak model because the results suggest 86 %, of the variations not explained by the model. The small number of local people who plant mangrove trees as it stipulated in section 4.2.2 also supports the low coefficient of determination. Among the people interviewed in the study area 88.1 % have not planted mangroves in their lifetime, 4.8 % planted between one and fifty stems and 7.1 % planted above fifty stems of mangroves. The study conform to other studies as reported by Mbaga and Hoen (1998). Who established that; despite of the data inconsistency and invariably readjustment, still the R^2 was still relatively low about 7%. This was because of omitting relevant factors in the model specification.

The model results reflect F-statistics of 1.770, which plausibly assists to explain reinforcement of the t-statistics which portrays the significance of different independent variables included in the model towards dependent variable (Appendix 5).

- **Multicollinearity**

A correlation matrix (Table 18) shows that there is a correlation between age and marital status, after regressing each independent variable on all other independent variables. A high multicollinearity can affect the reliability of the estimates of the separate effects (Wittink, 1988). The variable (marital status) was dropped from the model because the age increased coefficient of determination more than marital status.

4.3.1 Household Income

The result in Table 18 indicates a significant correlation between planted mangrove trees and the household income. The implication is that farmers or households with relatively higher income planted more mangrove trees than those with low income. The explanation is that high-income earners, who possess relatively high income, have a greater potential to undertake tree-planting activities than poor community, because they can manage to purchase gears like gumboots for working in very difficult environment involving muddy soils.

Table 18: Correlation matrix for variables

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
X_1		.180	-.161	.135	.178	.029	.224*	-.567**
X_2			.043	.193	-.030	-.203	-.091	-.081
X_3				.003	.021	-178	-.180	.192
X_4					-.171	.066	-.114	-.170
X_5						-.190	.110	-.105
X_6							.122	-.153
X_7								-.280**

* Correlation is significant at 0.05 level

** Correlation is significant at 0.01 level

X_1= age; X_2 = household size; X_3 = education; X_4 = household income; X_5 = residence duration; X_6 = distance to mangrove; X_7 = marital status; X_8 = sex.

4.3.2 Education

Table 18 indicates that level of education is positively correlated even though not significant correlated with the number of planted mangrove trees. The logical interpretation is that people with more education plant more trees than those with less education. The implication is that education has a positive and a direct influence on community participation. These findings are in line with those of Katani (1999), who stated that; education creates awareness for natural resources management among the community.

4.3.3 Residence Duration

The results showed that there is positive correlation between number of trees planted and number of years an individual has lived in the village. This implies that individuals with many years of residence in the village plant more mangrove trees. This could be due to the fact that natives are always knowledgeable about the trend of mangrove forests degradation, so they are aware of the necessity of tree planting (Table 18). Another reason for natives to plant trees is that they are living permanently in the area and mangrove trees are long-term products.

4.3.4 Distance to the Mangrove Forest Reserves

Table 18 indicates a negative correlation between number of mangrove tree planted and the distance to the mangrove forests. This means that villagers living closer to the mangrove forests plant more trees than those living far away. May be because

they are aware of the importance of tree planting. Also people who are living far away from the mangrove forests may be have other alternatives of getting forest products from public forests surrounding them. The distance from household to mangrove forests ranges between 20 m to 3 km.

4.3.5 Sex

The results showed negative correlation between sex and number of mangrove trees planted (Table 18). Men planted more trees than women, although both male and female depends on mangrove trees for various uses. May be because mangrove planting is very difficult and risk, also forest products are not scarce especially for women who are more responsible in collecting firewood. The study area is surrounded by both mangrove forest reserves and public forests.

4.3.6 Age

Regression analysis showed that age is negatively correlated with number of mangrove trees planted (Table 18). This means that young people planted more mangrove trees than old people. This may be due to the fact that their awareness have been raised through extension services rendered by the MMP as well as environmental conservation subject in primary schools curriculum, which include Mangrove conservation. Mangrove conservation topic has been added to the environmental conservation subject purposely by MMP so as to raise awareness about the mangrove conservation to the school pupils adjacent to mangrove forest reserves.

4.3.7 Household size

A household normally consist of family members (husband, wife/wives and their children). In the extended African family set-up a household frequently consists of close relatives assimilated in the family. The study revealed that household size is negatively correlated with the number of trees planted (Table 18). These results agree with Njana (1998) and Katani (1999), who revealed in their studies that as household size increases the number of trees planted tend to decrease. This is due to the fact that most of the large households are composed by children who can not plant trees.

4.4 Local People Attitudes Towards MMP

Most of the people in the study area are aware of MMP and its role (Table 19). This may be due to many activities performed by MMP in collaboration with villages towards conservation of mangrove resources as well as extension services rendered by MMP staff to local people in order to raise their awareness about mangrove resources.

The study revealed that 64.3 % of the respondents are aware of the existence of the MMP while 35.7 % are not aware. Similarly people seemed to be aware of mangrove forest reserve boundaries. This was indicated by about 73 % of the respondents who knows boundaries of mangrove forest reserve and 27.4 % are not aware of the boundaries. Also it was revealed that only 9.5 % of the respondents get access to mangrove forest reserve freely, while 90.5 % get permission from either MMP staff or VNRC before entering in the mangrove forest reserve.

In the case of ownership, 71.4 % of the respondent understands that mangrove forest are owned by government and villages, 11.9 % by village only and 16.7 % by the government only. Most of the respondents do understand that Mangrove Forest Reserves are owned by both villagers and government because they are involved in different levels of management such as decision making, implementation, benefit sharing and evaluation process through interviews. Mangrove forest reserves are owned by central government while local people are given user rights; and they participate in various activities related to conservation under Joint Forest Management.

4.5 Suggestions by Local People Towards the Management of Mangrove Forest Reserve

The study shows that the local people have good perceptions and suggestions on the management of mangrove forest reserves. Table 20 shows that about 44 % of the respondents suggested that measures to conserve mangroves should involve both regeneration and protection strategies. The study indicates that approximately 42 % of the respondents had no opinions about measures to be taken for mangrove conservation. However, about 5 % and 10 % of the households supported protection and regeneration of mangroves respectively. The results also indicated that about 96 % of the respondents were in favour of the government to continue taking measures to improve the management and protection of the mangrove forests.

Table 19: Response on awareness of MMP, awareness of boundary, access to mangrove forest reserve and mangrove forest ownership

Villages	Sudi (%) n = 26	Mkwaya (%) n =23	Mchinga II (%)n = 35	Total (%) N=84
Awareness of MMP				
Yes	61.5	69.6	62.9	64.3
No	38.5	30.4	37.1	35.7
Total (%)	100.0	100.0	100.0	100.0
Awareness of boundary				
Yes	92.3	43.5	77.1	72.6
No	7.7	56.5	22.9	27.4
Total (%)	100.0	100.0	100.0	100.0
Access to MFR				
Free	7.7	13.0	8.6	9.5
Permission	92.3	87.0	91.4	90.5
Total (%)	100.0	100.0	100.0	100.0
MFR ownership				
Government	15.4	26.1	11.4	16.7
Village	11.5	13.0	11.4	11.9
Both	73.1	60.9	77.2	71.4
Other (s)	-	-	-	-
Total (%)	100.0	100.0	100.0	100.0

Table 20: Response on conservation measures and if the government should continue with mangrove conservation

	Sudi (%) n = 26	Mkwaya (%)n = 23	Mchinga II (%)n = 35	Total (%) N= 84
Response on conservation measures				
Mangrove regeneration	-	4.3	8.6	4.8
Protection intensification	11.5	-	14.3	9.5
Both regeneration and protection intensification	46.2	46.2	37.1	44.0
None	42.3	42.3	40.0	41.7
Total (%)	100.0	100.0	100.0	100.0
Response on if the government should continue with conservation				
Yes	100	91.3	97.1	96.4
No	-	8.7	2.9	3.6
Total (%)	100.0	100.0	100.0	100.0

4.6 Constraints to Mangrove Conservation

4.6.1 Revenue Given to Villages

The study showed many of the respondents were of the opinion that the current 10% revenue sharing is insufficient, given the efforts and time they have to invest in participating on the activity. However, there are inherent problems of devolving the powers and responsibilities to local people in the management of common property resources. When the objective of revenue generation is given higher priority in the villages, it can create tendency of accelerating exploitation. Village authority can be more interested on revenue than protection. As a result the villagers will not stop illegal activities including harvesting so as to earn more revenues from fines. In that way exploitation of the mangrove forest reserves can be encouraged and the result will be an increase of environmental degradation.

4.6.2 Harvesting Procedure

The results revealed that there is a problem of travel costs from the remotely located villages to Lindi town. This hinges on the issue of required payments prior to being allowed to harvest mangrove products. This creates an environment of promoting illegal harvesting of mangrove resources.

CHAPTER 5

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

A number of lessons can be learnt from the results and the discussion.

First, the conditions which created a loophole for local people to utilize mangrove resources unsustainably, such as poor management, inappropriate state policy and break down of traditional authorities have been reduced to great extent under MMP in collaboration with the communities.

Second, mangrove forests have increased in quantity and quality due to strict control over the resource. This situation led to local people shifting from total dependence on mangrove forests to other alternatives, such as general land forests. Also some environmental factors contributed to the increase of the mangroves such as; increasing of sea water and accumulation of sediment materials as revealed by respondents.

Third local communities along the coast, in Lindi district in particular, participate in one way or another in the conservation of mangrove resources. Their participation is under different levels such as; in decision-making, implementation of various activities, benefit sharing and evaluation process whereby local people are interviewed about the progress of their participation. Currently they regard mangrove resources as shared property and no longer as solely a government property.

Fourth, mangrove trees planting are influenced by some socio- economic factors such as; household income, education, distance to mangrove forests, gender, household size, residence duration and age .The only factor which significantly influence mangrove trees planting was household income, the rest were not significant. According to nature of the study even sign can be used to explain the effect of variation.

Fifth, the performance of various conservation activities under MMP in collaboration with local communities are successful. Hence, forms an important learning ground on new forestry management approaches (bottom up management approach), which can be subsequently applied in other parts of the country.

5.2 Recommendations

The recommendations of the study are based on the results, personal opinions and suggestion of the villagers during the interviews and PRA.

5.2.1 Mangrove Tree Planting Under MMP

Mangrove tree planting is carried out at small scale with few people, most of them as hired labourers. One of the roles of community participation is voluntarily working to reduce some unnecessarily costs in the management. It is therefore important for people to know their responsibilities in the management and conservation under joint forest management regime.

5.2.2 Extension Services in Conservation Rendered by MMP

Extension efforts need to be focused more on conservation strategies in order to raise people awareness about mangrove resources towards sustainable utilization, as well as management with respect to forest policy changes.

5.2.3 The Need to Revise Harvesting Procedures

Payment for harvested mangrove resources should be made in the respective village government offices instead of paying at MMP and district offices. There is a need of harvesting procedures to be revised in order to meet local people's needs, since these are the main partners in conservation. Also distribution of revenue should be raised substantially from the current one which is 10% of the total revenue collected from selling mangrove poles. The amount will be somehow reasonable incentive for local people to continue to take care of the resource.

5.2.4 Gender Sensitisation

Both male and female villagers are actively involved in the conservation and management of mangrove forest through VNRCs. Females are not participating fully in some of the activities related to conservation such as: patrols and decision making. Effective measures should be taken to make sure that females are involved in all levels of participation including decision-making.

5.2.5 Law Enforcement

It is being recommended that there is a need to reformulate the existing by-laws in order to make them amenable in assisting MMP staff and local communities in forest reserve protection. VNRCs should be given legal powers. This will give them powers to demand, to inspect licences for forest use, powers to search, seize, arrest and compound the offenders.

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APPENDICES

Appendix 1: HOUSEHOLD QUESTIONNAIRE

VILLAGE----------

DATE----------

ENUMERATOR----------

HOUSEHOLD IDENTIFICATION NUMBER----------

1 HOUSEHOLD DATA

1.1 Name of the household head

1.2 Gender

1. male
2. female

1.3 Marital status

1. Single
2. Married
3. Divorced
4. Widowed

1.4Age of the household head ----------years

1.5 Household composition

Age	Male	Female
<18 years		
18-55		
>55		

1.6 Education level

1. None
2. 2. Adult literacy
3. Standard IV
4. Standard V-VII/VIII
5. Secondary education
6. Others (specify)

1.7 Major source of income----------

1.8 Estimated annual income----------

1.9 Residence duration in the village---------- years

2.0 LAND USE SYSTEMS

2.1 How do you own your land?

1.Communal

2. Private

3. Others (specify)

2.2 What system of growing crop do you apply?

1.Permanent and mono cropping

2.Permanent and mixed cropping

3.Shifting cultivation and mono cropping

4.Shifting cultivation and mixed cropping

2.3 Do you own livestock?

1. Yes

2. No

2.3.1 If yes, what type of livestock do you keep? ----------

2.3.2 How do you graze your livestock?

1.Zero grazing

2. Free range grazing

2.3.3 If free range grazing, where do you graze your livestock?

1. In the mangrove forest reserve

2. In the public land

2.4 Do you plant tree in your own land?

1.Yes

2.No

2.4.1 If yes how many per year, what uses and which species?

Species	Number	Uses

2.4.2 Where do you get the seeding?

2.4.3 If you don't plant, what is the reason?

1. No seedling
2. No need
3. No land to plant
3. Seedlings are expensive

3. MANGROVE FOREST UTILIZATION

3.1 What are the uses of mangrove forest resources?

Tree species	Uses

3.2 How do get access to the mangrove forest reserve?

1. Free

2.Permission

2. Fee

3.3 What is the main fuel energy do you use?

1. Firewood

2. Charcoal

3. Kerosene

4. Others (specify)

3.3.1 If the main fuel energy used is charcoal and firewood, what is the source?

1.Mangrove forest reserve

2.Public forest

3.Both

3.3.2 If the source is Mangrove Forest Reserve, what measures do you think is proper to make sure that fuel continues to be available?

1.Regeneration of the trees in the Mangrove Forest reserve

2.Intensify protection

3.Both

3.3.3 How many mangrove trees have you planted?

3.4 How many numbers of headloads of fuelwood per week do you collect?

3.5 What is the distance to the Mangrove Forest Reserve?

3.6 What is the distance to the public forest?

3.7 Who is responsible on fuelwood collection?

3.8 Who are the beneficiaries of Mangrove Forest Reserve?

1. People down stream
2. Village leaders
3. MMP staff
4. None

3.8.1 If people down the stream benefit, do they contribute anything on protection?

1. Yes
2. No

3.8.2 If yes, how do they contribute?

4 MMP AND COMMUNITY PARTICIPATION IN CONSERVATION

4.1 When did the project start? Month ---------- Year ----------

4.2 What is the aim of the project?

1. To manage mangrove on the sustainable basis
2. To improve living standard of the local people
3. To control illegal harvesting
4. Others (specify)

43 Are you aware of different activities performed by MMP project?

1. Yes
2. No

4.3.1 If yes, list them----------

4.4 Who owns the Mangrove Forest Reserve?

1. Government
2. Village
3. Both
4. None

4.5 Do you know the forest reserve boundaries?

1. Yes
2. No

4.6 What is your opinion about the progress of this project?

1. Very progressive
2. Reasonably progressive
3. Slightly progressive
4. No progressive

4.7 We would like to have opinions on community participation at different levels:

Level	Opinion			
	Very satisfactory	Satisfactory	No opinion	Unsatisfactory
1. Decision making				
2. Implementation of various activities				
3. Evaluation				
4. Benefit sharing				

4.8 Are they're any other institutions participating in mangrove conservation?

1. Yes

2. No

4.8.1 If yes, what are they?

1. ----------

2. ----------

3. ----------

4.9 Are you involved with the Government or Project in mangrove conservation?

1.Yes

2. No

4.9.1 If yes, how?

4.9.2 Do you think the Government/ Project should continue to involve community in managing the mangrove forest reserve?

4.10 Do you know any case of encroachment in the forest reserve?

1. Yes
2. No

4.10.1 If yes, mention reasons for encroachment

1. Boundary not known
2. Land scarcity
3. Others (specify)

4.11 What is the importance of Mangrove Forest Reserve?

4.12 What do you think stimulates/ would stimulate members to participate in conservation of mangrove? ----------

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4.13 Are there any gender-oriented factors, which prevents community members to participate in conservation?

1. Yes
2. No

4.13.1 If yes, what do you think prevents women to participate fully in conservation?

4.13.2 what do you think prevents men to participate fully in conservation?

4.14 Do you have further comments on how mangrove forest reserve can be best managed?

Appendix 2: Checklist for key informants

1. **Village leaders**

1.1 Brief history of the village

1.2 The composition of the village

1.3 Formal and informal institutions in the village

1.4 The role of these institutions towards mangrove conservation

1.5 Awareness of villagers towards MMP

1.6 Impact of the MMP to the village

1.7 Methods used in protection of mangrove resources

1.8 The role of the community in mangrove conservation

1.9 Benefits of MMP to villagers

1.10 Relationship with MMP

1.11 Suggestions to improve management of Mangrove Forest Reserves

2.0 The MMP staff

2.1 Management objectives

2.2 Involvement of local communities

2.3 Management problems and their underlying causes

2.4 Strategies to improve management

2.5 Achievements/ problems of the project

2.6 Forestry legislation and rules

2.7 Suggestions for improving MMP

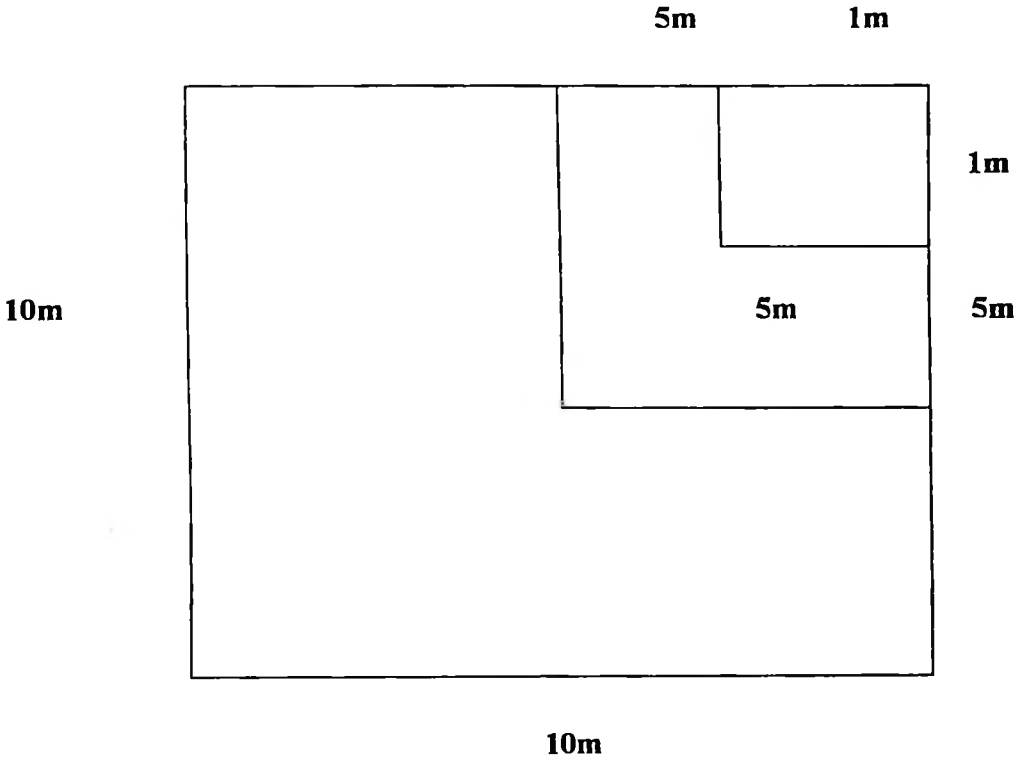
3.0 Natural resources officers

3.1 Their role in mangrove conservation

3.2 Relationship with the MMP

3.3 Any other comments/ remarks.

Appendix 3: Plot layout



Note:

Plot layout not drawn to scale

Appendix 4: Proportional of basal area, volume and density by plots

Plot No.	N	G	V
1	5900	7.065	32.84562
2	11700	4.629538	15.07592
3	9900	3.2342	10.34725
4	13000	8.15615	38.2469
5	6000	4.07415	17.78931
6	5500	9.9381	57.90709
7	3800	12.874	88.73193
8	4900	2.30005	6.302192
9	3800	3.3127	15.41801
10	11900	7.51245	32.80616
11	7100	7.87355	49.96224
12	8900	8.841063	38.1534
13	4600	9.47495	59.92967
14	19800	7.2534	31.75401
15	4400	2.48845	12.81393
16	8400	5.23595	23.55221
17	7000	4.87485	23.61287
18	2500	1.7741	8.590022
19	9000	6.08375	23.14005
20	6700	8.5408	52.5894
21	10400	6.13085	26.80313
22	8600	6.31925	30.60698
23	13900	6.74315	25.19669
24	15000	6.53905	28.80167
25	9300	16.52425	80.76055
26	13700	11.45315	50.48723
27	3300	3.3755	13.60412
28	7100	6.85305	29.06783
29	5900	7.169013	32.256
30	3200	4.62365	19.9091
31	3200	5.31445	22.67518
32	8200	9.6398	35.94897
Mean	8018.750	6.757	32.365
STD	4072.206	3.195	19.609
N	32	32	32
STE	719.871	0.565	3.466
TSx	1410.919	1.107	6.794
lower limit	6607.831	5.650	25.571
upper limit	9429.669	7.864	39.159
Precision	17.595	16.382	20.992

Appendix 5: Analysis of variance

Model	Sum of squares	Df	Mean square	F	Sig.
Regression	183501.3	7	26214.478	1.770	0.106a
Residual	1125416	76	14808.108		
Total	1308918	83			