REVEALING THE FOREST HIDDEN VALUE: THE CASE STUDY OF ERITREA

Mulugheta Ghebreslassie Araia

Thesis submitted in partial fulfillment of the requirement for the degree of Master of Science in Community Forestry at the University of Stellenbosch

The Department of Forest and Wood Science
The Faculty of Agricultural and Forestry Sciences
University of Stellenbosch
South Africa

Supervisor: Jeanette Clarke
Lecturer, University of Stellenbosch

December, 2005

DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and has not previously in its entirety or in part been submitted at any university for a degree.

Signed …….

Date……

Abstract

Like in many developing countries, forest and woodland resources contribute significantly to ensure the sustainability of livelihoods of rural people of Eritrea. However, the contribution made by forest and woodland resources has been masked due to the inability of the traditional economic valuation methods to reveal the hidden values of forest resources. As a result they do not reflect in GDP accounting, development planning and conservation policymaking. The underestimation of the importance of forest and woodland resources to the rural subsistence economy results in both market and policy failures. These in turn lead to escalated forest degradation, livelihood insecurity, value conflicts and ineffective conservation programmes.

The forest and woodlands of administrative sub-zone Dighe were selected as a case study as they comprise trees, shrubs and other non-woody plants of outstanding importance both in terms of socio-economics and biodiversity richness. However, these resources are being rapidly depleted as a result of clearing for commercial agriculture and are under growing pressure due to resettlement of returnees and needs of other social actors. The study was carried out in three representative administrative areas of the sub-zone.

A literature survey was carried out to identify the best of traditional neo-classical economic valuation methods to use in this study. Complementary methods from various streams of economics, ethnobotany, ecological anthropology and rural sociology were reviewed. The sub-set of selected marketable items were quantified and monetised based on market-based valuation approaches; and compared with non-marketable roles to indicate the magnitude of full values of the forest and woodland resources. Values that could not be quantified were described qualitatively. A production-consumption analysis of dom palm scrub leaf harvesting for household utensils was carried out. Forest health was investigated based on observation, semi-structured interviews and secondary information.

The study revealed that local forests and woodlands provide essential goods and services for subsistence use, to generate income and to reduce vulnerability during times of hardships. Riverine forests, acacia woodlands and scattered trees and shrubs of grassland are the three vegetation types found in the study area. The riverine forest, dominated by dom palm, is a most valuable resource as it provides for multiple uses. Among the many marketable and non-marketable benefits, forests and woodlands provide wild food, construction material, livestock feed, household utensils, firewood, traditional medicine, shade, climate amelioration, erosion control, cultural heritages and scenic values. All members of rural households regardless of age, gender and wealth extract forest products, which minor variation between households and administrative areas. Variability of consumptive use values between households and between administrative areas and other non-marketable values are determined by relative wealth status, seasonality, resource availability and distribution, market outlets and local institutions.

The study revealed that the riverine forests and woodland values of the Dighe administrative sub-zone alone have contributed economical values many times greater than US $ 1.43 million per annum for selected quantifiable items only. This would be higher if the other non-marketable forest values were monetised including the livestock grazing and access to watering points. Beyond any doubt, the high local values of forest and woodlands and consequently the contribution to the national economy justify the conservation of the remaining forest. Moreover, the production-consumption analyses showed that the present level of dom scrub leaf harvesting is sustainable. Forest health situation analysis indicates, however, that the entire forest is under immense pressure. Moreover, the findings of this study suggest that conserving forest resource for local values is compatible with the millennium global development agendas.

Opsomming

Soos in baie ontwikkelende lande, dra die woud- en bosbou hulpbronne baie by tot die volhoudbaarheid van lewensonderhoud in die plattelandse streke. Die bydrae van hierdie hulpbronne word dikwels verberg deur die onvermoë van die tradisionele ekonomiese waardasie metodes om die verborge waardes van die bos hulpbronne te toon. Gevolglik word dit nie reflekteer in die Bruto Huishoudelike Produk berekeninge, ontwikkelingsbeplanning en bewaring beleid-vorming nie. Die onderskatting van die belangrikheid van bos- en woudhulpbronne in die oorlewingsekonomie lei tot beleid- en mark mislukking. Die mislukking lei weer tot vinniger agteruitgang van die woud, onsekere lewensonderhoud, waarde konflikte en ondoeltreffende bewaringsprogramme.

Die woude van die administratiewe subsone Digbe is geselekteer as ‘n gevalle studie omdatr daar bome, struike en ander nie-houtagtige plante is wat baie belangrik is in terme van sosio-ekonomiese en boidiversiteit. Hierdie hulpbronne word egter vinnig uitgeroei as gevolg van die behoefte aan kommersiële landbougrond en druk wat te wyte is aan die terugkeer van burgers vanaf die buiteland en ander sosiale gebeure. Hierdie studie is uitgevoer in drie administratiewe areas wat verteenwoordigend is van die subsone.

‘n Literatuur oorsig is uitgevoer om die beste tradisionele neo-klassieke ekonomiese waardasie metodes vir gebruik in hierdie studie te identifiseer. Daar is ook gekyk na ander metodes wat gebruik word in die ekonomie, etnobotanie, ekologiese antropologie en landelike sosiologie. Die substel van gekose bemarkbare items is gekwantifiseer en in geldwaarde omgesit volgens mark-baseerde waardasie benaderings, en toe vergelyk met die nie-bemarkbare rolle om die volle waardes van die woud- en boshulpbronne te toon. Waardes wat nie gekwantifiseer kan word nie, is kwalitatief beskryf. ‘n Produksie-verbruiker ontleding van die dompalm blaar oes vir huishoudelike houers en gerei,, is uitgevoer. Die gesondheid van die woude is ondersoek, baseer op observasie, semi-struktueerde onderhoude, en sekondêre inligting.

Die studie het getoon dat die woude en bosse noodsaaklike goedere en dienste voorsien vir oorlewing en om inkomste te genereer, asook om die inwoners minder kwesbaar te maak tydens moeilike tye. Woude langs riviere, die akasië woude, en die verspreide bome en struike van die grasvelde is die drie plantegroei tipes wat in die studie area gevind word. Die rivierbos wat oorheers word deur die dompalm, is die waardevolste hulpbron want dit voorsien in baie behoeftes. Die bemarkbare en nie-bemarkbare voordele van woude en bosse sluit in die voorsiening van natuurkos, konstruksie materiaal, weiding vir diere, huishoudelike houers, vuurmaakhout, tradisionele medisyne, skaduwee, klimaatsverbetering, die beheer van grondverspoeling, kulterele erfenis en 'n lieflike uitsig. Alle lede van landelike huishoudings, sonder inagneming van ouderdom, geslag of rykdom, is betrokke by die versamel van bosprodukte, met klein afwykings tussen huishoudings en administratiewe areas. Die verskille in die verbruikers waardes tussen huishoudings en tussen administratiewe gebiede en ook ander nie-bemarkbare waardes word bepaal deur die relatiewe rykdom status, seisoenaliteit, beskikbaarheid van hulpbronne en verspreiding, mark uitsetpunte en plaaslike instansies.

Die studie het getoon dat die rivier bosse en woudwaardes van die Digbe administratiewe subsone alleenlik baie maal groter is as die US $ 1.43 miljoen per jaar vir geselekteerde kwantifiseerbare items alleenlik. Hierdie bedrag sal nog hoër wees as die ander nie-bemarkbare woudwaardes insluitende weiding vir diere en toegang tot water ingesluit word. Sonder enige twyfel regverdig die plaaslike waardes van bos en woudgebied en die gevolglike bydrae tot die nasionale ekonomie, die bewaring van die oorblywende woude. Die produksie-verbruik ontleding toon dat die huidige vlak van dompalm oes volhoudbaar is. Verdere ontleding van die gesondheid van die woud toon egter dat dit die hele woud onder druk verkeer. Die bevindinge van hierdie studie suggereer dat die bewaring van boshulpbronne vir plaaslike waardes versoenbaar is met die millennium wêreldwye ontwikkelingsagendas.

Acknowledgments

My sincere gratitude goes to the Ministry of Agriculture of the Government of Eritrea for funding my study. Special thanks go to Mr Naigzy Gebremedhin, Mr Semere Amlesom, Mr Mebrahtu Iyassu, Mr Mogos Weldeyohannes and other staff of the Ministry of Agriculture. I gratefully acknowledge the support I received from Ms Lula Ghebreyesus for facilitating financial and administrative matters by liaising with the government of Eritrea and the University of Stellenbosch. Her moral support did not be escape unnoticed.

I am indebted to the rural community and respected local administrators including the councils of elders of the administrative sub-zone Dighe who shared their time, knowledge, living skills and patience with me while I was collecting my data. Many thanks go to Mr Abraha Graza, Director of Branch Ministry of Agriculture office for Gash-Barka Administrative Region who supported me in the field arrangements including seconding his staff and vehicles. I would like also to thank to Mr Khassay Tesfay, Ms Hidat G. and others for their assistance in facilitating the PLAR, and in collecting household survey and market survey data.

My appreciation goes to Ms. Jeanette Clarke for her relentless support technically, morally and materially. She was supervising, guiding and advising me enthusiastically from the beginning of my fieldwork in Eritrea to when I wrote up and edited my thesis. All the pictures in this thesis are sourced from her. I cannot escape without mentioning her amicable moral support throughout my academic life in the University of Stellenbosch. I also extend my gratitude to Mr. Warren Nelson for all his friendly moral support.

I am also indebted to my family, particularly my mother, sisters and brothers for their moral assistance and for enduring my absence. Special thanks to my friends and colleagues, Iyob Zermariam, Redae Teclai, Ms. Sandu Weldemariam Seyum, Misgina Gilay, Yirgalem Tagese, and Cliff S. Dlamini, Ratsodo P. Tshidzumba and others for their encouragement and moral support. I also appreciate to the moral support and

camponionship that I received from friends at the University of Stellenbosch- Miss Marte Taylor Bye, Miss Hilde Moa, Amanual Tesfayesus, Fanual Mesfin and other Eritrean students. I hope we will remain friends forever.

To those people who provided me with input to this study and who have not been mentioned, thank you very much for your generosity. May God bless you all!

Acronyms and Abbreviation

Organisations

AMRF	Assessment and Management of the Riverine Forests
DoE	Department of Environment
DCG	Dryland Coordinating Committee
EEA	Eritrean Environmental Agency
FAO	United Nation- Food and Agricultural Organisation
GDP	Gross Domestic Product
GoE	Government of Eritrea
NAP-E	National Action Plan to combat desertification-Eritrea
NEMP-E	National Environmental Management Plan-Eritrea
NTFPs	Non-Timber Forest Products
PENHA	Pastoral and Environmental Network in the Horn of Africa
UNCED	United Nation Conference on Environment and Development
UNEP	United Nation Environmental Programme
WCED	World Commission on Environment and Development,

Units

Ha	Hectare(s)
Hrs/day	Hours per day
Kg	Kilogram(s)
No	Number
Qt	Quintal (s)
Yr.	Year(s)

Table of contents

List of Tables

List of figures

List of Boxes

Chapter 1. Introduction

1.1. General introduction

The Rio Earth Summit in 1992 raised appreciable awareness of environmental problems resulting from the decline of global forest cover and forest health. Consequently, representatives of the 108 countries who attended the Rio de Janeiro summit adopted the resolutions and conventions of Agenda 21. The Statement of Forest Principles for Sustainable Management of the global forest resources is one of the most important components of Agenda 21 (UNEP, 1992). Nevertheless there is insufficient evidence to demonstrate a decline in the rate of deforestation of natural tropical forests (Kramer, Sharama & Munasinghe, 1995).

Most recently, researchers in this field admonished that natural capitals in general and global forests in particular are experiencing an accelerated rate of degradation (Armsworth & Roughgarden, 2001). Sadly, the world summit in Johannesburg, a decade after Rio de Janeiro, revealed that global attention to safeguard forest health appears to be declining. Kaimowitz (2003) reported to the world forestry congress that forest issues were not even on the agenda for most part in the Rio+10 summit. Among the many reasons, the following factors can explain the situation.

Firstly, for the majority of policy makers, the perceived value of forests is in large-scale commercial production of building materials, energy, and industrial raw materials, as well as foreign exchange generation (Buttoud, 2000; Panayotao & Ashton, 1992). Forests are also seen as potential agricultural land. Land use decisions tend to be based on comparing the economics of commercial production, be it agricultural or forestry. The key question is whether decisions should not also be based on careful consideration of non-commercial use, and of ethical and distributional issues of natural resource use.

Forest resources provide significant benefits to the maintenance and sustainability of rural economy (Arnold & Pěrez, 2001; Gram, 2001; Arnold & Byron, 1999: IIED, 1997; Arnold 1995). Recent studies showed that the about 240 million people living in

forested regions are highly dependent on those resources for their livelihood (World Bank, 2003). At the same time, in spite the mixed research findings, many believe that the extraction of the local forest products could sustain the natural forests while providing various goods and services to the rural poor (FAO, 2002; SCBD, 2001; Peters, 1996; Peters, Gentry & Mendelsohn, 1986).

Secondly, the lack of mechanisms to create synergy between sustaining local values and global environmental advocacy could be mentioned as a potential threat to forest management. One of them is the advocacy and practices of 'precautionary principles' by many environmentalists. This principle is based on the ecosystem management approaches to preserve the global values of forests with less emphasis on the local values of forest resources. The compatibility of conservation programmes based on the precautionary principles with the livelihood strategies of local people are still questioned by many authors (Vermeulen & Koziell, 2002; Arnold & Pérez, 2001).

The intention in this thesis is not to imply that timber is not an important product for national economic growth. On the other extreme, it is not also to negate the importance of conservation for global values of forest resources. There are *prima facie* cases that conserving forests provides benefits to everybody on earth. There is no doubt that if new markets for global values developed, then the per capita well being of local people could be improved (Pearce, Putz & Vanclay, 2002), it would be a value addition to the existing local incentives for co-management. However, the motive of this study is to demonstrate that those factors are the underlying causes for ignoring local values in the economic valuation of forests resources (Vermeulen & Koziell, 2002).

Progress has been made with developing methods to incorporate the environmental values in the field of economics for policymaking (Emerton, 2003; Kant, 2003; Gram, 2001, Buttoud, 2000; IIED, 1997). However, these developments have not been able to address the issues of local values and social welfare sufficiently. To date, most of the valuation exercises have been criticised for methodological shortcomings and their overly of academic orientation (Emerton, 2003; Kant, 2003; Sheil &Wunder, 2003;

Gram, 2001). There is still a demand for methodological research to ensure a better understanding of forest resource values that actually make a difference in the real world for better conservation and development decisions, to private sector profitability, to national economy and to local livelihood (Emerton, 2003).

This research is based on the assumption that policy oriented valuation research based on creative and new constructive methodology contributes to safeguard the global forest resource while providing local level poverty alleviation and food security. After all, whose value counts to conserve the locally available resources? Does exclusion of local values ensure the maintenance and sustainability of global values and sustainable development?

Ignoring or undervaluing the hidden harvest[1] of forest resources leads policymakers to treat many areas as 'economic wastelands' (IIED, 1997:1). Even if environmentalists identify the areas as important resources or natural heritages, they advocate the entire preservation of the resources and the total exclusion of people from using forests for their subsistence. These cause market and policy failures that threaten the sustainability of the conservation and development programmes. Consequently, participatory and local level forest valuation comes to the forefront of academic and policy research to tackle the challenge (Kant, 2003; Armsworth & Roughgarden, 2001; IIED, 1997; Kramer *et al*, 1995). Revealing local values alone might not be a panacea that resolves every problem of the global forest management challenges (Kengen, 1997). It does however provide a broader understanding of livelihood strategies and possible policy and institutional arrangements for the co-management of forest resource (IIED, 1997).

Principally, this research was motivated to provide quality data to empower local people to negotiate in co-management arrangements and to demonstrate the value of the forest for well-informed policy and decision-making. This study was motivated to review appropriate valuation methodologies that could help to reveal the hidden local economic

[1] The hidden harvest refers to those forest products or value that is not included in a formal economic calculation. In other words they are species and values that are perfectly visible to local people, but much less visible to policy makers and researchers (IIED, 1997).

values of the forest resources in the western lowlands of Eritrea. Conserving local values of forests resource could also contribute to the achievement of the millennium global development agendas; as they provide food security and poverty alleviation while maintaining biodiversity and other environmental resources. Hence, revealing local level values of forest resources could greatly help to revive attention from the world society before the global forest resources are further depleted.

1.2. Research rationale and justification

1.2.1. Research rationale

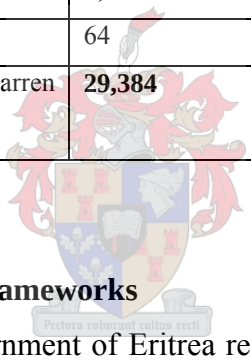
i. Forest resources in Eritrea

Eritrea[2] is positioned in drought prone Sub-Saharan Africa and is characterised by arid and semi-arid climatic conditions. It is located in the horn of Africa. Consecutive colonisation by Italy, Britain and Ethiopia has left a legacy environmental deterioration. Historical information indicates that Eritrea had a sizable amount of forests and woodland cover. The forest cover has dwindled from 30% to less than 2% of the total landmass of the country in the last one-century. Eritrea has three major forest vegetation types. These are highland forests, acacia woodlands and riparian forests (FAO, 1997, Table 1.1).

[2] The state of Eritrea has a total area about 124 500 km^2 and a population of 3.5 millions with about 2.9% annual rate of growth. This horn of Africa country gained its independence in 1993(FAO, 2000).

Table 1.1. Forest cover of Eritrea (modified from FAO, 1997)

Forest vegetation type	Area (km^2)	Share of total area (%)	Remarks
Forest	**1,001**	**0.8**	
Closed to medium forest	591		
Open forest	410		
Woodlands	**14,074**	**11.2**	
Closed to medium	4,533		
Open woodland	9,541		
Bush & grassland	**79401**	**64**	
Grassland/wooded grassland	1865		
Bush	64		
Riparian forest	**1,929**	**1.6**	
Riverine forests	1,865		
Mangroves	64		
Other categories (Agriculture, Barren land, others and unclassified land	**29,384**	**23.4**	Agriculture accounts 8,712 km^2



ii. Legal and institutional frameworks

The constitution of the Government of Eritrea recognises the importance of sustainable resource management and the harmonisation of public participation for better achievement of social welfare and sustainable economic development. The most relevant articles of the constitution to this research in particular, and conservation of environmental resources in general are Article 8 and Article 23. Article 8 defines the national economic and social development framework and Article 23 defines the rights of property including usufructs. These articles explain that land, water, air and other natural resources are state domains to ensure their sustainable management. Both articles also give the state a duty to ensure the creation of favourable conditions to secure the participation of citizens in safeguarding the environment.

The overall objective of these articles is to provide as national code of conduct for better social welfare, economic development and environmental health in the interest of

present and future generations (GOE, 1997). The article provides a framework for guiding the formulation and implementation of comprehensive forest and environmental sector policy and legislation.

Considering the constitutional duties and mandates of the state, the Ministry of Agriculture has recently drafted new forestry and wildlife legislation. The newly drafted legislation has holistic and comprehensive environmental and socio-economical objectives[3] (FAO, 1997). However, a close scrutiny of forest sector policy and legislation shows the need to review and amend some of the articles to achieve the desired objectives.

The definition of 'forest products' in the draft legislation is the most relevant article for this research. In the draft legislation, forest products are defined as any part of a tree including roots, trunks, leaves, fruits, flowers, and bark (FAO, 2000). The definition does not include the values of non-tree plant species of the forests and other ecosystem services. The draft legislation also does not have a distinct definition of timber and non-timber forest products (NTFPs). This may created ambiguity regarding the difference between timber and NTFPs, but may also result in under-valuation of the significant contribution of the forest resources to the rural household and national economies. There is a need to provide a definition of NTFPs in order to include the socio-cultural, informal economy and environmental roles of the national forest resource.

Consequently, this research adopted a broader definition of forest products that incorporates the missing values of the forest resources to capture the full range of values. To date, many definitions have been used to articulate the non-wood values of forest products using different terms for the same item and objectives. These include NTFPs, non-wood forest products or secondary forest products (FAO, 1999). In effect, those

[3] The objectives of forest policy and strategy of the country are targeted to ensure the protection of the natural resource base from inappropriate or excessive use; to ensure production of fuelwood and construction poles; to foster soil conservation through reforestation; restoration of ecosystems through natural regeneration and the development of national reserves and parks.

words are used interchangeably. In the present Eritrea context, forest products and NTFPs can also be used interchangeably due to the absences of national large-scale commercial wood products. Non-timber forest products are defined in this thesis as follows:

> All the biological material (other than industrial round wood and derived sawn timber, wood chips, wood-based panel and pulp) that may be extracted from natural ecosystems, managed plantations, etc. and be utilised within the household, be marketed, or have social, cultural or religious significance (Chamberlain, Bush and Hammett, 1998).

Like in many developing countries, life and development in Eritrea are firmly dependent on the remnant natural capitals (World Bank, 1996). Rural people are widely reliant on forest resources both for subsistence and for income generation in a multitude of ways (NEMP-E, 1995). Presently, Eritrea does not have a source of domestic timber supply, as most of the valuable timber once found in the sub-humid highland forests was extracted during the Italian colonisation (FAO, 1997). However, Eritrea's remaining forest resources have high values although not easily quantified. Forests provide raw materials for shelter, medicines, fuel, fodder and household utilities. Alongside, these direct uses, forests are sources of spiritual nourishment and the basis for the local and indigenous knowledge systems. Other functional roles of the forest resource include climate amelioration, watershed protection and soil conservation. Recently, it was estimated that forests contribute about 29% of the quantified economic values of Eritrea's biological resources and ecosystems (Emerton & Asrat, 1998).

The Government of Eritrea has identified the riverine forests and woodlands of the western lowlands of Eritrea as extremely important environmental and economic resources (MoA/SOS Sahel, 1995; NEMP-E 1995). Particularly, the riverine forests of the western lowlands were identified as a top priority area for natural resource management. The total area of the riverine forests in the western lowlands is estimated at 40,735 ha. Riverine forests of the western lowland contain more than 48 identified

tree and shrub species of relative abundance or scarcity consistent with the composition that would be expected of tropical semi-arid riverine forests (AMRF, 2000).

Many studies (Asfaha, 1999; Connelly & Wilson, 1996; Hansen, 1994) have also confirmed that beyond doubt these forests are essential to the maintenance and sustainability of the livelihood of hundreds of thousands of local people. They contribute largely to poverty alleviation and food security for the large numbers of rural population. Local communities extract wild food, herbal medicines, construction materials for traditional housing.

One of the most outstandingly important species is the dom palm (*Hypheana thebica*), which provides many benefits including wild food, firewood, medicines, and leaves for artefacts, local construction materials, and livestock fodder/browsing materials, traditional medicines and raw materials for household utensils, for household consumption and income generation. Dom palm leaves and associated artefacts are also an export commodity both to Ethiopia and Sudan (NAP-E, 1997). Hansen (1994) stressed that the riverine forests are the last resort as insurance to cope with drought and famine. Moreover, the forests have other vital functions apart from the economic ones. Amongst others, they are a source of primary importance for biodiversity conservation in terms of wild flora, avifauna and mammals. They also conserve the riverine soil from bank erosion and assist in regulating river water flows. Their role in social and cultural life of the western lowlands is also of great importance (AMRF, 1997).

On the contrary, it would be hard to believe forests have significant economic importance by merely investigating the national statistics. Like many countries of Eastern and Southern Africa, the forest sector is reported to contribute less than 3% of GDP. A major reason why the forest sector apparently has such low values to national economies is that official statistics tend to record only the output of formal wood based industries. They focus mainly on products supplied from exotic plantations, such as timber, pulp and paper, large-scale pole wood, charcoal and fuelwood production. They

thereby miss a large proportion of the value of the forest sector that is generated from NTFPs (Mogaka *et al.*, 2001).

The undervaluation of the forest and woodland may yield deceiving figures that show certain landuse types to appear more desirable than the conservation of forest (Kant, 2003; Kramer et al, 1995). Consequently, forest conservation may enjoy less public attention compared with the other landuse types (Amacher and Hyde, 1996). Such undervaluation and ignoring of the local values believed to be the underlying causes of the current market and policy failures[4].

Riverine forests are subjected to many threats including conversion of land into commercial irrigated agriculture, overexploitation by local use, encroachment of the invasive species *Prosopis chilensis* from Sudan, resettlement, and livestock pressures (Asfaha, 1999). NEMP-E (1995) warned that the loss of riverine forest will result in an irreversible loss of biological diversity, expansion of desertification along the riverbank and disruption of the livelihood strategies of local people including the loss of cultural heritage.

Many studies substantiated these fears by revealing the hidden resource value conflicts between local people and other stakeholders (Amanual *et al*, 2000; Asfaha, 1999; AMRF, 1997). This serious but non-violent conflict has surfaced as a stiff competition between local people, commercial agriculture investors, the army and brick kilns particularly in the *mimhdar nues-zoba* Dighe. Conflict between different interest groups may have debilitating effects in the long run. According to Amanuel, *et al* (2000) and Asfaha (1998) who examined of the expansion of commercial agriculture, over-

[4] "Market failure occurs due to absent, distorted or malfunctioning markets in which forest goods and services are undervalued or not valued at all. Sources of market failures include negative externality effects which are not 'internalised' in market prices, missing markets for environmental and other 'open access ' public goods and market imperfections, such as lack of information… Policy failure occurs both when the state fails to take action to correct market failures, and when policies are implemented which further distort market prices and cause disincentive for sustainable management (Richards & Costa, 1999:2)

exploitation of forest resource by the army and brick kilns have the following impacts on local livelihood:

- Local people are deprived of their traditional dry season grazing resources.
- The livestock is cut off from access to watering points in the riverbeds and routes to dry season grazing areas.
- The riverine forests resources will be depleted and the associated uses also.
- Reduction of their source of income, particularly for the poor. Moreover, as the dom forest are cleared, the time spent and the distance for the collection/harvesting of dom leaves become longer, rendering more difficulty in transporting dom leaves to the areas where they used and marketed
- In some areas, due to the clearance of forests for agriculture, the opening encourages colonization of the undesirable and invasive *Prosopis chilensis* tree species.

Experience has shown that resource use conflicts can have a short-term adverse impact ranging from a temporary reduction in efficiency of resource management regimes to hindrance of local level development initiatives. In the end, these conflicts may lead to social violence and even the complete collapse of initiatives of conservation of both by national and international agencies (Castro & Nielsen, 2001; Warner, 2000).

For forests to be managed sustainably for their local values there needs to be an active participation of local people in forest management (Emerton, 1999). Local values including the cultural attachment to riverine forest could provide economical incentives to co-management. Among the many merits of participation, it encourages active participation, facilitates the resolution of conflicts, reduces cost of management, optimises the use of indigenous technical knowledge and promotes equity and social justice in the community (Borrini-Feyerabend, *et al*., 2002).

It is understood that the precautionary principle is to maintain the globally valuable resources as much as possible before these became endangered and extinct (Vermeulen & Koziell, 2002). However, lessons from the experience of many parts of the world

show that excluding local people results in the failure of conservation programmes. Conversely, community based forest management has shown a promising result. For example, Emerton (1999) reported that the local value of the Mount Kenya forest is an economic incentive for local people to manage the forest. The same author also reported that once Mount Kenya forest is conserved for its local value, the national and global less tangible benefits can be maintained.

Besides, local harvesting of NTFPs is believed to be less ecologically destructive than timber harvesting and other forest uses, and could therefore provide a sound basis for sustainable forest management (FAO, 2002). There is no doubt that the maintenance of forest and forest-like structures associated with NTFPs is generally acknowledged as a positive resource management model because it helps to meet the basic needs to local communities without destroying the integrity and stability of the forest functions (FAO, 1995).

1.2.2. Research questions

This research investigated the following key points related to the local values of forest resources and the extent of sustainable exploitation that the national forest programme should adopt in the system of collaborative forest management. These include:

- Who are the local user groups; to what extent are they dependent on the forest resources as compared to other livelihood strategies? For what purpose? Is there a difference in extent of utilisation among different wealth categories?
- What are the perceived local values of the riverine forests of the western lowlands of Eritrea? This includes a comparative study of the relative importance of marketable and non-marketable goods and services in the local livelihood.
- Is the existing level of local use ecologically benign?

Sustainability of Dom palm was selected as a case study for detailed investigation, as it provides a multitude of household consumption and income generation products. Moreover, general indicators of forest sustainability are also researched.

1.2.4. Research aim

This research project has three academic objectives. These include:

- To investigate the socio-cultural and economical contribution to sustainable rural livelihoods both in terms of poverty alleviation, food security and biodiversity conservation
- To understand the local perceptions of values of marketable and non-marketable forest products
- To contribute to the development of methodology that could assist the incorporation of local values in the conservation and development planning

Furthermore, the research project has also strategic objectives. These include:

- Urge broader forest product definition and highlight its relevance to economic policy
- Identify the hidden values of forest products for improved decision-making by providing information for policymakers to strike a balance between economic development, biodiversity conservation and sustainable rural livelihoods

1.3. Structures of the thesis

An area as broad and complex as valuation studies demand some structuring if it is to be accessible. To this end, this M.Sc thesis is divided into eight chapters.

In chapter one, there is a general introduction on the importance of valuation studies, and the rationales and justifications of the research are explained. The rationale and justification in the context of Eritrea are reviewed from relevant studies, government policy and strategy documents. This was helpful in order to draw research questions and objectives of the study.

In the second chapter, literature about the essence of valuation, challenges and prospects of economic valuation of forest biodiversity and other natural resources is reviewed and discussed. The chapter summarises the current debate about value, value systems,

valuation, and terms and concepts of the research. Moreover, challenges of neo-classical valuation and directions for future relevant research are discussed. It also sheds light on the importance of participatory local level valuation and viable approaches of valuation in the context of policymaking. The chapter shows the scope and delimitation of the study as well as justifing the methodology employed for this research.

The third chapter provides general description of the study area and an overview of research methods. A hierarchy of research tools for valuation of the forest resource is presented in a diagram.

In chapter four, the importance of forest products for the subsistence economy is discussed. In this chapter, a descriptive analysis of livelihood strategies of local people, major types of product flows at community level, identification of resource zones and temporal variation of product flow are discussed in depth.

In chapter five, a valuation of marketed forest goods and services is presented. The chapter presents the major sub-set of monetary values of the forest products used for both household consumption and sale for the study area. This is followed by chapter six in which the perception of local people on the relative importance of marketable and non-marketable values of forests product is explored.

In chapter seven, a sustainability analysis of the local extractive economy on the existing forest resources is presented. In this chapter, a particular emphasis put on to the dom palm forest type, as it is composed of the most usable tree species in the entire ecosystem. Furthermore, this chapter sheds light on the major threats posed to forest health.

Chapter eight provides a synthesis of key findings of chapter four, five, six and seven and provides an overall conclusion and recommendation of the research followed by a list of reference materials.

Chapter 2. Forest and natural resource valuation methods: a review of the literature

2.1. The essence of the economic valuation of forest and natural resources

In the last three decades, research on the economic valuation of natural resources has become a top priority of both development planners and natural resource scientists (Kant 2003; Turner *et al,* 2003). Comprehensive guiding principles with regard to the valuation of natural resources were drawn up the Earth Summit to build a platform for holistic and adaptive sustainable forest management. This summit was held in 1992 in Rio de Janeiro, and is widely known as the UN Conference on Environment and Development (UNCED). The conference built a consensus of 180 country representatives on promoting sustainable utilisation of natural resources. Moreover, the UNCED were also agreed on the significance of an assessment for recovering the full valuation of goods and services that flow from forest ecosystems. This is set down in Agenda 21, in sub-section C of chapter 11 on combating deforestation (UNEP, 1992). One of the objectives of the statement of forest principle is to promote recognition of the social and ecological values of trees, forests, and woodlands, including the consequence of the damage caused by the destruction of forest resources (Glűck, 2000).

Recently, Armsworth & Roughgarden (2001) underlined that the prime motive of research in the economic valuation of natural resources is to safeguard the remaining forest ecosystems. The same authors argue ecosystems could be undervalued and abused if ecological and economic systems are not examined thoroughly. Furthermore, most authors agree that high quality economic information provides a sound basis for sustainable management of forest resources (Turner *et al*, 2003).

Consequently, many economic concepts of resource valuation have emerged and evolved rapidly to address the need for valuation at local, national, regional and global. Though the delimitation of these concepts and theoretical backgrounds are difficult to separate, the most common ones are natural resource economics, ecological economics and biodiversity economics (Turner *et a*l 2003; Vermeulen & Koziell, 2002).

All of the above economic fields are commonly rooted in the neo-classical economics and have extended their boundaries by incorporating concepts of evolutionary economics, new institutional economics, new household economics and other streams of economics (Kant, 2003; Tocconi, 1997a; Tocconi, 1995). Theoretical concepts and research approaches for valuation exercises have evolved rapidly, as there is recognition of their importance for forest sector policymaking. A taxonomy and definition of value systems, value, and valuation used in this are provided below.

2.2. Taxonomy of forest biodiversity values

2.2.1. Significance of value classification

The debate over what values reside in forest resources and how these can be classified have attracted the attention of many researchers both in the natural science and social science arena, as those values are both anthropocentric and non-anthropocentric (Farber, Castonza & Wilson, 2002). Some of the foremost important terms and concepts that need to be defined are value systems, value and valuation. Those terms and concepts are the philosophical basis for current methodological debates in natural resource valuation exercises. The various terms are reviewed to highlight the current understanding of natural resources valuation taxonomy and to justify the selection of research methods for this study.

2.2.2. Value systems, value and valuation of natural resources

The terms value system, value and valuation are explained in various ways according to the discipline of the authors. Farber *et al.* (2002:375) articulated the definitions of value systems and value as follows:

> 'Value systems' refer to the intrapsychic constellation of norms and precepts that guide human judgements and actions. They refer to the normative and moral frameworks people use to assign importance and necessity to their beliefs and actions. Because 'value systems' frame how people assign rights to things and activities, they also imply practical objectives and actions. We use the term

'value' to mean the contribution of an action or object to user- specified goals, objectives or conditions. A specific 'value' of that action or object is strongly attached and determined by a user value system as value systems determine the relative importance of an action or object to others within the perceived world.

From an economic perspective on nature, Turner *et al.* (2002) depicted values as assets providing a flow of goods and services, physical as well as aesthetic, intrinsic, and moral. 'Valuation' is defined as the process of expressing a value of a particular action or object (Farber *et al.*, 2002) within the context of space and time (Sheil & Wunder, 2002)

2.2.3. Dichotomous and conflicting value systems: Intrinsic value believers versus instrumentalists

The anthropocentric and non-anthropocentric values residing in nature are described using two major value systems: intrinsic and instrumental value of nature (Turner *et al* 2003; Pearce, Moran & Biller, 2002). Intrinsic value believers maintain value systems in which ecosystems or species have an intrinsic right to a healthy and sustaining condition (Turner *et al*, 2003; Hampicke, 1994). Many people from intrinsic value systems feel uncomfortable with placing instrumental values on biodiversity. The common argument is that biodiversity has values of its own. A more extreme version of these perspectives even claims that instrumental valuation of biodiversity and other natural resources, often translated into monetary terms, is a nonsense exercise (Nunes & van den Bergh, 2001). For these authors, the value of any action or object is measured by its contribution to maintaining the health and integrity of an ecosystem.

On the other hand, instrumentalists believe that values are reflected by the difference that something makes to the satisfaction of human preferences. Instrumental values are fundamentally anthropocentric in nature. Instrumentalists forward two additional related motivations to support their arguments. They argue firstly, that making public or private decisions which affect biodiversity means attaching a value to it; and secondly,

monetary valuation can be considered as a democratic approach to decision making on public issues, including biodiversity ones (Farber *et al*, 2001).

2.2.4. Reconciling the conflict of value systems: the concept of total economic value

From a policy formulation and decision making point of view, considering both the intrinsic and instrumental values are the key for the success of biodiversity conservation, economic development and the promotion of social welfare (Farber *et al*, 2001; Buttoud, 2000). One of the most prominent economic valuation methods used by many researchers is the concept of "full value" or "total economic values" (Buttoud, 2000; Kramer, *et al,* 1995; Turner *et al*, 2001). This is the aggregation of use values and non-use values and incorporates the notions of intrinsic and instrumental value systems (Figure 2.1).

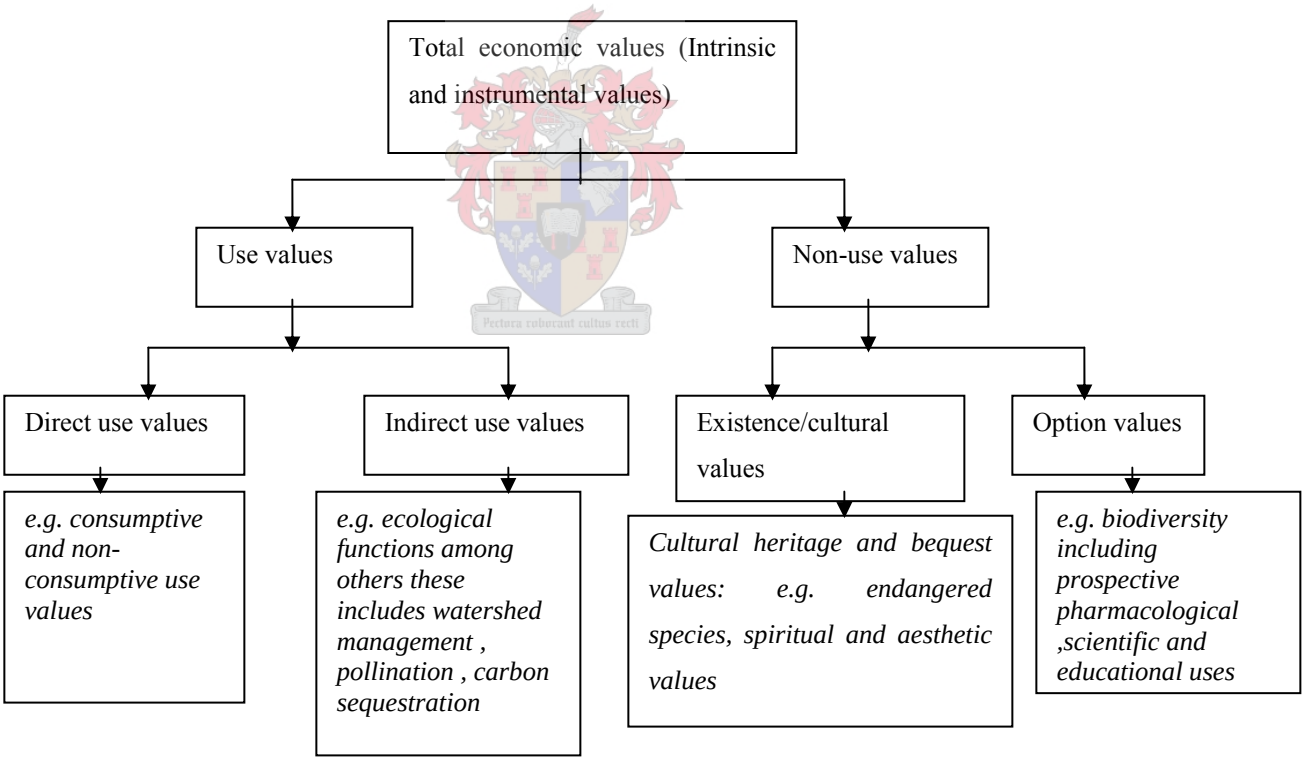


Figure 2. 1. Categories of economic values associated with forests

(re-constructed from Armsworth & Roughgarden, 2001; Nunes & van den Bergh, 2001; Glűck, 2000; IIED, 1997; Martin, 1995)

i. Use value

Use value is a combined direct and indirect uses derived from the forest resources. Direct use values refer to the direct use that people make of resources for wild food and other means of subsistence including non-consumptive benefits such as shade and burial grounds (Glűck, 2000; IIED, 1997; Martin, 1995). These values contribute to people's livelihood both by providing subsistence goods and services as well as income generation by selling marketable products. Until very recently, most valuation studies were focused on direct use values that go through market channels. Many wild products are however not traded and are consumed directly by the people who collect them (IIED, 1997).

Forest resources also provide services that rarely come under effective ownership or management (Glűck, 2000). Consequently, their true economic significance is often ignored in many studies (IIED, 1997). These use values are non-consumptive use values and indirect use values. The indirect use value refers to ecological services that have an important role in supporting other economic activities. Indirect use values include the role of forests in watershed management, environmental maintenance and regulation including carbon sequestration (Vermeulen & Koziell, 2002; Glűck, 2000; IIED, 1997; Martin, 1995).

ii. Non-use value

Forest goods and services have also non-use values that encompass the existence and cultural values of the resources (IIED, 1997); and optional or future values that are unrelated to the current use values (Glűck, 2000). Individuals may have little or no uses for a given environmental asset or attribute but would feel a 'loss' if such resources were to disappear. Besides, forests can provide other future values (option values) that cannot be captured using the conventional economic tools. Intrinsic value believers may underlie their position that nature should be conserved in its own right without reference to an economic use (Turner *et al.*, 2001). According to Martin (1995), these values are borne in many cultures, as the belief that life has intrinsic existence. In other word existence value is a value derived simply from the fact that the resource exists.

2.3. Challenges and prospects of neo-classical economic valuation of forest resources

2.3.1. Neo-classic economic thought and key assumptions

Neo-classical economic thought and its assumptions are the theoretical foundations of many studies of natural resource economic valuation (Kant, 2003; Farber *et al,* 2002, Nunes & van den Bergh, 2001, IIED, 1997; Tacconi, 1995). However, researchers agree that neo-classical economic valuation has limitations when it comes to addressing total economic values and moral values fully (Farber *et al*, 2002; Gram, 2001; Buttoud, 2000). Consequently, many authors argue the importance of creating innovative approaches and multidisciplinary tools to fill the gaps and to address limitations effectively (Tacconi, 1997a; Tacconi, 1997b). It is not the intention of this research to argue that neo-classical economic tools are worthless for the valuation of natural resources. The intention is to review the strength and weakness of neo-classical economic methods in natural resource valuation by considering the alternative and complimentary research methods that can be used to enrich them.

The prime assumption of neo-classical economics is that efficient resource decisions are determined by the self-interested behaviours of individuals, households and companies (IIED, 1997). Individuals are assumed as self-interested utility maximising agents who make rational decisions on the allocation of their scarce resources (Tacconi, 1997a; Tacconi, 1995).

Further important assumptions in neo-classical economics relate to how values are determined in the market process. Economic values are determined through a market process in which people or groups can express their preference for various goods and services. Values are expressed in the outcome of the exchange (prices). The key assumptions here are that markets are free and competitive; buyers and sellers have the same power and have equal access to information. No single group or person can influence the market outcomes in their favour (IIED, 1997).

Neo-classical economists derive market prices for non-marketed goods and services, such as subsistence goods and ecosystem services, based on the assumption that group and individuals have preference for these goods and services (Bann, 2002; Vermeulen & Koziell, 2002). Based on the neo-classical economic assumption, various quantitative and monetary valuation methods are devised to value marketable and non-marketable goods and services (see Box 2.1).

Box 2. 1. Valuation methods of marketable and non-marketable forest resources (adapted from Bann, 2002)

Approaches Based on Market Values

• Observed Market Value and the Related Goods Approach –market prices for environmental goods and services can be combined with quantity information to derive estimates of value. The related goods approach uses information on the relationship between a marketed and non-marketed good or service to estimate the value of the non-marketed good (e.g., barter exchange approach, direct substitute approach, indirect substitute approach).

• The Productivity Approach – uses market prices to value environmental services in situations where environmental damage or improvement shows up in changes in the quantity or price of marketed inputs or outputs.

• Cost-Based Methods – uses some estimate of the costs of providing or replacing a good or service to approximate its benefit (e.g., opportunity cost, indirect opportunity cost, restoration cost, replacement cost, relocation cost, preventive expenditure). Cost-based methods are second best techniques and must be used with caution.

Revealed Preference Approaches - use information about a marketed commodity to infer the value of a related, non-marketed commodity (e.g., travel cost method, hedonic pricing method).

Stated Preference Approaches - elicit directly, through survey methods, consumers' willingness to pay for non-marketed environmental values (e.g. contingent valuation method).

2.3.2. Limitation of economic valuation methods

As illustrated in Box, 2.1 there are several quantitative methods to estimate the value of forest resources including those products for rural subsistence economy and other non-marketable goods and services of the forests (Buttoud, 2000; IIED, 1997; Kramer *et al*, 1995). However, many researchers point to the flaws in these methods and justify their

concern by the fact that they provide different results of value for the same forest resource (Kant, 2003; Gram 2001).

The underlying factor that results in uncertainty around the quantification and monetisation of natural resource is a lack of consideration of the real dimensions of human behaviour rooted in neo-classical economic assumptions. The premises of neo-classical economics are also criticised due to ill-placed terms and concepts, inefficiency of moral consideration and negligence of spatial and temporal variations (IIED, 1997; Tacconi, 1997a).

i. Critiques on the dimension of human behaviour

Among the many limitation, the methods explained in Box 2.1 lack a consideration of the multi-dimensionality of human behaviour and a recognition of the un-substitutability of products. Moreover, they are based on hypothetical situations that are not unqualified to reveal actual scarifies, i.e. willingness to pay or willingness to accept (Armsworth & Roughgarden, 2001). Tacconi (1997a) questioned the neo-classical economic thoughts and assumption that individuals act as consumers (self-regarding), pointing out that they also act as citizens (other regarding behaviours). Citizens are concerned with public interest and self-interest. Indeed, individuals face an internal conflict between the consumer self and citizen self.

Moreover, the neo-classical economics assumes individuals to be the only unit of analysis; there are other units at a higher level of aggregation. In fact, this unit at a higher level makes decisions which cannot be regarded as a simple sum of individuals' decisions. The continuous interaction between individuals and multiple factors, such as social, political, institutional and cultural factors, at higher aggregations shape and reshape rules, behaviours and goals. Furthermore, these factors are also responsible for influencing markets and result in 'market distortion' or 'imperfection'. These factors limit the ability of derived market values to reveal the true values of forest goods and services (IIED, 1997; Tacconi, 1997a).

ii. Limitation of quantified and monetised total economic values

The most widely used term, total economic value or full value, has been criticised for its inaptness. The existence of a unique global or full value of the forest, about which everybody agrees or which can be observed as a matter of fact, is questionable. Particularly, in the field of social science and policymaking, the different stakeholders perceive different values for the same resources, related to their own value systems. In these situations, it is considered as delusive for public decision makers to define a value that every body can agree to as the value given by the society (Buttoud, 2002).

Moreover, Buttoud (2000) argued that some components of the forest values (aesthetic, pedagogic, cultural values) are impossible to measure because every thing in life is simply not measurable. Some values cannot be given a price tag in money terms. Many ecological functions and even some of direct consumptive uses are not passed through a proper market channel. Institutional factors can also distort the market price of items (IIED, 1997). These make the additive and substitution values much more complicated. The danger is that the results of research are unreliable to the extent that some of the most important economic roles may be lost (Buttoud, 2002; Gram, 2001).

Furthermore, where forests provide multi-functional goods and services, the value of one component might be accounted by of the existence of the others. This joint production of forest resources creates difficulty when attempting to value various functions separately (Glűck, 2000). That is why full accounting of ranges of various values of complimentary and competitive services is becoming important before any aggregation is completed (Turner *et al.,* 2003). After all, even the best valuation exercise has not been able to quantify all potential uses and put them in one-aggregated value terms (Sheil & Wunder, 2002). The same authors recommend that properly defined and delimited subsets of principal values should be included in the study rather than confusing and misleading information. Unclear results may misinform public decision makers.

iii. Caveats of terms and concepts used in valuation studies

Most of the concepts and terms used in conventional economics have been questioned for suitability in the context of developing countries. Terms are adopted from developed western countries where socio-economic conditions are different from in the developing countries. Furthermore, most of the concepts and terms used in quantitative studies not only hide values but also miss some important values (Gram, 2001; IIED, 1997), as results and interpretations are aggregated (Sheil & Wunder, 2002).

Aggregated results mask the variability. To illustrate, most findings are presented in terms of households and do not show inter-household and intra-household relations and variation (Campbell & Luckert, 2002). Major flows of cash and kind are presented per household income and low values of self-provisioning source and yet regular and important means of income for households are ignored. Meals recorded are limited to major meals and seasonal variations; and snacks are ignored. Labour is expressed as person hour or days, sometimes differentiated by age and sexes; but variation in work intensity and difference between individuals are ignored. Yield is considered as out put from main field in main harvest; however other seasonal harvests and harvests from other sites are ignored (IIED, 1997). Besides, most economic studies use conventional units while traditional people use local units (Gram, 2001). The inefficiency of those terms and concepts needs to be corrected to reveal the real and practical values of forests for better forest policymaking.

iv. Omission of sustainable development, distribution, equity and efficiency in valuation studies

The assumptions made in neo-classical economics fails to take into account the moral values of forest biodiversity and other natural resources. These include issues of sustainability, distribution and equity in the promotion of social welfare and justice (Kant, 2003; Turner *et al*, 2003; Tacconi, 1997a; Tacconi, 1997b, IIED, 1997; Tacconi, 1995). Efficiency in resource allocation based on maximisation of financial returns may not be compatible with sustainable use of the ecosystems and may ignore the importance of equity (Tacconi, 1997a). Until recently, forestry has been governed by the principles

of sustainable yield management without full consideration of social-cultural values and ecological importance. Sustainable yield management focuses mainly on profit maximisation from timber production. With the recognition of the deterioration of global forest health and the declining of forest cover, this sustainable timber yield management has evolved into sustainable forest management (Kant, 2003).

The concept of sustainable forest management is based on the overall sustainable development agenda. The agenda gives consideration to the social and ecological aspects. Sustainability in this context is defined as the ability to meet the needs of the present without jeopardising the capacity to meet the demand of the future generation (WCED, 1988). On the social side, sustainable forest management includes people in decision-making, incorporates value pluralism (both timber and NTFPs) and ensures fair and equitable distribution. On the ecological side, it considers the holistic interaction among components of forest ecosystems on different spatial and temporal scales and focus as on long-term ecosystem sustainability (Kant, 2003).

It is important to stress that resources are often the basis of rural communities' livelihood. In some cases, depriving NTFPs could threaten the survival of the community. Understanding the decision-making, distributional and equity issues is far more complicated than the assumptions made in neo-classical economics (IIED, 1997). Both individuals in the whole community and extended families are heterogeneous, factional and stratified (Watts, 2003). Likewise, different strata in the community also have also different preferences (Kant, 2003). The key question of whether the livelihood of the community should been traded-off against economic benefits or not, has ethical and distributional implications (Kant, 2003). Hence, valuation research should not only consider the financial cost-benefit analysis as base for decision making.

v. Complexity of extrapolation in economic valuation studies

Forests contain diversified biotic and abiotic elements that are used and perceived in a multitude of ways by various user groups. While the recognition of the value of wild resources is vital to their efficient utilisation, knowledge of resource availability is also

important (Cotton, 1996). Goods and services are not evenly distributed; there is structural and functional variation both at micro and macro scale. Spatial patterns affect the use patterns significantly (Sheil &Wunder, 2002; IIED, 1997).

Economic analyses need to integrate the context of the choice faced by rural populations against the availability and distribution of the forest resources. These analyses also are complicated by variability of social and institutional settings at local level. These include lack of security of land tenure, low level of price stability, non-economic preference, traditions and taboos, among others. These factors may also contribute to the difficulty of extrapolating the findings into the large regional scale strategic planning process based on quantitative results drawn from special scientific cases. Moreover, it is usually impossible to make such difficult measurements in a sufficiently large number of places (IIED, 1997).

Forest use, and therefore values of goods and services, is highly seasonal. Values may change from year to year, depending on need. For example, people are highly dependent on forest products during drought years. Most economic valuation studies reflect the temporal values as units per year. A unit per year hides the significance of the insurance values of the forests in time of socio-economical and natural crises (Sheil &Wunder, 2002; IIED, 1997).

The limitations of quantitative and monetary valuation methods based on neo- classical economic assumption highlights the importance of more constructive and pragmatic approaches. One of the most prominent methods promoted in the last one decade is the use of participatory valuation methodology; that was widely exercised by IIED and also many other researchers (Gram, 2000; IIED, 1997; Tacconi, 1997a, Tacconi, 1997b, Tacconi, 1995).

2.4. Complementary methods to augment neo-classical economic valuation approaches

Like many fields in social science research, neo-classical economic valuation of natural resources is trapped in the concept of rigor adopted from positivist methodological philosophy. Many studies evidenced that relevance and rigor have an inverse relationship in many social science studies. The intention is not to negate that the significance of speculative and 'curiosity driven' research carried using positivist research approaches in the advancement of knowledge. However, it is merely to underline that policy-oriented research needs the adoption of new constructive methodology using multidisciplinary research approaches (Tacconi, 1997a; Tacconi, 1997b; Tacconi, 1995).

Considering the methodological shortcomings of neo-classical economics explained in sub-section 2.3, many authors argue the importance of extending the boundary of neo-classical economics. This can be done by incorporating the concepts and methods of new economic principles, developed by evolutionary, institutional and ecological economics including other streams of economics (Kant, 2003; Tacconi, 1997a).

Simply generating quantified information and monetising the economic value should not be considered as an endpoint. The restrictions of simple and reductionalist neo-classical models should not limit valuation study to a mere focus on quantifying monetary values. Instead, a number of participatory research tools can be adopted from ethnobotany, ecological anthropology and other rural sociological tools to generate both qualitative and quantitative data for practical use (Vermeulen & Koziell, 2002). Among many benefits, participatory tools help to reveal the role of forest resource in rural livelihoods, resource availability and relations with other production systems, and also reveal the moral values of forest conservation.

Many participatory tools have evolved to collate, analyse and present information for public decision-making. These approaches and tools are collectively called participatory learning and action research (PLAR) (Davie, 2003). These tools can be used to generate

quantified data, scores or indexes to indicate the relative weight of perceived facts or values (IIED, 1997; Cotton, 1996; Martin, 1995). For local people, rigor and relevance of research is measured by how much of people's life experience is incorporated (Vermeulen & Koziell, 2002). Moreover, using a combination of various tools simultaneously to investigate and analyse the same issue from different directions help to triangulate and verify the reliability of the information (Hart, 2004; Nemarundwe & Richards, 2002).

Considering the complexity of global values and also appreciating the relevance of local values in public decision-making arenas, participatory local level valuation of resources can contribute to solving market and policy failures. However, this does not imply that local values are better than global values. On the contrary, the intention is to advocate that sustainable forest resource management that gives due respect to local values would contribute to food security and poverty alleviation while maintaining and regulating the global values of the forests.

Those advocating the importance of global values give priority to the preservation of indirect use values, option values and existence values. If policy decisions at various levels do not consider the importance of local values in their management objectives, they not only threaten the maintenance and sustainability of rural livelihood, but may also render any national and global conservation policies and programs futile. On top of that, they may entail resource conflict that could negatively affect integrated rural development programmes. Indeed, the principal motive of participatory local value assessment is therefore not to reveal values for local people themselves, but to provide them with a tool to better communicate their perceived values to other local and global stakeholders (Vermeulen & Koziell, 2002).

In other words, findings from the local valuation of forest resources can assist local people to negotiate resource use rights with the more powerful external interests that may threaten their sustained use (IIED, 1997). One of the merits of participatory local valuation of forests is its usefulness to reveal the 'hidden values' of wild resources in a

more comprehensive and relevant way. Local level valuation assists to avoid generalisations about the landscape outside of the study area, and magnifies local understanding of present and future values for better local level resource management (Vermeulen & Koziell, 2002; IIED, 1997; Tacconi, 1997a).

Reviews of studies showed the availability of a wide range of PLAR techniques that are useful for carrying out local level valuation studies. However, this does not imply that those techniques can be a viable substitution for the importance of economic theories. Certainly, those two fields are not comparable fields of knowledge or approaches. Economics is an academic discipline based on evolving a body of theory about how human beings' behaviour and interaction results in the choice and allocation of resources efficiently (Dosman and Luckert, 1998; IIED, 1997). Conversely, PLAR approaches do not carry the same history of institutionalised disciplines or body of theories but have grown out of a variety of perspectives and backgrounds (Davie, 2003; IIED, 1997).

Consequently, various authors have shown the appriopriatness of methodological reconciliation between PLAR and mainstream economical valuation tools (Buttoud, 2000; IIED, 1997; Hot Spring Working Group, 1995). Combining them is the first step in creating a methodological appropriateness between costly and lengthy resource assessment on the one hand; and revealing the hidden values of local resources on the other hand. In addition, this results in better understanding of local use and value by explaining patterns and behaviours (IIED, 1997). A range of social surveying tools are used to complement the findings of economic calculations. Those surveying tools are found to be more helpful to address the difficulties of the concepts and terms, monetisation and quantification, spatial and temporal variations and moral considerations of forest management discussed in 2.3.2. (Table, 2.1.).

Table 2.1. Participatory learning and action research tools widely used in local valuation of forests' resources

(Extracted from FAO, 2001; IIED, 1997;Hot Spring Working Group 1995)

Key research issues	Tools
Forest resource assessment	Participatory mapping, farmers transects, aerial photos, participatory forest inventory, key informant interviews
Ethnobotanical survey	Product flow diagrams, product seasonal calendar, household surveys, producers case studies, historical timeline
Forest management	Tenure maps, conflict case studies, market analysis
Market value and non-market	Villagers' role plays, ranking and scoring; casual interviews, focus group interviews
Sustainability	Farmers' sustainability analysis, aerial photo assessment, production- consumption estimation

Recently, exemplary studies have been carried out using a combination of both of the two different traditions to reveal hidden values of forests to policymakers. Marketable goods and services including those used for household consumption are valued using the local market prices. Participatory learning and action research approaches are employed to present perceived values of non-marketable goods and services and to compare these with marketable goods. Finally, the comparisons then revealed to public decision makers the perceived relative importance of various values of the forests, which are the incentives to local people to sustainable management of their resource(IIED, 1997; Hot Spring Working Group, 1995).

Chapter 3. Study area and methods employed

3.1. Physical and social setting of the study area

The study was conducted on *mimhdar nues-zoba* Dighe (Administrative sub-zone) in the Gash-Barka administrative zone of Eritrea. Dighe has a landmass of 332, 800 ha and is bordered by *nues-zoba* Forto on the west, *Neus zoba* Gogni on southwest, *nues-zoba* Mogolo on southeast, *nues-zoba* Agordat on the east, Kerkebet on north (Figure 3.1.). Mogoraib is the central administrative township of the sub-zone 207 km, 48 km, and 113 kms faraway from Asmara[5] Agoradat[6] and Barentu[7] respectively.

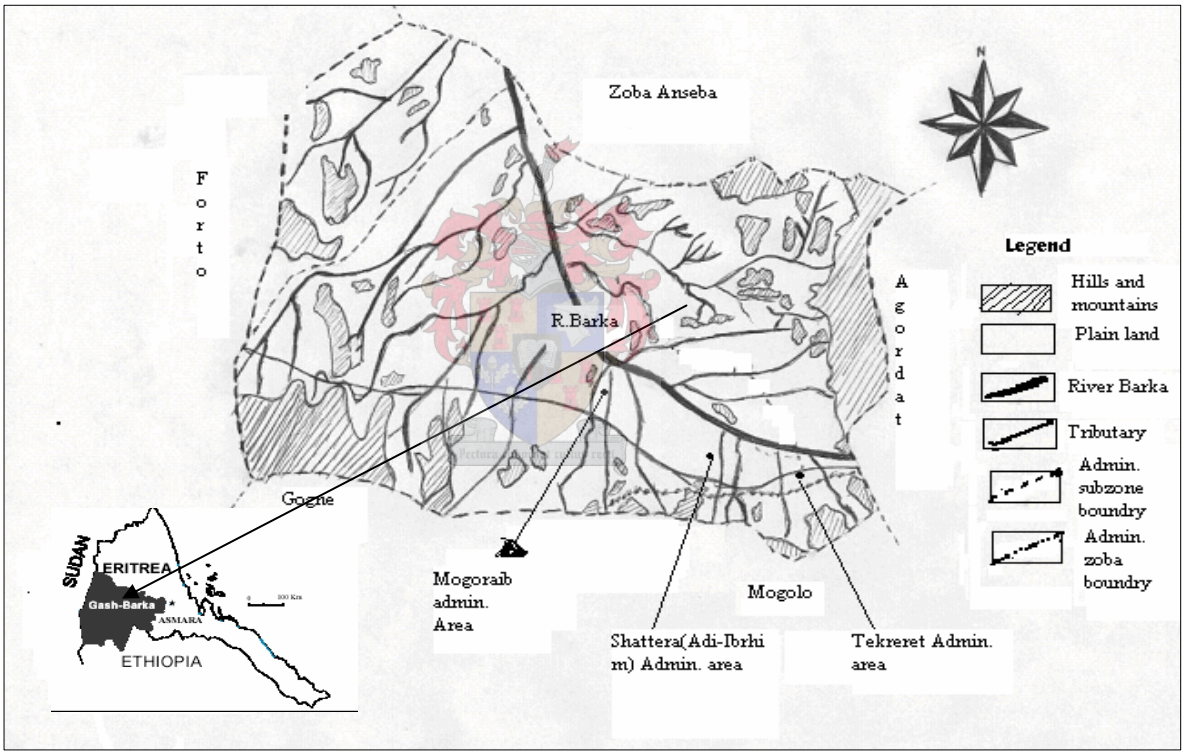


Figure 3. 1. Administrative boundary and landform map of *nues-zoba* Dighe

(Modified from Daniel, 2000)

[5] Asmara is the capital city of Eritrea

[6]Agordat is the nearest large market to sub-zoba Dighe where a diversity of NTFPs are exchanged. Previously it was a capital city of Barka Province prior to the re-arrangement of regional government in 1996

[7] Barentu is the present main administrative city of Gash Barka regional government.

Administratively, there are eight *Mimhdar kebebies* (administrative areas) that were formed as the result of reorganising the former 86 geographically scattered small hamlets or villages of the *nues-zoba* under the 1996 sedentarisation programme aligned with the decree for the establishment of regional administration no. 86/1996(GOE, 1996). The main objective of relocating scattered villages into few *Mimhdar Kebabies* was to mitigate the development hindrance syndrome of scattered villages and to facilitate the delivery of efficient social services for better rural development. The proclamation no. 86/1996 also provides for decentralisation and devolution of power to the grassroots level. Concerns have been raised about the possible impact of greater concentration of population on the sensitive vegetation environment in this arid zone. The disruption of social fabrics as a consequence of relocation is also a cause for concern (Dorman, 2003; Asfaha, 1999; EEA, 1996).

The suitability of the area for irrigation agriculture has created employment opportunities, and also a steady growth in population. This has been augmented by the influx of returnees from Sudan. The most recent estimation of the total population size of the *nues-zoba* administration is 29,119. The mean household size is estimated to be 5.5 per family. Proportionally, Tigre, Hiderab and Tigrigna ethnic groups constitute about 84.8%, 12.5% and 2.7% of the total population of the area respectively (Daniel, 2000).

Nues-zoba Dighe is located in the Northwestern lowland agro-ecological zone or arid zone (Daniel, 2000) of the country characterised by low precipitation, higher temperature and excessive evapotransparation (Amanuel *et al*, 2002; Appendix 1). The annual rainfall ranges from 239-354 mm per annum in the last ten years; mainly falling between June and September. The temperature varies from 18.5^{o}c to 42.6^{0}C. The rate of evapotransparation is estimated to be in the range of 1800-2000 mm through the year except between Decembers and January. Low tree and shrub covers are the dominate vegetation type (Daniel, 2000).

Nues-zoba Dighe is characterised by extensive plains surrounded by mountains and hills. The mountains and hills cover 11.8% of the total landmass. These mountain and hill landscapes are highly valuable to local people as reservoirs of livestock feed. These soils on the mountains are *entisols,* which are unsuitable for crop production.

The Barka river dissects the Dighe and flows to Sudan through Kerkebet. It has three major tributaries and 12 minor tributaries. The river banks are characterised by *inceptisols (fluvisols)* which are fertile sedimentary soils from the upper-catchments of the uplands of Eritrea. The soil fertility together with a shallow underground water table makes the riverine ecosystem a priority area for promoting irrigation based commercial horticulture (AMRF, 1997). As the distance from the riverbank increases, the area is dominated by *aridsols* (Daniel, 2000).

3.2. Socio-political history and landuse dynamics of the Sub Zoba Dighe

Historically, *nues-zoba* Dighe has been subjected to recurrent drought, war and migration. These factors have been shaping and reshaping the socio-culture and livelihood strategies including landuse patterns of the *Nues-zoba* for generations. Pastoralism and semi-pastoralism are an age-old traditional mode of production practised by local people (Hansen, 1994), but also a prevalent survival mechanism in the harsh arid environment of the western lowland of Eritrea (DCG 2002; DCG, 2001). The *Nues-zoba* is still recognised for its wealth of livestock in the country (Table 3.1), though the number has dwindled in the last four decades (Daniel, 2000)

Table 3.1. Livestock population of the Nues-zoba Dighe

(Daniel, 2000)

Types of livestock	Number	Types of livestock	Number
Goats	126,652	Camel	3235
Sheep	48,606	Donkey	3798
Cattle	13913		

Moreover, the historical profile extracted from various studies showed that large-scale commercial agriculture development has been practiced as financially attractive landuse for more than five decades (Box 3.1). Consequently, many patches of riverine forests have been converted and local people have been deprived the subsistence goods and environmental services from forest resources.

Box 3.1. Major national and administrative sub-zone historical chronology

(Extracted from Daniel, 2000; Mellese, 2000; Connelly & Wilson, 1996)

1890: Eritrea was born as a colony of Italy

1906: There known as a 'year of hunger'- people from the Highland of Sahel fled to this *Subzoba.* Some of them remained there and some of them moved to Gash River

1941: The British defeated Italy and administered Eritrea until 1952 as a protectorate

1950: Omer Hassen, Hamed Fereje, Dawid Edris and Osman Abdrhuman were the first local people to invest in irrigated vegetables and fruits over an extensive area along the River Bank of Barka

1955: Franco and Mozar, the first German investors, owned horticultural farms

1961: The beginning of war of independence against the Ethiopian colony as the consequence of the unlawful annexation of Eritrea to Ethiopia

1964: Franco and Mozar introduced cotton

1965: Angelo, Italian investor, introduced sugarcane and watermelon

1967: Many people fled to Sudan following the first brutal Ethiopian offensive

1970: Frank and Mozar started swine and dairy farms in Tekreret targeting the to domestic markets and export markets

1985: Many people fled to Sudan due to drought

1990:1991- Minor drought occurred and resulted in the death of animals but not people

1991: *De facto* national independence day when the Ethiopian army was defeated by EPLF

1993: *De-jure* national independence through referendum and the decree of legal independence

1992-1993: The revival of agricultural concessions in the *Neus-zoba*

1995: The first organised resettlement programmes of returnees from Sudan in collaboration with UNHCR

1996: Good harvesting season and sedentarsation programme

1998: Border war with Ethiopia

1998-2002: Settlement of internal displaced people due to the border war

2003: Low rainfall season

3.3. Composition, distribution and extent of forest vegetation type of Nues-zoba Dighe

As in most other parts of the country, detailed information on the distribution and extent of forest and woodland resources is lacking other than for the riverine forest[8] of the western lowland. Additionally, even the existing scant data are not systematically assembled to retrieve for usage, and the reliability of the research methods employed to generate these data are questionable[9]. This study made use of all relevant secondary information. These included: aerial photographs[10] 1996; the Forest cover map (FAO, 1997); the Riverine Forest project maps (Alazar, 1999); the *Nues-zoba* preliminary land use classification maps (Daniel, 2000) and participatory mapping produced by the local people (Asfaha, 1999). The various sources of information were assessed and extensive field visitz undertaken to verify them.

In addition, the inventory of riverine forests of the western lowlands of Eritrea was reviewed and relevant data extracted for use. In the light of the importance of the data for valuation research, recent findings by Bampton (1998) provided the most reliable information. This information is processed and presented in a suitable fashion to be used for various strategic purposes and by multi- stakeholders (AMRF, 2000).

Three forest vegetation types were recorded (Daniel, 2000). These are riverine forests, acacia woodlands and savannah/open grasslands.

---

[8] AMRF project, a joint project by the Ministry of Agriculture(MoA) of the state of Eritrea and SOS-Sahel International UK, carried out a detailed assessment of the Riverine forest resources from 1996-2000 (AMRF, 2000). The main objective of the project was to develop a management plan for the forest resources. This was subscribed to by the MoA and other stakeholders; with clear indications of resource needs, priorities, management structures and an action plan (MoA/SOS Sahel, 1995).

[9] There is significant discrepancy between the estimations of Riverine forests of the Western lowlands by FAO (1997) and AMRF (2000). The AMRF (2000) showed that the extent of the Riverine forests is three times lower than the estimate made by FAO (1997).

[10] 1:16,000 aerial photographs of the Riverine forests of the Western lowland were produced by Sweden Survey Company in 1996 after a request by Assessment and Management of the Riverine Forests Project (Bampton, 1997).

3.3.1. Riverine forests

Riverine forests are the densest forest type in the *Nues-zoba* located on the banks of River Barka and its major tributaries. Moreover, there are scattered patches of riverine forests along minor tributaries, which make a significant contribution to the livelihood of the adjacent rural people. Table 3.2 and Table 3.3 show riverine forests are dominated by dom palm (Hyphens thebica). Alazar (1998) showed that the *Nues-zoba* contains the largest area of intact dom palm resources in the entire riverine forest systems of the country.

Table 3.2. Riverine forests in the Dighe subzoba

(Daniel, 2000)

Areas	**Ha**
Barka (Main Riverine systems)	4612.4
Tributaries (Major in Mogoraib, Hawashait, Shiglet)	1371.6
Total	5984.0

Table 3.3. Riverine forest composition

(AMRF, 2000)

Forest type	**Trees/ha**
Dom palm	97
Dom scrub	1510
Shrub/ *Acacia nilotica, Tamrix aphylla, Acacia tortlis*	37
Other species	40

Dom palms are the the top priority tree species listed in the national conservation programme (DoE, 1998). In addition, Mulugheta, Redae & Yacob (1998) found that this particular forest area carries thirty-three species of birds and seven mammals. The riverine forests are very important areas for national and global conservation values and local subsistence uses. However, this excludes 1725 ha of land along the main river granted for agricultural concession to develop export-oriented fruits and other horticultural crops since the independence of the Eritrea. Up to now, 938 ha have already been developed using irrigation schemes (Daniel, 2000).

The land use proposal made by the Ministry of Agricultural identified the availability of 12200 ha for irrigation agriculture and 5800 ha for ranch developments (Daniel, 2000). The proposal pays scant attention to the value of the existing riverine forests and raises a concern on the sustainability of the forests.

3.3.2. Acacia woodland

Acacia woodland refers to the shrub vegetation dominated by acacia species that are found in the scattered patches along the landscape i.e. on the mountains, valley bottoms and at the edge of the riverine forests. This forest type is characterised by open to medium canopy closure and covers about 21160 ha or 6.5% of the total landmass (Daniel, 2000). The approximate biomass productivity of Dighe woodland is roughly estimated at 1700-2600 kg/ha/year (van Buskirk, 1999; Appendix 1).

3.3.3. Savannah

Savannah woodland is the most dominant vegetation of the *Neus zoba.* It is characterised by seasonal grass species, dominant grass species, with scattered trees of *Acacia nubica*, *Acacia mellifera*, *Balanites aegyptiaca* and *Capparis deciduas*. It is estimated to cover about 298,830 ha or 89.8 % of the total landmass. The approximate biomass production of the area is estimated to be 500-1700 kg/ha/year (van Buskirk, 1999; Appendix 1)

3.4. Site selection and methodological synopsis

This study made use of a combination of participatory and conventional economic tools to answer various research questions posed in sub-section **1.3** in three *Mimhdar kebabies.* Spot interviews with villagers at different spots both at public places of the different villages and walking in the forests of the *nues-zoba*, were carried out to verify the representativeness of the findings from those *Mimhdar kebabies*. The three-M*imhdar kebabies* selected were Tekreret, Adi-Ibrhim and Mogoraib. These *Mimhdar kebabies* were selected on the basis of risks due to the higher rate of commercial agriculture expansion which converted the forest, and on the basis of other threats to the

forest. In addition, these *Mimhdar kebabies* include many villages near and far from the Riverine forests and are high priority area for resettlement of returnees from Sudan (EEA, 1996).

The research began with reviewing secondary information. The availability of baseline socio-economic studies of the area is mainly limited to the description of uses of the riverine forests. These include Daniel (2000), AMRF (2000), Asfaha (1999), Tarke (1999), Connelly and Wilson (1996), among others. The review then followed with a preparation of checklists for PLAR and structured questionnaires for household surveys. The checklists are Appendixed at the end of the thesis.

Two male and two female staff from the Regional Ministry of Agricultural of Zoba Gash-Barka and two local teachers were deployed in collecting information and also in interpreting the local languages (Tigre). They were trained for one week.

After evaluating their level of understanding of the approaches, the field workers were introduced to local government staff of the *nues-zoba* Dighe, *Mimhdar kebabies* administrators and councils of elders. At the same time relevant government statistics and other relevant documents were gathered.

Field data collection was carried out over three months. A formal household survey was carried out with a 5 % simple random sample of households for the three *Mimhdar kebabies* of *nues-zoba*. A combination of PLAR tools and conventional economic tools used in the survey; including market surveys to collate qualitative and quantitative information about the values of marketable and non-marketable goods and services from the forests.

The details of methods used to collate, analyse and present valuation data for different components of forest goods and services are presented in each of the following chapters of the thesis. However, to illuminate the steps and interfaces, the hierarchal valuation approaches used to address the key questions of the thesis and are presented diagrammatically below (Figure 2.2). These approaches are adapted from various studies including Davies (2003), FAO (2001a), Hot Spring Working Group (1995), IIED (1997), Cotton (1996) and Martin (1995), among others.

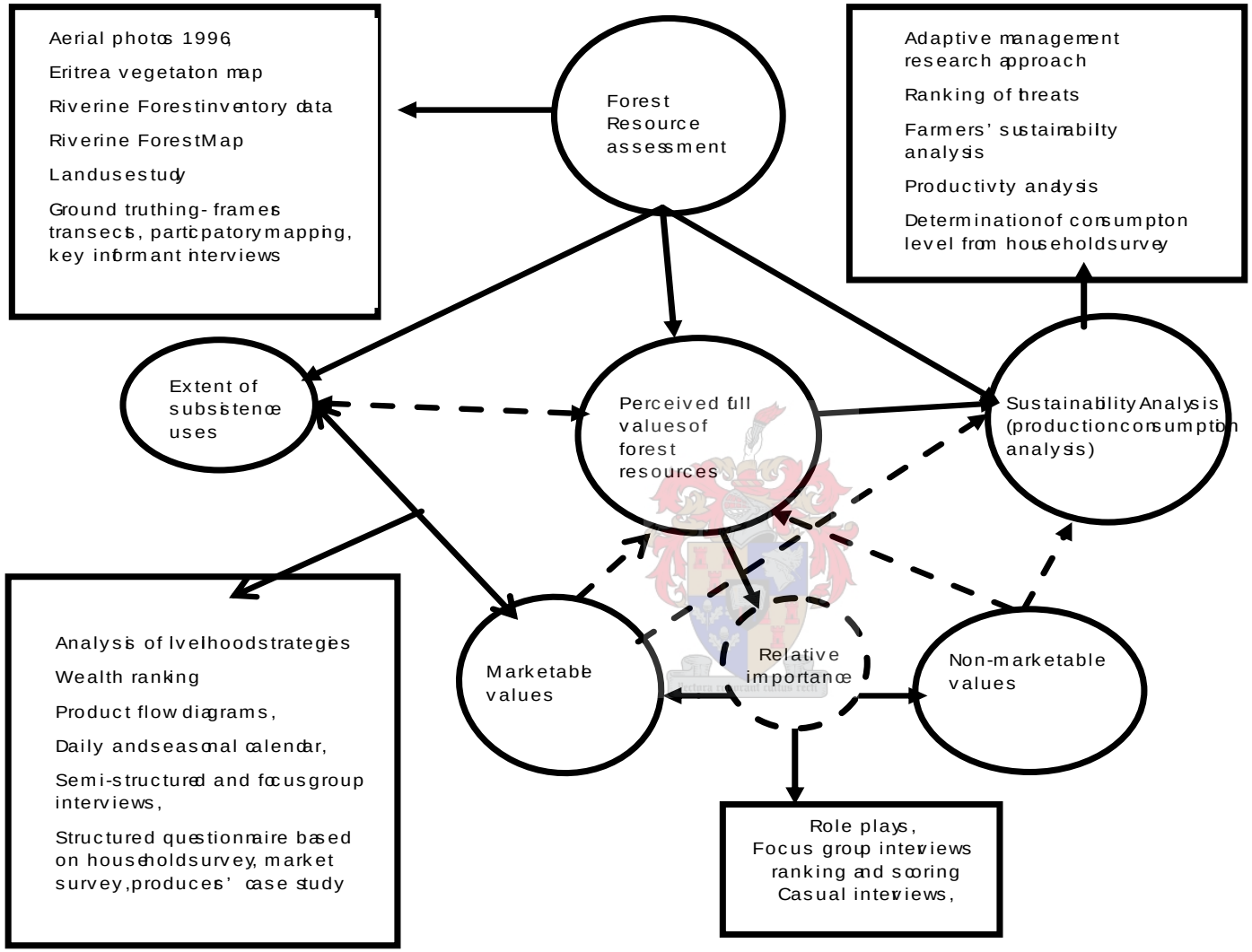


Figure 3.2 Visual presentation of hierarchies and interfaces of methods used in the research

Chapter 4. The role of forest products in the rural subsistence economy of *nues-zoba* Dighe

4.1. Introduction

"A rural livelihood is sustainable when it can cope with and recover from stress and shocks, and maintain or promote its capabilities and assets both now and in the future, while not deteriorating the natural basis"(Carney, 1998). The contribution of forest resources in these aspects is significant for most developing countries. Throughout Africa forests form an integral part of the rural economy, providing a wide variety of subsistence goods and services as well as items of trade. Many studies in various part of Africa showed that the sustainability of rural livelihoods depends on forest resources (Cocks & Weirsum, 2003; Shackleton, Shackleton, Ntshudu & Ntzebeza, 2002; Barnay, Hamett, Sene & Amichev, 2001; Shackleton, Shackleton & Cousins, 2000; Crafter, Awimbo & Broekhoven, 1997; Shackleton and Shackleton, 1997; Wilson, 1992; Falconer, 1990).

The above argument holds true for the rural people of Eritrea. Forests are an indispensable natural capital without which rural life could not be sustained (NEMP-E,1995). Various studies revealed that forests support the livelihood of rural people mainly by providing construction materials, fire wood for household consumption, household utilities, wild food, fodder/browsing materials, income generation, farm implements and medicinal plants (Asfaha, 1999; Tereke, 1999; Connelly & Wilson, 1996). Connelly & Wilson (1996) found riverine forest to be the most crucial resource for household food security and poverty alleviation. Hansen (1994) underscored its importance as a form of insurance for the sustainability of the rural livelihoods during famine and drought.

In this chapter, forest products that provide direct use values to the local community of *nues-zoba* Dighe were examined to understand the extent of dependence, types of products, use patterns and trends. This chapter focuses on first research question listed

in sub-section 1.2.3. The research question is sub-divided into sub-questions, for clarity, as follows:

- Who are the local user groups and to what extent are they dependent on forest resources compared to other livelihood strategies?
- For what purpose, how and when do they use these forest products?
- Is there a difference in perception of utilisation patterns among different social strata, particularly with respect to gender and age?

This chapter provides a description of the value of forest resources in food security and poverty alleviation in the context of rural livelihoods. The findings of this chapter are also the basis to quantify and monetise marketable values of the forest resources explained in the chapter five.

4.2. Methods

A combination of PLAR tools and approaches were used to describe the various forest products and to understand the relative importance of various direct use values, patterns and trends. The tools and approaches included semi-structured interviews with community groups, key informant interviews, focus group interviews and spot interviews (Appendix 4.1. & Appendix 4.2.). Product flow diagrams, direct and restricted overall matrix scores, daily and seasonal calendars and historical use trend analysis were employed to analyse and elucidate the data. The meaning and definitions of those tools and approaches are explained below.

4.2.1. Terms and definitions of PLAR tools and approaches used

Participants are the local people who share their cultural and ecological knowledge and who are called respondents by most anthropologists (Martin, 1995). Through out this thesis, the term 'participants' is used as PLAR research was based on a two-way learning process.

Semi-structured interviews are an interviews tool used to collect qualitative data, based on a checklist of topics or questions that a researcher wishes to cover (Cotton, 1996). They refer to interviewing tools in which some questions are predetermined to guide the interview and new questions come up during the discussion (Theis & Grady, 1991).
Key informant participants are those who have special knowledge of the subject matter under investigation (Molnar, 1991).

Focus group interview refer to the situation when smaller, homogenous groups of people are assembled during a field visit to gain in-depth information about particular issues (Molnar, 1991).

Group interviews refer to discussions with small groups of individuals either causally or on spot during visits to market places or transect walks (Theis & Grady, 1991).

Flow diagrams are diagrams drawn by participants showing causes, effects and relationships between key variables (Theis & Grady, 1991). They can also show a flow of commodities from natural resources (Davies, 2003).

Simple Scoring refers to a participatory scoring exercise of fixed attributes of forest items using stones or other countess. This can be done by either free scoring, where stones or counters are unlimited in number, or it can be done by fixed numbers of stones or counters.

Direct matrix scoring refers to an exercise in which participants are asked to score a list against several attributes using stones or other countess. Overall ranking can be calculated based on the total scores.

Restricted overall scoring refers to the fixing of the number of points or scores for the matrix as a whole, and not per column or row. Matrix scorings are analytic tools that complement semi-structured interviewing by generating basic information that leads to more direct questioning (IIED, 1997; Cotton, 1996).

Daily routine diagrams help to collect and analyse patterns of activities of community members and to compare the daily routine patterns for different groups of people and seasonal changes in these patterns. They show time constraints and opportunities (Theis & Grady, 1991).

Seasonal calendars are diagrams that show the main activities, problems, and opportunities throughout the year. They help to identify the months of peak dependence on various products, difficult and vulnerability, or other significant factors that have an impact on people's lives (Theis & Grady, 1991).

4.2.2. Process approaches

i. Rural livelihood strategy

Comparative analysis of livelihood strategies was carried out to investigate the role of forest products in comparison with other economic activities using semi-structured interviews followed by simple scoring exercises. Initially, discussions with men and women groups were held in three of the *mimhdar kebabies* separately to avoid dominance of one gender over the other. Eightytwo men and 65 women of different age and wealth groups participated in community discussion groups from the three *mimhdar kebabies* (Table 4.1). These were held independently in the local assembly halls of the three *mimhdar kebabies*.

Table 4.1. Numbers of participants in discussion groups

Mimhdar Kebabies	**Number of participants Men groups**	**Number of participants Women groups**
Mogoraib	31	25
Adi-Ibrhim	31	25
Tekreret	20	15
Total	81	65

Each gender group in three *mimhdar kebabies* was asked to identify the key economic activities found in the community. In all of the three *mimhdar kebabies*, the list of main

activities in the rural subsistence economy was recorded on flip charts. This was followed by a simple scoring exercise using 100 stones allocated according to the perceived relative importance of each of the main livelihood strategies. Once the team made sure that there was awareness of the consideration of forest products as one component of the rural economy, people were asked to score how important forest product harvesting, processing and marketing are *vis-à-vis* other economic activities. There were strong debates on all occasions to reach consensus on how the stones should be distributed.

ii. Types of direct consumptive uses and value flows

After the completion of the assessment of the relative importance of the NTFPs *vis-à-vis* the other subsistence strategies, participants were asked to point out consumptive use values of the forests and matching forest species. Flow diagrams were drawn on flip charts to show the species from which these products derive.

iii. Identification of resource zone and useful trees and shrubs

Based on the collated information using the flow diagrams, further focus group interviews were carried out with the members of the "*Bioto*[11]". Participants were asked to choose the six outstandingly important multipurpose species. Unrestricted overall scoring with 150 stones was exercised to understand the relative values of the species in the flow diagrams. The research crews explained the objectives of the exercise. Also, the crews facilitated the process to initiate critical thinking of the participants to allocate the scores with caution. Eventually, the matrices resulted in a clear picture of what species were scoring high *vis-à-vis* the corresponding direct use values, and which species were highly preferred for their multiple uses by the local community.

iv. Temporal patterns of product flows

Daily routine activity diagrams, seasonal calendar diagrams, as well as historical trends were used to understand the underlying factors that govern the consumption patterns. In

[11] A local committee selected by the people that are responsible to administrative and development issues at grassroot levels (AMRF, 2001).

each of the *mimhdar kebabies*, male groups produced seasonal calendar diagrams that listed the main activities in the row and the months in the column with the assistance of the field crews. Afterwards, they were asked to indicate normal harvesting and peak harvesting seasons. The results were then pooled as there was no major variation observed between the three *mimhdar kebabies*. As most of the peak seasons of harvesting falls in the dry season, daily activities of both gender groups for the dry seasons were assessed for better understanding of the day-to-day involvement in forest product industry. Changes in consumption patterns over years were assessed using semi-structured interviews and historical timelines.

4.3. Results and discussion

4.3.1. Rural livelihood strategies and the extent of dependence on direct forest use values

Table 4.2 below shows that, on average basis, the men groups gave the highest scores to the contribution of rainfed crop production followed by forest products. It was only in Adi-ibrhim that forest product harvesting and utilisation scored the highest relative to other economic activities. In contrast, the women groups gave the highest scores to NTFPs as the most crucial economic activities for their livelihoods in all instances (Figure, 4.1). It was only in Tekereret that women showed enthusiasm to be involved for crop production, although they reported that their involvement was restricted by the lack of money for tractor renting and absences of draft animals for farming.

Table 4.2. Scores of forest product vis-a vis other livelihood strategies in *nues-zoba* Dighe

Economic activity	Scores							
	Mogoraib		Ad-Ibrhim		Tekreret		Average	
	Men group	Women group	Men group	Women group	Men group	Women group	Men group	Women group
Forest products	28	37	40	30	23	38	26.3	35
Rainfed crop cultivation	32	23	30	26	60	29	41.3	26
Livestock	29	28	20	30	10	-	22.67	19.3
Wages	6	-	10	1	20	19	10.67	6.67
Others (Aid)	5	12	5	13	-	19	3.3	13

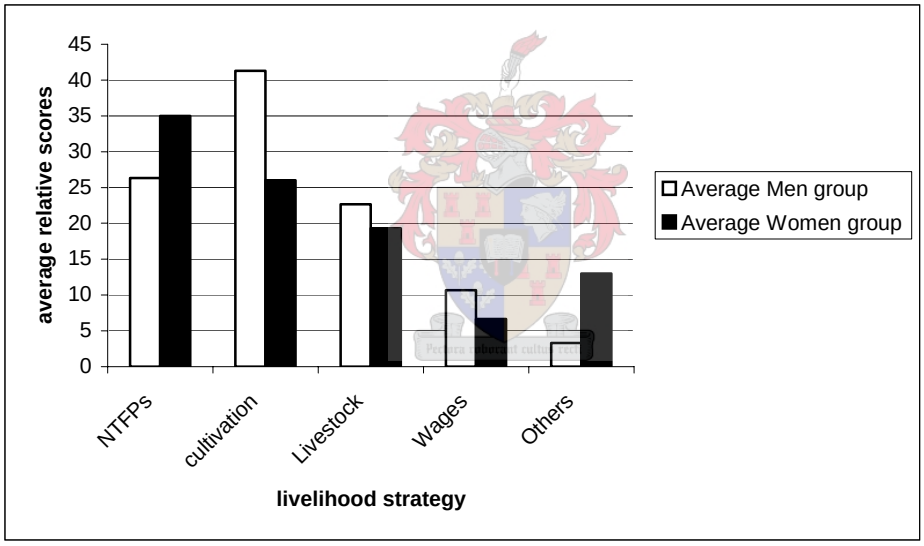


Figure 4.1. Average scores of various livelihood strategies by men and women groups of *nues-zoba* Dighe

There was a lengthy debate by the men's group in Mogoraib on the significance of the contribution of food aid/food for work in rural livelihoods. The majority considered its contribution to be insignificant mainly due to the low quota of food distributed. On the contrary, the women gave relatively higher scores to food aid than wage labour. People are occasionally employed as daily labourers in the agriculture concessions, but rarely women. The *baito* members explained that women, regardless of their martial status, are

the household mangers, who spend much of their time on household tasks. Moreover, they mentioned that women are culturally prohibited to work outside of their houses for wages.

The estimated level of dependence on forest products was similar to findings of Asfaha (1996), except for Tekreret. Dependency on forest products was reported to be about 10-15 % in Tekreret in 1996 and 30.5% in 2003. Asfaha (1999) said that this could be due to the higher prevalence of returnees from Sudan in Tekreret. Returnees have much more experience in crop cultivation, gained when they were in Sudan, than the pastoral indigenous people. Moreover, the data used by Asfaha (1999) was collected in 1996, which was reported to be a 'normal season'. However, the data for this study was gathered in 2003, which was reported to be low rainfall year, particularly for rainfed agriculture.

Considering the higher livestock population in the area (Daniel, 2002), scores given are surprisingly low. The low scores relative to the large numbers of livestock can be attributed to the livestock migration and cultural attachments. Except for very few milking cows and goats, which are left behind in their wet season settlement areas, livestock migration are usually moved far away from their permanent settlement camps. As the result, families remaining in the permanent settlements do not benefit a lot from their livestock. Besides, people dislike selling their livestock for income (AMRF, 2000). They prefer to preserve livestock for cultural prestige[12] (AMRF, 2000; Asfaha, 1997; PENHA, 1996).

4.3.2. Types of direct consumptive uses and value flows

People derive six major direct consumptive uses for maintenance and sustainability of their livelihoods from the forest. The major use categories are wild food, livestock feeds, firewood, construction materials, household utensils and traditional medicine. Participants also explained that the forest provides other products such as dyeing

[12] Large livestock size is leading criteria for wealth groups that determine the social status including marriage, power and respect (AMRF, 1999).

materials, tannins and ploughing implements in small quantities. A flow diagram was produced in flip charts to identify the species from which these products derive (Figure, 4.2.)

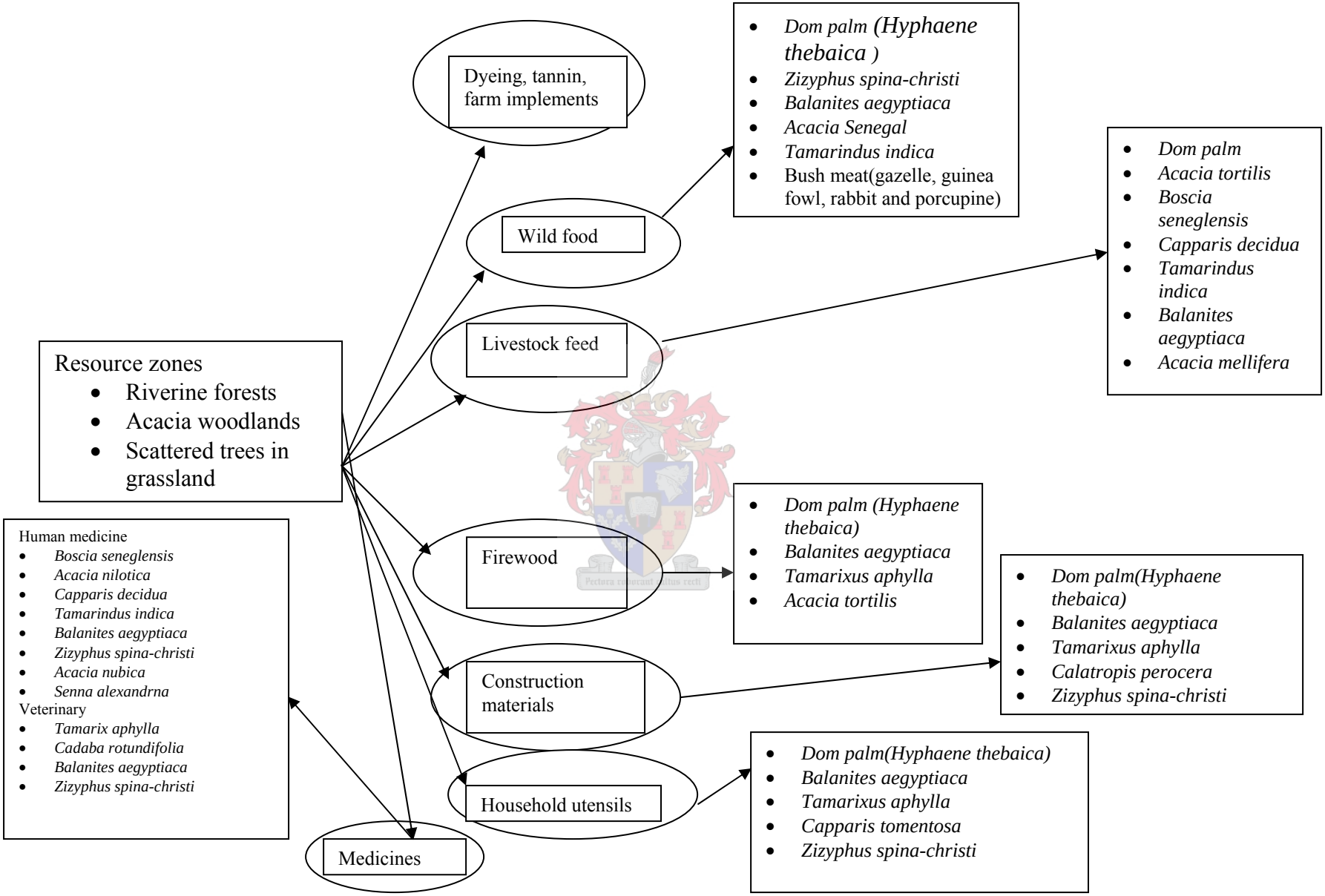


Figure 4.2. Diagrams of direct consumptive uses and species

4.3.3. Resource zone and relative importance of trees and shrub species

Discussions elucidated that these products are harvested from the riverine forests, the acacia woodland and scattered trees and shrubs in the grasslands. The *baito* members underlined that the riverine forests are an exclusive resource pool for wild food, construction materials, and household utensils merely due the higher contribution of Dom palm*(Hyphaene thebaica)* and *Tamarix aphylla*. The major source of traditional medicine, *Acacia nilotica*, is only found in the riverine forests. Acacia woodlands and trees scattered in the grasslands are said to be as major suppliers of fuelwood, livestock fodder and browsing materials due to the higher prevalence of acacia species.

Table 4.3. Overall matrix scores of trees and species vis-à-vis types of use and values in *nues-zoba* Dighe

Species	Wild food	Livestock feed/ Browsing	Traditional medicine	Construction material	Household utensils	Fuel wood	**Combined scores**
Hyphaene thebaica [R]	20	6	2	15	10	5	58
Zizyphus spina-christi [R]	7	2	1	2	1	3	16
Acacia nilotica [R]	-	3	7	1	-	3	14
Tamarix aphylla [R]	-	2	2	11	10	4	29
Acacia tortilis [A,R,G]	-	7	-	1	-	10	18
Balanites aegyptiaca [G, A]	5	3	2	1	1	3	15
Combined scores	32	23	14	31	22	28	**150**

The symbols in superscripts represent resource zone, where R refers to riveine forest, A refers to acacia woodlands and G refers to grassland

The combined scores in Table 4.3 show the ranking of species in terms of multi purpose use. The table also shows the relative scores for particular purposes assigned to individual tree/shrub species.

Hyphaene thebaica (Dom palm) scored the highest particularly with regard to its contribution to wild food, construction materials, and household utensils. Moreover, it makes a significant contribution to livestock feed and fuelwood. *Tamarix aphylla*

cumulatively scored second due to its higher role for construction and household utensils. *Acacia tortilis* and *Acacia nilotica* are particularly the most important species for fuel wood and traditional medicine respectively. Despite its fourth rank, *Balanites aegyptiaca* can be used for a wide range of products by the local community (Figure 4.3.).

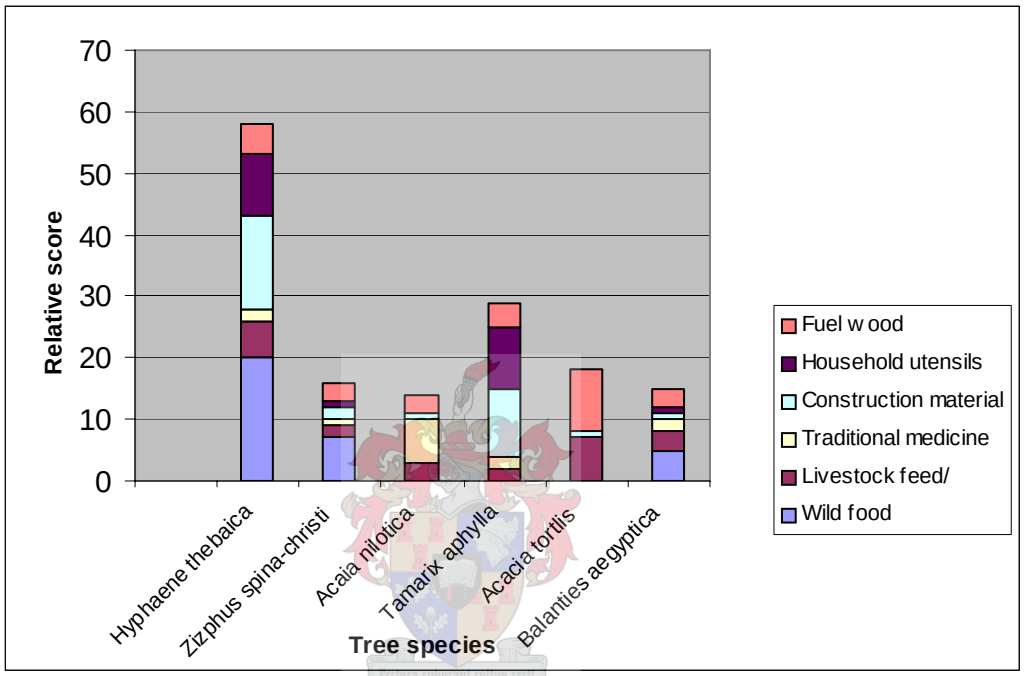


Figure 4.3. Relative importance of species based on overall matrix scores in *nues-zoba* Dighe

i. Wild food

Edible seeds and fruits

Across the region, wild food was the first product mentioned when answering the question about types of direct consumptive forest uses. Participants talked about fruits, seeds, and leaves with zest and at length, describing the method of processing and time of consumption. When the research team tried to move on, by asking specifically about the other NTFPs, people kept reverting to talking about the wild food. The same observation was also reported by other studies (e.g. Asfaha, 1999; Connelly & Wilson, 1996).

Table 4.3 shows that wild food scored the highest of all major direct uses. In terms of local values, dom palm is the most important species followed by *Zizyphus spina-chrsti* and *Balanties aegyptica*. Table 4.4. shows the species and the details of traditional uses including the processing prior to consumption.

Table 4.4. Wild food: Species, wild food processing and Consumption

Species	Details of traditional uses
Dom palm	Prior to the ripening, the drupe is dissected to extract the inner fluid to eat as a snack. People said that this is a most popular dessert equal to caster in Sudan. Likewise, the emerged cotyledon of wild seedlings is also collected for that purpose. Locally it is known as '*Shukumtit*' When the fruit is ripe, the outer cover is eaten. Most frequently, dom fruit is eaten in this form. Once the outer part is eaten, the remainder is buried for two months and dissected, and the inner white flesh and the sweet liquid inside are used for food. Dom fruit is harvested mostly for domestic consumption particularly in hunger years and during agricultural seasons. It is used as a substitute for staple food during these periods.
Zizyphus spina-christi	The fresh fruits are used as a staple of food particularly during famine and used as a snack during good times.
Acacia Senegal	Herders and children chew the *gum-arabica* directly after harvesting from the bark. It is as equally important as chewing gum in the community.
Balanites aegyptiaca	The leaf is cooked as a vegetable during drought and starvation. The fruit is edible when it is ripe. The fruit is also mixed with butter and used as a sauce for porridge.

Bush meat

The local people use bush meat from gazelles, guinea fowls, rabbits and porcupine. It is legally prohibited to poach wild animals for any purposes. This could be the possible reason why people were reluctant to talk about it. In spite of the legal restriction, the study revealed that bush meat is an important source of protein. Gazelles from open

acacia woodlands and guinea fowls from riverine forests are mentioned as relatively abundant in the diet.

ii. Livestock fodder/browsing

One of the bottlenecks for livestock production in *nues-zoba* Dige is the absence of sufficient feed sources and the inadequacy of watering points (Daniel, 2000). Table 4.3 shows that the contribution of NTFPs in fulfilling the demand for livestock fodder and browsing materials was scored fourth. Considering the high density of livestock (MoA, 2000), it was difficult to accept the reliability of the relative scores. However, participants underlined that, except for very few goats, milking cows, donkeys, and camels that remained behind in their settlement, most of their livestock were taken for grazing to the riverine forests of River Gash extending up to River Setit (AMRF, 1997; Mulugheta, 1996, PENHA, 1996).

Table 4.5. Species, livestock fodder/browsing processing and Consumption

Species	Details of traditional uses
Dom palm	The ripe fruit is used as an animal feed especially during feed shortage. The inner kernels are also crushed and used as feed during drought and famine. Recently, small-scale industrial production using locally-made grinders has started to produce supplementary feed from Dom fruits in Agordat. Both pastoralistz and semi-pastoralistz are also harvesting the male flowers (Shidob – local name) for feed. People mentioned the current practices of stamen harvesting as the main reason for the lower production of dom fruits. Dom leaves and palm hearts are also used as a supplementary feed during drought and famine.
Acacia tortilis	The pod is used as a fodder. The pods are knocked down by livestock herders using 'tir', i.e., locally made hooks with very tall wooden poles.
Capparis deciduas	The leaves are browsed by camels and goats.
Boscia seneglensis	Browse and the fruit is used also a supplementary feed.
Calatropis procera	Browse from this species is said to increase the lactation of goats.
Acacia nilotica	The pod is used as a fodder. The pods are knocked down using 'tir'.
Balanites aegyptiaca	The leaves are lopped for livestock during the dry season of the year and when there is an acute shortage of fodder.

In addition, the participants also showed that people exercised seasonal movements a short distance around their vicinity. A case study in Adi-kiternai vaillage, in Mogoraib, revealed that people have two settlement camps based on the rain seasons. The movement from one camp to the other is locally said to be "*dammer*". People used to settle near to the riverine forests during dry season (Mulugheta, 1996). Principally, riverine forests were frequently mentioned as fodder banks for dry season and drought years. Moreover, riverine forests are also used as a route to livestock water points; shade for the livestock and herders as well as a source of wild food for livestock herders (AMRF, 1999).

During the wet season, local people moved to the seasonal camps near to their market centres, which are a way from the riverine forest and relatively higher in altitude. According to the participants the objectives of the shift to the wet season camps is to escape from malaria and to save the fodders/browsing materials for the dry season. In this survey, seven species were mentioned of which *Acacia tortilis* and dom palm were mentioned to be the major contributors to livestock fodder and browse. The species mentioned and the relative scores only considered those vegetation types within the limit of seasonal movement (Table, 4.5).

iii. Traditional medicine

Traditional medicine scored the lowest compared to the other direct uses values of NTFPs. *Acacia nilotica*, exclusively found in the riverine forests, was mentioned as the most dominant phyto-medicine used in the entire region (Table, 4.3).

Table 4.6. Species, traditional medicines processing and consumption

	Species	Details of traditional uses
For human use	*Acacia nilotica*	The ground leaves are used as a massage ointment to relieve pains.
		The soup of boiled seeds is used for treating malaria and for coughing.
	Acacia nubica	The volatile ingredient coming out of the leaves in a steam bath is used as treatment for migraine. Alternatively, people also put the leaves in a tea for the steam bath treatment of migraine.
	Zizyphus spina-christi	The leaf is widely used for anti-dandruff treatment in human hair. The root is used as antibiotic for tonsillitis.
	Senna alexandrina	The leaves are used as a purgative and laxative for the reliev of constipation.
	Capparis tomentosa	The leaves are cooked with chicken sauces for jaundice treatment.
	Balanites aegyptiaca	The young branchlets are smoked to treat joint pains.
For veterinary use	*Tamarix aphylla, Capparis decidua and Cadaba rotundifolia*	The mixture of the ground leaves from the three species is over lain to treat the skin rush of camels and goats.
	Giosis quartoangular	The leaves are put into the wombs to facilitate the delivery of the placenta for domestic stock.

The field crew observation confirmed that it was the most dominate item in Agordat traditional medicine market centre (Figure, 4.4.). The discussion also confirmed that the availability of ranges of indigenous knowledge in the local community in human and veterinary medicines in the three *Mimhdar kebabies*. Participants in all of three *Mimhdar kebabies* also gave similar information about the species and details of traditional uses including the processing (Table, 4.6.). However, participants in Adi-Ibrihim reported that there were very few traditional healers.

Figure 4.4. *Acacia nilotica* pods in Agordat traditional medicine market

In line with Asfaha (1999) and Connelly & Wilson (1996), the above findings show that traditional human and veterinary medicines were used up to recent past in almost all the rural communities. Casual interviews with six teenagers in Tekreret showed that they have little knowledge of the topic. This suggests that there is a danger of erosion of this traditional knowledge before it has been well researched and documented.

iv. Fuel wood

the third most important way in which the forests contribute to rural life, is the provison of fuel wood (Table 4.3.). *Acacia tortilis* was perceived the most important fuel wood species compared to the other five outstandingly important species. Unlike construction materials that are selected based on their shape, pest resistance, durability, and tensile strength, it was mentioned that almost all species can be used for fuel wood. However, they said dom timber, *Acacia tortilis, Acacia tortilis spirocarpa, Acacia mellifera, Tamarix aphylla and Balanites aegyptiaca* are the most frequently preferred fuel wood species in the area. Participants asserted that acacia woodlands supply more of their domestic fuel wood demands that the riverine forests. However, dom palm stems are used in large quantities for commercial lime and brick kilns as its coals lasts a long time once combusted (Figure 4.5). In addition, they used dom stalks for domestic fuel wood consumption due to the short distance of collection and its abundance.

Figure 4.5. Dom palm timber cleared for commercial agriculture used by brick kilns in Tekreret

Participants asserted that local people only collect dry and dead wood (Figure, 4.6). They also denied producing charcoal and said they only use charcoal that remained after burning wood in cooking fires. MoA (2000) howvere reported that local people occasionally cut live trees and produce charcoal for domestic consumption and for sale illegally.

Figure 4.6. Fuel wood transporting in the western lowlands of Eritrea

v. Construction materials

A wide range of trees and shrub species are used for timber in traditional house buildings, livestock pens, shades, and local assembly halls. Construction materials scored the second highest value (Table, 4.3.) compared with the other major direct use values. Table 4.7 also showed that dom palm and *Tamarix aphylla* are the most important species amongst the seven species mentioned for the same purpose. Riverine forests are considered as warehouses of local construction materials as dom palm and *Tamarix aphylla* predominately occur there.

Table 4.7. Species and construction materials

Species	Details of traditional uses
Dom palm	The male trees have strong and termite resistant characteristics. As a result, they score the highest local values for house construction, livestock pens, and shades and local assembly halls. The walls of many houses are made of mats woven from dom leaves and the dom leaves are also used for roofing The dom leaves petioles are widely used for building and fencing. In some traditional houses, the strong, wood petioles are used to make the walls; some times as the material to fill gaps. Leaves and petioles are also used for fencing.
Tamarix aphylla	The pliable branches are used to tie the conical shaped roofs of traditional huts and as a pole in house construction.
Zizyphus spina-christi	The pliable branches are used to tie the conical shaped roofs of traditional huts.
Acacia tortilis	Round wood for construction of traditional huts and house construction
Acacia nilotica	Round wood for construction of traditional huts and house construction
Acacia mellifera	The thorny twigs are used fencing
Calatropis procera	The small sized stems are used for fencing
Delinox elata	The timber is used for doors and windows
Gynocarpus jacquini	The timber is used for doors and windows

The value of tree and shrubs species for construction purposes is determined by various local criteria. People mentioned shape, pest resistance, durability, and tensile strength as the most relevant criteria used for scoring (Asfaha, 1999). However, use of deformed and thin branches of A*cacia mellifera* and *Calatropis procera* for fencing, sheep and

goat pens and, in some cases, for house construction was observed. The research revealed that local people depend on those species with relatively undesirable construction properties merely to spare the cutting of the other outstandingly important species.

vi. Household utensils

Household utensils scored fifth in relative importance as compared with the other selected direct forest use value flows (Table, 4.3). However, it was evidenced from field observation that the role of NTFPs in household utensils and furniture is significant. Household utensil products may be used for a long time before they need to be replaced and the amount of raw materials required to assemble them is low. These might be the reasons for lower scores.

Table 4.8. Species and their importance in household utensils

Species	Details of traditional uses
Dom palm	The split young dom leaves (spears) are used for making diversified artifacts both for domestic consumption and income generations; such as mats, hats, chairs, beds, food containers, cleaning brooms, baskets, and ropes. The green leaf petioles are used for making brooms handles, bed making, and cooking sticks. The inner kernel is used for making traditional kohl.
Tamarix aphylla	The wood is carved into milk containers and coffee grinders. Also, it is used for making beds and chairs.
Zizyphus spina-christi	The wood is useful for bed making and chairs.
Balanites aegyptiaca	The wood is useful for bed making and chairs.
Capparis deciduas	The young twigs are used for cooking sticks

Dom palm and *Tamarix aphylla* are the most outstandingly important species (Table, 4.8.). Riverine forests are the main source of raw materials for almost all household utensils and furniture.

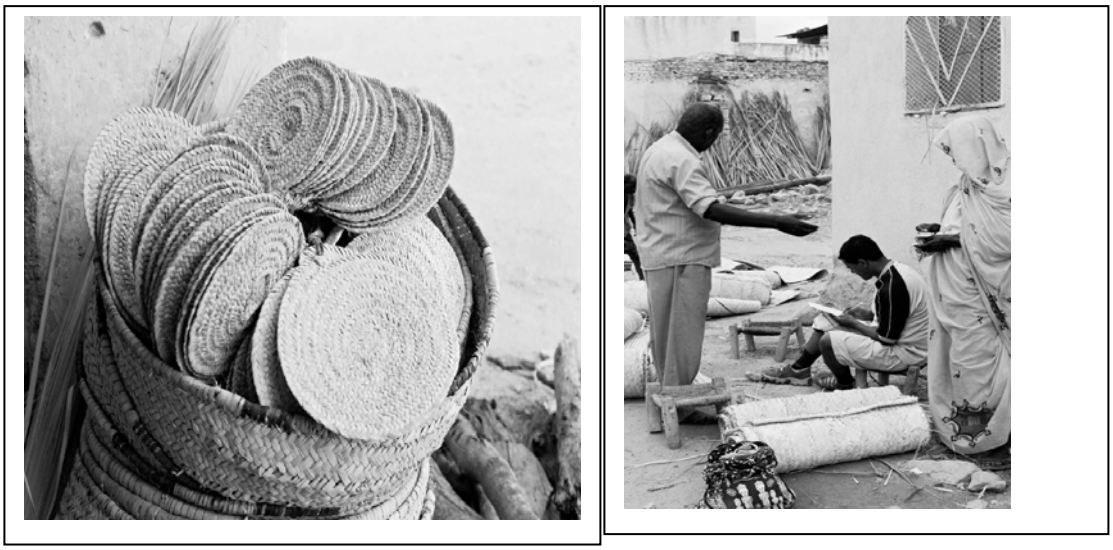


Figure 4.7: Fans and food baskets made from the dom palm leaf in the Agordat market

Items made from forest products were observed in every household regardless of their wealth status. Some households produce items to sell in the market as a means of income. Tareke (1999) identified more than 30 diversified household utensils used in the western lowlands of Eritrea mainly made the dom palm leaves harvested from the riverine forests (Figure, 4.8). Moreover, there is a small urban industry in Agordat that produces beds, chairs and farm implements.

4.4. Temporal patterns of direct forest use value

4.4.1. Daily routine activities and forest products

Scrutinising the day-to-day activities by both gender groups in different seasons of the year illuminated how local people budget time in the subsistence household economy. During the dry season, both men and women groups spent a considerable length of time on the harvesting, processing and marketing of forest products (Table, 4.9). However, people focused more on crop production activities during the rainy season (Table, 4.10). Traditionally, men are responsible for heavy tasks including fetching firewood and dom leaves, using donkeys and camels. In female-headed households, the women must perform these tasks themselves. They carry the loads themselves, as they cannot afford to own livestock, or pay others to collect for them.

Table 4.9. Dry season Daily activities of women and men in *nues-zoba* Dighe

Time	Women	Time	Men
5.00-7.00	Wakeup from their beds, praying, house cleaning and preparing breakfast before their children go to school	5.00-7.00	Wakeup from bed, read Koran and then breakfast (coffee)
7.00- 12:00	Breakfast for husband including coffee ceremony Washing clothes and preparing lunch. In between they weave mats, baskets, fans, baskets. When they have spare time, they collect dom leaves from the nearest dom scrub	7.00-7.30 7.30-12.00	Go to the riverine forests Harvesting dom leaves and fruits and at the same time herding livestock
12.00-1.00	Entirely busy with lunch for the family	12.00-12.30	Back to home
1:00-4.:00	Weaving mats, baskets, fans, hats etc…if the family is headed by women, they spent some time gathering dom leaves from the scrub	12.30-1.00	Praying
4:00-7:00	Preparing dinner for the family	1.00-3.00	Lunch and resting
7:00	Praying	3.00-5.00	Fetching fuel wood and water and then praying
7-8	Coffee ceremony/leisure time	5.00-7.00	Managing livestock, milking and putting in their pens
8-8:30	Praying and afterwards sleeping	7.00-9.00	Coffee entertainment with family and then sleeping

4.4.2. Seasonality of forest products

The seasonal calendar shows the flow of products at different seasons of the year and the temporal patterns of labour allocation. The main crop production season of the *Nues-zoba* Dighe is from July to late October. Table 4.9. shows that almost the whole season for harvesting, processing and utilisation of NTFPs does not impinge on the labour

requirement for agricultural production. However, in the discussion the prevalence of NTFPs harvesting in small quantities was also revealed through the year as either a supplement to the agriculture production or when people have spare time.

Table 4.10. Seasonal calander of forest product harvesting, processing and utilisation and marketing

Months Activities	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Dom fruit harvesting	x	xx	xx	xx	X							x
Other wild food harvesting	xx	xx	xx	xx								
Dom leaf harvesting for crafting (young spears)	xx	xx	xx	xx	Xx	X	x	x	x	x	xx	xx
Dom leaf and petioles harvesting for construction	xx	xx	xx	xx							xx	xx
Weaving of mats, fans, baskets and other handcrafts	xx	xx	xx	xx	Xx	X	x	x	x	x	x	xx
Crop production							xx	xx	xx	xx	x	x
The wet season camp	xx	xx					xx	xx	xx	xx	xx	xx
Dammer to the dry season camp			xx	xx	Xx	Xx						
Dom leaf selling	xx	xx	xx	xx	Xx	X	x	x	x	x	xx	xx
Dom fruit selling	x	xx	xx	xx	X							
Selling cereal crops for income								xx	xx	xx	x	x
Browsing Peak season		X	xx	xx	Xx	Xx	x					
Traditional medicine	x	X	x	x	X	X	xx	xx	xx	x	x	x
Fuel wood harvesting	x	X	x	xx	Xx	Xx	x	x	x	x	x	x

N.B. The symbol x represents the normal forest product harvesting and marketing and xx represents peak harvesting season

i. Wild foods

Dom palm fruits are harvested from December up to April. Participants stated that are the time when ripe fruits are available abundantly matches the hunger period. The availability dwindles in May and June, although stored fruits are still available. Palms resume reproducing fresh fruits from July up to November. The fruits of *Zizyphus spina-christi* and *Balanites aegyptiaca* are harvested from January up to April.

Historically, the extent of consumption of wild food varied greatly due to the impact of recurrent drought and long lasting war on household food security. Participants recollected the importance of dom fruits during drought seasons. Connelly & Wilson (1996) also reported that people were highly dependent on dom fruits and palm hearts during the occurrence of the long drought and starvation of 1984-1986 and also the minor drought of 1990-1991. One of the participants in Adi-Ibrhim expressed his feelings as follows:

> "Dom palm forests are much more precious resources blessed from God to us… More precious than gold, diamonds or silver… Without this resource, no life was to be maintained including the life of livestock during those past drought and starvation times. We are living in a dry land, which frequently suffers from recurrent drought and starvation. … I am sure no lives will be lost due to rainfall shortage or crop failure, if and only if those forests resources are preserved for local uses."

Nevertheless, in the last one-decade, participants mentioned that the consumption level declined due to clearance of the forest cover for agriculture and the reduction of fruit production of individual trees. In Mogoraib, participants said that soldiers cut the male trees for trench construction; and herders cut the male flowers of dom palm for livestock feed. Participants noted that these are the main reasons for the declining fruit production. A recent study showed the presence of the male dom palm is very sporadic and follows no obvious patterns. In some localities there is not even a single tree (AMRFP, 2000; Bampton, 1999). There should be at least one male tree for every 10 female trees for cross-pollination (Connelly & Wilson1996).

ii. Dom leaf harvesting for crafting artefacts

Dom leaves harvesting for plaiting of diverse household artefacts is carried out through the year. The peak season is from January and extended up to May. During wet season, harvesting becomes difficult as the understorey grass becomes thick and difficult to walk through (Asfaha, 1999). Some households are dependent on harvesting; processing and selling of dom leaf products for weaving throughout the year. Female-headed households are often dependent on dom palm leaf harvesting throughout the year (Connelly & Wilson1996). The peak season for weaving mats, baskets, hats, and fans for sale is from end of June to December. This is because of the demand to renovate the huts during rainy seasons and to harvest agricultural production. Although women produce a small amount during the other months, there is little market demand at this time of the year.

iii. Forest products for construction

The peak season for harvesting dom leaves for roofing, harvesting dom petioles for construction and collection of other construction material including *Tamarix aphylla* and *Zizyphus spina-christi* is November to April. This season coincides with the season of roof renovation, house reconstruction and new house building that are usually practised after the raining season. At the same time, those months fall outside of the peak season of crop production. It was also reported that people engage these selling those products as means of income during non-agricultural season.

Participants perceived that the extent of consumption of dom products, construction materials and household utensils has increased at village level in the last 13 years due to population increment, sedentrasation programs and the recurrent drought and starvation. People returned to their original places from Sudan in 1995 and the administrative village re-grouping was practised in 1998. Consequently, the demand for construction materials, household utensils and fuel wood by the rural people also increased significantly. The recurrent droughts have caused an increase in dependence on dom leaf and processed products to earn additional income to buy food and meet other household demands.

iv. Seasonality of livestock dependence on fodder and browsing

Forests are also used as livestock fodder and browsing materials through out the year. The herders move their livestock to their dry season camps from February to June. They move elsewhere near to the riverine forests mainly due to the absence of pasture grass and scarcity of water availability. During this season, camels and goats mainly depend on browsing trees and shrubs.

v. Traditional phyto-medicine harvesting

The peak season for harvesting traditional human and veterinary phyto-medicine coincides with the peak season of crop production. This may be due to the prevalence of malaria and flies during the wet season. However, participants mentioned that the harvesting of traditional medicine does not take much time from agriculture as it is harvested occasionally in small quantities.

Over the last ten years the use of wild medicine has declined. Participants said that the use of traditional medicines has declined due to the improvement of public services delivery especially the increase in the numbers of hospitals and veterinary clinics. Daniel (2000) reported that the government of Eritrea has established six health clinics and one veterinary clinic for the *nues-zoba*. However, Connelly & Wilson (1996) also reported the people may be reluctant to talk openly about their use of traditional medicine for two reasons: first, people feel that medical knowledge is the secret preserve of a few specialists, so talking about it may reduce some of its magical power to heal; secondly, it may be an embarrassment to some people to admit to using a 'primitive remedy'.

In sum, local forest product harvesting, processing and selling plays a significant role in the livelihoods of pastoral and agro-pastoral communities of the *nues-zoba Dighe*. These products are harvested from riverine forests, acacia woodlands and trees scattered in the landscape. The riverine forests are locally perceived to be the most essential socio-cultural and economical asset of the country in terms of its contribution as safety net for local level poverty alleviation and food security. The values derived from the 19

trees and shrub species include wild food, construction materials, firewood for household consumption, household utensils, fodder/browsing materials and medicinal plants both for own use and for sale as a means of income. The research also revealed that dom palm, found only in the riverine forest, is the most important species in terms of providing those products.

Chapter 5. Valuation of Marketable products: extent of use and monetary values of the forest products for the rural subsistence economy in *nues-zoba* Dighe.

5.1. Introduction

Chapter 4 shows descriptively the role of forest products in the sustainability of rural livelihood including a comparison with other livelihood strategies, types of product flows, relative importance of species and temporal patterns of use extent. This chapter attempts to present monetary values of a subset of selected important forest products to indicate the relative magnitude of locally perceived values of the forest. Thus, the total direct use value could be considerably greater than those of the subset (see also section 2.4). To this end, this chapter investigates the following research sub-questions. The answers to those sub-questions are also helpful to give comparative insight into the magnitude of the entire set of local forest values explained in the next chapter.

- What are the perceived local values of the forests and woodland of the western lowlands of Eritrea in terms of marketable products? The term 'marketable products' in this research stands to both subsistence and sale products. It is often only small proportion for total consumptive uses value that goes through a formal market; most of the products are subsistence in nature (IIED, 1997).
- Is there any difference among different relative wealth groups when it comes to values derived from forest products?

5.2. Methods

5.2.1. Data gathering

i. Questionnaire survey

A questionnaire survey was used quantify the household use and sale of marketable forest products. Information on actual household harvesting, domestic uses and income generation was gathered using a questionnaire survey. Random sampling provided 5 % of all households across the three *Mimhdar kebabies* used to get statistically reliable information (32 in Adi-ibrhim, 31 in Tekereret and 27 in Mogoraib). The information

was used to calculate the household use and value using observed market value and related goods approach (Box 5.1).

The questionnaire included a checklist of the five major direct uses provided by local indigenous forest resources (Appendix 5.1). This includes wild food, traditional medicines, construction materials, household utensils and fuelwood for cooking. However, it did not include the market values of livestock fodder/browsing materials and materials for fencing and compounds. Moreover, it was observed that participants had a problem of recollecting some with the items and estimating the exact quantity used through the year. In such cases, frequency per three months of all products was recorded and changed into annual basis.

ii. Market price survey

The questionnaire survey was followed by local market price surveys for various forest products using a checklist of various local forest products, amounts and their corresponding prices. All the data were recorded in local units converted into scientific units by measuring locally defined units of equipment available in the local market. These instruments include measuring tape and beam balances. This was followed by a market price survey for all items with traders and small cottage wood processing industries and fuel wood sellers (see the details in Appendix 5.2.).

iii. Wealth ranking

In each study area the participants developed a simple wealth ranking classification using local criteria. This was followed by simple scoring using 100 stones to indicate the proportion of people falling in each of the wealth groups. The same procedure was also used to assess the level of dependence on forest products by different wealth groups. The concept of wealth used in such research is different form the conventional economical definition; it only shows the relative difference of economic groups in poor rural areas based on the local people's criteria (Gwaii working group, 1997).

5.2.2. Data analysis

i. Baseline socio-economic data

Total permanent residents' and settlements' patterns were averaged per *Mimhdar kebabies*. Analysis of variance (ANOVA) and Bonferroni post-hoc tests were used to study the statistically significant difference between means of various forest product use for domestic consumption and sales. Participatory analysis using matrix scoring was also used to determine the influences of relative wealth groups on the extent of direct use value.

ii. Resource use

The percentage of households that use more than zero units of each product was calculated to elucidate the proportion of rural communities that use and sell forest products for their livelihood. Thereafter, the mean annual household consumption of each commodity in each *Mimhdar Kebabies* was calculated using SPPS software. The mean annual household consumption calculated by the averaging the reported annual consumption was divided by averaging household size of the *Mimhdar Kebabie.* Analysis of variance (ANOVA) and Bonferroni post-hoc tests were used to investigate statistical differences between village means for each product.

iii. Direct use values

Mean annual direct-use values for each resource was calculated by multiplying mean annual household consumption per *Mimhdar Kebabies* (averaged across all households) by current local market prices (see Box 5.1). In this study, the value of the product is taken as the forest gate prices, meaning the price paid by the local or passing buyer for the collected or processed products (Gram, 2001; Shackleton & Shackleton, 2000). The labour opportunity cost was not deducted from the gross values mainly because poor people in Eritrea do not have other employment opportunity and forest product harvesting and marketing are done opportunistically (adopted from Ballance *et al.*, 2001).

Moreover, many researchers, IIED (1997) and Gram (2001) among them, agreed that gross values using forest gate price could be used to derive the value of the product for domestic use and for sales to generate income. Related goods approaches were used for items that were not available in the market. The market prices for chicken, goats and wooden cooking sticks available in the local market respectively were used to substitute for price of Guinea fowl, gazelles, and traditional cooking sticks. In short, the following equation (Box, 5.1) was modified from Shackleton & Shackleton (1998) to determine the annual direct use value per average household:

Box 5.1. Equation of value calculation for direct consumptive values at local level

$V_i / HH = C_i X P_i$…Where V_i / HH stands for annual average value of a specific item *i* per household;
C_i stands for average household consumption per annum;
and P_i stands for local price/substituted price in local market

5.3. Results and discussions

5.3.1. Socio-economic information

Table 5.1, Table 5.2, Table 5.3 and Table 5.4 below summarise the socio-economic profiles of the three study areas. Average permanent household size did not differ significantly from between *Mimhdar kebabies* (F=1.01). Table 5.2 particularly shows that rural communities in all *Mimhdar kebabies* use the possession of cattle, female camels and sheep as the basic criteria for classifying household sizes into rich, middle class and poor. The size of livestock possession is the prime criteria to locally differentiate the wealth classes. However, in all cases goat herd and land size were not considered as important criteria in differentiating relative wealth classes.

Table 5.1. Household size and percentage of returnees from Sudan in study area

Name of *Mimhdar Kebabies*	Average household size	Returnees from Sudan (%)
Adi-Ibrhim	5.77	51.6
Tekreret	5.81	56.2
Mogoraib	4.89	18.5
Average	5.5	42.1

Table 5.2. Herd size of the three study areas in nues-zoba Dighe

Name of *Mimhdar Kebabies*	Shoats[13]	Cattle	Camels	Donkeys
Adi-Ibrhim	15109	1294	142	462
Tekreret	15429	1752	102	417
Mogoraib	16154	1407	255	643

On average, almost 15 % of the population was grouped to be relatively rich. About 20-30 % of the population was grouped to be middle class. The rest, the majority, of the rural households were grouped into relatively poor groups. Very few households in these rural communities undertake commercial agriculture. The poor group in the three study areas did not have any livestock. The poor social strata included the female-headed households and those who depend on wage labour in commercial agriculture or daily labour in construction works (Table, 5.3; Table 5.4).

Table 5.3. Local criteria of wealth ranking

	Local criteria		
Wealth category	Adi-Ibrhim	Tekreret	Mogoraib
Rich	10 cattle, 1female camel and 10 sheep	15 cattle, 10 female camels and 50 sheep	10 cattle, 1female camel and 10 sheep
Middle	5 cattle, 4 sheep and 1 donkey	5 cattle, 2 female camels and 25 sheep	5 cattle, 4 sheep and 1 donkey
Poor	Daily labourer and female headed households	Daily labourer and female headed households	Daily labourer and female headed households

[13] Shoats refers to sheeps and goats population

Table 5.4. Proportion of local people and the extent of their dependence on forest products in a rural community based on their wealth classes in percentage

	Percentage of the population			Percentage of use out of perceived total consumptive use (%)		
Wealth category	Adi-Ibrhim	Tekreret	Mogoraib	Adi-Ibrhim	Tekreret	Mogoraib
Rich	15	15	15	20	25	20
Middle	30	20	25	25	50	25
Poor	55	65	60	55	25	55

Regardless of the relative wealth strata, all households relied on forest products for their livelihood. The matrix scores with rural people showed that the poor are more dependent on forest products than the middle class in Tekeret (Table 5.4). In Tekereret, households that fall into the middle wealth group own camels to harvest and transport NTFPs; whereas the poor rural communities do not have transportation. The focus group interviews with '*Biato*' members in Tekreret revealed that the poor rural communities usually rent from the rich or from the middle class to harvest and transport products both for subsistence and income generation.

Participants mentioned the main reason the rich were mentioned as users of the forest products is because of their relatively higher demand for construction materials, fuel wood and household utensils; where as the poor are highly dependent on wild food and also dom leaf products as a means of income. Cavendish (2001) in Campbell and Luckert (2002) showed that there is a strong correlation between the local wealth stratums and types of forest products consumed. When forest products required higher investment and skills, then the wealthier households are able to exploit them.

5.3.2 Wild food

i. Percentage of household using wildfood

The household survey confirmed the findings of chapter 4.3 that people used wild food such as dom palm fruits, *Zizyphus* fruits, and guinea fowl and gazelle meat both for household consumption and income generation.

Table 5.5 shows that the majority of local people use dom fruits for household consumption and almost half of the entire population sell dom fruits as a means of income. On average, the result showed that the number of household in Morgoraib and Tekreret that used dom palm fruits is higher than in Adi-Ibrihim. This might be due to the prevalence of abundance and the short distance to dom palm forest resources. More than 25% of the population use *Zizyphus* fruits for domestic consumption while a small proportion of the entire population also sell *Zizyphus* fruits as a means of income, only in Mogoraib.

Rural households also used bush meat occasionally when they chance upon wild animals while undertaking other forest and agriculture related daily business. On an average basis, less than 25% of the population eat Guinea fowls; while between 18- 40 % of ate meat occasionally. The survey also revealed that rural communities used bush meats only for domestic consumption.

Table 5.5. Percentage of households using wildfood

Items	Adi-Ibrhim	Tekreret	Mogoraib	Mean
Dom fruits for Domestic uses	41.9	84.4	92.6	73
Dom fruits for sale	41.9	50	40.7	44.20
Zizyphus fruits for domestic uses	51.6	0	60	37.2
Zizyphus fruits for sale	0	0	14.8	4.9
Guinea fowl meat	6.5	15.6	29.6	17.2
Gazelle meat	29	18.7	40.7	29.5

ii. Quantities of household wild foods used

Table 5.6 shows that there is not a significant difference between the three *Mimhdar kebabies* based on the quatities of wildfood consumed per household (F=5.717); except for zizyphus fruits. Mogoraib uses the largest amount (18.56 kg/HH/annum) and Adi-Ibrihim uses the lowest amount of Zizyphus fruits (1.39. kg/HH/annum) for domestic consumption. There is also an enormous variability between households in consumption level indicated by the large standard error at 95% of confidence limit (Table 5.6). This variability might be stemed from higher prevalence of Zizyphus woodland patches in Mogoraib and Adi-Ibrhim (Alazar, 1999).

Table 5.6. Mean annual household consumption of Wild food, averaged across all households sampled

Items	95% confidence interval for mean use of Mimhdar Kebabies			
	Adi-Ibrhim	Tekreret	Mogoraib	Mean
Dom fruits for domestic uses (qt)	1.5±0.60	0.9±0.95	1.8±0.46	1.40
Dom fruits for sale (qt)	6.9±5.06	3.2±1.55	2.2±1.63	4.20
Zizyphus fruits for domestic uses (kg)	1.4±0.60[a]	1.6±0.60[ab]	18.6±16.00 [b]	6.40
Zizyphus fruits for sale (kg)	0	0	3.0±3.90	0.90
Guinea fowl meat (No)	0.2±0.30	0.4±0.50	1.1±0.90	0.50
Gazelle meat (No)	0.7±0.43	0.30±0.20	1.0±0.60	0.60

Values in the same row with different superscripts are statistically significantly different at P<0.05

iii. Direct use values of wild food

The annual direct use worth of utilising wild food from forests and woodlands, averaged across all households, was estimated to be US $32.00 per annum. The greatest values come from gazelle meat and dom palm. Though many studies qualitatively documented the values of dom palm fruit (Asfaha, 1999), the values of gazelle meat were masked as killing of any wildlife is legally prohibited (FAO, 2000). The total annual value ranged from US $47.20 /annum/HH in Mogoraib to US $17.40/annum/HH in Tekreret (Table 5.7).

Table 5.7. Mean direct-use values of wild food per households. Units are US dollar

Items	Adi-Ibrhim	Tekreret	Mogoraib	Mean
Dom fruits for domestic uses	1.70	1.00	2.00	1.60
Dom fruits for sale	7.60	3.60	2.50	4.60
Zizyphus fruits for domestic uses	0.10	0.10	1.40	0.50
Zizyphus fruits for sale	0.00	0.00	0.20	0.10
Guinea fowl meat	1.00	2.30	5.60	2.80
Gazelle meat	24.10	10.40	35.60	22.60
Total	34.50	17.40	47.20	32.10

5.3.3. Traditional medicine

i. Percentage of households using traditional medicine

Table 5.8 shows that 47 % of the rural households used the pods of *Acacia nilotica* for medicine for household consumption and for tanning.

Table 5.8. Percentage of households using traditional medicine

Items	Adi-Ibrhim	Tekreret	Mogoraib	Mean
Acacia nilotica pods for domestic traditional medicine	45.20	34.60	63.	47.60
Acacia nilotica for medicinal and tanning purpose sale	3.20	0	11.10	4.77

ii. Quantities of household phyto-medicine used

Rural households in Mogoraib consumed a significantly higher amount of traditional phyto-medicine than in Adi-Ibrhim and Tekreret (F=5.58). The quantities used ranged from 6.78 kg/HH/annum in Mogoraib to 0.69 kg/HH/annum in Tekreret (Table 5.9). The underlying causes for such differences could be the availability of patches of *Acacaia nilotica* woodlands in the riverine forests adjacent to Mogoraib (Alazar, 1999). There was no significant difference in the sale of *Acacia nilotica* pods for medicine and tanning among the three study areas.

Table 5.9. Mean annual household consumption of traditional medicine, averaged across all households sampled

Items	95% confidence interval for mean use of *Mimhdar kebabies*			Mean
	Adi-Ibrhim	Tekreret	Mogoraib	
Acacia nilotica pods for domestic traditional medicine (kg)	1.35±0.796[a]	0.69±0.460[ab]	6.78±5.200[b]	2.74
Acacia nilotica for medicinal and tanning purpose sale (kg)	3.23±6.452	0	5.56±6.164	2.78

Values in the same row with different superscripts letters are statistically significantly different at P<0.05

iii. Direct use values of phyto-medicine

The annual direct use worth of utilisation of *Acacia nilotica* pods as a medicine for malaria and other diseases as well as for tanning, averaged across all households, is estimated to be US 1.80 /HH/ annum (Table 5.10).

Table 5.10. Mean direct-use values of wild food per household. Units are US dollar

	Adi-Ibrhim	Tekreret	Mogoraib	Mean
Acacia nilotica pods for domestic traditional medicine	0.40	0.20	2.20	0.90
Acacia nilotica for medicinal and tanning purpose sales	1.00	0.00	1.80	0.90
Total	1.50	0.20	4.00	1.80

5.3.4. Construction materials

i. Percentage of households using construction materials

Table 5.11 below shows that 97% of the rural households live in traditional huts. An estimation made by *biato* members during focus group interviews showed that a typical traditional hut (t*ukul or Agudo*) uses 12 poles of dom palm, 8 pillars of dom palm, 34 transverse beams, 10 camel loads of dom leaves and 4 bundles of tying sticks from young twigs of *Zizyphus spina-christi*. Except for the 12 dom palm poles and the transverse beams which needs to be replaced every four year, the other materials are renovated once per year. Though about 10 % of the population possessed brick made

huts; the roof part is totally made up of dom products, *Tamarix aphylla* and *Zizyphus spina-christi*.

Many households also constructing shade houses that allow air circulation during the peak hot hours of the day, the time that is also the time for resting. A typical shade house (*Rakuba*) is constructed with eight pillars from dom timber, thirty-four transverse beams, ten supporting beams and four loads of young twigs. The shade houses are renovated every four years except that the roof should be replaced every year. Thirty three percent of the rural population have sheep and goat pens that are made using forest products. A typical pens construction demands the lowest amount of materials compared to traditional huts and shade houses.

Table 5.11. Percentage of households using construction materials

Item	Adi-Ibrhim	Tekreret	Mogoraib	Mean
Traditional huts (*Agdo or tukul*)	100	100	92.6	97.53
Brick huts	6.5	12.3	11.1	9.97
Sheep and goat pen	48.4	18.7	33.3	33.47
Shade (*Rakuba*)	71	96.9	55.6	74.5

ii. Extent of households' construction materials uses

Table 5.12 shows there was no significant difference recorded between the three Mmhidar kebabies (P>0.05), except for shade. There were a significantly higher numbers of shades in Tekreret than in the other two study areas (F=11.527). The number of shades ranged from 0.56 HH/ annum in Mogoraib to 1.34 HH/ annum in Tekreret. As explained in sub-sub-section **5.3.1.**, Tekreret has a higher livestock size and also higher numbers of returnees from Sudan. Returnees from Sudan are more familiar with sedentary agriculture than the permanent local residents.

Table 5.12. Mean numbers of construction structures, averaged across all households sampled

Items	95% confidence interval for mean use of *Mimhdar Kebabies*			Mean
	Adi-Ibrhim	Tekreret	Mogoraib	
Traditional huts (Agdo or tukul)	1.80±0.30	2.10±0.32	1.70±0.36	1.9
Brick huts	0.1±0.90	0.10±0.12	0.20±0.24	0.12
Sheep and goat pen	0.6±0.24	0.20±0.17	0.40±0.22	0.38
Shade (Rakuba)	0.80±0.20[a]	1.30±0.28[ab]	0.60±0.194[b]	0.92

Values in the same row with different superscripts letters are statistically significantly different at P<0.05

iii. Direct use values of construction materials

Table 5.13 shows that the mean annual direct uses' values of the construction purposes was US $144.23/annum/households). The use value ranges from US $171.30 in Tekreret to US $124.45 in Mogoraib.

Table 5.13. Mean direct-use values of construction material per households. Units are US dollar

Items	Adi-Ibrihim	Tekreret	Mogoraib	Mean value	Total for *Neus-zoba* Dighe
Traditional huts (*Agdo or tukul*)	94.03	110.65	90.39	98.70	52252.6
Brick huts	2.43	5.27	7.70	4.86	25754.72
Sheep and goat pen	6.36	2.54	4.28	4.39	23246.54
Shade (*Rakuba*)	31.94	52.84	22.08	36.28	192041.2
Total	134.76	171.30	124.45	144.23	763568.1

5.3.5. Household utensils

i. Percentage of households using household utensils

Tarke (1999) identified more than 30 diversified household utensils used in the western lowlands of Eritrea mainly made from the riverine forests product. In the household survey, 21 items were identified as making the most significant economic contribution to rural households. Almost all of the household utensils are made from dom leaves. They

are used in the household as well as a means to generate income. Connelly & Wilson (1996) found that particularly female–headeds household in the western lowlands of Eritrea are highly dependent on dom leave products both for household use and income generation. The percentage of households using the various products is given Table 5.14.

Table 5.14. Percentage of households using utensils

Items	Adi-Ibrhim	Tekreret	Mogoraib	Mean
Small baskets for domestic use	41.9	12.5	40.7	31.7
Medium baskets for domestic use	71	84.6	55.6	70.4
Medium baskets for sale	3.2	0	0	1.07
Big baskets for domestic use	61.3	78.1	63	64.47
Small fans for domestic use	63.5	100	100	87.84
Big fans for domestic use	87.1	100	88.9	92
Dom leaves for plaiting (Kaale) for selling	51.6	53.1	59.3	54.67
Bed mats for domestic use	80.6	76.9	72.6	76.7
Bed mats for sale	19.4	59.4	11.1	29.97
Big mats for domestic use	71	81.2	77.8	76.67
Big mats for sale	3.2	3.1	0	2.1
Coloured mats for domestic use	51.6	53.7	70.4	58.57
Coloured mats for sale	0	37.5	3.7	13.73
Praying mats for domestic use	77.4	75	85.2	79.2
Ropes for domestic use	38.7	76.9	77.8	64.47
Brooms for domestic use	80.6	96.9	76.3	84.6
Brooms for sale	38.7	65.6	37	47.1
Huts for domestic use	9.7	28.1	40.7	26.17
Mesob	83.9	100	71.5	85.13
Cooking sticks	74.2	96.9	75.2	82.1

ii. Quantities of households using utensils

Table 5.15 shows that there was no significant difference between study sites for many types of household utensils ($P>0.05$) except for six items ($P<0.05$). The four items recorded for their significant difference were small baskets for domestic use($F=3.4$), big baskets for domestic use($F=6.2$), dom leaves for sale($F=6.25$) and huts($F=12$).

Table 5.15. Mean annual household consumption of household utensils, averaged across all households sampled

Items	95% confidence interval for mean use of Mimhdar kebabies			Mean
	Adi-Ibrhim	Tekreret	Mogoraib	
Small baskets for domestic use (no)	1.03±0.53 [a]	0.28±0.30 [ab]	.63±0.39[b]	0.64
Medium Baskets for domestic use (no)	2±0.63 [a]	3.06±0.78[ab]	1.37±0.60[b]	2.19
Medium basket for sale (no)	1.61±3.27	0	0	0.56
Big baskets for domestic use	1.19±0.45	2.97±1.03	2±0.68	2.07
Small fans for domestic uses(no)	6.39±1.61	7.47±1.25	6.11±1.11	6.69
Big fans for domestic use (no)	2.87±0.91	3.84±0.97	2.52±0.67	3.11
Dom leaves for plaiting (*Kaale*) for sale (Qt)	3.52±1.76[a]	11.41±8.10[ab]	47.07±33.04[b]	19.39
Bed mats for domestic uses (no)	3.23±1.020	4.78±0.22	2.33±0.51	3.51
Bed mats for sale (no)	2.77±3.33	6.44±4.50	4.89±6.20	4.77
Big mats for domestic use (no)	3.32±1.65	3.69±0.93	2.26±0.92	3.13
Big mats for sale (no)	0.39±0.80	4.38±8.75	0	1.69
Coloured mats for domestic use (no)	1.68±1.55	1.34±0.845	1.26±1.00	1.43
Coloured mats for sale (no)	0	1.47±1.40	0.19±0.70	0.53
Praying mats for domestic use (no)	1.77±0.45	1.97±0.51	1.72±0.48	1.83
Ropes for domestic use (no)	1.94±0.56	20.38±27.26	10.56±10.46	11.08
Brooms for domestic use (no)	8.16±2.562	9.56±1.484	9.04±2.192	8.90
Brooms for sale (no)	5.23±2.90	7.94±2.80	5.85±3.78	6.38
Huts for domestic use (no)	0.13±0.15[a]	0.32±0.22 [ab]	5.15±3.04[b]	1.72
Traditional food containers (*Mesob)*(no)	1.48±0.37	3.13±0.94	1.44±0.36	2.06
Cook sticks (no)	1.74±0.56	2.59±0.66	3.48±0.29	2.57

Values in the same row with different superscripts are statistically significantly different at P<0.05

iii. Direct use values of household utensils

The annual total direct use worth of household utensils from forests, averaged across all households was US $80 HH per annum. The greatest values come from dom leaves for sale. The total value ranged US $170/HH/annum in Mogoraib to US$ 24.20/HH/annum in Adi-ibrhim(Table, 5.16).

Table 5.16. Mean direct-use values of household utensils per households per annum. Units are US dollar

Items	Adi-Ibrhim	Tekreret	Mogoraib	Mean
Small baskets for domestic use (no)	0.31	0.08	0.19	0.19
Medium baskets for domestic use (no)	1.04	1.59	0.71	1.14
Medium baskets for sale (no)	0.83	0.00	0.00	0.29
Big baskets for domestic uses	0.66	1.65	1.11	1.15
Small fans for domestic use (no)	0.59	0.69	0.57	0.62
Big fan for domestic use (no)	0.64	0.85	0.56	0.69
Dom leaves for plaiting (Kaale)	11.74	38.03	156.90	64.63
For sale (Qt)				
Bed mats for domestic use(no)	0.96	1.42	0.69	01.04
Bed mats for sale (no)	0.82	1.91	1.45	1.41
Big mats for domestic use (no)	1.48	1.64	1.00	1.39
Big mats for sale (no)	0.17	1.95	0.00	0.75
Coloured mats for domestic use (no)	1.24	0.99	0.93	1.06
Coloured mats for sale (no)	0.00	1.09	0.14	0.39
Praying mats for domestic use (no)	1.31	1.46	1.27	1.36
Ropes for domestic use (no)	0.09	0.91	0.47	0.49
Brooms for domestic use (no)	0.91	1.06	1.00	0.99
Brooms for sale (no)	0.58	0.88	0.65	0.71
Huts for domestic use (no)	0.02	0.05	0.76	0.25
Mesob(no)	0.44	0.93	0.43	0.61
Cook sticks (no)	0.39	0.58	0.77	0.57
Total	24.21	57.75	169.61	79.74

5.3.6. Fuel wood

i. Percentage of household using fuelwood

Table 5.17 shows all households in the study areas were found to be dependent on fuel wood for household cooking. The household survey also showed that, 9.2 % of the total households sold fuel wood as a means of income.

Table 5.17. Percentage of households using fuelwood

Items	Adi-Ibrihim	Tekreret	Mogoraib	Mean
Fuel wood for domestic cooking	100	100	100	100
Fuel wood for sale	6.4	0	21.2	9.2

ii. Quantity of fuelwood for household uses

Table 5.18 shows that there was no a significant difference in the magnitude of utilisation of fuel wood both for domestic use and sale amongst the three study areas. There was noticeable variability among households within the study areas. This might be due to the difference in the relative wealth status where poor people do not have camels and donkeys to carry fuel wood from a far distance. The mean annual fire wood consumption for domestic consumption and for sale, averaged across the three study areas, was estimated to be 37.48 Qt and 5.67 Qt respectively. The participants in Tekreret reported they do not sell fuelwood as a means of income. This is hard to believe, as people in Agordat, the nearest town informed the field crew that they get their fuelwood from the nearest settlement areas including Tekreret.

Table 5.18: Mean annual household consumption of fuel wood, averaged across all households sampled

Items	95% confidence interval for mean use of Mimhdar kebabies			Mean
	Adi-Ibrhim	Tekreret	Mogoraib	
Fuelwood for domestic cooking (Qt)	37.24±9.5	39.22±5.732	35.57±6.084	37.48
Fuelwood for sale (Qt)	7.87±4.230	0	9.85±8.732	5.67

iii. Direct use values of fuel wood

The annual total direct use worth of utilising fuel wood harvested, mainly from the acacia woodland, averaged across all households was US $ 127 HH/ annum. The total value ranged from US $135.00 /HH/annum in Mogoraib to US $116.00/HH/annum in Tekreret (Table 5.19).

Table 5.19. Mean direct-use values of fuel wood per household. Units are US dollar

Item	Adi-Ibrihim	Tekreret	Mogoraib	Mean	Total
Fuel wood for domestic cooking (Qt)	110.34	116.21	105.39		587908.50
Fuel wood for sale (Qt)	23.32	0.00	29.19	16.80	88939.20
Total	133.66	116.21	134.58	127.85	676847.7

In sum, Table 8.1 shows the extrapolated estimation of total major direct use values per annum at *nues-zoba* level based on the findings of the three representative study areas.

Table 5.20. Extrapolated annual direct use value for *nues-zoba* Dighe. Units are in US Dollars

Items	Adi-Ibrhim (US $ / HH)	Tekreret (US $ / HH	Mogoraib (US $ / HH)	Mean (US $/HH)	Total US $ for *nues-zoba* Dighe
Wild food	35.50	17.40	47.20	32.10	170090.30
Traditional phyto-medicine	1.50	0.20	4.00	1.80	9380.18
Construction material	134.80	171.30	124.45	144.20	763568.10
Household utensils	24.20	57.75	169.61	79.75	422137.87
Fuel wood	133.70	116.20	134.58	127.85	67684.71
Total	328.60	362.85	479.83	385.72	1432861.00

The only difference in the extent of use and value of products amongst the three study sites was found for the *Zizyphus spina-christi* fruits for food, *Acacia nilotica* for medicine, four household items (such as small baskets, medium baskets, dom leaves for sale and huts) and biomass demand for shade construction. The difference might be due to the prevalence of locally available species and market outlets. The study also revealed that the perceived proportion of the total use of the consumptive direct use values was higher in relatively poor households.

Chapter 6. Local perception of values in *nues-zoba* Dighe: Relative importance of marketable and non-marketable values

6.1. Introduction

In addressing the total economic value or full values of forest and woodland resources, both marketable goods (both for subsistence and sale) and non-marketable goods and services should be considered (IIED, 1997). Chapter five assessed the marketable direct use values of selected goods and services based on their importance for local people. This represents the bigger sub-set of the direct consumptive use values (see Section 2.1 & Section 2.4.). This chapter compliments the monetised direct use values of the forests and the woodlands by extending the scope into the locally perceived full values. To this end, this chapter scrutinises the following key sub-questions using a combination of participatory learning and action research methods

- What are the perceived local values of the forests/woodlands of the western lowlands of Eritrea in terms of marketable and non-marketable values?
- Which goods and services have higher perceived values in the rural livelihood?

6.2. Methods and process approaches

The survey was carried out with five men and five women in each of the *Mimhdar kebabies*. The list of full values of forest goods and services were produced using role-play. When answering the question "what are forests and woodlands worth both in terms of marketable and non-marketable values?", participants mentioned eleven benefits. There was a hot discussion to clarify their local understanding on the various benefits from forests/woodlands. However, as an exhaustive survey was carried out to determine the details of the flow of selected marketable use values described in the last chapters of this thesis the discussion was delimited to define those values that were not covered in the previous discussions.

This was complemented with simple scoring to investigate the relative weight of 11 marketable and non-marketable goods and services in the three study areas. Each

gender group scored the weight of the perceived full values using 100 stones according to the perceived relative importance of each in relation to the others. There was a strong debate on all occasions to reach consensus prior to scoring. This was followed by an office based comparative analysis by combining the results of the simple scores.

6.3. Results and discussions

6.3.1. Local understanding of values

In answering the question; "What is the forests worth besides their contribution to the household subsistence extractive economy?" participants mentioned the following basic socio-cultural and environmental uses.

i. Shade: people explained that they see forests and woodlands as similar to a house; as they provide shade during livestock herding and cultivation. One of the participants in Mogoraib expressed his concern about the current deforestation of riverine forests in Mogoraib by stating "These days, we have started to suffer from lack of shading during hot working time, the calm atmosphere of the forests is gone; and we are exposed to a very burning sun in bare lands. We have to go to very far places from our farm to find shade during cultivation and herding livestock". Recent studies listed that this situation as one of factors leading the latent conflict between pastoralists and commercial agriculturalists in the western lowland (Asfaha, 1999; PENHA, 1996; Amanual, *et al*., 2000). In answering which species are important, participants mentioned that without prioritising species, the riverine forests are very important.

ii. Climatic amelioration: participants said that local forests and woodlands are also important as a rain trap and windbreak. Participants have a perception that forests are helpful in trapping cloud and making rain fall. They also feel that if the current rate of deforestation does not halt, the rate and the intensity of the dust blown by the wind will be severe. In comparison, participants said that areas near to the riverine forests have a pleasant climate, good moisture, shade and a lower temperature.

iii. Erosion control: participants said with the current expansion of commercial agriculture, the riverbanks are severely eroded at some spots where the forests are cleared up to the edge. Local people perceived that land clearing for commercial agriculture poses a threat to the stability of the riverbank (Amanual, *et al*. 2000). The same case study reported that heavy flood in 1998 washed away about 10 ha of banana farms, one watering well and 43 pumping tubes and an undefined number of water pumps. This was localized in the riverine bank area of Dighe, where forests had been cleared up to the edge of the river. A number of government forestry directives and regulations ban forest clearing along the riverine forests (see AMRF, 2000)

iv. Heritage: this was only mentioned in Mogoraib. The participants in Mogoraib said that the forest resources, particularly dom palm riverine forests are the most precious resources inherited from their fathers and forefathers. This includes the traditional bylaws on the utilisation and management of the resources.

v. Scenic: participants in the three-study areas mentioned the beauty of the riveine forests and the wildlife harboured in the forests/woodlands as an important value. The riverine forest ecosystem was reported to be higher in birds and mammal biodiversity compared to the other ecosystems (Mulugheta, *et al* 1998; AMRF, 1997; EEA, 1996).

6.3.2. Locally perceived full values and their relative importance to local people

Table 6.1 demonstrates that cumulatively participants gave relatively heavier weight to the marketable direct use values except traditional medicines. Answering the question whether the perception of relative values are the same throughout their memories, they said that judgement of values depends on cultural belief, climatic factors, economic status, seasons/production years, availability of forests/woodlands and prevalence of peace. They said these values only represent their judgement for year 2003. This year was characterised by low rainfall; as a result there was shortage of food production and pasture (Box 3.1.). Though attempts were made to recollect their memories along the historical profiles, participants were very reluctant to do this because they were tired and also had difficulty reaching consensus on scores.

Table 6.1. Combined scores and ranking of locally perceived 'full values' of the forests and woodlands of *mimhdar nues-zoba* Dighe

Types of values	***Mimhdar kebabies***						**Total**		**Grand total**	**Ranks**
	Tekreret		**Adi-Ibrihim**		**Mogoraib**					
Market Values	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**		
Wild food	14	15	20	14	16	15	50	44	94	1
Traditional medicine	3	9	8	9	5	3	16	21	37	9
Household Utensil	4	11	10	9	10	15	24	35	59	5
Construction materials	19	18	11	9	11	10	41	37	78	2
Firewood	16	13	10	9	10	10	36	32	68	4
Livestock feed and water points	10	12	15	10	12	10	37	32	69	3
Sub-total	**66**	**78**	**74**	**60**	**64**	**63**	**204**	**201**	**405**	
Non-marketable										
Shade	9	12	10	14	8	5	27	31	58	6
Climatic amelioration	8	5	5	10	10	12	23	27	50	7
Erosion control	7	0	4	8	6	8	17	16	33	10
Heritage	0	0	0	0	6	0	6	0	6	11
Scenic	10	5	7	8	6	12	23	25	48	8
Sub-total	**34**	**22**	**26**	**40**	**36**	**37**	**96**	**99**	**195**	

Table 6.1. shows the marketable values of the forests goods scores higher than the non-marketable social and environmental values of forest services except traditional medicines. The participants emphasised that the marketable forest goods have direct consumptive values which satisfy an immediate need for sustaining their livelihoods. Moreover, it was only in Mogoraib that it was mentioned that owning forests is a social prestige as this is attached to their inheritance. In the other two study areas, participants

refused to score for the relative importance of heritage. Mainly, the participants felt the value of heritage is a different matter associated with their pride and social status. In sum, the study revealed that rural communities gain various marketable and non-marketable forest goods and services for their livelihood. Moreover, the forests and woodlands also have symbolic values. This local importance and the existing sense of ownership (AMRF, 2000) can justify their willingness to conserve the forest through collaborative arrangement.

Chapter 7. Sustainability analysis: impact of local extractive economy on the existing forest resources in *nues-zoba* Dighe

7.1. Introduction

Many authors in valuation studies emphasise that resource sustainability analysis is the centrepiece of economic valuation studies (e.g. Kant 2003; Tacconi 1997a). In this chapter, the impact of local level livelihood dependence on the existing forest resources is investigated. The threats to and the biological health of the forest are also discussed.

Understanding the potential production rate determines how much of a resource can be used sustainably. Geldenhyus (2000) illustrates this concept through comparing production to the interest rate on invested capital. If the amount of harvest exceeds the interest rate, the invested capital is eroded and the future benefits are not sustained.

Dom palm was singled out for an in-depth investigation in this study because of its prominent contribution to rural livelihoods. A multitude of products derived from dom palm contribute significantly to rural food security and poverty alleviation of the western lowland population of Eritrea (see chapter 4 and 5). Products derived from dom palm leaves are also vital commodities in other parts of the country and in neighbouring countries including Sudan and Ethiopia. Understanding the leaf productivity of dom palm trees and scrubs, and the level of local consumption could greatly help as one sustainability indicator for that particular species.

Many studies show that dom palm is a very robust species with considerable resilience to leaf harvesting (for the detail see AMRF 2000). Despite their apparent resilience, dom forests in some areas are under threat from overexploitation and land use change. For example, Connelly & Wilson (1996) showed dom palm used to be abundant in Sudan; but now almost all that land has been converted to commercial agriculture. Consequently, Sudan imports dom leaves and other related products from the western lowland of Eritrea. Likewise, if the current trends of riverine forest clearance continue,

the result will be irreversible environmental degradation and the disruption of local level livelihood strategies.

Similarly, many studies have reported that the riverine forests of the western Lowlands of Eritrea, particularly the dom palm forests, are subjected to many threats (AMRF, 2000; Asfaha, 1999; Bampton, 1998). Hence, assessing the relative health of the dom palm forest was included in this research in order to provide information for informed decision making.

Moreover, the existing dom leaf harvesting recommendation in management plan for the riverine forest of the western lowlands is based on the findings of Connelly & Wilson (1996). In spite of the difference on the availability of resources and traditional cutting styles between rural people in Gash and Barka rive, the dom leaf use sustainability analysis in management plan was made based on the Gash cutting style. Connelly & Wilson (1996) and other studies used to develop the management plan show some anomalies and inconsistencies. It is important to re-examine some of the contentious findings to come up with an improved understanding of resource use sustainability

The scope of this research is limited to assess the sustainability of existing practices. To this end, the third key research question of this study in section 1.4 has been paraphrased for clarity as follows:

- Is the existing level of harvesting for local household utensils (both for own use and the local market) ecologically benign in the riverine forests of *nues-zoba Dighe*?
- What are the threats to the general forest health of the riverine forests in the study area? This will assist in determining whether or not the recent reports that riverine forest is relatively healthy give a sense of false security to forestry and alternative landuse policymaking (AMRF, 2000; Bampton, 1998; Connelly & Wilson, 1996).

7.2. Biological description and distribution of dom palm forest

7.2.1. Morphology and anatomy of the dom palm

The dom palm (*Hyphaene thebica*) is a fan-leaved palm, unusual amongst palms in that it branches dichotomously. Mature trees have four to eight crowns and unbranched trees are rare. Although the stands in Eritrea are typically 10-15 m in height, individual trees reach 20 m or more. Dom is usually dioecious, that is they produce male and female flowers on separate trees (Connelly & Wilson, 1996). Bampton (1998) found that more than 80 % of the forest is composed of female trees and the rest are hermaphrodite and male. The male trees are highly valuable for timber as they are termite resistant. The female trees are not used for timber. This might explain why most of the dom forests patches contain virtually no males as presumably all have been harvested (AMRF, 2000).

The fruit is hard drupe, smooth and reddish brown in colour, 6-8 cm long. It is borne in large branches in the crowns of trees. A single seed is contained in each one, surrounded by edible pericarp. The fruit is produced in very large quantities by mature female trees; estimated at from 50-200 kg/annum (Connelly & Wilson, 1996)

7.2.2. Ecological description of the dom palm

Dom palm is confined naturally to areas with a high water table and indicates the fertility of the soil. It is a robust species and can be regenerated naturally by seed. In addition, dom palm can reproduce vegetativly when adult palms are disturbed in some ways e.g. through cutting, fire or root exposure by the riverbank (Connelly & Wilson, 1996). The vegetative regeneration could be either by sprouting from the cut stool, root suckers or from underground stems (rhizomes).

Dom palms are frequently found in pure stands. This is typically true for the *nues-zoba* Dighe riverine forest ecosystem. When dom palm trees mature, they form dense canopies with very little undergrowth. In most part of the riverine forests, the dom palm forest formation is dominated by a single age class. It is unclear why such single age forests have developed. Perhaps they were subjected to clearance at sometime, or to

fire, flood or drought, and then all regrew together. Absence of dom scrubs (the young dom palm without trunks) is an indictor that dom palm forests are not excessively harvested for leaves by the local people (AMRF, 2000; Connelly & Wilson, 1996).

Where the canopy is more open, the forest floor is often filled with young palms, both from wild seedlings and coppice regrowth (Connelly & Wilson, 1996). On average, the rate of natural regeneration for dom palm in the Barka riverine system was estimated be 2876±167 seedlings per ha (Bampton, 1998). Seedling survival is hampered either by grazing (AMRF, 2000), and/or fire (Connelly & Wilson, 1996). Though there is no quantitative research has been carried out to determin/e the impact, the uprooting and collection of dom seedlings for their cotyledons as a wild food might also have contributed to the recruitment failure of wild dom palm seedlings (Table, 4.4).

Table 7.1. Forest composition -% composition

(AMRF, 2000)

Forest composition	Gash river	Barka river
Proportion of areas that contain >75% matured dom palm /scrubs	17	61
Proportion of areas that contain 25-75% dom palm/scrubs	31	77

Table 7.1 shows that the dom palm resource on the Barka river is significantly greater than on the Gash river. Both matured dom palm and the dom scrubs play a significant role in rural livelihood (see Chapter four & five). Studies show that dom scrub should be viewed as a valuable resource in its own right rather than as degraded forests to be improved or alternatively removed for agriculture (Connelly & Wilson, 1996). Dom scrubs are used for leaf harvesting and support a large home based industry of fibre production for ropes, mats, baskets and many other aritensial products (AMRF, 2000). Dom scrubs are used for fodder in drought years (Bampton, 1998).

7.2.3. Local knowledge and skills of dom leaf cutting

Dom palm leaves are harvested from dom scrub and mature dom trees. People harvest dom leaves mainly from the scrub as it is easier than climbing a big dom palm tree. However, in some localities young people climb the matured dom palm trees to collect

leaves. In such case, every leaf tends to be cut, since removing only one or two leaves would not justify the effort exerted to climb the tree (Connelly & Wilson, 1996).

The leaves of mature dom palm trees are preferred. They fetch higher prices for weaving, as the leaves of mature trees are longer than those from scrub, and the number of the leaves needed to intertwine is less. Longer leaves from mature trees save energy and increase the durability of the products without losing quality (Mulugheta, 1997).

There are certain cutting techniques that allow the regeneration of the dom palm leaves. When one of the maturing spears is harvested or opens into fan shape then a little one starts to grow beneath, from the same growing points that are not damaged. Thus, this ensures the regeneration of the younger spear leaves. Traditionally, people also harvest in different places on a cyclic basis (AMRF, 2000; Asfaha, 1999).

Studies carried out showed that a single growing point on a dom scrub can produce a new leaf approximately every 25 days (AMRF, 2000). On average, the dom scrub in *neus-zoba Dighe* has 2500 dom scrubs per ha and estimated number of growing points of 2825 per ha (Bampton, 1998). The sun-dried weight of a single leaf is 150gm (AMRF, 2000).

There are two existing cutting styles used by the local inhabitants of the western lowlands of Eritrea. In the Barka river system and upper part of the Gash river system (Appendix 1.1), the whole leaf is cut, including the top of the leaf stalk, using an axe or sharp knife or sickle. This cutting style is locally known as *Barka cutting style.* Only every alternate leaf is cut. The study area is part of the area where such a harvesting style is practised. People in the lower Gash, however, cut only the tips of the young leaves, leaving the remainder to grow on as a small fan at the top of the leaf stalk. This style of harvesting is referred to as '*Gash cutting style'* (Connelly & Wilson, 1996: 46). Only 30 g of the young grown spears is harvested out of 150 g (the dry weight of a leaf) using the Gash cutting style. The Barka cutting style may be a response to a bigger market demand in Sudan, as it yields a greater quantity of leaves.

7.3. Methods and process approaches

Unlike in the other parts of the country where information on forest inventories and yield assessment is meagre, baseline information is available for the riveeine forests of the western lowlands of Eritrea to estimate the yield potential of dom palm. This chapter made use of the following relevant secondary information to estimate the dom leaf productivity. This included: aerial photographs taken by AMRF in 1996; the Forest cover map (FAO, 1998); the Riverine Forest project maps (Alazar, 1999); the n*ues-zoba* preliminary land use classification maps (Daniel, 2000); Eritrean Vegetation Map (van Buskirk, 1998) and a participatory map produced by the local people (Asfaha, 1999).

However, the available information on the biological or silviculture nature of dom palm scrubs and mature trees with regard to the leaf productivity are contradictory. Important parameters were lacking to carry out a 'forest production capacity versus rural people consumption analysis' (Campbell, Luckert & Scoones, 1997; Hot Spring Work Group, 1995). The best available secondary information, used as a basis for the management plan, was measured dom palm production capacity *vis-à-vis* current consumption using pair wise scenario analysis. Threats exerted on the forest and the general forest health was assessed through semi-structured interviews and literature reviews.

7.3.1. Dom palm leaf production capacity and current consumption analysis

i. Scenario for production-consumption analysis

Scenarios were based on two different cutting methods and two different size of forest areas. On the basic assumption of leaf cutting regime, current management cutting recommendations made by AMRF and alternative scenario were constructed. On the possible change in forest area size two basic assumptions are made: these are the forest area would remain the same (status quo scenario) and that the forest would be changed by 787 ha-lands that have already been granted but not yet developed by commercial agriculture (Forest clearance scenario).

A pair wise scenario matrix was used to investigate the difference between the possible sustainable production regimes against the current rate of harvesting dom leaf biomass

for the *nues-zoba Dighe*. This was used to assess if the current estimation based on the existing knowledge of sustainable dom leaf harvesting is biologically friendly or if the estimation was wrong.

ii. Cutting regime

A. Cutting regime based on the current management recommendation

The assumption for cutting regimes based on the current management recommendation was constructed based on the findings that dom leaf harvesting practices and intensity is sustainable. These studies showed that local people harvested 30 g dry weight leaves from the upper tip of the leaf (*Gash style*). As a result the remaining part was believed to be useful for photosynthesis (AMRF, 2000; Connelly & Wilson, 1996).

B. Alternative cutting regime

The alternative cutting regime scenario was constructed based on the biology of dom leaf productivity. Dom palm leaves die every six months naturally, therefore, harvesting half of the total leaf production alternatively over a six-month cycle was assumed to be sustainable. This scenario is based on the existing Barka cutting style, but has been adapted so that every alternate leaf is cut, not every leaf. If every new leaf were cut, that would ultimately kill the plant (Connelly & Wilson, 1996).

iii. Forest area

A. The size of forest area remainz the same scenario

This scenario assumes the remaining forest areas will remain the same. Even lands that have been granted but yet not developed for commercial irrigation based agriculture along the riverine forest; remain the same. The recent estimation of the forest area is 5197 ha (Daniel, 2000). As a result the current rate of dom leaf production for the local economy will be the maintained.

B. Forest clearance scenario

Since 1992, about 1725 ha of land along the main river Barka in Dighe was granted as agricultural concession to develop export-oriented fruits and other horticultural crops.

Up to now, 938 ha have been already developed using irrigation schemes (Daniel, 2000). There is a real danger that the remaining 787 ha of land dominated by dom palm forest will be cleared by the investors, as it has already been allocated to them for agricultural development. Clearing the forest would create pressure on the remaining stock.

7. 3.2. Procedures of production capacity-consumption analysis

Leaf biological production estimations for each of the pair-wise scenarios of cutting regimes and forest area assumptions were compared with the estimated amount of dom leaves that was gathered during the household survey. Studies carried out showed that a single growing point on a dom scrub can produce a new leaf approximately every 25 days (AMRF, 2000; for details see section 7.2.3.).

As the household data were gathered using local units, the local units were converted into standardised metric units (kg). The detailed methodological approaches including the sampling design and intensity for household survey are explained in Chapter 5. The total mean annual harvest/consumption per average household was calculated by simple arithmetic addition of dom leaf dry biomass used for various items at household level. This was then extrapolated by multiplying with the total household size of the *nues-zoba* Dighe to determine the annual gross harvest or consumption for the entire research area (Box 7.1.).

Box 7.1. Equation of total dom leaves and leaves product harvest/consumption

G_h(Kg/annum) $= N \sum x_{i,\ldots}$ Where stands G_h for annual gross harvest for specific region,

N stands for total number of households for specific region,

$\sum x_i$ refers to sum of mean annual household uses of various dom leaves products in kg for various items.

7.4 Results and discussions

7.4.1 Dom leaf potential production estimation

The estimated potential biological dry leaves biomass production of the dom scrub forest type in the entire research area was estimated to be 37182 tonnes per annum. Daniel (2000) reported that out of the 1725 ha land allotted to the concessionaries along the riverine forest 938 ha has already been developed into commercial irrigation based agriculture. This implies that there are 787 ha land from the existing that would be converted. This will result in a decline of potential leaf biomass production by 13.2 %(Table, 7.2).

Table 7.2. Annual potential yield estimation and sustainable yield estimation

Production parameters	Estimation	Sources
Average no of leaves produced per scrub per year	14.6	AMRF,2000
Average dry weight of a dom leaf	150 g	AMRF, 2000
Dom scrub per ha	2500	Bampton, 1998
Estimated number of growing points	2825	Bampton, 1998
Estimated total harvestable dry matter per ha	6.2 tonnes	Calculated
Total Areas (existing forests at present or assumed that the forest will remain at status quo)	5984 ha	(Daniel, 2000)
Total Area (under the assumption the remaining undeveloped granted 787 ha of potential agricultural land will be converted	5197 ha	Calculation based on Daniel (2000)
Estimated annual dry leaves biomass production from the riverine forests of Dighe of existing forest area	37182 tonnes	Calculated
Estimated annual dry leaves if 787 ha is cleared for commercial agriculture	32299 tonnes	Calculated
Production estimation based on the current cutting regime management recommendation if the forest area remains the same	7436 tonnes	Calculated
Production estimation based on the current cutting regime management recommendation based on the forest clearance	6460 tonnes	Calculated
Production estimation based on alternative cutting regime if the forest area remains the same	18591 tonnes	Calculated
Production estimation based on alternative cutting regime and the forest clearance scenario	16150tonnes	Calculated

7.4.2. Dom leaf consumption estimates

As explained in chapter 4 and chapter 5, dom leaves are used by local people either unprocessed or partly processed for various weaving and plaiting industries. The harvesting could be both for own consumption or for sale for income. The mean annual dried dom leaves biomass consumption for an average household and for the total *nues-zoba* was estimated to be 2 tonnes and 10781 tonnes respectively (Table 7.3). About 95% of the consumption was found to be unprocessed dom leaves sold as a means of income.

Table 7.2. Household harvest of dom leaves for various purposes per annum (extracted from Table 5.14 and converted into a standardised scientific unit)

Items	Unit	Mean (χ_i)	Equivalent Standard/unit (kg)	Estimation in kg per household per annum
Small baskets for Domestic use (no)	No	0.64	0.35	0.224
Medium Baskets for Domestic use (no)	No	2.19	0.5	1.095
Medium baskets for sale (no)	No	0.56	0.5	0.28
Big baskets for domestic use	No	2.07	0.75	1.5525
Small fans for Domestic use (no)	No	6.69	0.1	0.669
Big fans for Domestic use (no)	No	3.11	0.075	0.23325
Dom leaves for plaiting (*Kaale*) for sale (Qt)	Qt	19.39	100	1939
Bed mats for domestic use (no)	No	3.51	1.12	3.9312
Bed mats for sale (no)	No	4.77	1.12	5.3424
Big mat for Domestic use (no)	No	3.13	5.6	17.528
Big mat for sale (no)	No	1.69	5.6	9.464
Coloured mats for Domestic use (no)	No	1.43	5.6	8.008
Coloured mats for sale (no)	No	0.53	5.6	2.968
Praying mat for domestic use (no)	No	1.83	0.25	0.4575
Ropes[14] for Domestic use (no)	No	11.08	2	22.16
Brooms for domestic use (no)	No	8.9	1.25	11.125
Brooms for sale (no)	No	6.38	1.25	7.975
Huts for domestic use (no)	No	1.72	0.02	0.0344
Traditional food containers (*Mesob)*(no)	No	2.06	2.1	4.326
Grand total consumption per average household in Kg ($\sum x_i$)				**2037**
Converted to tonnes per household				**2.0**
Extrapolated total annual consumption of *nues-zoba* Dighe (tonnes)				**10781**

[14] The average length of a rope made from dom leaves is 10 m.

7.4.3 Dom leaf production capacity *vis-à-vis* consumption analysis

Table 7.3 and Table 7.4 show the sustainability analysis of dom leaf production capacity to meet the local demands for household utensils based on pair wise scenarios.

Table 7.3. Matrix of dom scrub leaf production-annual consumption anlysis

Level of extraction scenario	**Forest area**			
	Forest area remains the same scenario		Forest area clearance scenario	
	Estimated productivity	Annual consumption	Estimated productivity	Annual consumption
Cutting regime based on the existing management plan recommendation	6459.87	10780.7	7436.32	10780.7
Alternative cutting regime	18590.8	10780.7	16149.7	10780.7

Table 7.3. Matrix analysis of dom scrub leaf production potential under pair wise scenario and annual consumption

Level of extraction scenario	**Forest area**			
	Forest area remains the same scenario		Forest area clearance scenario	
	Difference Estimation in tonnes from the annual demand	Difference in Percentage	Difference Estimation in tonnes from the annual demand	Difference in Percentage
Cutting regime based on the existing management plan recommendation	-4320	Less than the annual demand by 61 %	-5369.0	Less than the annual demand by 45 %
Alternative cutting regime	7810	Greater than the annual demand by 72%	5412.0	Greater than the annual demands by 50 %

Table 7.4 shows that the Gash style of cutting as proposed by Connelly and Wilson and adopted by AMRF for the management plan will yield insufficient biomass to meet the estimated demand. As yet shortages have not reported. This suggests that these authors may have been mistaken in assuming this to be the dominant cutting method. Even if harvesting from mature trees is taken into account, the shortfall between demand and supply is significant.

The Barka or alternate whole leaf cutting style, on the contrary, yields a mass surplus to current estimated demand, even if the granted 787 ha land is cleared for commercial agriculture. This study therefore recommends that the Barka method be used as the basis for management planning, not the Gash, as currently proposed in the AMRF management plan. The above analysis in Table 7.4 also provides sufficient evidence to call for revision of the recommendation made by AMRF (2000) to double the production and to increase commercialisation.

7.4.4. Dom forest cover changes in *nues-zoba* Dighe

There is insufficient historical data to draw conclusions about forest vegetation distribution and dynamics (AMRF, 2000). Some papers dating from the Italian colonial period are still existent but not easily accessible. Connelly & Wilson (1996) is one of the best sources of information about the historical distribution of dom palm forest in the riverine ecosystem of the western lowlands of Eritrea.

Connelly & Wilson (1996) traced back the occurrence of dom palm forests along the riverine forest ecosystem of *nues-zoba* Dighe to from before 1853. There have been periods in their history when heavy demands have been made on them. Their resilience and ability to recover from exploitation is legendary (AMRF, 2000).

Commercial agriculture has been identified as the main driver of change to the extent of dom palm forest in the riverine forests of the western lowlands of Eritrea for more than a century. The attractiveness of the riverine area to the agriculturists cannot be denied.

The soil under the forest is amongst the most fertile in Eritrea, and although rainfall is unreliable from season to season, both surface and ground water resources could be easily tapped for irrigated agriculture. This potential has been recognized for a long time and the Italian administration during the 1920s and 30s cleared large areas of forest for this purpose (AMRF, 1997). Historical evidence shows that a large tract of land was cleared in *nues-zoba* Dighe by foreign investors (Box 3.1.). These activities stopped as a result of the independence war against Ethiopian colonisation and the nationalization policy of the Ethiopian regime. Many of these gardens were abandoned and have subsequently regenerated to forest.

After independence in 1992, based on the expectations and social responsibility of the government to reconstruct the nation and the policy of self-sufficiency in food, the areas being used by foreigners in the form of concessions were redistributed to national agricultural investors (AMRF, 1997). Up to now, 938 ha have already been developed using irrigation schemes mainly for banana production in *nues-zoba* Dighe (Daniel, 2000).

Discussion held with *baito* members to learn the main causes of forest destruction of the *nues-zoba* showed that the forests are exposed to other threats also. These include illegal selective timber cutting by the Eritrean defence force. The higher demand of construction materials for refugee resettlement, open grazing, fire and recurrent drought have also been identified as driving forces of forest cover change in the area.

In addition to the dom palm deforestation, the absence of various height classes (AMRF, 2000), serious recruitment failure (Bampton, 1998; AMRF, 1997), and sex composition imbalance[15] (AMRF, 2000; Bampton, 1998) are also indictors that the forest health is severely declining.

[15] The female trees in the dom palm forest constitute about 80% of the total population. The remaining 20% of the forest is either the male or hermaphrodite (Bampton, 1998). Remember the participatory action research in this study showed that the soldiers for construction purposes extract the male trees. Connelly & Wilson (1996) found that at least one male tree is important for cross-pollination per 10 female dom palm trees.

In sum, Dom leaf production capacity *vis-à-vis* consumption analysis also showed that the local level of household consumption in the research area does not exceed the dom scrub biological leaf production capacity. However, the recommendation made by AMRF (2000) on the possibility of doubling the production based the Gash-cutting style needs to be reconsidered carefully. The current demand may not be maiantained unless the forest degradation is stopped.

Chapter 8. Synthesis, conclusion and recommendation

8.1. Synthesis and conclusion

The *nues-zoba* Dighe is part of the arid zone of the western lowlands of Eritrea; characterised by low precipitation, high temperature and excessive evapo-tarnspirations. Except for the riverine ecosystem, which is characterised by a shallow water table and rich alluvial deposits that make the area suitable for irrigation based on commercial horticulture and livestock farming, the larger area of the *nues-zoba* is not suitable for rainfed or irrigation agriculture. Consequently, the major mode of production of local people is agro-pastoralism and nomadic pastoralism as it better suits the carrying capacity of the environment.

This research revealed that local forest product harvesting, processing and selling plays a more significant role in livelihoods than rainfed crop cultivation, livestock rearing and others (wages and food aid) in *nues-zoba* Dighe. Forest products are harvested from three resource zones: riverine forest, acacia woodlands and trees scattered in the landscape. The local people perceived riverine forest as the most outstanding of the three resource zones in terms of the local direct use values. It provides for the maintenance and sustainability of their livelihood.

Local people mentioned 19 trees and shrub species for their significance in the provision of direct use values. These values include wild food, construction materials, firewood for household consumption, household utensils, fodder/browsing materials and medicinal plants both for own use and for sale as a means of income. This study revealed that *Hyphaene thebaica (*Dom palm*), Tamarix aphylla, Acacia tortlis, Zizyphus spina-chrsti, Balanties aegyptica* and *Acacia nilotica* scored higher than other species in terms of their relative ability to meet the immediate needs of local people in the subsistence economy.

Hyphaene thebaica (Dom palm) is the most abundant and useful tree species in the riverine forest of the *nues-zoba* Dighe. It provides wild food, construction materials and

raw materials for household utensils. Dom palm provides leaves and fruit used for livestock feed during feed shortage. People weave various items from dom leaves for own use or sale. Cash generated from the sale of leaf-based artefacts provide a safety net for the purchase of food. Moreover, local people use the petioles of dom leaf for fuel wood when there is a scarcity of dead acacia trees.

Tamarix aphylla is ranked second in relative importance mainly due to its high significance in local construction material supply. Next, *Acacia tortilis* and *Acacia nilotica* are the most important species for fuel wood and traditional medicine respectively. *Zizyphus spina-christi* is also mentioned, as it is significantly vital for its wild food value. *Balanites aegyptiaca* provides all sorts of major products to the local community. Bush meat derived from the forest resource is also an important product although hunting is illegal.

Residents (be it permanent local people or returnees from Sudan) are dependent on the forest products to different degrees. Gender, wealth status, seasonality, availability of species and local institutions are found to be the basic factors that determine the magnitude of rural people dependency on local forest products.

This study revealed that the value and availability of forest products are constantly changing. The value of the forest increases when there is drought, famine and war. However, their value declined during good harvest. Population increment and concentration due to resettlement of returnees on Sudan and government sedenterasation program has also increased demand from the local forests and woodlands. Furthermore, the availability of forest resource is declining due to clearing for commercial agriculture, over-exploitation and drought.

The only difference in the extent of use and value of products amongst the three study sites was found for the *Zizyphus spina-christi* fruits for food, *Acacia nilotica* for medicine, four household items (such as small baskets, medium baskets, dom leaves for sale and huts) and biomass demand for shade construction. The difference might be due

to the prevalence of locally available species and market outlets. The study also revealed that the perceived proportion of the total use of the consumptive direct use values was higher in relatively poor households.

The perceived total economic value of the resources includes marketable and non-marketable forest goods and services. Table 8.1 indicates the list of locally perceived full values of forest goods and services. The ranking of perceived total economic value was derived using the grand total values of simple scores of the study. A comparative analysis of the various products was made using the monetary values of selected items from chapter five and qualitative total economic values described in chapter six.

Table 8.1. Comparisons of value ranking from the market-gate prices analysis and value ranking including non-market values

Market Values	**Grand total scores**	**Ranking of perceived 'full values' (source: Table 6.1.)**	**Monetary values of the sub-set of direct use value products (Source: Table 6.20)**
Wild food	94	1	170,090.30
Traditional medicine	37	9	9380.18
Household utensils	59	5	763,568.10
Construction materials	78	2	422,137.87
Firewood	68	4	67,684.71
Livestock feed	69	3	Uncalculated
Sub-total	**405**		**1,432,861.00**
Non-marketable			
Shade	58	6	
Climatic amelioration	50	7	
Erosion control	33	10	
Heritage	6	11	
Scenic	48	8	
Sub-total	**199**		**Uncalculated**
Grand total	**600**		**Greater than US 1,432,861.00**

Table 8.1 shows that value of three of non-marketable items (shade, climatic amelioration and scenic) have values greater than that of traditional medicine (US $ 9380/annum) at local level. This suggests that their value accrues at least US $ 28,140.00 to local economy.

Moreover, though it was difficult to quantify the value of livestock grazing /browsing and access to livestock watering point, Table 6.2 shows that livestock grazing/browsing ranked 3rd in the matrix scoring next to construction materials and greater than firewood, which have values of US $ 422,137.87/annum & US $67,684.71 /annum respectively. This suggests that the value for grazing/browsing is also significant.

The existence of the cultural values and identity attachments of local people to the forests/woodland is also significant. This was verified using the role-plays and matrix scoring during the assessment of the perceived full values. People refused to compare the cultural heritage values with the other forest values except in Mogoraib. During role plays, the participants in Tekreret and Adi-Ibrihim were unobliging as they felt such exercises compromise their cultural heritage and identity. They believed that the cultural values of the riverine forests are by far greater than any values derived from this landscape. This study is consistent with that of the similar study carried out in Zimbabawe (Hot spring working group, 1996).

In sum, the current study showed that the riverine forests and woodland values of Dighe administrative sub-zone alone contribute economical values greater than US $ 1,432,861.00 per annum for selected quantifiable items only. This would be many times higher if the other non-marketable forest values are quantified including the livestock grazing and access to watering points. This study provides evidence that the national value of forest goods and services is many times greater that the current estimate of 3 % contribution in the GDP. The high local values of forest and woodlands of the study areas as central means of livelihood and also contribution to the national economy justify the conservation of the remaining forest beyond any doubt.

8.2. Policy recommendations

- A clear definition of forest products is a prerequisite for sound policy forest policy formulation and implementation. The current definition in the draft forest legislation should be reviewed to accommodate the non-tree plant products, ecosystem services and socio-cultural values of forests and woodlands. The review should also be able to provide basic forest product classification: timber and non-timber forest products with full lists of marketable and non-marketable items. These amendments would assist would assist to acknowledge the role of local forest products both to the rural subsistence economy and to the GDP.
- Local level valuation studies should be carried out in other forest and woodland areas of different ecological zones and socio-economical settings to determine the magnitude of their contribution to GDP. The local level participatory valuation approaches used in this study could be used for further valuation research in other parts of the country
- There is no doubt that Eritrea needs to promote food security and poverty alleviation. However, the promotion of agricultural enterprises, particularly along the riverine forest, should not marginalize the rural poor by trading-off the local values of the forest with financial benefits incurred to agricultural investors. Policy decisions that ignore the role of forest products in rural household food security, poverty alleviation and biodiversity conservation may not only intensify value-conflicts and environmental degradation, but may also jeopardise the sustainability of the agricultural investment and local-level development initiatives. Thus, it is advisable to carry out both socio-economic and bio-physical environmental assessment prior to any land use change decisions.
- Respecting local values including the cultural attachment of the riverine forest to local people to the riverine forests could provide economic incentive to craft co-management arrangements. Among the many merits of co-management are ensuring participation, reduction of management costs, optimisation of indigenous technical knowledge and achievement of equity and social justice. Considering local values in devising co-management arrangement is also the basis for conflict management and a basis for sound local level development

initiatives. Therefore, the possible institutional arrangements and detailed policy reviews are research priority areas to devise viable co-management strategies.

- The inclusion of local values in forest management, precautionary principles and ecosystem management are not contradictory objectives. Rather, any prospective conservation and development planning should treat these concepts as complimentary to conserve the forest resources.
- Dom leaf production capacity *vis-à-vis* consumption analysis also showed that the local level of consumption in the research area does not exceed the dom scrub biological leaf production capacity. However, the recommendations made by AMRF (2000) that indicate the possibility of doubling the production and commercialisation of dom palm products should be revised. Forests are subjected to many threats. The level of dom palm leaf harvesting may not be sustainable if the forest area decreases due to current trends of settlement, drought and starvation, unfortunate and miserable war and population increment. This part of the research was limited by the availability of data on the dom forest biology. Long-term research is important to understand the forest productivity and to provide a reliable knowledge basis for monitoring and adjusting forest management strategies.
- The findings of this study are a practical demonstration to show that conserving forest resources for local values are vital to the achievement of the millennium global development goals of 2015 as forests provide a resource flow in food security and poverty alleviation while maintaining biodiversity and other environmental resources. Hence, the declined global attention to forest resource management should be revived on the basis of conservation for local values before the global forest becomes a legend.

References

Alazar, M., 1999. Vegetation type map report. Ministry of Agriculture/SOS Sahel, Asmara, Eritrea.

Amanual, N., Bo,T., Estifanos,B. and Kifle,G. 2000. Soil conservation in Eritrea: Some case studies: *RELMA-technical report no.23*. Nairobi, Kenya.

Amacher, S. & Hyde S., 1996. Application of environmental accounting and the new household economics: a new technical issue with a common theme in forestry. *Forest Ecology and Management* 83: 137-148

AMRF, 2000. Management Plan for the Riverine Forests of the Western Lowlands of Eritrea. Ministry of Agriculture/ SOS-Sahel, Asmara, Eritrea.

AMRF, 1997. Consultative workshop report on the status of the riverine forests of western lowlands. Ministry of Agriculture/ SoS-Sahel, Agordat, Erirea.

Armsworth, R. & Roughgarden, J., 2001. An invitation to ecological economics. *Trends in Ecology and Evolution* 16: 229-234

Arnold, J. & Pérez, M., 2001. Can non-timber forest products match tropical forest conservation and Development objectives? *Ecological Economics* 39(3): 437-447

Arnold, J. & Byron, N., 1999. What futures for the people of tropical forests? *World Development* 27: 789-805

Arnold, J., 1995. Socio-economic benefits and issues in non-wood forest products use. *In:Report of the expert consultation on non-wood forest products, Yogyarta, Indonesia.* Non-wood forest products 3. FAO, Rome.

Asfaha, S., 1999. *Socio-economic survey: the role of the Riverine Forests on people's livelihood*. Ministry of Agriculture/ SOS-Sahel, Asmara.

Bampton, J., 1997. Inventory report: River forests of the Western Lowlands. AMRF- Project, MoA/ SOS Sahel Int. UK, Eritrea, Asmara.

Bann, C, 2002. An overview of valuation techniques: advantages and limitations: Special reports, Asian regional centre for biodiversity conservation. [Online]. URL. http://www.arbc.org.ph.

Borrini-Feyerabend, G., Farvar, M. T., Nguinguiri, J.C. & Ndangang, V.A., 2002. *Co-management of Natural Resources: Organising, Negotiating and Learning- by- Doing*. GTZ and IUCN, Kaspark, Heidelberg, Germany.

Buttoud, G., 2000. How can policy take into consideration the "full value" of forests? *Landuse policy 17*: 169-175

Campbell, B. & Luckert, M., 2002. Towards understanding the role of forest in rural livelihood. In: Campbell, B. & Luckert ,M.., 2002(eds.). *Uncovering the Hidden Harvest: valuation methods for woodland and forest resources*, Earthscan Publication, Landon

Campbell, B., Luckert, M. & Scoones, I., 1997. Local-level valuation of savanna resources: a case study from Zimbabwe. *Economic Botany* 51(1): 59-77

Carney, D., 1998(eds). Sustainable Rural livelihood: what contribution can we make? DFID, London.

Castro, A. & Nielsen, E., 2001. Indigenous people and co-management: implication for conflict management. *Environmental Science and Policy* 4: 229-239.

Cavendish, W., 2001. Rural livelihoods and non-timber forest products. In: W de Jong and B Campbell (eds). *The role of non-timber forest products in socio-economic development*, CABI Publishing, Wallingford

Chamberlain, J., Bush, R. & Hammett, A., 1998. Non-timber forest products: the other forest products. *Forest products* 48: 2-12

Cocks, M. & Wiersum K., 2003. The significance of plant diversity to rural households in eastern Cape Province of South Africa. *Forests, Trees and Livelihoods* 13:39-58

Connelly, S. & Wilson, N., 1996. Preliminary study of the riverine forests of the Western Lowlands of Eritrea. GOE/SOS-Sahel Report No.1, Asmara.

Cotton, C., 1996. Ethnobotany: principles and applications. John Wily and Sons Ltd, London UK.

Crafter, S., Awimbo, J. & Broekhovea, A. 1997(eds). Non-timber Forest products: Value, use and management issues in Africa, including examples from Latin America. IUCN, Nairobi.

Daniel, Y., 2000. Preliminary study for agricultural landuse of *nues-zoba* Dighe: paper presented in 'Landuse classification and rural development project appraisal for Zoba Gash- Barka". MoA, Gash-Barka, Agordat

Davie, D., 2003. Whose involvement? Can hierarchal valuation schemes intercede for participatory methods for evaluating secondary forest resource use? *Forest Policy and Economics* 5: 265-283

DCG, 2002. Sustainable livelihoods of farmers and pastoralists in Eritrea. *In the proceedings of consultative workshop organized by DCG Eritrea, Asmara.* DCG proceeding 8, DCG/Norgaric, Agricultural university of Norway, Ăs.

DCG, 2001. The formation of the Dryland coordination Group in Eritrea, Asmara. *In DCG Proceedings 2,* DCG/ Norgaric, Agricultural university of Norway, Ăs.

DoE, 1998. National biodiversity strategies and action plan. DoE, Ministry of Land, Water and Environment, Asmara.

Dorman, S., 2003. Eritrea's nation and state-buildings: re-assessing of the impact of the struggle. *Paper presented at the Conference on globalisation and self-determination*, London, UK.

EEA, 1996. Refugee reintegration Projects: environmental assessment report. Asmara, Eritrea.

Emerton, L., 2003. Tropical forest valuation: has it all been a futile exercise. Paper presented to the XII World Congress, 2003, Quebec City, Indonsia.

Emerton, L & Asrat, A., 1998. Eritrea Biodiversity: Economic Assessment, DoE, Ministry of Land, Water and Development, Asmara, Eritrea.

Farber, S., Costanza R & Wilson, M., 2002. Economic and ecological concepts for valuing ecosystem services. *Ecological economics* 41: 375-392

Falcnor, J. 1990. The major significance of 'minor forest' forest products: the local use and values of forests in the West African Humid Forest Zone. Community Forestry Note 6. Rome: FAO

FAO, 2002. Rattan: current research issues and prospects for conservation and sustainable development. *Non-Wood Forest Products* 14. Rome, Italy.

FAO, 2001. Resource Assessment of Non-wood Forest Products: *Non-Wood Forest Product 8*. FAO, Rome, Italy.

FAO, 2000. Forestry and Wildlife Project Preparation report. FAO/ADB, Cooperative Programmes Vol 1. FAO, Rome.

FAO, 1999. Towards a harmonised definition of non-timber forest products. *Unasylva* 50(198): 63-64

FAO, 1997. Eritrea: support forestry and wildlife sub-sector pre-investment study TCP/RI/712(F). FAO, Rome, Italy.

FAO, 1995. Non-wood forest products for rural income and sustainable forestry*: Non-wood forest products* 7. FAO, Rome, Italy.

Geldenhuys, C.J. 2000. Sustained yield determination of forest and woodland produce. In: Owen, D.L. & Vermeulen, W.J., *2000* (eds). *South Africa Forestry Handbook*, Vol 2, The Southern African Institute of Forestry, Pretoria. p. 643-650

GOE, 1997. The constitution of Eritrea: ratified by the constitute Assembly (May 23,1997), Asmara

GOE, 1996. Proclamation of the establishment of regional administration, gazette of Eritrea laws Vol. 6/1996

Glűck, P., 2000. Policy means for ensuring the full value of forests to society. *Land Use policy* 17: 177-185

Gram, S., 2001. Economic evaluation of special forest products: an assessment of methodological shortcomings. *Ecological economics* 36: 109-117

Gwaai working group, 1997. Local level valuation of woodlands and state forest: cases from Matebeleleland South in Zimbabwe.IES Working paper, 7. Institute of Environmental Study, Harare

Hansen, A., 1994. Baselines report on food security, social, demographic, economic and political relationships and conditions in Gash-Setit. Integrated Food Security Programme Gash-Setit, Minstry of Agriculture/ GTZ, Tessenay, Eritrea.

Hampicke, U., 1994. Ethics and economics of conservation. *Biological conservation* 67(3): 219-231

Hart, T., 2004. The value of using rapid rural appraisal techniques to generate and record indigenous vegetables in Uganda, M. Phil. University of Stellenbosch, South Africa.

Hot spring working group, 1995. Local level economic valuation of savanna woodland resources: Village cases from Zimbabwe. *Research series*, 3(2) IIED, London.

IIED, 1997. Valuing the hidden harvest: A methodological approach for local level economical analysis of wild resources. *Sustainable Agriculture Program Research Series*, 3(4), IIED, London.

Kaimowitz, D., 2003. From Rio to Johannesburg and beyond: forest conservation and rural livelihood in the global South: Paper presented to the XII World Congress, 2003, Quebec City, Indonesia.

Kant, S., 2003. Extending the boundaries of forest economics. *Forest Policy and Economics* 5: 39-56

Kengen, S., 1997. Forest valuation for decision making: lessons of experience and proposal for improvement. FAO, Rome, Italy.

Kramer, R., Sharma, N. & Munasinghe, M., 1995. Valuing tropical forests: methodology and case study of Madagascar, *World Bank Environment 13*, World Bank, Washington DC

GOE, 1997. Gazette of Eritrean laws, Form 7/1997, No., Tigrinya Version, Asmara, Eritrea.

IIED, 1997. Valuing the hidden harvest: a methodological approach for local level economical analysis of wild resources. *Sustainable Agriculture Program Research Series*, 3(4), IIED London

Martine, G., 1995. *Ethnobotany: a conservation manual*. Chapman & Hall, London

Mellese, W., 2000. Deportation of Eritreans from Ethiopia, A lesson to the world. Sabor Printing services, Asmara, Eritrea

MoA, 2000, Landuse classification and rural development project appraisal for Zoba Gash-Barka". MoA, Gash-Barka, Agordat

MoA/SOS Sahel, 1995. Assessment and Management of riverine forests of the Western Lowlands of Eritrea (Draft proposal). MoA/ SOS Sahel, Eritrea, Asmara

Mogaka, H, Simons G, Turpie J, Emerton L & Karanja F, 2001 (eds). Economic aspects of commmunity involvement in sustianable forest managment in Eastern and Southern Africa, IUCN, Nairobi

Molnar, A, 1991. Community Foestry: Rapid Appriasal. Community Forestry Note 3: FAO, Rome, Italy.

Mulugheta, G., Redia, T. and Yacob, Y. 1998. List of Birds and large mammals found in the Riverine Forests of the Western Lowlands of Eritrea. Ministry of Agriculture, Asmara (Unpublished document)

Mulugheta, G., 1996. Observation and recommendation on lower Barka riverine forests of Western Lowlands of Eritrea. AMRF-project document: Ministry of Agriculture, Asmara.

NAP-E., 2001. National action plan to combat desertification and mitigate the effects of drought. Government of Eritrea. Asmara.

NEMP-E, 1995. National environmental management plan of Eritrea. Government of Eritrea. Asmara.

Nemarundwe, N. & Richards M (2002). Participatory methods for exploring livelihood values derived from forests. In: Campbell, B. & Luckert, M., 2002 (eds.). *Uncovering the Hidden Harvest: Valuation methods for woodland and forest resources*. Earthscan Publication, Landon.

Nunes, P. & van den Bergh, J., 2001. Economic valuation of biodiversity: sense or nonsense? *Ecological Economics* 39: 203-222

Panayotou, T. & Ashton, P., 1992. *Not only by timber: a major component of forest total value*. Island press. Washington, D.C.

PENHA, 1996. Consultative workshop on Pastoralist, land and the state: Background to the workshop. Keren, Eritrea

Pearce D., Moran, D. & Riller, D., 2002. *Handbook of Biodiversity valuation: A guide for policy makers*. Organisation for Environment and development, Paris, France

Pearce, D, Putz, F. & Vanclay J, 2002. Sustainable forest management: Panacea or folly. *Forest Ecology and Management* 130: 85-105

Peters, C., 1996. Observations on the sustainable exploitation of Non-timber Tropical products: an ecologist prospective: In Pérez, M & Arnold M (eds). *Current issues in Non-timber forest products research*. Centre for International Forestry Research, Bogor, Indoniesia, 19-40

Peters, C, Gentry A & Mendelsohn, R, 1998. Valuation of an Amazonian rainforest (Commentary). *Nature* 339: 655-656

Richards, M & Costa, P, 1999. Can tropical forestry be made profitable by 'internalising the externalities'? *Natural Resource Perspective*. Overseas Development Administration, London

Shackleton, C. & Shackleton, S., 2000. Direct use values of secondary resources harvested in the Bushbuckridge lowveld, South Africa, *Journal of Tropical Forest Products* 6: 28-47

Shackleton, C., Shackleton, S., Ntshudu, M. & Ntzebeza, J., 2002. The role and value of savanna non-timber forest products to rural households in Kat River Valley, South Africa. *Journal of Tropical Forest Products* 8(1): 45-65

Shackleton,S., Shackleton, C. & Cousins, B., 2000. Revaluing the communal lands of southern Africa: A new understandings of rural livelihoods. *ODI natural resource perspective*. DFID, London.

Secretariat of the Convention on Biological Diversity (SCBD), 2001. Sustainable management of non-timber forest resources. Montreal, SCBD. (*CBD technical series no.6*)

Sheil, D & Wunder, S., 2002. The value of tropical forest to local communities: Complications, caveats and cautions. *Conservation Ecology* 6(2):9. [Online]. URL: http://www.consecol.org/vol6/iss2/art9

Tareke, W., 1999. AMRF business development study. Government of Eritrea/ SOS-Sahel, Asmara, Eritrea.

Turner, R., Paavola, J., Cooper, P., Farber S, Jessamy, V. & Georgiou, S., 2003. Valuing nature: lessons learned and future research directions. *Ecological economics* 46: 493-510

Tacconi, L., 1997a. An ecological Economic approach to forest and biodiversity conservation: The case of Vanuatu: *World Development* 25(12): 1995-2008

Tacconi, L., 1997b. Participatory research and ecological economics for Biodiversity conservation in Vanuatu: *Participatory learning and action notes* 28,74-78. International Institute for Environment and Development

Tacconi, L., 1995. Rethinking the economic analysis of forests: theory and practice. *Forest Ecology and Management* 73: 229-238

Theis, J. & Grady, H., 1991. Participatory rapid rural Appraisal for community development: A training manual based on experience in East and North Africa. IIED/ Save the children, London, UK.

Turpie, J., Heydenrych, B. & Lamberth, S., 2003. Economic value of terrestrial and marine biodiversity in the Cape Floristic region: implications for defining effective and socially optimal conservation strategies. *Biological Conservation* 112: 233-251

UNEP, 1992. *Rio Declaration*, World conference on environment and Development, UNEP, Brazil.

van Buskirk, R., 1999. Eritrean vegetation zone: [Online]. http://www.punchdown.org/rvb/biomass/vzone.html

Warwick, T., 2002. Special issues in watershed development in Eritrea. *In :* Juel, M.,(ed)., 2002. *Watershed development: economic and institutional sustainability at community level-*

evidence from case studies: proceedings of Fourth International Danida Workshop. Asmara, Eritrea.

Vermulen, S. & Koziell, I., 2002. *Integrating global and local value: a review of biodiversity assessment*. International Institute for Environment and Development, London, UK.

Watts, S., 2003. The effects of communal land resource management on forest conservation in northern and north-eastern Namibia. *Development South Africa 20:338-359*

Warner, M. 2000. Conflict management in Community Based natural resource projects: Experiences from Fuji and Papua Guinea. Natural Resource Perspectives: paper 135. London Overseas Development Institute.

WCED, 1987. *Our common future*. Oxford University Press, Oxford

Wickens, G., 1991. Management issues for development of non-timber forest products. *Unaslyva* 42(195): 3-8

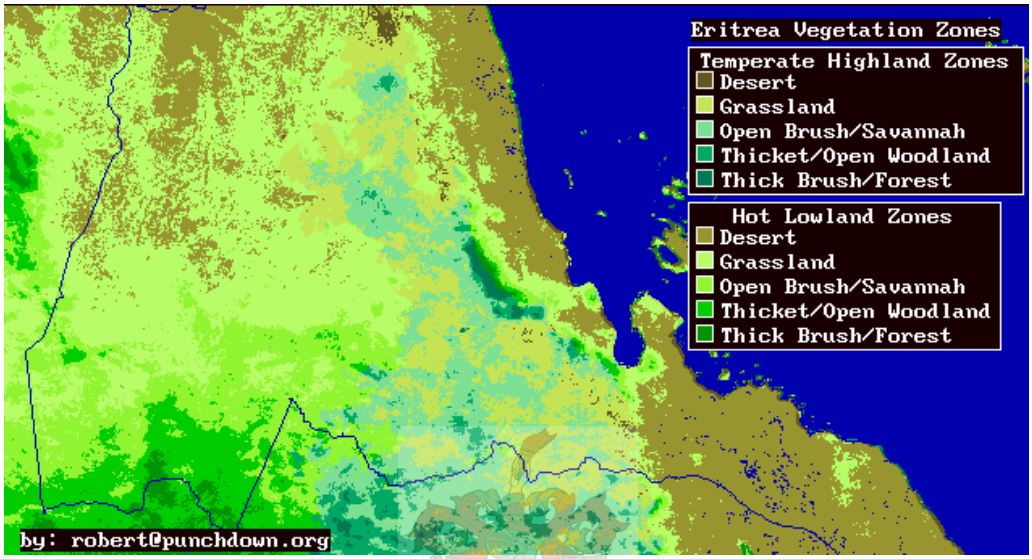
World Bank, 2003. Sustainable development in a dynamic world, World development report, 2003. Washington, D.C.

World Bank, 1996. Eritrea environmental mission strategy paper. Washington, DC

APPENDIXES

Appendix 3. 1. Eritrea Vegetation Zones (Adopted from Van Buskirk 1999)

Central Eritrea View[16]



[16] This map does not include the entire political boundary of the country- particularly on the northern tips.

Appendix 4.1: Checklists for semi-structured interviews and PLAR tools used

Focus group interviews

- What are the key economic activities of the *Mimhdar kebabies* for their livelihood?
- How important is the collection of NTFPs within a community *vis a vis* other economic activities for their livelihood

Ethnobotanical survey (Men, women and school children)

- Identify various forest products derived from the local forests. Which species for what purpose?
- Assess the seasonality of product flows at various periods using matrix scoring and time series/historical profiles
- Assess the annual flow using daily routine activities and seasonal calendar
- Reasons for the difference of usage patterns at various periods?
- Prepare gender division of labour and decision making using participatory methods in relation to the forest product collection, processing and marketing

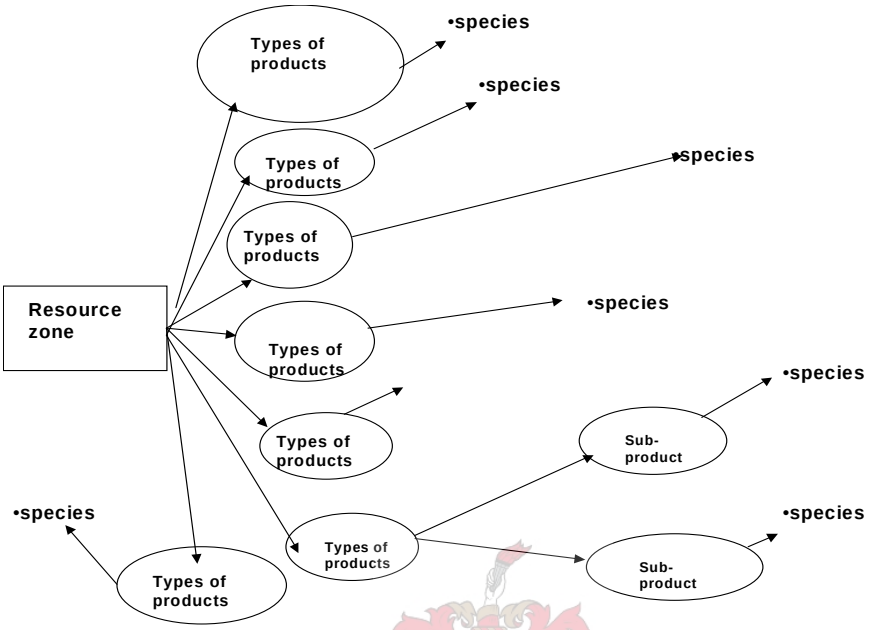
PRA data gathering tools and matrixes

Sheet 1: Livelihood strategies: Forest products Vs other economic activity

S.no	Economic activity	Scores
1	NTFPs harvesting and marketing	
2	Rainfed agriculture	
3	Livestock	
4	Wages	
5	Others	

N.B. Please specify other economic activities

Sheet 2. Forest use flow diagrams



Sheet 3. Gender Division of labour

NTFPs goods	Scores			
	Men	**Women**	**Children**	**Remarks**
Household care				
Forest product harvesting				
Wild food				
Traditional medicine				
Household utensils				
Construction materials				
Firewood				
Processing				
Marketing				

N.B. Please specify forest use activities clustered under others

Appendix 5.1. Household Survey Questionnaire

Description

Village:_____

Name:_____

Gender of household head_____

Age:_____

Household size:_____

Martail status_____

A. Married B. Divorced

C. Widow/widower D. Single

Settlement Pattern:

A. Permanent resident B. Returnees from Sudan

C. Agricultural concessionaires D. Others (specify)

Forest product consumption patterns

Quantification of Direct consumptive use of forest products

Instruction: Local units of measurement should be strictly used during interviews

Wild food

A.1. From trees and shrubs

Fruits/other parts	Household consumption	For sale	Remarks
Dom palm fruit			
Zizyphus spina-christi fruit			
Balanties aegyptica fruit			
Tamarndus aegyptica fruit			
Adonsonia digitat leaves/fruits			
Boscia seneglansis leaves/fruits			

A.2. From wild animals

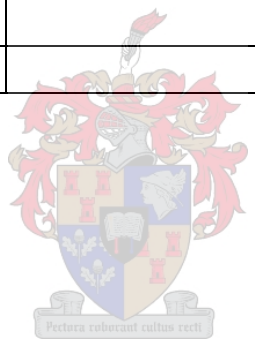
Types of wild animals	Household consumption	For sale	Remarks
Gazelle			
Rabbit			
Porcupine			
Guinea fowl			

B. Energy

Item	Household consumption in donkey load/camel load	For sale in donkey load/camel load	Remarks
Fire wood for cooking			
Brick making			
Other purposes (specify)			

C. Phyto-medicine

Fruits/other parts	Household consumption	For sale	Remarks
Acacia nilotica pods			
Tamarindus indica			
Others (specify)			



D. Household utensils inventory

Items	Units	Household consumption	Sale	Remarks
Small baskets for domestic use				
Medium Baskets for domestic use				
Medium baskets for sale				
Big baskets for domestic use				
Small fans for domestic uses				
Big fans for domestic use				
Dom leaves for plaiting (Kaale) for selling				
Bed mats for domestic use				
Bed mats for sale				
Big mats for domestic use				
Big mats for sell				
Coloured mats for domestic use				
Coloured mats for sale				
Praying mats for domestic use				
Rope for domestic uses				
Brooms for domestic use				
Brooms for sale				
Huts for domestic use				
Mesob				
Cook sticks				

E. Inventory of built structures from forest products

No of traditional huts:_____

No of brick huts:_____

Cattle pens:_____

Shoat pens:_____

Other structures:_____

Remarks:_____

_____

Are you willing to participate in managing the forests? Yes/no

If yes, why?

_____

_____

_____

If not, why not?

_____

_____

_____

_____

Appendix 5.2. Market Survey Data for selected commodities

Name of the Data collector: _____

Name of the Market place

Date: _____

Wild food items	Market Price In Nakfa	Converted in to US Dollars
Dom fruits (qt)	15	1.11
Zizyphus fruits for sale (kg)	1	0.074
Chicken (substitute for Guinea fowl meat) (No)	70	5.19
Goat (substitute for Gazelle meat) (No)	500	37.04
Acacia nilotica for medicinal and tanning (kg)	4.5	0.32

Fuel wood Items	Market Price In Nakfa	Converted in to US Dollars
Fuelwood (Qt)	40	2.96

Household utensil items	Market Price In Nakfa	Converted in to US Dollars
Small baskets (no)	4	0.30
Medium Baskets (no)	7	0.52
Big baskets	7.5	0.56
Small fans (no)	1.25	0.09
Big fans(no)	3	0.22
Dom leaves for plaiting (Kaale (Qt)	45	3.33
Bed mat for domestic uses (no)	4	0.30
Bed mats (no)	4	0.30
Big mats (no)	6	0.44
Coloured mats (no)	10	0.74
Praying mats (no)	10	0.74
Rope (no)	0.6	0.04
Brooms (no)	1.5	0.11
Huts (no)	2	0.15
Mesob(no)	4	0.30
Cook sticks (no)	3	0.22

Source of supply_____

Do you sell it wholesale or retail? Where?

How much of the products are processed, semi-processed or raw materials?

Items	Unit price in Nakfa	Unit prices
Traditional huts (Agdo or tukul)	701.00	51.95
Brick huts	547.00	40.54
Sheep and goat pens	156.00	11.56
Shade (Rakuba)	532.00	39.43

Case Studies

- About traditional medicine
- dom leaves processing using PRA tools