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FORESTRY ACCOUNTS FOR NAMIBIA: The Value of Timber and Firewood in the Namibian Economy

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ABSTRACT

The traditional System of National Accounts (SNA) does not include all economic activities, or all goods and services that contribute to the welfare of the country. GDP, which is used as an indicator in macroeconomic policy-making, is derived from the SNA and may therefore be underestimated. Environmental resources such as forests have multiple uses which are not accounted for in the conventional national accounts. It is important to include the value of the natural resources into the national accounts to be able to calculate the true value of the gross national product and also for being able to make the correct policy-making decision. Forest resources are important to developing countries since the forests satisfy many basic and every-day needs for the rural people. Examples of such needs are fuelwood, food, medicine, construction material and fodder for livestock. The forest is very important for the rural population in Namibia since they derive both economic and environmental benefits from the forest. More than 70% of the Namibian population depend directly on natural resouces, including the forest, for much of their livelihood. However, at present the forestry sector is not included in the national accounts for Namibia.

The purpose of this study is develop both physical and monetary forest resource accounts for 1997 and 1998 for two areas in Namibia (the Tsumkwe, Okakarara and Otjinene region and the Caprivi region). By constructing forest resource accounts an assessment of the physical status of the forest stock is derived and hence, more correct macroeconomic decision-making can be made. Furthermore, this study aims to determine the value of timber and fuelwood for the Namibian economy and to look at the sustainability of the forestry sector in Namibia for 1997 and 1998. The method used for calculating the monetary accounts is the net price method.

The results show that the physical stock in the Tsumkwe, Okakarara and Otjinene area increased in both 1997 and 1998, while the physical forest stock in the Caprivi region decreased during these years. Furthermore, the value of the forest in the two areas, concentrating on timber and fuelwood, decreased in 1997 and increased slightly during 1998. This indicates that the two regions has an unsustainable forestry sector in 1997 while for 1998 the forestry sector is sustainable.

Keywords:

Namibia
Natural resource accounting
Forestry accounting
Value of firewood
Value of timber
Economic sustainability

PREFACE

I have always been interested in traveling and in experiencing new parts of the world. Some friends of mine told me about SIDA´s scholarship - Minor Field Study, where you are given the possibility to go to a developing country and write your thesis. I started to look around for possible topics for my thesis and I found a proposal on the Internet. The proposal was to establish forestry accounts for Namibia, and it was written by Jesper Stage who is a graduate student at the Umeå University working in Namibia within the natural resource accounting program. Environmental economics is a topic of current interest today and I find it to be very interesting. Therefore, my interest was captured by the proposal and I decided to apply for the SIDA scholarship and to investigate further in the subject forestry accounts and natural resource accounting.

The forest in Namibia is very important to the economy and to the people since they derive fuelwood, construction material, medicines, food and fodder for their livestock from the woody resources. The forestry sector is also very important to other sectors such as the expanding tourist sector. The forests provide wildlife habitats which are necessary for game watching and for national parks with wildlife. Consequently, it is significant to include the value of the forestry sector in the traditional national accounts. The forestry sector has not been included in the framework for natural resource accounts in Namibia and hence, I saw an opportunity to establish something with my thesis that would contribute to the country. Furthermore, I found it to be extremely satisfying to write my thesis in a developing country and hence, to be able to help in a more concrete way.

Finally, I would like to thank SIDA for the scholarship which made it possible to go to Namibia to collect information for this thesis. My time in Namibia was very interesting and wonderful in every possible way. I would also like to thank Jesper Stage for all the help and support during the time I have been working with this thesis. Furthermore, I would like to thank Moses Chakanga and Thomas Selläniemi at the Directorate of Forestry in Namibia for their help with information about the forestry sector in Namibia. I would also like to thank Jon Barnes, and Carole Roberts as well as other people working at the Directorate of Environmental Affairs in Namibia for their help and support during my time in Namibia. Without SIDA´s scholarship and help and guidance from the people mentioned above, this study could not have been completed.

1. INTRODUCTION

1.1 Background

The Gross Domestic Product (GDP) has been used as a key indicator in macroeconomic policy-making for a long time. A major limitation of the economic indicators of the System of National Accounts (SNA) like GDP is that they do not include all economic activities, or all goods and services that contribute to the social welfare of the country. Environmental resources such as forests have multiple uses which are not included in the traditional System of National Accounts and hence, the SNA may underestimate the economic contribution of forests. Forests are a source of timber, which has a market value, but forests also influence the local and regional climate, preserve soil conversion and are also sources of non-market products such as firewood, medicine, food and fodder for livestock. Consequently, ignoring the multiple uses of the forest in economic planning can result in serious and irreversible environmental consequences and mismanagement of the forestry sector in a country.

Since the contribution of the forests to the economy can be significant, it is important to "green" the traditional national accounts and include the value of this natural resource. "Greening" the national accounts is made by constructing natural resource accounts where natural capital is treated in the same way as man-made capital, such as buildings and equipment. Natural resource accounts measure the value of the use of natural resource assets, including the depreciation, degradation and capital formation of such assets. This type of expanded accounting results in an adjustment to the gross national product and it is also important for creating a more correct measure of economic sustainability in a country.

Forest resources are often very important to developing countries such as Namibia, because the country derives both economic and environmental benefits from the forests. The national forest resources in Namibia satisfy the basic needs of many households. They also help preserve biological diversity and further perform erosion prevention, soil conversion, carbon sequestration and finally work as a climate regulator. One reason why forest resources are of such a great economic value for Namibia is that they contribute to many products used daily in the households. Rural and low-income households are the major users of the forest resources. Forest resources are used in Namibia for many different purposes: firewood, construction timber, food, materials, crafts, medicine, fodder and wildlife habitat. Firewood is used daily by the rural households for cooking and is their major source of energy. The inhabitants can simply enter the forest and collect the amount of wood they need without paying for it. Poles, which the rural households use as construction material for fencing and building homesteads, are also collected in the forests and are not paid for. Furthermore, some of the most valuable forests and woodlands in southern Africa are found in the northern part of Namibia, where you can find species like mopane, teak and kiaat.

At present the forestry sector is not included in the national accounts for Namibia. Therefore, macroeconomic decision-making in Namibia is not based on an assessment

of the availability and quality of this natural resource, which can result in an unsustainable or inefficient use of the forests and can also lead to a lower social welfare. Since the forests in Namibia are of significant value for the Namibian economy it is necessary to derive an appropriate value of the forests.

The Directorate of Environmental Affairs at the Ministry of Environment and Tourism in Namibia has established a natural resource accounting program to assess the status of Namibia´s resources and economic use. The natural resource accounting program has since its start in 1995, included many natural resource sectors, but not the forestry sector. The economic importance of the forest sector in Namibia and its contribution to the welfare of the society indicates the necessity of developing physical and monetary forest resource accounts for Namibia. The aim is to analyze the physical and monetary forest resource accounts to understand the forestry sector´s contribution to the country. Furthermore, the forestry accounts should later be incorporated into the SNA and hence, a more correct value of GDP would be derived.

1.2 Problem

The following problem arises from the discussion above:

How are forestry accounts constructed for Namibia and what is the value of timber and firewood in the Namibian economy?

1.3 Purpose

The purpose of this study is to develop both physical and monetary forest resource accounts for 1997 and 1998 for Namibia. The forestry accounts are concentrated to the two products timber and firewood and limited to two areas in the northern part of Namibia.

Furthermore, the purpose of this study is to determine the value of timber and firewood for the Namibian economy, focusing on the two areas investigated. Finally, I have also looked at the sustainability of the forestry sector in Namibia for 1997 and 1998.

1.4 Demarcations

These forestry accounts are limited to two regions in north-eastern Namibia. The two regions considered are the Tsumkwe, Okakarara and Otjinene region and the Caprivi region. The reason for this restriction is that inventory reports were only finished for these two regions by the time of the research and hence, forestry accounts could not be compiled for any other areas. Therefore, conclusions for the whole forestry sector in Namibia cannot be drawn from this report since the data in this report is not representative for the whole country. However, conclusions for the two areas examined may be drawn from the findings in this study, and it should be noted that the Caprivi region is the area in Namibia with most wooded land and also the area that contains most valuable species.

Furthermore, forestry accounts are constructed for Namibia for the years 1997 and 1998. Since the inventory reports for the two areas were made in 1997 and information about 1999 was not yet available, the study is restricted to years 1997 and 1998.

Due to the time limit for this thesis it is further limited to the economic benefits derived from timber (hardwood), firewood and the non-market product grazing. Since many other products and services which also have a substantial value are derived from the forest, the results from this study understate the true value of the forests in Namibia. This is important to remember and to take into consideration when reading this study.

1.5 Abbreviations and definitions

SNA Standard National Accounts
SEEA System for integrated environmental and economic accounting
DEA Directorate of Environmental Affairs
MAI Mean Annual Increment
N$ Namibian dollars (1 N$= 1,35 SEK[1])
GDP Gross Domestic Product
NDP National Domestic Product

Stumpage Timber standing uncut in the forests

Firewood and fuelwood are used interchangeably in the study.

Definition of a forest in a developing country:
Ecosystem with a minimum of 10% crown cover of trees and/or bamboo, generally associated with flora, fauna and natural soil conditions and not subjected to agriculture purpose. [2]

1.6 Content

The content of the following chapters are presented below to make the study easier to overview.

Chapter 2: In this chapter I have summarized some important facts about Namibia as well as a description of the forestry sector and its importance for the Namibian people. This helps the reader to understand the economy in Namibia and the importance of the forestry sector in Namibia today.

Chapter 3: In this chapter I describe theories for natural resource accounting and for forestry accounting. A framework for natural resource accounting is studied; The System of integrated Environmental and Economic Accounting (SEEA), and a work regarding adjustments to

[1] Exchange rate 1999-10-06
[2] UNSD Workshop on Integrated Environmental and Economic Accounting, New York, 1999

the current and asset accounts developed by Vincent & Hartwick are discussed. Furthermore, economic sustainabiliy is explained in the chapter. The chapter ends with a description of three methods used when calculating the value of natural resources.

Chapter 4: This chapter deals with the empirical model and data used for the construction of forestry accounts for Namibia. The SEEA model is used and in this chapter I have explained in detail how the forestry accounts for Namibia is calculated and which assumptions are made.

Chapter 5: In this chapter I present the results from the study. Both physical and monetary accounts for the two areas, for 1997 and 1998, are presented and analyzed. Furthermore, an analysis of the economic sustainability for the two areas are made in this chapter. Possible biases in the study are also discussed.

Chapter 6: Conclusions of the study.

2. FORESTRY IN NAMIBIA

"Namibia is not a forestry country because of its climate. It does not have the site potential for any type of commercial plantation forestry. Yet timber products are a basic commodity in the socio-economic development of the area".[3]

2.1 Namibia overview

Namibia is a new, independent and democratic nation since 1990 when Namibia emerged from more than a century of foreign occupation. The occupation started in 1884 when Germany proclaimed South West Africa. Namibia was colonized by Germany until May 1915 when the Germans were defeated and Namibia came under the regime of South Africa[4]. The consequences of more than a century of occupation and the systems of colonial rule, apartheid and repressive laws, are that Namibia is one of the most inequitable countries in the world. Namibia is a society where many poor people exist and live side by side with extremely wealthy people[5].

2.1.1 Social development

In 1995 the population in Namibia was 1,6 million, which makes Namibia carry approximately 0.2 per cent of the whole population of Africa[6]. The distribution between white and black people in Namibia is approximately 5 per cent white and 95 per cent colored and black people. The growth rate of the population is 3.1 per cent per year.[7]

Less than one third of the population live in urban areas which makes Namibia mainly a rural society. The rural households are characterized by poverty, no cash-income, dependency on the forestry sector for firewood, food, medicine and other necessary everyday products.

2.1.2 Macroeconomic structure

Namibia is a developing country with a per capita Gross Domestic Product of USD 1956 in 1996[8]. The wealthiest 5% of Namibians account for more than 70% of the country's GDP and the poorest 55% for only 3%[9] Despite the world and regional recession Namibia has achieved a positive average rate of economic growth since Independence 1990. [10] The inflation rate was 8,8% in 1997[11].

[3] Geldenhuys, C. J., Past, present and future forest management in the Southern African Region with special emphasis on the Northern Regions of Namibia
[4] Lonely planet, Zimbabwe, Botswana & Namibia
[5] First National Development Plan (NDPI) volume I, Government of the republic of Namibia
[6] ibid.
[7] Central Statistics Office, 1991 population and housing census, National Planning Commission
[8] Central Bureau of Statistics, National Accounts 1982-1997
[9] The international fund for agricultural development, Northern regions livestock development project, Africa division, Project management department
[10] NDP1, volume I

The Namibian economy is dominated by mining (diamonds and uranium), tourism and fishing, as well as subsistence agriculture. Mining is and will continue to be a major contributor to the economy and, hence, the economy is dependent of the mineral resources. Furthermore, in 1997 the mining sector provided over 45% of the total export by value[12]. The major trade partner is the Republic of South Africa, which provides Namibia with 87% of its imports[13].

2.1.3 Geography

Namibia is a country situated in the southwestern corner of Africa (see map in Appendix 1). It is bordered to the north by Angola, Zambia and Zimbabwe, to the east by Botswana, to the south by the Republic of South Africa and to the west by the Atlantic Ocean. The capital city of Namibia is Windhoek.

Namibia has an area of approximately 825000 km^2 and, hence covers nearly 3 per cent of the total land area of Africa. The only perennial rivers in the country are found along the southern and northern borders of the country, the Orange river in the south and in the north the Kunene, Kavango, Kwando-Linyanti-Chobe and Zambezi rivers[14]. The three vegetation zones found in Namibia are deserts that occupy approximately 16% of the land area, savannas which occupy approximately 64% and finally, woodlands that occupy approximately 20% of the land area in Namibia.[15]

The average annual rainfall increases from less than 20 mm on the coast towards the northeast part of the country which receives more than 700 mm (see map of ecological zones as determined by rainfall availability in Appendix 2). The low average and highly variable rainfall is the major climatic factor influencing the performance of natural resources such as agriculture, forestry and wildlife in Namibia.[16]

2.1.4 Land Tenure

Namibia has dualistic land tenure today, which is a legacy from the colonial period. Communal land covers 41% of the total land area and is placed in the higher rainfall areas in northern Namibia. Freehold tenure area occupies 44% of the total land in Namibia. The freehold tenure area is divided into 6300 farms belonging to 4200 large-scale farmers.[17]

[11] Central Bureau of Statistics, National Accounts 1982-1997
[12] Economist Intelligence Unit, Country Report, Namibia, p. 5
[13] ibid.
[14] Erkkilä, A. & Siiskonen, H., Forestry in Namibia 1850-1990, p. 19
[15] Directorate of Forestry, Namibia forestry strategic plan, p. 2
[16] Erkkilä, A. & Siiskonen, H., Forestry in Namibia 1850-1990, p. 20-22
[17] NDP1, volume I

The definition of communal land is that every person in the area has the right of use of land enough to feed himself/herself and his/her family. Usually the chief of the tribe, or the village headman, is the owner/trustee of all tribal land and therefore, he has the final say in matters of land distribution and land ownership. Newcomers and landless individuals must to turn to the chief or the village headman, to be given rights to use land. Normally, transfer of land is made within the family. With communal land individuals do not necessarily own land but have the right to use the land and will maintain ownership over the land as long as they utilize it properly.[18]

2.2 Background on the forestry in Namibia

Forests and woodlands in Namibia are located in the northern and northeastern parts of the country. The central region is covered by wooded grassland and bushland and in the desert, in the south, only a few scattered trees and shrubs are found. Woodlands cover only one fifth of the country while savannas cover 64%.[19] Even though these are the conditions met in Namibia, 70% of the Namibian population depend directly on natural resources, including trees, for much of their livelihood[20]. The forest resources provide the Namibian population with fuelwood, building material, food and fodder for their cattle. In addition to the forest resources economic value, forests also have social, cultural and psychological impacts.

2.3 Past efforts to develop the forestry sector[21]

The forestry sector has been developed on and off since the beginning of the twentieth century. Forestry development started when the German colonial government recognized the importance of environmental protection. A national forest policy was developed which emphasized nature conservation. Plans for afforestation were established but the high expenditures and the unsatisfactory results of regeneration made the plan for forest plantation a failure. Instead, farmers were recommended to plant trees on agricultural land, which would lower the public expenditure on tree planting.

After the first World War when Namibia became a mandate of South Africa, the interest for forest development initiated by the Germany colonial government disappeared. The forest policy changed towards forest exploitation. The lack of qualified people in decision-making positions made forest exploitation even worse when no one was able to administer the forest resources. Immediately after independence in 1990, the government of Namibia created the Directorate of Forestry which has as its mission to promote and create a sustainable forestry development.

[18] Directorate of Foresty, An assessment of the potential for community forestry in the Caprivi region
[19] Erkkilä, A., & Siiskonen, H., Forestry in Namibia 1850-1990
[20] Ashley, C., Population growth and renewable resources management: The challenge of sustaining people and the environment
[21] Directorate of Forestry, Namibia forestry strategic plan, p. 1

The Directorate of Forestry in Namibia is working toward the goal of integrating forestry into wider national goals and policies. The aim is to conserve the natural ecosystems for their biodiversity, encourage increased agricultural productivity through soil and water conservation, move closer to poverty alleviation and an equitable development and finally protection of biodiversity and prevent climate changes.

2.4 The importance of forest resources

Forest resources are of great economic value for Namibia as they contribute to many products used daily in the households. The primary users of forestry resources are farmers and local communities with low-income households in the rural areas, who use the resources for their domestic consumption needs. They have for a long time utilized the forest and are continuing the exploitation.

2.4.1 Wood products

The most important domestic consumption product from forests is firewood which is used to produce energy for cooking by the households. Certain regions in the country have started to experience a shortage of firewood because of harvesting from unsustainable supplies. Another important wood product is wood carvings which is purchased by tourists visiting the country. The private sector uses wood from forests to produce consumer products such as firewood and carvings which will be sold in the market and hence become a source of cash. Finally, wood is also used as building material for construction works, building traditional homesteads and for making fences to protect farmlands. [22]

2.4.2 Non-wood forest products

Another use of the forest which is almost as important as firewood is consumption of non-wood products, such as food, animal fodder, crafts and medicinal products. Non-wood products are mostly used by rural and low-income households for own consumption as well as cash income. Fruits and other food are used in the household as well as traded and sold in the market. Fodder is used to feed livestock which contribute both food and income to the household. Furthermore, for the majority of rural people, forests traditionally provide land for shifting cultivation and free grazing areas for cattle. Finally, medical plants collected from the forest areas are used by Namibians to treat a variety of ailments.

Another importance of forest resources is the wildlife habitat provided by the forests, which is important for the growing tourism industry. The tourism sector is Namibia´s most rapidly expanding economic sector. Necessary for this sector is the wildlife and the national parks in the country which is dependent on the biodiversity conservation. Trees and woodlands represents an essential component in the habitat of most wildlife species in Namibia. Without these habitats the wildlife could not exist and hence, woodlands have a substantial indirect tourism value.[23]

[22] Directorate of Forestry, Namibia forestry strategic plan, p. 11-14
[23] aa

Conservation of soil and water resources is one of the most important services derived from sustainable management of the forestry resources. Conservation of soil and water resources is vital for agricultural production since Namibia has a low utilization of commercial fertilizers and strenuous climate conditions in some areas. Other important functions of the natural forestry resources are preservation of biological diversity and genetic material, and also the impacts the forestry sector has on climate changes through its ability to sequester carbon. Even though the genetic material may not be of importance today, it has a potential future value which should not be ignored.[24]

Benefits derived from forestry resources which are managed on a sustainable basis will indirectly affect the nation´s economic activity in a positive way. It is therefore important to find a solution to deforestration and to manage forestry on a sustainable basis.[25]

2.5 Important species in Namibia

Some of the most valuable forests and woodlands in southern Africa are found in the northern part of Namibia, where major commercial species like mopane, teak and kiaat can be found. 20% of the land area in Namibia is covered by dry woodland which contains these species[26]. One of the dominant species in this region is Baikeae plurijuga (Zambezi teak), which produces excellent timber for furniture, parquet and carvings. Another important species in Namibia is Pterocarpus Angolensis (wild teak or kiaat), which is worked easily and is therefore preferred among curio makers.

[24] Directorate of Forestry, Namibia forestry strategic plan, p. 4
[25] aa, p. 7
[26] Erkkilä, A. & Siiskonen, H., Forestry in Namibia 1850-1990, p. 23

The following table shows the most common species in Namibia and their economic importance.

Table 1: Common tree species in Namibia and their economic importance

SPECIES	OTHER NAME	ECONOMIC IMPORTANCE
Acacia tortilis	Umbrella thorn	firewood, nitrogen fixing
Acacia erioloba	Camel thorn	firewood, shade
Acacia karroo	Sweet thorn	firewood
Aciacia species		mainly firewood
Burkea africana	Red syringa	hardwood, firewood
Baikeae plurijuga	Zambezi teak	hardwood, saw milling
Boscia albitrunca	Shepards tree	fodder, fruit
Colophospermum mopane	Mopane	firewood, poles, fodder
Combretum psidioides		firewood, fodder
Combretum zeyheri	Large-fruited bushwillow	firewood, fodder
Combretum species		mainly firewood, poles
Guibourtia coleosperma	Shivi tree	hardwood, fruit
Lonchocarpus nelsii	Apple leaf	fodder, nitrogen fixing
Ochna pulchra	Peeling plane	
Pteracarpus angolensis	African teak	hardwood, saw milling
Terminalia sericea	Silver terminalia	poles, fodder
Strychnos pungens	Spiny monkey orange	fruit
Schinziophyton rautanenii	Manketti	food, fodder

Source: Namibia Forestry Strategic Plan, 1991

3. THEORY: ACCOUNTING FOR FORESTRY RESOURCES

3.1 Measuring economic sustainability

The economic literature has identified conditions that must hold if a country's population is to be as economically well off in the future as in the current period[27]. Furthermore, two main approaches has been developed for measuring economic sustainability. The first condition is often referred to as "Hartwick's rule".

$I_t = dK_t/dt + dH_t/dt + dR_t/dt$

I_t = value of net change in capital stock in period t
K_t = value of physical capital in period t
H_t = value of human capital in period t
R_t = value of natural capital in period t

This approach states that the net investment, which broadly defined includes all forms of capital, must be greater than or equal to zero. If $I_t > 0$, the economy can continue to support the population's current consumption level. An increase in consumption is possible through an increase in the economy's total capital stock.[28]

The second condition for sustained economic well-being is the net domestic product. The net domestic product represents the present value of consumption for a competitive economy and the net investment after deducting depreciation.

$NDP_t = C_t + I_t$

NDP_t = net domestic product in period t
C_t = consumption in period t
I_t = net change in capital in period t

For sustained economic well-being the NDP, broadly defined in order to include all forms of capital, must remain constant or increase from one period to another. An increase in long-run welfare is possible if $dNDP_t/dt > 0$.[29]

The concept described above for measuring economic sustainability is called weak sustainability. Weak sustainability is characterized by the assumption of perfect substitutability within the capital stock and, hence between produced and natural assets. The rule is consistent with any one asset being reduced as long as another capital asset is increased to compensate. This means that the country can have a declining level of environmental quality and natural resource availability as long as other forms of capital are substituted for the natural capital. It is the overall stock of capital assets that should be constant or increasing over time.[30]

[27] Vincent, J. R. & Hartwick, J. M, Forest resources and the national income accounts: concepts and experience
[28] aa, p. 5
[29] aa, p. 6
[30] Turner, R. K., Sustainable environmental economics and management. Principle and Practice, p 11

Other economists feel that a more appropriate concept is strong sustainability, which stresses the missing elements in the economic calculus that underlies the weak sustainability concept. It is not sufficient to protect the overall level of capital in the strong sustainability approach; rather, the natural capital must be protected because at least some of the natural capital is non-substitutable. The natural capital stock must be constant for the strong sustainability rule to hold. The concept of strong sustainability is preferred in cases where the following conditions are found: uncertainty about ecosystem functions and their service value, some environmental resource degradation and loss are irreversible, and finally in cases where non-substitutability of some natural capital is present.[31]

An attempt to prognosticate the future course of a country´s economy is made by measuring its economic sustainability. The conventional national accounts do not include the necessary information to measure economic sustainability, though; they only contain information on investments and depreciation of man-made capital. It is therefore important to adjust the national accounts for forest resources and derive estimates of the net changes in the value of forest resources, which together with changes in other forms of capital will give an aggregate measure of the net investment in the country. Growth of the forest illustrates a type of investment that increases the value of the forest resource.

There are many possible options for how a country might exploit a forest resource. If the forest is state-owned one alternative is to control the exploitation and thereby create sustainable forestry. If the government wants to have a sustained income from the forest resource the only harvesting made will be the harvest of the economic rent. This may be relevant if the opportunity cost of holding the stumpage and land are less than the asset value of the sustained economic rent from the forest. To have a sustainable forestry is also relevant in the case where the forest has multiple functions for the country.

3.2 Background to natural resource accounting

The economic indicators of the System of National Accounts (SNA) like GDP have some major limitations because they do not include all economic activities, or all goods and services that contribute to the human well being in a country. The SNA ignores the non-marketed services provided by the natural assets like forest resources.

Natural resource accounting is a further development of the traditional national accounts, which strives to extend the traditional national accounts to include natural resources. Natural resource accounts attempt to treat natural capital in the same way as man-made capital is treated in the national accounts. The assets of woody resources are recorded in the natural resource accounts, the different uses of the woody resources are included under different accounts. Growth of the forests is treated as an addition in the natural resource accounts and harvesting is treated as a reduction of the natural capital. In the traditional national accounts only the income from the harvested timber is included. By introducing the natural resource accounts the cost and the

[31] Turner, R. K., Sustainable environmental economics and management. Principle and Practice, p 13

income of harvesting can be compared with each other, which is not possible with the traditional national accounts.

Natural Resource Accounts (NRA) are recognized for providing information and analysis about the natural resources, to support sustainable macroeconomic policy. When macroeconomic decision-making in a country is not based on an assessment of the availability and quality of natural resources, it results in unsustainable or inefficient use of the natural resource, which further results in a lower social welfare. NRA function like any other accounts and provide a detailed set of statistics and a bottom line, which tells the country how well it is doing. The statistics will help resource managers to take policy decisions which attempt to improve the social welfare of the country.

3.3 Classification of products and services of woody resources

Forests and other woody resources provide various products and services to production and consumption activities. Some of the products and services provided by forests and other woody resources are directly used by households for final consumption while others are used as intermediate production inputs by industries. A classification of the products and services derived from the woody resources is necessary since it has important implications for the required type of adjustment to current SNA. Products and services of woody resources are classified by type of use as described below[32].

3.3.1 Products for direct intermediate use by other industries

Marketed timber and non-timber products for woody processing industries. Examples are commercial logs, craftwood and grazing resources for livestock production.

3.3.2 Products for final consumption

- Non-marketed timber products, which are not traded in the market. Examples are fuelwood and poles used by the households.
- Non-market, non-timber products, which are whole or parts of plants and animals used for food, medicinal and other purposes.
- Forest amenities, which are woody resources that are used for social, religious and recreational purposes. An example of a forest amenities is game parks where tourists go out in the forests to watch wild animals.

[32] Hassan, R. M., Accounting for asset depreciation and non-market values of woody land resources: methods and results from south Africa

3.3.2 Services for indirect intermediate use by others

Environmental (ecological) services provided by the forests that indirectly benefit other industries. Examples are watershed protection which benefits agriculture and the hydropower sectors, biological diversity, soil conversion and carbon sequestration. Polluting deposition (acid rain) is a service which is benefiting manufacturing industries while it may be damaging to the forest health.

The necessity of the required adjustments to the current SNA is easily understood when considering the contribution of woody resources to the economic activity defined above.

3.4 SNA93 (System of National Accounts)

SNA93 is the traditional accounting system for calculating the value of the economic assets in a country and, further, is also the source from where GDP is derived. SNA93 defines economic assets as "assets over which ownership are enforced and which provide economic benefits to the owners"[33]. In the forestry sector, economic assets are forest resources which provide inputs like timber to production or final consumption.

Economic assets can be divided into two different types. The first is produced assets, which means that the asset comes into existence as a result of a production process, e.g. plantation forest and livestock for breeding. The second type of economic assets are non-produced assets which are assets that can be inputs to production without being produced. Non-produced assets include land and timber resources in a natural forest.[34]

SNA93 includes the change in the asset value of produced economic timber in the asset accounts. According to SNA93, asset accounts present information in the following categories:

⇒ opening stocks (the growing stocks of timber in the beginning of the accounting period)
⇒ capital formation (changes in inventories, acquisition less disposal of non-produced assets)
⇒ other changes in volume (natural growth, catastrophic losses, timber harvesting, afforestation, changes in classification)
⇒ revaluation (gains and losses in the monetary holding during the period)
⇒ closing stocks (opening stock plus the sum of the depletion during the period)

Asset accounts in SNA93 contain information on forest resources explicitly and implicitly. The asset accounts in the SNA93 show information on changes in non-produced assets such as for example the amount of timber harvested during the period, natural growth, forest fires and virgin forests that are added to economic reserves. However, non-market forest products and depletion of these products are not included in the SNA.

[33] Vincent, J. R, & Hartwick, J. M, Forest resources and the national income accounts: concepts and experience, p. 7
[34] ibid.

3.5 SEEA Framework

During the last twenty years significant efforts have been made to refine the existing SNA and incorporate natural resources. The World Bank and the United Nations have invested considerable effort in studying the issues involved and developed guidelines for improving the national accounts. An accounting system that treats the natural assets in the same manner as man made assets has been established. *The System of integrated Environmental and Economic Accounting* (SEEA: United Nations, 1993).

The United Nations has developed a Satellite System of Integrated Environmental and Economic Accounts (1993) that provides an essential framework for environmental accounts and contains several modifications related to the treatment of natural resources in the core national accounts.[35] The reason why the SEEA has been developed as a satellite system of the SNA is because additional data are required to be able to describe the interrelationships between the environment and the economy. In a satellite system of environmental accounts these additional data can be included in a special data set that would be closely linked with the traditional national accounts.

The satellite system also provides a greater degree of freedom for concepts and methods of valuation than the conventional national accounts. In the traditional national accounts market valuation is used, but within the SEEA satellite system valuation methods that are not necessarily consistent with the traditional valuation method can be used such as the willingness-to-pay concept and method using the opportunity cost. The objective of the environmental accounting system is to monitor environmental changes caused by economic activities and the reverse and hence, to become the basis for integrated environmental and economic policies.[36]

SEEA proposes a multi-step process for creating satellite environmental accounts. It identifies three different types of natural assets[37]:

- Produced natural assets, including those assets that are "produced" and are immediately marketable (e.g. man made plantations).
- Non-produced economic assets are natural assets that are currently exploitable or likely to become so, for economic purposes, even if no explicit ownership or control is currently applied over these resources (e.g. commercially exploitable timber in forests and land).
- Non-produced environmental assets are those assets for which neither ownership rights are enforced nor economic benefits derived from their use. Examples are water, air and forests which are not commercially exploitable as well as those forests that exhibit significant environmental amenities, wild fauna and flora.

[35] United Nations, Integrated Environmental and Economic Accounting
[36] ibid.
[37] aa, p. 11-14

In the initial step, the SEEA suggests establishment of physical accounts with information about opening stocks, depletion, other volume changes and the closing stocks. As a second step the SEEA suggests valuing the opening stocks by multiplying them by the net price of the resources at the beginning of the period. Furthermore, the SEEA suggests multiplying other volume changes and depletion by average net price of the resource during the period and closing stocks by net price at the end of the period. Net price is defined as the market price of the extracted resource minus average total extraction cost.[38]

3.6 Incorporating the SEEA in the SNA

In the SEEA it is possible to expand the forest accounts to include non-produced natural capital in the asset balance. The SEEA suggests making existing environmental and resource related information in the SNA more clear by disaggregating the current accounts and assets accounts without changing their basic structure.

Regarding the asset accounts, the SEEA advises reclassifying the information on "other changes in volume" for non-produced economic and environmental assets into four categories.[39]

- Depletion: reduction in the quantity of assets due to economic uses (e.g. timber harvesting)
- Degradation: changes, positive or negative, in the quality of assets due to economic decisions (e.g. reduced productivity of forests because of soil erosion)
- Other accumulation: additions or reductions in the quantity of assets due to economic decisions (e.g. transfer of forests to non-forest uses such as agriculture or afforestration)
- Other volume changes: quantitative or qualitative changes in the assets caused by other factors than economic decisions (e.g. destruction of forests by natural fires, storms, floods)

These modifications involve some redistribution of existing information in the SNA, without changing the connection between current and asset accounts.

In the next step, the SEEA suggests moving the information on "depletion", "degradation" and "other accumulation" from the asset accounts to the product accounts. In the asset accounts, adjustments of non-produced economic and environmental assets will be made for "depletion", "degradation" and "other accumulation" and hence, "net capital accumulation" will be derived.[40]

As a third step, SEEA suggests including non-market environmental costs and assets, such as those associated with air and water quality and biologic diversity. The SEEA also proposes adding a third asset type, non-produced environmental assets, to the asset accounts.

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[38] aa.

[39] United Nations, Integrated Environmental and Economic Accounting, p. 57-60

[40] Vincent, J. R, & Hartwick, J. M, Forest resources and the national income accounts: concepts and experience

3.7 Construction of physical accounts according to SEEA[41]

The SEEA framework for constructing volume accounts in physical terms is described below. The accounts describe the changes in the stocks of standing timber between the beginning and the end of the period. Ideally one would like to have volume accounts for the different regions in the country as well as accounts for different species.

I Opening stocks
The opening stock represents the growing stock of forestry resources present at the beginning of the accounting period. May be taken as the total growing stock in the country.

II Changes due to economic activity
Changes due to economic activity refer to human production activities such as logging/harvest for market products as well as logging/harvest for non-market products, logging damage, illegal logging and afforestation that change (decrease or increase) the stock of forests.

I. Other volume changes
Other volume changes include reductions of forests caused by stand mortality, insect infestation, grazing, forest fires and natural disasters. It also contains any transfer of land to forestry from other economic use. The volume of forest stocks affected by forest fire and grazing is derived by multiplying the naturally regenerated volume and the afforestated volume with the percentage of area subject to heavy grazing and forest fire.

II. Other accumulation
Other accumulation shows the accumulation of timber due to natural growth (the mean annual increment), natural regeneration and the transfer of forest land for non-forest uses such as agriculture and industrial purpose.

III. Closing stocks
The closing stocks are the opening stocks less reductions plus additions. Closing stocks is actually stocks available at the end of the period and the difference between the computed closing stock and the actual closing stock is called statistical discrepancy.

[41] Haripriya, G., Accounting for forest resources in the national accounting framework of India

Table 2: Physical forestry accounts

Activity / Forest type	***Name of the area***
I. Opening stocks	
II. Changes due to economic activity	
Depletion (-)	
Logging/harvest for market products	
Logging/harvest for non-market Products (household consumption)	
Illegal logging	
Logging damage	
Afforestation (+)	
III. Other volume changes (+/-)	
Reductions (-)	
Forest fires	
Stand mortality, insects, diseases	
Animal grazing	
Shifting cultivation (+)	
IV. Other accumulations (+/-)	
Additions (+)	
Natural growth (mean annual incre.)	
Regeneration	
Transfer of land to other activities (-)	
Net volume change (II-IV)	
V. Closing stocks	

3.8 Adjustments to SNA according to Vincent & Hartwick (1997)[42]

A more recent work than the SEEA, for correcting the conventional measures of income and net savings for the missing values of woody resources is made by Vincent and Hartwick (1997), *Forest resources and the national income accounts: concepts and experience.* A number of adjustments are made to the current and asset accounts when taking the woody resources contribution to the economy into account.

3.8.1 Product (current) account adjustments

GDP Adjustments

One way of calculating GDP is by adding up expenditures on consumption and investment. An alternative way of computing GDP is by adding up income across all production sectors. The value of products that enter the market is usually captured in SNA and therefore do not require any further adjustments. The value of most of the forestry products for final consumption is on the other hand not included in the SNA, even though these types of goods contribute to the welfare of the country[43]. They are

[42] Vincent, J. R & Hartwick, J. M, Forest resources and the national income accounts: concepts and experience

[43] Products for final consumption are described as category 2 in classification of products and services of woody resources, see p. 12 in this study

not recorded in the traditional GDP because the goods are not sold and bought on the market. Adjustments should be made to GDP and household consumption of non-market, non-timber products should be included in the product accounts.

Environmental services are also not accounted for in the conventional SNA[44]. Adjustments are required to the GDP for the value of these services as well.

No adjustments need to be made to GDP for benefits provided by woody resources to production activities of other sectors. The reason for this is that indirect environmental and ecological services provided by natural resources that contribute to increased or decreased output in another sector are already accounted for in the GDP. For instance, the benefit of watershed protection services from forests is realized through higher output within the agriculture sector. However, the value of these services should be reallocated from the source sectors and added to the forestry sector (for example from the agriculture sector to the forestry sector).

NDP Adjustments

Net domestic product, NDP, is considered a better measure of sustainable income and long-run welfare than GDP since it accounts for depreciation of assets. However, conventional SNA only captures depreciation of man-made (manufactured) capital, and depreciation of natural capital is left out. NDP needs to be adjusted for depreciation/consumption of natural capital to obtain a more accurate measure of social welfare and wealth formation. Therefore, conventional measures of NDP need to be adjusted for changes in the value of the stock of woody assets.

- Net depreciation of timber stocks
  Represents changes in the value of standing timber stocks as a result of natural growth, harvesting and forest fires. Another factor influencing the value of standing timber is movements in timber prices.
- The future flow of other products and services of the resource
  When the quality and/or quantity of forest resources decline the future flow of the many direct and indirect products and services of the resource is reduced. Therefore, the NDP needs to be adjusted down.

3.8.2 Capital (asset) account adjustments

Adjustments are automatically made to asset accounts since the value of the closing stock reflects the net change (accumulation/depletion) of natural capital in terms of woody assets.

3.9 *Construction of monetary accounts*

Monetary changes correspond to the physical changes except for the revaluation term, which shows changes in value of standing timber caused by price changes between the beginning and the end of the period.

[44] Category 3 in classification of products and services of woody resources, see p. 12 in this study

3.9.1 Calculating asset value and depreciation

The exploitation of forest resources does not always take full account of the economic value of timber resources and forest land; therefore, economic asset valuation and estimation of the depreciation of timber resources and land are of great relevance. Forests hold stocks of timber that can be converted to capital and occupy land that has alternative uses. One of the causes of deforestation is the interest in the alternative uses of the value of the timber and land.

3.9.2 Methods for calculating the asset value and the depreciation

A reduction in the asset value of timber should be counted as a loss of capital (depreciation) and not as production in the national accounts. There are different approaches for estimating the asset value and the degree of capital depreciation from the exploitation of natural forest resources. Which method is used depends on the accuracy and availability of the data required for calculating the asset value and the depreciation. Methods for calculating the asset value and the value of depreciation are presented below.

3.9.2.1 Present value method [45]

The present value method is the conventional way of measuring the value of a natural resource. When using the present value method the asset value of a natural resource is considered to be equal to the discounted sum of all expected net economic rents it generates over time. The total economic rent is the net profit from exploiting the forest resources, the market price less the total extraction cost and the cost of transporting the timber from the forest to the user.

$q_t (P_t - C(t))$ = total economic rent at time t

q_t = quantity timber exploited at time t
P_t = market price of timber at time t
C(t) = extraction cost and transporting costs

The value of the natural resource can be described with following formula:

$$V(t) = \sum (1+i)^{t-s} [\, pq(s) - C(q(s))]$$

i = the discount rate
p = price of one unit of the extracted resource, (assumed to be constant over time)
q(s) = quantity extracted in period s
C(q(s)) = the total extraction cost
T = the terminal time, the period when the resource is exhausted
the sum is evaluated over the interval s = t,...T

[45] Vincent, J. R & Hartwick, J. M, Forest resources and the national income accounts: concepts and experience

Furthermore, the asset value should also include the discounted sum of all other benefits derived from the forest such as intangible non-market, non-timber products and environmental benefits.

Economic depreciation is defined as the change in value of an asset from one period to the next, and calculated as following:

$D(t) = V(t) - V(t+1)$

$D(t) = [pq(t) - C(q(t))] - iV(t+1)/(1+i)$

V(t) = asset value in period t
V(t+1) = asset value in period t+1
(see above for definition of the other variables)

Assumptions underlying the present value method are that prices and the discount rate are constant over time. If constant prices are not assumed, projections about several unpredictable factors need to be made such as the future price of a resource, future resource availability and rates of extraction and future costs of extraction. Moreover, the present value method requires a forecast of the net revenue generated by the natural resource for each year the resource is used and discounting it to the present time. The high degree of uncertainty surrounding each of the above factors makes this method rather difficult to use.

3.9.2.2 Net price method[46]

The asset value of the resource when using the net price method is the current economic rent, the stumpage value, multiplied by the reserve of the resource.

$V(t) = Q(t)*(P-AC)$

V(t) = Asset value at time t
Q(t) = The total reserve of the resource at time t
P = Price of the resource at time t
AC = Average extraction costs at time t
(P-AC) = Current economic rent (net price), at time t

Depreciation of the natural resource is the current average economic rent per unit multiplied by the change in the resource reserve.

$D(t) = (P - AC) * \Delta q(t)$

D(t) = Depreciation at time t
$\Delta q(t)$ = change in the resource reserve at time t

Depreciation = net price * net depletion of the physical timber stock

The net price method is the most commonly used approach for valuing the net accumulation and the asset value of forest. The method is very popular and used in many studies because of its simplicity. The net-price method does not require information on either the discount rate or the age of the forest. An assumption made in the net-price method is that the net price of the marginal unit of the natural resource

[46] Linddal, M., The asset value and depreciation of timber resources and forest land

extracted will equal the nominal interest rate[47]. This condition may be true in the long run but there are most likely periods of disequilibrium when this is not true. Despite the problems of this assumption, the net-price method has been the method of choice for many countries since this simple assumption may yield results which are as good as results derived from other methods. Furthermore, the net-price method uses average cost because data about marginal cost are not available. Some studies argue that this method over estimates the asset value and, hence, also the value of the depreciation, because average cost is often lower than marginal cost. The size of this bias in the estimate depends on the degree of linearity of the cost function.

3.9.2.3 The marginal cost method [48]

This approach has been suggested to be a more correct approach to assess the depreciation of timber resources. The problem is that the marginal extraction cost used in this approach are difficult to estimate and require extensive and expensive data collection. Therefore, Vincent and Hartwick (1997) have developed a simplified marginal cost method, which makes use of the elasticity of the marginal cost function. The simplified method establishes a simple relationship between the known average costs and the uncertain marginal cost given some assumptions. Vincent and Hartwick also states the importance of using marginal net pricing whenever the cost function is non-linear (not proportional to the amount extracted).

$MC = (1+\beta)*AC$
$AC(t) = C(q(t))/q(t)$

MC = marginal cost of extraction
AC = average cost of extraction at time t
C(q(t)) = the extraction cost at time t
β = the elasticity[49] of the marginal cost function[50]

The asset value of the resource is calculated by following formula:

$V(t) = \sum(1+i)^{t-s}[\, pq(s) - (1+\beta)C(q(s))]$

V(t) = value of the resource at time t
the sum is evaluated over the interval $s = t,\ldots T$
(see *3.9.2.1* for definition of variables)

Depreciation of the resource is calculated by using following formula:

$D(t) = (P - AC) * q(t) \Rightarrow$
$D(t)$[51] $= [(P - (1+\beta)C(q(t))/q(t)]*q(t)$

D(t) = depreciation at time t

[47] Lange, G-M. & Motinga, D. J., The Contribution of Resource Rents from Minerals and Fisheries to Sustainable Economic Development in Namibia, p 24
[48] Linddal, M., The asset value and depreciation of timber resources and forest land
[49] percentage change in the marginal cost per one percent change in the quantity extracted
[50] Marginal cost function: MC = dTC / dq(t), where TC = total cost and q(t) = the removal of the timber resource at time t
[51] Vincent, J. R & Hartwick, J. M, Forest resources and the national income accounts: concepts and experience

Even though this approach is suggested to be the most correct approach the method is complicated and only works under certain conditions[52]:

- The resource is extracted optimally
- The price of the extracted resource and the discount rate are assumed to be constant over time
- Marginal cost is assumed to be an increasing function, constant over time and unrelated to the size of the reserve.

3.9.2.4 A comparison between net price, marginal cost and the present value method

Compared to the net price method (where depreciation is the entire timber rent, P-AC) the marginal cost method (which has a depreciation equal to P-MC), will result in a lower estimate of depreciation because MC>AC. An assumption made for the net price method, $\beta=0$. Furthermore, the outcome of the marginal cost method will be a higher estimate of depreciation compared to the present value method, where $\beta \rightarrow \infty$.

3.9.3 Prices on timber products

When market stumpage prices for standing timber are available they must be used in calculating the value of timber. Stumpage price is "the value of or the price paid for timber as it stands uncut in the woods"[53]. When no market stumpage prices are available an estimated stumpage price is used, which is derived from data from logging and other forestry industries. The price of timber harvested during the period is measured at roadside pick-up prices. It also includes expenses for felling, transportation to the roadside and other costs due to the harvesting.[54]

The opportunity cost of labor may be used when valuing household´s collection of non-timber products, such as fuelwood. In developing countries, forest ownership rights are not usually well-defined or enforced and hence, the forests are a complete open-access resource. As a result, households collecting non-timber products usually do not have to pay for the use of the forest resource. Therefore, households will collect non-timber products up to the point where the obtained value of the last unit collected exactly equals the opportunity cost of labor used to collect it. In this case, the value of the collected non-timber products will equal the opportunity cost of labor involved, which is calculated as the amount of time spent collecting fuelwood times the labor cost.[55]

When some non-market timber products used for household consumption are sold in the markets, they can be valued using the market price of the products. An assumption has to be made that the market price is the price the households would pay if they were not able to make the harvesting themselves. The market price may be used for valuing both the stocks and the flows that decrease or increase the stocks.[56]

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[52] Linddal, M., The asset value and depreciation of timber resources and forest land
[53] Newson, B. & Gie, G., Forest economic and environmental accounting
[54] Newson, B. & Gie, G., Forest economic and environmental accounting
[55] Vincent, J. R, & Hartwick, J. M, Forest resources and the national income accounts: concepts and experience, p. 21
[56] United Nations, Integrated Environmental and Economic Accounting, p. 16

3.9.4 Fodder

Fodder obtained from the forest can be valued using the current market price of fodder, and if fodder is not marketed the market price of similar products can be used. Several studies have estimated the value of fodder attained from the forests using indirect valuation techniques like market value of fertilizer and milk output from cattle feeding on land. Such valuation is best applied to programs like afforestation and social forestry programs and applied to a small region, when the change in value before and after the project is known.[57]

The value of fodder obtained from the forests can also be derived as the opportunity cost of allotting acreage to the agricultural land. This value is equivalent to the loss in revenue from agriculture due to cultivating equivalent amount of fodder obtained from forests on agricultural land. This kind of approach for valuation of fodder is used when there is no detailed information about the fodder obtained from the forests.[58]

An indirect non-market valuation technique can also be used when valuing fodder obtained from the forest. The cost of using the forest for grazing is extended to include the maintenance costs, which is the costs that would have occurred if the environment had been used in such a way that it would not have affected its future use.[59]

3.9.5 Land[60]

Land should be valued at its current price paid by the owner. When no exchange of land has occurred the value of the land should be derived from markets in which the same or similar items are currently traded. The market price reflects the expected present value of the flow of future net returns connected with the use of the assets. If the land is rented it may be valued by the discounted future streams of "net" rent.

To be able to price the land correctly it is important to identify the location and use of a specific piece of land since the current market value of land can vary enormously depending on location and use.

A simplified way to value forests is to consider the value of land as negligible and value standing timber and natural growth by multiplying the volume of timber by current net price.

[57] Haripriya, G., Accounting for forest resources in the national accounting framework of India
[58] Haripriya, G., Accounting for forest resources in the national accounting framework of India
[59] United Nations, Integrated Environmental and Economic Accounting, p. 19
[60] Newson, B. & Gie, G., Forest economic and environmental accounting, p. 4-10

3.9.6 Revaluation

Prices and costs fluctuate over time and revaluation is the term in the monetary accounts which takes into account the price difference between the beginning and the end of the accounting period[61]. The revaluation term is the residual difference between the value of the opening stock and the sum of the value of the opening stock and the depletion during the accounting period[62].

[61] Haripriya, G., Accounting for forest resources in the national accounting framework of India
[62] Vincent, J. R & Hartwick, J. M, Forest resources and the national income accounts: concepts and experience

4. EMPIRICAL MODEL AND DATA

4.1 Data

In this thesis the empirical data used is mainly obtained from the Directorate of Forestry in Namibia. Most of the data is collected in the inventory reports compiled for different regions in Namibia. The inventory reports are made by the National Forest Inventory Project, which is a project division within the Directorate of Forestry. The inventory project is an ongoing project today and, hence, inventory reports are not finished for all forest areas in Namibia yet. The inventory project is scheduled to finish in year 2002. The areas investigated in this study are the Tsumkwe, Okakarara and Otjinene region and the Caprivi region. The inventory reports cover the volume of each species found in the area, the total number of trees, damages in the area, the area in hectares of each species, the dominant species and the species composition, species diversity and finally also information on the vegetation structure of the area.

The primary data[63] used in the study is mainly interviews. Interviews with people at the Directorate of Forestry in Namibia is a major source of the primary data in this study. Interviews have also been made with forest officers at the regional forest offices in the northern part of Namibia. Interviews were a necessary part of my research since information about the forest in Namibia is very limited. I have also had interviews with people at the Veterinary Service, Ministry of Agriculture in Namibia, to find out information about the livestock browsing in the forest. Furthermore, a lot of information about the country, the conditions of the forest and the different species and their uses was provided by people working within the Directorate of Environmental Affairs in Namibia. This is information which was difficult for me as a newcomer to Namibia to be aware of and it was not written anywhere, but was essential for my study. Moreover, I interviewed different wood companies to find out the price of hardwood and the costs of harvesting.

4.1.1 Technical aspects of the two regions

A short description of the vegetation structure of the two areas studied in depth is made below to make it easier for the reader to understand what the areas look like.

4.1.2 Tsumkwe, Okakarara and Otjinene region[64]

The area covers the eastern and southern parts of Tsumkwe district, the northern parts of Otjinene district and the eastern parts of Okakarara district. The Giess (National Atlas of South West Africa) classifies the area to the Forest Savanna and Woodland and Camelthorn Savanna vegetation zones. The following land zones are found in the area: dunes, dune valleys, dry river beds and sandy substrates. The ground is

[63] Primary data is the kind of data the researcher is able to collect during the period for the research.
[64] National Forest Inventory Project, Woody resources of western Tsumkwe and Woody resources of east and south Tsumkwe, Otjinene and Okakarara districts, Directorate of Forestry, 1997

everywhere sandy, annual rainfall in the region is 300-400 mm, and elevation is 1100-1300 m over sea level.

The total land area of the east and south Tsumkwe, Otjinene and Okakarara district is 8212447 ha. According to the Vegetation Maps made by the Directorate of Forestry in Namibia 591521 ha is classified as forest, 7598346 ha as savanna and 22580 ha as cultivated land.

The structure of the vegetation in the region is that 51.6% of the area is covered by low bushland, tall closed shrubland, low closed shrubland and low open woodland[65].

4.1.3 Caprivi region[66]

The Caprivi region includes the Katima Mulilo and Mukwe magisterial districts. Mukwe covers West Caprivi Game Park. Land forms present in the Caprivi region are dunes, dune valleys and sandy substrates. The soil is derived from Kalahari sand and hence, everywhere sandy. Average annual rainfall in the area is 700 mm and the elevation is about 930 m above sea level. The total land area of the Caprivi region is 2009527 hectares. The distribution of the land is following: 1632742 ha is forest, 15216 ha is Savanna, 100300 ha is grassland and pans, and 261268 is classified as other land, which is land under intensive cultivation, marshlands, water and town area.

The woodlands of Caprivi are mostly sparse, open to closed woodlands. However, the total area of woodlands is noticeable. Woodlands cover most of the Caprivi area, 75.2%. The woodlands are mostly in the category Short Closed Woodland (tree cover 11-75% and height 5-10 m) and Tall Closed Woodland.

4.2 The applied empirical model

The forestry sector is at present not included in the national accounts[67]. Neither market products, nor non-market products are included in the conventional national accounts today. This study therefore attempts to construct forestry accounts for Namibia according to the SEEA framework and calculations will be made for both market and non-market products, concentrating on timber, fuelwood and grazing.

The study constructs physical accounts for 1997 and 1998 for the two regions Tsumkwe, Okakarara and Otjinene region and the Caprivi region. Furthermore, the physical accounts are divided into the two different categories, firewood and timber. The unit of measurement for the physical accounts is m^3.

[65] Low bushland: shrub cover > 10% and > 1m high, and tree cover < 10%, and tree height < 5 m, Tall closed shrubland: tree cover < 0.1% and shrub cover > 0.1%, and shrub height 1-2 m, Low closed shrubland: tree cover < 0.1% , shrub cover > 10%, and shrub height < 1 m, Low open woodland: tree cover 1-10%, and tree height < 5m

[66] National Forest Inventory Project, Forest inventory report of Caprivi region, Directorate of Forestry

[67] Central Statistics Office, National accounts manual Vol II, sources and methods, Windhoek

The study also constructs monetary accounts for the two regions, where a monetary value is calculated for the physical accounts. Separate accounts are constructed for fuelwood species and hardwood species since they have different values. The unit of measurement for the monetary accounts is 1000 N$.

4.3 Compilation of physical accounts

The implementation of SEEA and the framework for constructing the volume accounts in physical terms is explained below. Physical accounts for the different regions are found in Appendix 9-12, and the calculations made for the different volume changes are found further down in the same appendix.

4.3.1 Opening stock

The opening stock represents the growing stock of the forest resources present at the beginning of the accounting period. The opening stock is taken as the total growing stock in the different regions as per the 1997 inventory reports made for the Tsumkwe, Okakarara, Otjinene region and the Caprivi region. The growing stock is divided into fuelwood and timber species since they differ in value, are collected in different amounts and are used for different purposes. A breakdown between fuelwood and hardwood species has been made based on the volume of various strata in the total growing stock (see Appendix 3 and 4).

4.3.2 Changes due to economic activity

Changes due to economic activity refer to human production activities such as logging/harvest, logging damage, illegal logging and afforestation that affect (decrease or increase) the stock of forests.

4.3.2.1 Logging/harvest

Market products

The volume of timber logged to produce market products is derived from statistics of permits given out for timber and fuelwood harvested during the years 1997 and 1998[68]. It is necessary to apply for permits if the harvested products are intended for sale. The permitted logging of fuelwood and timber are reported in tonnes, m^3 or number of logs. However, an effort has been made to convert them to m^3 as accurately as possible. Estimates made in other studies on the volume of an average pole has been used to convert the number of poles to m^3 [69]. The volume of timber logs has been calculated by using information derived from an interview with a Namibian wood company[70]. Consequently, estimated total volumes of timber and fuelwood

[68] Information about the permits was reported from the forest officers at the Directorate of Forestry's regional offices in Grootfontein, Gobabis, Otjiwarongo, Ongwediva and Katima Mulilo.
[69] Klaeboe,.J. & Omwami, R., Forest policy for sustainable utilisation of the woodlands and savannas of Namibia
[70] Personal communication, Jagh, M, NAMIB EXOTIC WOOD

logged/harvested in cubic meters are available. (see Appendix 5 for permits for the Tsumkwe region and Appendix 6 for permits for the Caprivi region).

Non-market products

The volume logged to produce non-market, timber products is concentrated to fuelwood, since fuelwood is the only non-market, timber product this study is looking into. Most of the firewood being harvested in Namibia is subsistence cutting on communal lands. On communal lands, which are formally owned by the state, people are allowed to collect firewood for their own use free of charge. The consumption of firewood in the rural areas has been termed subsistence consumption in this study. This is a correct term in the sense that the firewood is not bought, but collected. Subsistence consumption of fuelwood in the rural areas is assumed to represent logging of the non-market product fuelwood.

Unfortunately, there is no information available on the yearly subsistence fuelwood consumption for the different regions; therefore, an estimate has been used for calculating the volume timber decreased due to logging of non-market products. Several studies on fuelwood consumption have been carried out in other African countries. A generally accepted estimate is that the average annual consumption of fuelwood in African conditions is about 1 m^3/capita. The same figure will reflect Namibian conditions, except in Caprivi where a slightly higher consumption figure of 1.3 m^3/capita has been estimated. The Caprivi region has a higher per capita consumption of fuelwood due to availability and closeness to the forest. Another factor affecting the consumption level are the traditional homesteads built by poles in the Caprivi region. [71]

To derive the volume logged for non-market products the annual consumption of fuelwood per capita is multiplied by the rural population in the region. Statistics on the rural population by 1991 has been used, and based on the expected rate of urbanization an annual growth of 1.6% has been estimated for the rural population[72].

The annual fuelwood consumption per capita is assumed to be constant over time and changes depend only on changes in the size of the population (see Appendix 7).

4.3.2.2 Illegal logging

The recorded volume of timber and fuelwood logged is less than the observed consumption, indicating that considerable illegal logging of timber and fuelwood goes unnoticed.

[71] Ollikainen, T., Study on wood consumption in Namibia

[72] Central Statistics Office, 1991 Population and Housing Census, Namibia,
Annual growth of the population: 3.1%, urban population in 1991: 28% and in 1996: 33%. Calculations give the annual growth of the rural population: $[(0.67/0.72)^{1/5}*(1.031)]=1.01627$

Because of the land tenure system with most areas being communal land, statistics on the volume of trees cut illicitly and the loss in revenue due to illicit logging are not available for fuelwood species. People are free to collect firewood for their own use on communal lands and it is therefore difficult for the forest officers to know whether the firewood is collected for own consumption or for trade. When calculating logging/harvest of non-market products the average annual consumption of fuelwood per capita is used and hence, it is assumed that the illegal logging of fuelwood is included in that number. Considerations has been taken for both the amount of fuelwood given out as permits which represents the volume fuelwood traded and to the annual household consumption of fuelwood and hence, nothing is left for illegal logging.

Illegal logging of the hardwood species is recorded by the forest officers at the regional forest offices when discovered (see Appendix 5 and 6). The volume timber decreased due to reported illegal logging is recorded in the physical accounts.

4.3.2.3 Logging damage

Logging damage is assumed to be nil in all regions. The forest in Namibia is described as open woodlands with sparsely distributed trees and hence, damage due to logging is not a problem[73].

4.3.2.4 Afforestation

Area afforested during the period 1997-1998 is zero. No plantations were established in the areas during 1997 and 1998.[74]

4.3.3 Other volume changes

Other volume changes comprise reductions (due to stand mortality, insect infestation, forest fires and natural calamities) and any transfer of land from economic use to forests.

4.3.3.1 Forest fires

The volume of forest stock affected by forest fire is derived by multiplying the mean annual increment by the area affected by forest fire (see example of calculation in Appendix 9). MAI is the annual growth of the forest and is different for firewood species[75] and hardwood species[76].

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[73] Personal communication, Selläniemi, T., Forest inventory field officer, Directorate of Forestry, Namibia

[74] Personal communication, Chakanga, M., Directorate of Forestry, Windhoek, Namibia

[75] MAI for firewood species: 0.075m^3/ha.
Hilbert, R., Inventory of Indigenous Forests and Woodlands in the Sarcus Region: Namibia, Suid-Afrikaanse bosboutydskrif, 1991

[76] MAI for hardwood species: 0.13m^3/ha. Calculation made with information derived from Piearce G.D., The Zambezi Teak Forest, p. 199 and FOREST INVENTORY REPORT OF CAPRIVI REGION, Directorate of Forestry, Namibia (see Appendix 9)

Information on area affected by fire is derived from the inventory reports for the different regions. Only the forest areas with serious or fatal damage from forest fires are considered as affected by fire in this study. It is assumed that the annual percentage of severe and fatal forest fires in the two regions is constant over time. This assumption is made because of limitations in data on forest fires in the two areas. For the Tsumkwe, Okakarara and Otjinene area there is no information available on the percentage of severe and fatal forest fires affecting the fuelwood species. Therefore, fire damage on Pterocarpus angolensis is used as a benchmark for fire damage on all species in that area. Fuelwood species are mostly small trees and bushes and it is assumed that their sensitivity to fire is similar to Pterocarpus angolensis, which is sensitive to fire[77].

4.3.3.2 Damage by mammals

The volume of the forest stocks affected by damage by mammals is derived by multiplying the mean annual increment by the area damaged by mammals. "Mammals" refers to wild mammals such as elephants, which are able to damage the forest by, for example, breaking the trees. Information about the percentage of the area that is damaged by mammals is given in the inventory reports and only moderate damage is assumed to affect the forest. (See example of calculation in Appendix 9).

4.3.3.3 Stand mortality, insects infestation, diseases

Stand mortality, insect infestation and diseases to the trees are limited. Nothing is recorded since 1997 and they are therefore assumed to have no effect on the forest.[78]

4.3.3.4 Animal grazing

The volume lost due to grazing is derived by multiplying mean annual increment per hectare by the area subjected to heavy grazing. In the construction of physical resource accounts only the forest area subjected to heavy grazing is considered. It is assumed that moderate and light grazing does not cause much damage to the forest.

When calculating volume changes due to grazing it is also assumed that goats are the only livestock affecting the forests through grazing. Cows and sheep are not taken into consideration and it is assumed that they affect the forest in a beneficial way since they are browsing on the ground level. Goats, on the other hand, browse on the branches which affects some trees negatively since it destroys parts of the tree and can decrease the annual increment. Goats also browse timber/hardwood species[79] which are the most valuable tree species, and which cattle do not browse. Furthermore, the goat industry in Namibia is largely dependent on browse from bushes and small trees[80].

[77] Piearce G.D., The Zambezi Teak Forest

[78] Personal communication, Juvelius, M., Katima Mulilo regional forest office, Directorate of Forestry, Namibia

[79] Baikaea plurijuga, Pterocarpus angolensis, Guibortia coleosperma, Burkea africana

[80] Marsh, A., The most important functions of the forestry sector in the Namibian economy

The area subjected to heavy grazing in the Caprivi region will be used as a benchmark for the other regions since information on area subjected to heavy grazing is only available for the Caprivi region[81]. The amount of livestock in Okakarara and Otjinene is about the same as for the Caprivi region, and the regions are therefore assumed to be subjected to the same grazing pressure[82].

Grazing does not affect the forest in the Tsumkwe area since the amount of livestock in Tsumkwe is very small. In east and west Tsumkwe there are about 800-1000 cattle and only a few goats and most of the livestock is grazing along the river or at the pans. The San people who live in Tsumkwe do not have a lot of livestock and hence the region is not subjected to heavy grazing pressure. [83] (see Appendix 8)

4.3.4 Other accumulations

Other accumulations indicate the accumulation of timber due to natural growth (mean annual increment), and the transfer of forest land to non-forest purposes (e g for agriculture or residential purposes).

4.3.4.1 Natural growth

Volume added due to regeneration is computed by multiplying the area regenerated with the mean annual increment of firewood species and hardwood species.
Due to forest fires, damage by mammals and grazing, the forest area with a regeneration potential is less than the total forest area, and the forest area with regeneration potential is derived by subtracting the volume reductions from the opening stock (see example of calculation in Appendix 9).

4.3.4.2 Transfer of land to other activities

The volume reductions due to transfer of land to non forest purposes is derived by multiplying the area transferred with the growing stock per sq. km. Information on land transferred to other activities was received by the regional forest offices, except for the Caprivi region where the information was derived from a project within the Ministry of Environment and Tourism[84] (see Appendix 5 and 6). The growing stock of fuelwood species and hardwood species per sq. km is derived from the inventory reports.

[81] Personal communication, Roberts, C., Environmental Profile Project, Directorate of Environmental Affairs
[82] Personal communication, Barnes, J., Directorate of Environmental Affairs, Windhoek
[83] Personal communication, Mr. Von Dermerve, Veterinary Service regional office, Grootfontein, Namibia
[84] Personal communication, Roberts, C., Environmental Profile Project, Directorate of Environmental Affairs

4.3.5 Closing stock

The closing stock is computed as opening stocks less reductions plus additions. In practice, the closing stocks are the actual stocks available at the end of the period and any difference in the computed closing stock and the actual growing stock are accounted for as statistical discrepancy. But since no new inventory report has been made after 1997, the closing stocks are the derived stocks. The closing stocks are also the opening stocks for the next period.

4.4 Choice of method when calculating the asset value and depreciation

Data on timber prices and costs for harvesting is very limited in Namibia, which restricts the choice of method in valuing the net accumulation and the asset value of the forest. In this study the net price method will be used for calculating the value and the depreciation of the forest resources in Namibia. Even though the net price method is argued to overestimate asset value and depreciation, it is the most appropriate method to use for forestry accounts in Namibia because of the lack of detailed data. Furthermore, it is assumed that the marginal unit of timber and fuelwood extracted equals the nominal interest rate. The only data needed for this method are the net price of the timber and the depletion of the timber stock.

In the net present value method the asset value depends on the discount rate, frequency between harvests, production cycles for non-timber benefits and finally the age of the forest. There is no information available neither on the frequency between the harvest nor on the age of the forest in Namibia and therefore this method will not be used in this study[85].

Although the marginal cost method is supposed to be the most correct approach for estimating depreciation it was not considered as an option. Estimations of the marginal extraction cost require extensive data collection which is very time demanding and costly. Furthermore, there are no data available on the marginal extraction cost of timber or on the elasticity of the marginal cost function in Namibia. Another reason why the marginal cost approach is not considered to be an applicable method is that it only works under certain conditions, which cannot be found in Namibia. The conditions are that the resource has to be optimally extracted at least cost, the price of the extracted resource has to be constant over time and finally the marginal cost has to be an increasing function which is constant over time and unrelated to the size of the resource.

[85] Personal communication, Selläniemi, T., Forest Inventory Field officer, Directorate of Forestry, Namibia

An argument for not using the net price method is that it over estimates the asset value and the depreciation. The bias of the net price method can be compared with the assumption taken in the present value method that timber prices and the discount rate are constant over time. To assume that timber prices are constant over time is not accurate and therefore, the present value method is not an unbiased method either. The method chosen in this study has a bias but that is not a strong enough argument for not using the net price method.

4.5 Valuation of forestry products

4.5.1 Hardwood and fuelwood

Hardwood is valued using prices on hardwood and costs for harvesting provided by a wood company in Namibia[86]. The company is harvesting in southern Zambia, close to the border of Namibia and Katima Mulilo. The company is harvesting the typical hardwood species such as kiaat and teak[87]. The procedure the company is using for harvesting and the species harvested are similar to other wood companies in Namibia and therefore, prices on timber and harvesting costs are applicable at Namibian conditions. However, the harvesting costs are underestimated since opportunity cost of capital invested in the business and labor cost for the owner is not included in the calculations.

Table 3: harvesting cost

Harvesting costs, 1999	
Labour costs (20 people*400N/$)	8000
Costs for concessions	12000
Diesel cost (1125L*2,15N$)	2418,75
Total cost/45m3	22418,75
Harvesting costs, N$/m3	498,1944

The average market price for hardwood species is N$2200 / m^3.

The market price of fuelwood is given from a study on consumption patterns of major wood and wood products in Namibia[88]. The estimated net price on fuelwood in the rural areas is N$ 120 per ton. To derive the net price of fuelwood in the rural areas the market price of fuelwood in the urban areas has been used and reduced by the cost of transportation and labor. Consequently, this gives us the net price of fuelwood since the market price is reduced with the opportunity cost for collecting fuelwood in the rural areas. The net price per ton has been converted to net price per m^3 by multiplying the net price per ton with a weighted average density for the fuelwood species[89].

[86] Personal communication, Jagh, W., NAMIB EXOTIC WOOD, Namibia
[87] Pterocarpus angolensis, Guibortia coleosperma and Baikaea plurijuga
[88] Klaeboe, J. & Omwami, R., Forest Policy for sustainable utilisation of the woodlands and savannas of Namibia
[89] Directorate of Forestry, Western Tsumkwe inventory report, 1997, Namibia

The value of fuelwood as a non-market product is the same as the net price for fuelwood as a market product described above. Market and non-market fuelwood do not differ and therefore the same net price can be used. The assumption is reasonable since if the households did not collect the fuelwood in the forest by themselves they would have to buy it at the market.

Furthermore, the net price for timber and firewood from 1997 are used for both 1997 and 1998 when calculating the value of the forest.

Table 4: Net price of firewood 1997

Firewood	
Net price per ton, N$, 1997	120,00
Average density fuelwood species, N$/m3	0,77269
Net price per m3,1997	155,30

Table 5: Net price of hardwood 1997

Timber	
Market price of hardwood species, 1999	2200,00
Cost of harvesting, N$, 1999	498,19
Net price, 1999	1701,81
Net price, 1997(defl. 8,8%, 2 years)	1437,65

4.5.2 Non-timber forest products

Grazing is the only non-timber forest product this study is looking into. If the forest is an important source of non-timber benefits, the asset value should include the discounted sum of net non-timber benefits as well. Therefore, the value of grazing derived from the forest has to be included in the monetary accounts.

This study deals with natural forests where there is no detailed information on the value of fodder obtained from the forest. Therefore, a different approach compared to recommended valuation techniques is used. This study uses the net price of goats to derive the value of grazing. To derive the total value of the goats browsing in the area, the amount of goats in the area is multiplied by the market value of the goats[90]. In an earlier study an assumption is made that goats derive 50% of their nutrition from browsing in the forest and that there is an annual off take of 10%[91]. The indirect use value of the woody vegetation in the savannas and woodlands of Namibia can be derived by using these figures. (See Appendix 13 for example of calculation)

[90] Directorate of Veterinary Services, Namibia Stock Census 1997 and 1998, Windhoek, Namibia
[91] Marsh Alan, The most important functions of the forestry sector in the Namibian economy, 1997, Namibia

4.5.3 Valuation of land

The value of land in northern Namibia is considered to be negligible and hence, calculated as zero. The reason for this is that all land in the northern part of Namibia is communal land and hence, there is no market for the land. The chief or the village headman decides who will have a piece of land and the people do not pay for the use of land. Furthermore, it is not possible to use the market price for land in the southern part of Namibia either due to the large difference in climate.[92]

4.6 Construction of monetary accounts

The framework adopted for calculating the monetary accounts is explained below. The monetary accounts for the Tsumkwe, Okakarara and Otjinene region and the Caprivi region are presented in Appendix 13-16 and the calculations made are found further down in the same appendix.

4.6.1 Opening stock

The opening stocks are multiplied by the net price. If the market products timber and fuelwood were the only products obtained from the forests the asset value of a forest would equal the net price of the timber and fuelwood in it. As the forests are also a source of non-timber benefits, the asset value should also include the value of non-timber products. Therefore, the value of grazing is included in the opening stocks.

4.6.2 Depletion and other volume changes

Depletion and other volume changes are multiplied by net price of timber and fuelwood. Furthermore, the cost of grazing is derived by multiplying the volume of trees that is depleted because of heavy grazing by net price for fuelwood.

As the grazing considered in the study is only ground browsing and browsing on bushes and branches made by the goats in the forest, the loss in value due to grazing is taken as the probable loss of fuelwood. An assumption is taken that there are no loss in the value of hardwood species from grazing since the goats are not able to browse on the branches of the high hardwood trees. On the other hand, grazing does affect the value of firewood species since the goats browse on bushes and lower branches, which will affect the small firewood trees and bushes. This is not a correct assumption to make, since grazing will of course affect the value of hardwood species as well, when the goats are grazing on young hardwood plants. However, due to lack of information on the age of the forests and lack of data on the net value of hardwood saplings, this assumption has to be made. However, the bias emerging from this assumption is less than the bias that would occur if calculations were made on reduction in the value of both firewood and mature timber species as a cause of grazing.

[92] Personal communication, Selläniemi, T., Directorate of Forestry, Namibia

4.6.3 Closing stock

The closing stock is calculated by multiplying the physical closing stock by the net price. The value of non-timber products is also included in the closing stock. The value of grazing in the end of the year is derived by subtracting the value of the yearly off take of goats from the value of grazing in the beginning of the year.

4.6.4 Revaluation term

In economic accounts there is an item called revaluation, which takes into account the price differences between the beginning and end of the accounting period when using nominal prices. The difference between the opening stocks and closing stocks plus the revaluation gives the value of the net volume change. However, since the monetary accounts in this study is calculated by using 1997 net prices for both years the revaluation term in this study is zero.

5. RESULTS

Physical and monetary accounts are derived from the calculations described in the previous chapter. A short description of the results and possible reasons for certain outcomes will be presented below.

5.1 Physical accounts

5.1.1 The Tsumkwe, Okakarara and Otjinene region

Table 6: Tsumkwe, Okakarara and Otjinene, physical accounts 1997, m^3

Activity / Forest type	Firewood	Timber/hardwood	Total
Opening stocks	30437120	11915630	42352750
Changes due to economic activity	-74915	-19934	-94849
Depletion (-)	-74915	-19934	-94849
Logging/harvest market prod.	-18116	-505	-18620
Logging/harvest non-market prod.	-56799	0	-56799
Illegal logging	0	-19429	-19429
Logging damage	0	0	0
Afforestation (+)	0	0	0
Other volume changes (+/-)	-105766	-128835	-234602
Reductions (-)	-105766	-128835	-234602
Forest fires	-52777	-36705	-89482
Mammals damage	-38725	-67330	-106056
Stand mortality, insects, diseases	0	0	0
Animal grazing	-14264	-24800	-39064
Other accumulations (+/-)	550437	1016815	1567253
Additions (+)	553949	1018191	1572140
Natural growth (mean annual incre.)	553949	1018191	1572140
Transfer of land to other activities	-3512	-1375	-4887
Net volume change	369756	868046	1237802
Closing stocks	30806876	12783676	43590552

In 1997 the total volume of the forest stock increased by 2.9%. Both the volume of fuelwood and hardwood species increased, by 1.21% and 7.28% respectively. Very few permits were given out in the area during the period and therefore the volume of logged/harvested market products is limited. The forest area in the region is classified as mostly savanna and hence, firewood species dominate and cover 67.10% of the forest area (see Appendix 3). This may explain why logging/harvest of market products is larger for firewood species than for hardwood species. Furthermore, the population in the area is small and the fuelwood consumption per capita is restricted to 1.0 m^3/capita, hence the volume harvested for non-market products (firewood) is also small. The major volume reductions during the period comes from "other volume changes" where forest fires and damage from mammals are the dominant factors.

Reductions from other volume changes correspond for almost three quarters (70.2%) of the total volume reductions of the forest stocks. However, the additions to the forest stock from natural growth of the forest is larger than the reductions of the forest and hence, the total volume of the forest stocks has increased during 1997.

Table 7: Tsumkwe, Okakarara and Otjinene, physical accounts 1998, m^3

Activity / Forest type	Firewood	Timber/hardwood	Total
Opening stocks	30806876	12783676	43590552
Changes due to economic activity	-67005	-243	-67248
Depletion (-)	-67005	-243	-67248
Logging/harvest market prod.	-9282	-243	-9525
Logging/harvest non-market prod.	-57723	0	-57723
Illegal logging	0	0	0
Logging damage	0	0	0
Afforestation (+)	0	0	0
Other volume changes (+/-)	-105206	-127868	-233074
Reductions (-)	-105206	-127868	-233074
Forest fires	-52771	-36701	-89472
Mammals damage	-38721	-67323	-106044
Stand mortality, insects, diseases	0	0	0
Animal grazing	-13714	-23844	-37559
Other accumulations (+/-)	553693	1018736	1572429
Additions (+)	554433	1019026	1573459
Natural growth (mean annual incre.)	554433	1019026	1573459
Transfer of land to other activities	-740	-290	-1030
Net volume change	381482	890625	1272107
Closing stocks	31188358	13674302	44862659

The same trend experienced for the forest sector in 1997 is found in 1998; the volume of the forest stock increased by 2.9%. Logging/harvesting of market products, both fuelwood and hardwood, decreased in 1998 compared to 1997. The volume of the forest stocks lost due to grazing was also less in 1998 than in 1997, which was a result of having fewer goats browsing in the forests in 1998. The net volume change was even more positive in 1998 compared to 1997 since reductions during 1998 was less and the transfer of forest land to other activities was also less than in 1997.

The total result derived from the physical accounts for the Tsumkwe, Okakarara and Otjinene region is that the forest stock was accumulating during the years 1997 and 1998. It is important to mention that the forest in this region are mostly used for non-market products. Since the population in the area is relatively small, their usage of the woody resource is less than the annual natural growth of the forest which consequently results in an increase of the forest stock.

5.1.2 The Caprivi region

Table 8: Caprivi, physical accounts 1997, m^3

Activity / Forest type	Firewood	Timber/hardwood	Total
Opening stocks	16756620	17639070	34395690
Changes due to economic activity	-115540	-1528887	-1644427
Depletion (-)	-115540	-1528887	-1644427
Logging/harvest market prod.	-5467	-1526387	-1531854
Logging/harvest non-market prod.	-110073	0	-110073
Illegal logging	0	-2500	-2500
Logging damage	0	0	0
Afforestation (+)	0	0	0
Other volume changes (+/-)	-37796	-65715	-103511
Reductions (-)	-37796	-65715	-103511
Forest fires	-30751	-53466	-84217
Mammals damage	-4536	-7887	-12423
Stand mortality, insects, diseases	0	0	0
Animal grazing	-2509	-4363	-6872
Other accumulations (+/-)	-536081	-505452	-1041533
Additions (+)	85801	149179	234980
Natural growth (mean annual incre.)	85801	149179	234980
Transfer of land to other activities	-621881	-654631	-1276513
Net volume change	-689416	-2100054	-2789471
Closing stocks	16067204	15539016	31606219

The volume of the forest stock in the Caprivi region decreased during 1997 by approximately 8.1%. Logging/harvest of market products was significant and is much more extensive than in the Tsumkwe region. Reductions from harvesting of market products account for 50.6% of the total volume reductions of the forest stocks in Caprivi. The characteristics of the Caprivi area is that it is classified as mostly wooded land. The most common tree species are hardwood species such as Baikaea plurijuga, Guibourtia coleosperma and Pterocarpus angolensis, which take up 50.1% of the forest area (see Appendix 4). That is the explanation to why harvesting of market products is more extensive in Caprivi than in the Tsumkwe region. Furthermore, harvesting of the non-market product fuelwood is considerably higher in the Caprivi region than in the Tsumkwe, Okakarara and Otjinene region. This is a consequence of the higher population density in Caprivi, and the consumption of fuelwood per capita is also higher in Caprivi with 1.3 m^3/capita. Reductions in the volume caused by forest fire is similar to the corresponding reductions found in the Tsumkwe region. Volume reductions caused by grazing are, on the other hand, much less than the volume reductions in the Tsumkwe area, because fewer goats are browsing in the Caprivi region. However, transfer of forest land has been extensive in the region and the volume reduction caused by this is large. Finally, the net volume change in 1997 for the Caprivi region is negative. Reductions in the volume of the forest stock were greater than additions from the natural growth of the forest.

Table 9: Caprivi, physical accounts 1998, m^3

Activity / Forest type	Firewood	Timber/hardwood	Total
Opening stocks	16067204	15539016	31606219
Changes due to economic activity	-114773	0	-114773
Depletion (-)	-114773	0	-114773
Logging/harvest market prod.	-2910	0	-2910
Logging/harvest non-market prod.	-111863	0	-111863
Illegal logging	0	0	0
Logging damage	0	0	0
Afforestation (+)	0	0	0
Other volume changes (+/-)	-34947	-60761	-95707
Reductions (-)	-34947	-60761	-95707
Forest fires	-29610	-51481	-81091
Mammals damage	-4368	-7594	-11962
Stand mortality, insects, diseases	0	0	0
Animal grazing	-969	-1685	-2655
Other accumulations (+/-)	-537818	-508473	-1046292
Additions (+)	84063	146158	230221
Natural growth (mean annual incre.)	84063	146158	230221
Transfer of land to other activities	-621881	-654631	-1276513
Net volume change	-687538	-569234	-1256772
Closing stocks	15379666	14969782	30349448

The volume reduction in the forest stock was less in 1998 than in 1997 (only 3,98%) due to the logging ban imposed during the year. No permits were given out for logging of hardwood species during 1998. Furthermore, volume reductions in the forest stock caused by grazing were less than in 1997 since the number of goats browsing in the area was considerably less than in 1997. However, the net volume change is still negative even if the reductions in the volume of the forest stock is much less than the previous year.

Finally, the physical accounts for Caprivi for 1997 and 1998 indicate that the volume of the forest stocks is decreasing for both years, even if the decrease is diminishing. It is important to notice that even though there was a logging ban introduced in 1998 the net volume change of the forest is still negative. One explanation for this might be the high population density in Caprivi which results in a high use of the forests.

5.2 Monetary accounts

Table 10: Monetary accounts 1997/1998, N$ 1000

Activity / Forest type	1997	1998	1997	1998	1997	1998
Opening stocks	21864086	23169200	27962311	24835382	49826396	48004581
Changes due to economic activity	-40292	-10755	-2215948	-17824	-2256240	-28580
Depletion (-)	-40292	-10755	-2215948	-17824	-2256240	-28580
Logging/harvest market prod.	-3539	-1791	-2195260	-452	-2198799	-2243
Logging/harvest non-market prod.	-8821	-8964	-17094	-17372	-25915	-26337
Illegal logging	-27932	0	-3594	0	-31526	0
Logging damage	0	0	0	0	0	0
Afforestation (+)	0	0	0	0	0	0
Other volume changes (+/-)	-165992	-165889	-94073	-90357	-260065	-256246
Reductions (-)	-165992	-165889	-94073	-90357	-260065	-256246
Forest fires	-60965	60959	-81640	-78611	-142606	-139569
Mammals damage	-102812	-102800	-12043	-11596	-114854	-114396
Stand mortality, insects, diseases	0	0	0	0	0	0
Animal grazing	-2215	-2130	-390	-151	-2605	-2280
Other accumulations (+/-)	1547321	1550992	-809918	-814531	737403	736461
Additions (+)	1549843	1551107	227792	223179	1777636	1774286
Natural growth (mean annual incre.)	1549843	1551107	227792	223179	1777636	1774286
Transfer of land to other activities	-2523	-115	-1037710	-1037710	-1040233	-1037825
Net volume change	1341037	1374348	-3119939	-922712	-1778902	451636
Revaluation term	0	0	0	0	0	0
Closing stocks	23169200	24508853	24835382	23910246	48004581	48419099

For the Tsumkwe, Okakarara and Otjinene region the value of the forest is increasing both in 1997 and in 1998, which can be compared with the increase in the physical stock for the region during these years. The increase in the value of the forest is approximately 6.0% per year. The loss in value from forest fires and damage from mammals is large and adds up to 78.1% of the total value reduction of the forests in the Tsumkwe region in 1997 and to 92.5% in 1998 .

For the Caprivi region the value of the forest is decreasing in both 1997 and 1998, with 11.2% in 1997 and with 3.7% in 1998. The loss in value of the forest due to logging/harvest of market products is much higher in 1997 than in 1998, but the loss in value due to logging of non-market products is higher in 1998. This is because the population density was higher in 1998 than in 1997 and hence, more fuelwood was used in the area. Moreover, the loss in value due to "other volume changes" and "other accumulation" is pretty stable between the years. The outcome of the logging ban on hardwood species introduced in 1998 is a reduced value of the forest stocks 1998 compared to 1997.

A comparison between 1997 and 1998 of the total area (the Tsumkwe, Okakarara and Otjinene region and the Caprivi region) indicates that there was a loss in the value of the forest for the two areas during 1997. This was corrected for in 1998, when the value of the forest for the two areas was kept pretty stable over the year. Since the value of the forest stocks for the Tsumkwe, Okakarara and Otjinene region has an increase for both years this difference in the total value for the two areas between 1997 and 1998 is derived from the Caprivi region. Consequently, the logging ban introduced in the Caprivi region in 1998 has an impact on the value of the total forest stocks for the two areas.

5.3 Economic sustainability

Calculations on the economic sustainability of the forestry sector in Namibia, concentrating on the two areas in focus for this study, is made in isolation from other sectors in the economy. Economic sustainability is calculated in an attempt to analyze the future course of the forestry sector and to find out if the forestry sector is managed on a sustainable basis.

The approach used for measuring economic sustainability of the forestry sector in this study is the strong sustainabiliy approach. This approach is explained earlier, in *chapter 3.1*, and it states that the net investment in the forestry sector has to be greater than or equal to zero if the country is going to have a sustained forestry sector. From the monetary accounts the net investments in the forestry sector is derived as the net volume change expressed in N$. The Tsumkwe region has a sustainable forestry sector since the value of the forest has increased for both 1997 and 1998. The interpretation of this result is that the Tsumkwe, Okakarara and Otjinene region can continue to support the current consumption level of forestry products of the population in the area. An increase in the consumption of forestry products is possible through the increase in the value of the forestry sector. The Caprivi region, on the other hand, had an unsustainable forestry sector during 1997 and 1998; the value of the net volume changes during the periods was negative for both periods even though the loss in value of the forest is less in 1998. The interpretation of this result is that the Caprivi region does not have the capacity to support the current consumption level of forestry products of the population in the region.

An analysis of both areas together indicates that they had an unsustainable forestry sector in 1997 which became sustainable in 1998, and this result is derived from the value of the total net volume change in the monetary accounts. This is explained by saying that the two areas together did not have the capacity to maintain the current consumption level of forestry products of the population living in the two regions in 1997. However in 1998, the two areas together did have the capacity to support the consumption level of the population living in the areas. When calculating economic sustainability for the forestry sector in isolation it is important to not confuse the implications of sustainability. Moreover, the fact that the forestry sector for the two areas together was unsustainable in 1997 does not necessarily imply that the overall economic well-being in the country was unsustainable. It is important not to make adjustments for forest resources in isolation of other adjustments to the national accounts. However, according to the concept of strong sustainability the natural capital in the country must be protected since at least some of the natural capital is

non-substitutable. Therefore, the forest stock must be at least be constant over time if the strong sustainability rule is going to hold. The forest stock in these two regions was decreasing in 1997 and hence, the strong sustainability rule did not hold. However, in 1998 the strong sustainability rule held since the forest stock was increasing.

5.4 Possible biases in the study

The findings in this study may be biased because of several reasons. First of all, since all contributions from the forestry sector to the economy are not taken into consideration, only hardwood, timber and grazing, the value of the forest is underestimated. There are many products derived from the forest and each of them has a specific value which should be included in the forestry accounts and since this study only looks at three products derived from the forest the value of the forest is not accurate. Furthermore, the net price method, which is used for valuing the forest, overestimates the value of the forest because average cost is used instead of marginal cost. Harvesting costs of timber are underestimated since wage for the owner and the opportunity cost of capital invested in the business is not included in the calculations. However, the value of the forest calculated here fully reflects these three products but the value is overestimated from the net price method as well as from calculations of the harvesting costs.

Another factor that might have influenced the result in this study is that much of the literature and information used in this study is old, at least a couple of years. The information available might not fully reflect the conditions found in Namibia today and hence, the findings might be under- or overestimated because of this reason. Moreover, the major part of the theories used in the study is constructed in other countries with totally different conditions from the conditions found in Namibia. Forestry accounts are possible to establish in every country even though the conditions might differ and therefore, I find the theories to be applicable and reliable in Namibia as well.

Another bias in the results may come from interviews. The data derived from interviews is relying on other people´s honesty and opinions. The people interviewed may answer what they think is the best for the reputation of themselves, the department, the company or the country, instead of giving the truth. Another problem with the data obtained through interviews in Namibia is that it may not be accurate since I did not have the possibility to check the credibility of the information received. As an example, during my interviews with the regional forest officers I asked the forest officer how many permits were given out in the area and the forest officer gave me the volume of timber given out as permits for each year. I did not have the possibility to verify this data and therefore, I have to trust the forest officers that I have received accurate and reliable information.

Finally, I have made several assumptions in this study which might have biased the result. For example, I have made an assumption in the study that browsing only affects the fuelwood species and not the hardwood species. This is certainly not true but because information about grazing is limited, this assumption had to be made. Moreover, these assumptions are necessary for the establishment of forestry accounts since information about the forestry sector in Namibia is limited.

6. CONCLUSIONS

The purpose of this study was to develop forestry accounts for 1997 and 1998 for two areas in Namibia, the Tsumkwe, Okakarara and Otjinene region and the Caprivi region. Through the establishment of monetary accounts the study also determines the value of timber and fuelwood for the two areas investigated in the Namibian economy. Furthermore, the study also looks at the economic sustainability of the forestry sector in Namibia.

The forests in the Tsumkwe, Okakarara and Otjinene region was growing during 1997 and 1998, with 2.9% per year. The forest is mostly used for non-market, non-timber purpose since 67% of the species are fuelwood species. The small population in the area collects less from the woody resource per year than the natural growth per year, which makes the forest stock increase. Moreover, the value of the forest is increasing with approximately 6% per year.

The forest stock in the Caprivi region was decreasing during 1997 with 8.1%. Logging/harvesting of market products, such as hardwood, was extensive and corresponded for 50.6% of the total volume reductions of the forest stock during 1997. The volume reductions during 1998 was less than in 1997, only 3.98%. During 1998 a logging ban on hardwood species was introduces, which resulted in diminishing volume reductions of the forest stock from 1997 to 1998. However, the net volume change of the forestry stock was still negative. Furthermore, the value of the forest stock in Caprivi was decreasing with 11.2% during 1997. During 1998 the value of the forest was decreasing with less than in 1997 (3.7%). The logging ban on hardwood species introduced during the year influenced the reduction in the decrease in the value of the forest stock.

The Tsumkwe, Okakarara and Otjinene region had a sustainable forestry sector during 1997 and 1998. The region were able to support the current consumption level of the population and even an increase in consumption of forestry products were possible. Caprivi, on the other hand, had an unsustainable forestry sector in 1997 and 1998. The forestry sector in the Caprivi region was not able to uphold the current consumption level of forest products of the population in the area in 1997 and in 1998.

The forest is one of the most important natural resources in Namibia today and will continue to be so in the future. Consumption of forest products will continue to expand in the future and hence, the demand for forest products will increase. Since the rural population is dependent on the forestry resources for their every day living, the increase in demand will rise at the same rate as the increase in rural population with little or no cash income. At the same time the demand for forestry products, especially industry products will probably increase when the income levels of the population rise due to the economic growth in Namibia. To be able to keep up with the increasing demand on the market, whether it comes from the growing rural population or from the higher income levels which create a higher consumption level, Namibia has to manage the forest resources on a sustainable basis.

One suggestion for improvement of the forestry sector is to establish tree plantations. Forest resource depletion is taking place at a fast rate, especially in the northern part of Namibia where the population density is high and the usage of the forest is extensive. It is therefore important to established plantations in the northern part of Namibia to be able to prevent depletion of the forest in the future. Planning and managing of the forest sector might be easier now when basic information on the physical status of the forest resources is developed through the inventory reports.

In conclusion I would like to point out that it is difficult to generalize the findings in this study to the whole forestry sector in Namibia since this study has only looked at two areas as well as only two forest products. It is therefore not possible to draw any conclusions about the total forestry sector in Namibia from the findings of this study. To be able to draw conclusions for the whole forestry sector in Namibia, forestry accounts for all regions in Namibia have to be established and aggregated. The model used in this study for construction of physical and monetary accounts can be used for constructing forestry accounts for other regions in Namibia. Hence, after constructing forestry accounts for the total forestry sector, decisions can be made to improve and develop the forestry sector.

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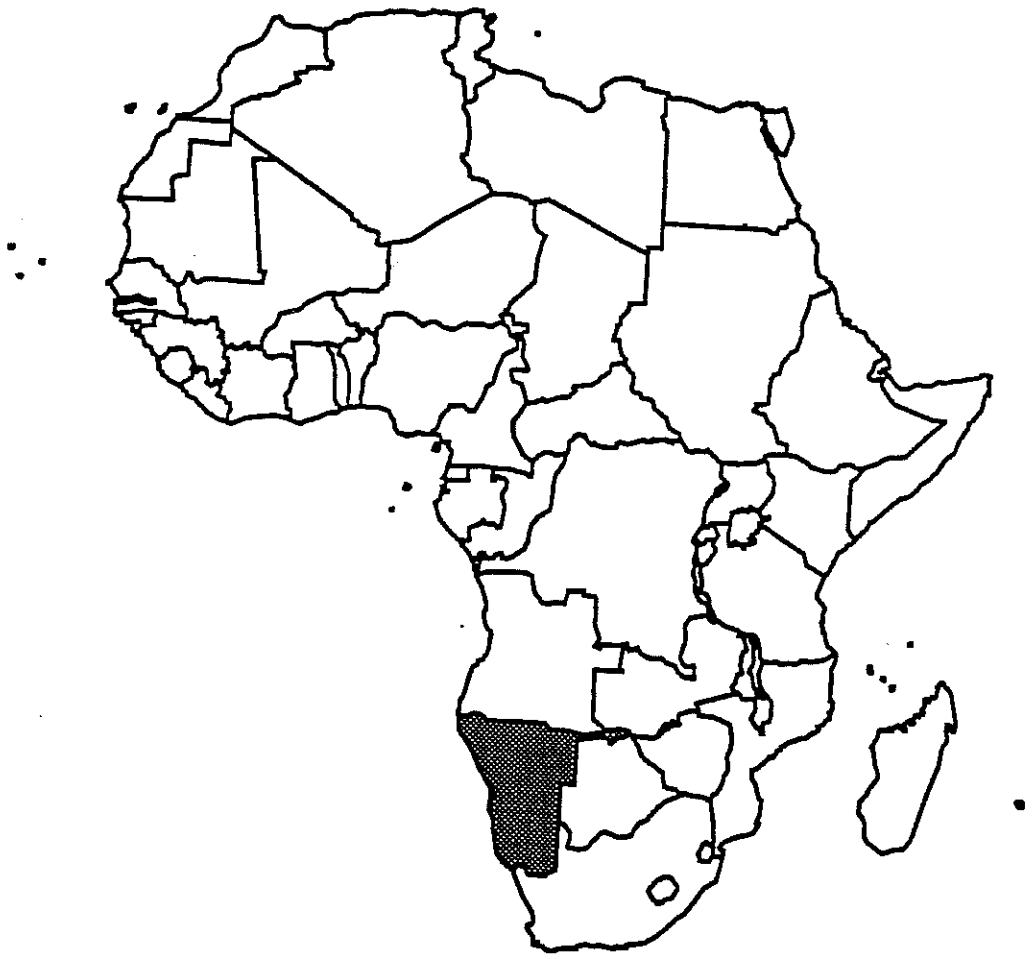
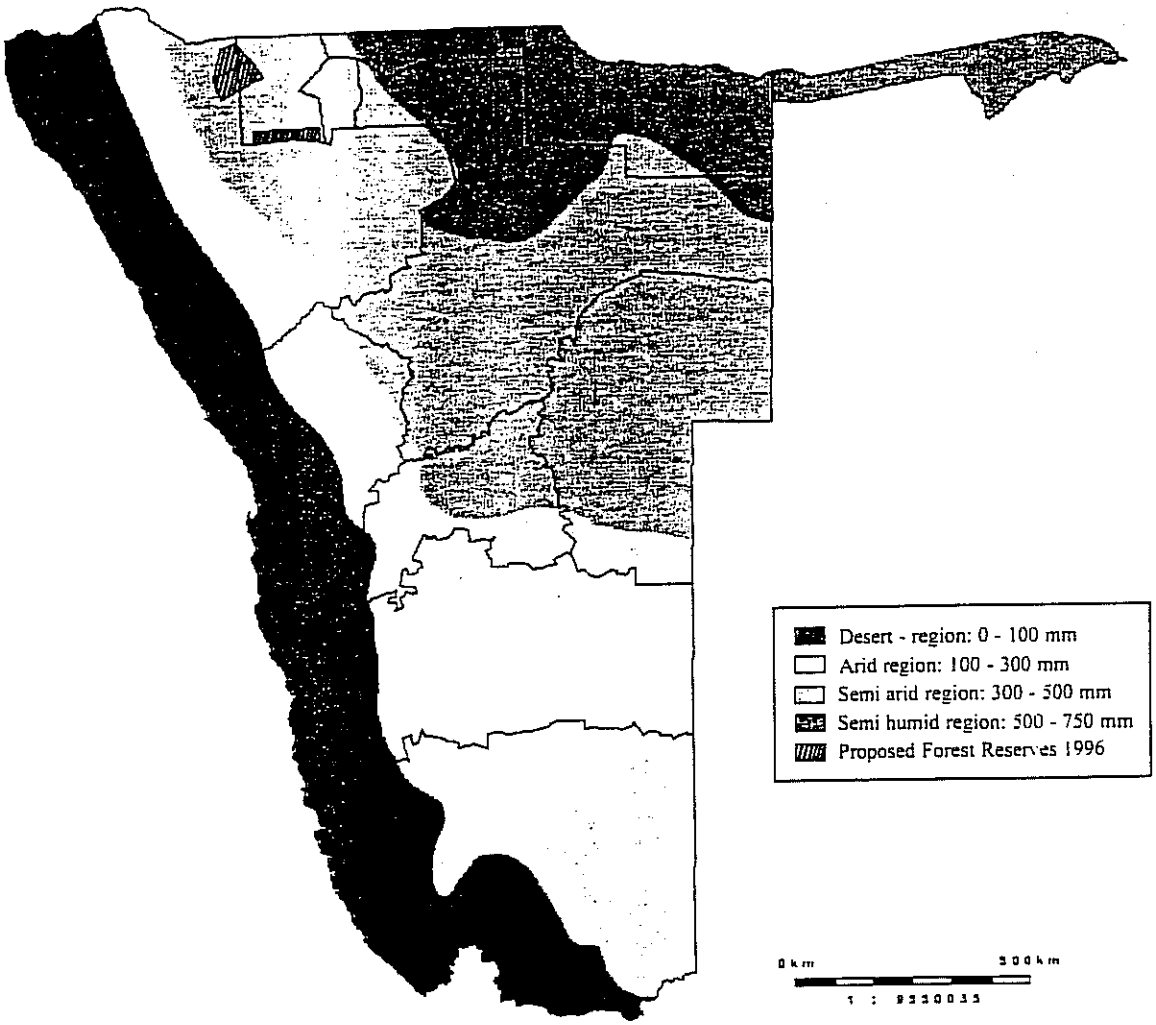


Map of Africa

Appendix 2

The extent of ecological zones as determined by rainfall availability



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FUELWOOD AND TIMBER 1997 (from inventory report)
Tsumkwe, Otjinene and Okakarara

Fuelwood	% of each tree	total vol(1000m3)	hectares	*m3/ha*
Acacia mellifera	18.04%	8182	1586679	
Acacia karroo	2.88%	1308	253685	
Acacia erioloba	2.62%	1188	230379	
Acacia fleckii	2.40%	1087	210814	
Acacia senegal	1.10%	499	96798	
Acacia tortilis	0.14%	62	12070	
Acacia hebeclada	0.65%	297	57549	
Acacia reficiens	0.59%	267	51737	
Albizia anthelmintica	2.90%	1318	255525	
Boscia albitrunca	0.40%	182	35320	
Combretum collinum	1.49%	677	131303	
Combretum zeyheri	0.73%	330	64042	
Combretum psidioides	6.96%	3155	611840	
Ochna pulcra	1.18%	534	103467	
Strychnos pungens	0.07%	33	6345	
Terminalia prunioides	13.96%	6334	1228372	
Terminalia sericea	10.76%	4881	946541	
Different minor species	0.23%	103	20048	
Total fuelwood	67.10%	30437	5902512	3.46
Timber/Hardwood				
Pterocarpus angolensis	5.92%	2687	521107	
Guibortia coleosperma	2.89%	1313	254584	
Baikea plurijunga	0.60%	274	53205	
Burkea africana	16.85%	7641	1481839	
Total timber/hardwood	26.27%	11916	2310736	1.35
Food				
Schinziophyton rautanenii	0.70%	319.55	61968.665	
Lonchocarpus nelsii	5.92%	2686.58	520994.45	
Total food	6.63%	3006.13	582963.11	0.34
Total	100.00%	45358.88	8796211	5.16

CLASSIFICATION OF THE AREA, Tsumkwe, Okakarara and Otjinene

According to the Vegetation Maps (Directorate of Forestry)

Classification	***Hectare***
Forest (trees higher than 5m)	1065426
Savanna (trees less than 5m)	7730785
Grassland, cultivated land	23767
Non-classified land	418
Total area	8820396
Total area with trees	8796211

Calculations

% of each tree derived from total volume of each species.
Hectares of each species derived from % of each species multiplied with total area with trees.

FUELWOOD AND TIMBER 1997 (from inventory report)
Caprivi

Fuelwood	% of each tree	total vol.(1000m3)	hectares	m3/ha
Acacia erioloba	4.90%	1726	80768	
Acacia fleckii	0.61%	216	10108	
Acacia reficiens	0.35%	123	5757	
Acacia karroo	0.20%	71	3328	
Acacia hebeclada	0.19%	66	3100	
Acacia mellifera	0.07%	25	1173	
Acacia tortilis	0.03%	12	561	
Boscia albitrunca	0.43%	153	7155	
Combretum collinum	7.19%	2532	118496	
Combretum zeyheri	2.15%	757	35426	
Combretum imberbe	1.86%	653	30573	
Combretum hereroense	0.15%	52	2442	
Combretum apiculatum	0.07%	26	1226	
Colophospermum mopane	10.42%	3669	171698	
Commiphora angolensis	0.23%	81	3811	
Commiphora africana	0.14%	50	2355	
Dialium engleranum	2.06%	725	33910	
Erythrophleum africanum	0.88%	312	14580	
Lonchocarpus capassa	0.69%	244	11411	
Ochna pulcra	0.82%	288	13461	
Peltophorum africanum	0.60%	213	9968	
Terminalia sericea	9.50%	3344	156507	
Terminalia prunioides	0.18%	64	2979	
Different minor species	3.85%	1356	63440	
Total fuelwood	47.59%	16757	784232	10.17
Timber/Hardwood				
Burkea africana	12.67%	4461	208787	
Baikaea plurijuga	28.16%	9915	464041	
Pterocarpus angolensis	2.75%	968	45313	
Guibortia coleosperma	6.52%	2295	107391	
Total timber/hardwood	50.09%	17639	825532	10.70
Food				
Lonchocapus nelsii	1.64%	578	27042	
Schinziophyton rautanenii	0.68%	238	11153	
Total food	2.32%	816	38195	0.50
Total	100.00%	35212	1647959	21.37

CLASSIFICATION OF THE AREA, Caprivi
According to the Vegetation Maps (Directorate of Forestry)

Classification	Hectares
Forest (trees higher than 5m)	1632743
Savanna (trees less than 5m)	15216
Grassland, pans	100300
Other land (intensive cultivation, marshland, water, town area)	261268
Total area	2009527
Total area with trees	1647959

PERMITS FOR TIMBER IN TSUMKWE, OKAKARARA, OTJINENE

Species	Density (ton/m3)	1997 Q - tonne	1997 Q - m3	1998 Q - tonne	1998 Q - m3
Pterocarpus angolensis	0.6	57	243.63	10	242.92
Guibortia coleosperma	0.6		120.00		
Terminalia prunioides	0.754		140.00		
Baikiaea plurijuga	0.9		1.00		
Total			504.63		242.92

Illegal logging, 1997

Timber 19429 m3

Area cleared for agriculture purpose:

year	hectares
1997	1015
1998	214

Density timber species: G.P. Piearce, The Zambezi teak forest, The forest department Ndola, Zambia, 1986, p.377

PERMITS FOR FUELWOOD/POLES IN TSUMKWE, OKAKAKARA, OTJINENE

(Directorate of Forestry, Windhoek, Namibia, Henry Maheinga (Grootfontein regional office), B.S. Lilungwe (Gobabis regional office), W. Piepmeyer (Otjiwarongo regional office).

Information on permits were recieved in total tonnes for all fuelwood species. Percentage of each species is used to divide total tonnes into ton/species and, further, the density is used to calculate m3/species.

Species	% of each sp.	1997 ton/sp	1997 m3	1998 ton/sp	1998 m3
Terminalia prunioides	26.08%	3569	4774	1833	2431
Teminalia sericea	20.10%	2750	3648	1412	1873
Acacia mellifera	33.69%	4610	6114	2367	3140
Acacia karoo	5.39%	737	978	379	502
Combretum collinum	2.79%	382	433	196	222
Acacia reficiens	1.10%	150	199	77	102
Acacia erioloba	4.89%	669	888	344	456
Acacia tortilis	0.26%	35	47	18	24
Acacia fleckii	4.48%	613	812	315	417
Acacia hebeclada	1.23%	168	223	86	115
Total	100.00%	13684	18116	7027	9282

Species	Density (ton/m3)
Terminalia spp.	0.754
Combretum collinum	0.881
Acacia spp.	0.754

(Western Tsumkwe and Caprivi inventory report,1997, assume d<30cm)

PERMITS IN THE CAPRIVI REGION FOR 1997/1998

			1997		1998	
Product	**Species**	**Density (ton/m3)**	**Q-tons**	**Q-m3**	**Q-tons**	**Q-m3**
Firewood	Colophospermum mopane	0.775	4237	5467.10	2252	2905.81
	Terminalia sericea	0.754			3	3.98
Kiaat planks	Pterocarpus angolensis	0.6		1526387		
Crafts	Combretum imberbe	0.881	2	2.27	1	

Illegal logging, 1997:
Pterocarpus angolensis 2500 m3

Area cleared for agriculture purpose
(Carole Roberts, Environmental Profiles Project, DEA, 1999)

year	hectares
1997	61160
1998	61160

SUBSISTENCE FUELWOOD CONSUMPTION (m3)1997/1998, RURAL AREAS

	1997		*1998*	
Region	**Population**	***Fuelw. cons.***	***Population***	***Fuelw. cons.***
Caprivi	84671	110073	86048	111863
Okakarara	21417	21417	21765	21765
Otjinene	27991	27991	28446	28446
Ongandjera	1274	1656	1294	1682
Tsumkwe South	3777	3777	3838	3838
Tsumkwe North	557	557	567	567
Tsumkwe West	2598	2598	2640	2640
Tsumkwe town	459	459	467	467
Tsumkwe total	7391	7391	7511	7511
Okak, Otjin, Tsu	56799	56799	57723	57723

FUELWOOD CONSUMPTION, M3 PER CAPITA/YEAR

(study on wood consumption in Namibia, Tatu Ollikainen, 1991, Directorate of Forestry, Windhoek)

Area	***m3/cap/yr***
Owambo	1.3
Kavango	1.3
Caprivi	1.3
Tsumkwe	1.0
Okakarara	1.0
Otjinene	1.0

GRAZING 1997-1998

CAPRIVI 1996 (Environmental Profiles Project, DEA, Carole Roberts)

Area, hectares, of woodland under high grazing pressure= 236150

Livestock in Caprivi, 1996:
(Namibia stock census, Directorate Veterinary Service, Windhoek)

Cattle	126491
Sheep	21
Goats	11135
Total	137647

Grazing pressure per livestock in Caprivi, 1996: 1.716

Caprivi

1997

Goats	19501
Grazing pressure	1.716
Heavy grazing, ha	33456

1998

Goats	7534
Grazing pressure	1.716
Heavy grazing, ha	12925

	Tsumkwe	*Okakarara*	*Otjinene*	*Total*
1997				
Goats	0	58365	52490	110855
Grazing pressure	1.716	1.716	1.716	1.716
Heavy grazing, ha	0	100132	90053	190185
1998				
Goats	0	57181	49402	106583
Grazing pressure	1.716	1.716	1.716	1.716
Heavy grazing, ha	0	98101	84755	182856

CALCULATIONS ON MEAN ANNUAL INCREMENT - TIMBER SPECIES

Information used in the calculation is derived from Piearce, G. D., (1986), *The Zambezi Teak Forests* and Directorate of Forestry, (1998), *Forest Inventory Report of Caprivi Region*. Furthermore, Thomas Selläniemi has helped me with the method used when calculating the mean annual increment. (The calculations are made with the assumption that the tree has the shape of a cone)

Baikea plurijuga

Average diameter/tree=	0.246	m
radius=	0.123	m
p*r^2= (3,14*0,12285^2) =	0.047	m2/tree
(average area/tree)*(number of trees per area)=	area of trees/ha=	
number of trees/ha=	7.37	trees/ha
(0,047413*7,37)=	0.349	m2/ha
(volume/ha)/(area of trees/ha) = average height (m) =		
volume/ha	6.02	m3/ha
(6,02/0,3494)	17.22	m

Pterocarpus angolensis

Average diameter/tree=	0.165	m
radius=	0.082	m
p*r^2 = (3,14*0,0823^2) =	0.021	m2/tree
(average area/tree)*(number of trees per area) = area of trees/ha =		
number of trees/ha=	2.24	trees/ha
(0,02127*2,24)=	0.048	m2/ha
(volume/ha)/(area of trees/ha)= average height (m)=		
volume/ha=	0.59	m3/ha
(0,59/0,0476)=	12.40	m

Weighted average height of Pterocarpus angolensis and Baikea plurijuga

(# of P. Angolensis*average height)+(# of B. Plurijuga*average height)/
(# of P. Angolensis + # of B. Plurijuga)
((2,24*12,40)+(7,37*17,22))/(2,24+7,37)= 16.095 m

Information derived from *The Zambezi Teak Forests:*
Average growth per year: 0.17 m2/ha

Weighted number of trees per hectare:

Total number of trees per 10 acres (*The Zambezi Teak Forests*) = 878
10 acres = 4.0568 ha
Number of trees growing per 10 acres in the Caprivi region:
P. Angolensis = (# of trees/ha)*(ha/10 acres) = 2.24*4.0568 = 9.09
B. Plurijuga = (# of trees/ha)*(ha/10 acres) = 7.37*4.0568 = 29.89
Guibourtia coleosperma = (# of trees/ha)*(ha/10 acres) = 1.09*4.0568 = 4.42
(G. Coleosperma is included since it is also a timber species which is similar to P. Angolensis and B. Plurijuga)

(29,899+9,09+4,422)/878 = 0.049 trees/ha

Mean Annual Increment - timber species:

Weighted average height of the timber species=	16.095	m/tree
Average growth per year =	0.17	m2/ha
Weighted number of timber species per hectare =	0.049	trees/ha

MAI =
16,095*0,17*0.049 = 0.13 m3/ha

Tsumkwe, Okakarara and Otjinene 1997, physical accounts, m3

Activity / Forest type	*Firewood*	*Timber/hardwood*	*Total*
Opening stocks	30437120	11915630	42352750
Changes due to economic activity	-74915	-19934	-94849
Depletion (-)	-74915	-19934	-94849
Logging/harvest market prod.	-18116	-505	-18620
Logging/harvest non-market prod.	-56799	0	-56799
Illegal logging	0	-19429	-19429
Logging damage	0	0	0
Afforestation (+)	0	0	0
Other volume changes (+/-)	-105766	-128835	-234602
Reductions (-)	-105766	-128835	-234602
Forest fires	-52777	-36705	-89482
Mammals damage	-38725	-67330	-106056
Stand mortality, insects, diseases	0	0	0
Animal grazing	-14264	-24800	-39064
Other accumulations (+/-)	550437	1016815	1567253
Additions (+)	553949	1018191	1572140
Natural growth (mean annual incre.)	553949	1018191	1572140
Transfer of land to other activities	-3512	-1375	-4887
Net volume change	369756	868046	1237802
Closing stocks	30806876	12783676	43590552

Calculations fuelwood

Fire damage

According to the western Tsumkwe inventory report fire damage was found on 90% of the clusters. Fuelwood species are mostly small trees and bushes, hence they are sensitive to fire in the same way as Pterocarpus angolensis. Fire damage on Pterocarpus angolensis is used as a benchmark for fire damage on fuelwood species.

% of Pterocarpus angolensis trees with severe or fatal damage from fire: 8%

Total area with trees: 8796211.0

Total area with severe/fatal damage from fire: 8%*8796211 ha= 703697

Fire damage= (MAI*percentage of area affected by the forest fire): 0,075*703697= 52777

Damage by mammals

According to the east and south Tsumkwe, Otjinene and Okakarara inventory report moderate damage from mammals were found on 5,87% of the area.

Total area damaged by mammals: 5,87%*8796211ha= 516338

Damage by mammals= (MAI*percent.of area damaged by mammals): 0,075*516338ha= 38725

Grazing

Area subjected to heavy grazing:

Area	Hectares
Tsumkwe	0
Okakarara	100132
Otjinene	90053
Total for the region	190185

Volume lost due to grazing, (area subjected to heavy grazing*MAI)= 14264

Natural growth

Cause for volume reduction	Hectares
Fire damage	703697
Damage by mammals	516338
Grazing	190185
Total volume lost	1410220

Area with regeneration potential 7385991 which is in percent: 83.97%

As a result of fires, damage by mammals and heavy grazing only 83,97% of the total forest area has regeneration potential

Total annual increment (MAI*area with regeneration potential)= 553949

Transfer of land

Total area transferred in hectares: 1015

Volume reduction due to transfer of land for non forest purpose (area transferred*growing stock per ha)

m3 fuelwood species/hectare	3.46
m3 lost due to transfer of land	3512

Calculations timber/hardwood

Fire damage

Species	severe/fat.damage
Burkea africana	1.6%
Baikaea plurijuga	1.6%
Guibortia coleosperma	1.6%
Pterocarpus angolensis	8.0%
Total	

Percentage of area damaged =		3.20
Total area in hectares:		8,796,211
Total area in hectares affected by severe/fatal fire damage:		281,479
Fire damage (MAI*area affected by fire)	281479*0,1304	36,705

Damage by mammals

According to east and south Tsumkwe, Otjinene and Okakarara inventory report moderate damage from mammals were found on 5,87% of the area.

Total area damaged by mammals: 5,87%*8796211ha= 516338

Damage by mammals= (MAI*percent.of area damaged by mammals): 0,1304*516338ha 67330

Grazing

Area subjected to heavy grazing:

Area	Hectares
Tsumkwe	0
Okakarara	100132
Otjinene	90053
Total for the region	190185

Volume lost due to grazing, (area subjected to heavy grazing*MAI)= 24800

Natural growth

Cause for volume reduction	Hectares
Fire damage	281479
Damage by mammals	516338
Grazing	190185
Total volume lost	988001

Area with regeneration potential	7808210	which is in percent:	88.77%

As a result of fires, damage by mammals and heavy grazing only 88,77% of the total forest area has regeneration potential.

Total annual increment (MAI*area with regeneration potential)= 1018191

Transfer of land

Total area transferred in hectares:	1015

Volume reduction due to transfer of land for non forest purpose (area transferred*growing stock per ha)

m3 hardwood species/hectare	1.355
Area in ha lost due to transfer of land	1375

Tsumkwe, Okakarara and Otjinene 1998, physical accounts, m3

Activity / Forest type	*Firewood*	*Timber/hardwood*	*Total*
Opening stocks	30806876	12783676	43590552
Changes due to economic activity	-67005	-243	-67248
Depletion (-)	-67005	-243	-67248
Logging/harvest market prod.	-9282	-243	-9525
Logging/harvest non-market prod.	-57723	0	-57723
Illegal logging	0	0	0
Logging damage	0	0	0
Afforestation (+)	0	0	0
Other volume changes (+/-)	-105206	-127868	-233074
Reductions (-)	-105206	-127868	-233074
Forest fires	-52771	-36701	-89472
Mammals damage	-38721	-67323	-106044
Stand mortality, insects, diseases	0	0	0
Animal grazing	-13714	-23844	-37559
Other accumulations (+/-)	553693	1018736	1572429
Additions (+)	554433	1019026	1573459
Natural growth (mean annual incre.)	554433	1019026	1573459
Transfer of land to other activities	-740	-290	-1030
Net volume change	381482	890625	1272107
Closing stocks	31188358	13674302	44862659

Calculations fuelwood

Fire damage

According to the western Tsumkwe inventory report fire damage was found on 90% of the clusters.
% of Pterocarpus angolensis trees with severe or fatal damage from fire: 8%
Total area with trees: 8796211-1015 = 8795196
Total area with severe/fatal damage from fire: 8%*8795196ha= 703616
Fire damage= (MAI*percentage of area affected by the forest fire): 0,075*703616= 52771

Damage by mammals

According to the east and south Tsumkwe, Otjinene and Okakarara inventory report moderate damage from mammals were found on 5,87% of the area.
Total area damaged by mammals: 5,87%*8795196ha= 516278
Damage by mammals= (MAI*percent.of area damaged by mammals): 0,075*516278ha= 38721

Grazing

Area subjected to heavy grazing:

Area	Hectares
Tsumkwe	0
Okakarara	98101
Otjinene	84755
Total for the region	182856

Volume lost due to grazing, (area subjected to heavy grazing*MAI)= 13714

Natural growth

Cause for volume reduction	Hectares
Fire damage	703616
Damage by mammals	516278

Grazing	182856		
Total volume lost	1402750		
Area with regeneration potential	7392446	which is in percent:	84.05%

As a result of fires, damage by mammals and heavy grazing only 84,05% of the total forest area has regeneration potential.

Total annual increment (MAI*area with regeneration potential)= 554433

Transfer of land

Total area transferred in hectares: 214

Volume reduction due to transfer of land for non forest purpose (area transferred*growing stock per ha)

m3 fuelwood species/hectare	3.46	(assume the same for 1997 and 1998)
m3 lost due to transfer of land	740	

Calculations timber/hardwood

Fire damage

Species	% severe/fat.damage
Burkea africana	1.6%
Baikaea plurijuga	1.6%
Guibortia coleosperma	1.6%
Pterocarpus angolensis	8.0%
Total	

Percentage of area damaged =		3.20
Total area in hectares:		8795196
Total area in hectares affected by severe/fatal fire damage:		281446
Fire damage (MAI*area affected by fire)	281446*0,1304	36701

Damage by mammals

According to east and south Tsumkwe, Otjinene and Okakarara inventory report moderate damage from mammals were found on 5,87% of the area.

Total area damaged by mammals: 5,87%*8795196ha= 516278

Damage by mammals= (MAI*percent.of area damaged by mammals): 0,1304*516278ha= 67323

Grazing

Area subjected to heavy grazing:

Area	Hectares
Tsumkwe	0
Okakarara	98101
Otjinene	84755
Total for the region	182856

Volume lost due to grazing, (area subjected to heavy grazing*MAI)= 23844

Natural growth

Cause for volume reduction	Hectares
Fire damage	281446
Damage by mammals	516278
Grazing	182856
Total volume lost	980580

Area with regeneration potential	7814616	which is in percent:	88.85%

As a result of fires, damage by mammals and heavy grazing only 88,85% of the total forest area has regeneration potential.

Total annual increment (MAI*area with regeneration potential)= 1019026

Transfer of land

Total area transferred in hectares: 214

Volume reduction due to transfer of land for non forest purpose (area transferred*growing stock per ha)

m3 hardwood species/hectare	1.355
Area in ha lost due to transfer of land	290

Caprivi 1997, physical accounts in m3

Activity / Forest type	*Firewood*	*Timber/hardwood*	*Total*
Opening stocks	16756620	17639070	34395690
Changes due to economic activity	-115540	-1528887	-1644427
Depletion (-)	-115540	-1528887	-1644427
Logging/harvest market prod.	-5467	-1526387	-1531854
Logging/harvest non-market prod.	-110073	0	-110073
Illegal logging	0	-2500	-2500
Logging damage	0	0	0
Afforestation (+)	0	0	0
Other volume changes (+/-)	-37796	-65715	-103511
Reductions (-)	-37796	-65715	-103511
Forest fires	-30751	-53466	-84217
Mammals damage	-4536	-7887	-12423
Stand mortality, insects, diseases	0	0	0
Animal grazing	-2509	-4363	-6872
Other accumulations (+/-)	-536081	-505452	-1041533
Additions (+)	85801	149179	234980
Natural growth (mean annual incre.)	85801	149179	234980
Transfer of land to other activities	-621881	-654631	-1276513
Net volume change	-689416	-2100054	-2789471
Closing stocks	16067204	15539016	31606219

Calculations fuelwood

Fire damage

According to the Caprivi inventory report fire damage was found on 88,1% of the area.
Most of the damages were mild, 45,3%, causing only noticeable but not serious damages to the trees.
% of the area with serious or fatal damage caused by fire: 24,88%
Total area with trees: 1647959
Total area with serious or fatal damage from fire: 24,88%*1647959ha= 410012
Fire damage= (MAI*percentage of area affected by the forest fire): 0,075*410012= 30751

Damage by mammals

According to the Caprivi inventory report moderate damage caused by wild mammals was found on 3,67% of the area.
Total area damaged by mammals: 3,67%*1647959ha= 60480
Damage by mammals= (MAI*percent.of area damaged by mammals): 0,075*60480ha= 4536

Grazing

Area subjected to heavy grazing:

Area	Hectares
Caprivi	33456

Volume lost due to grazing, (area subjected to heavy grazing*MAI)= 2509

Natural growth

Cause for volume reduction	Hectares
Fire damage	410012

Damage by mammals	60480		
Grazing	33456		
Total volume lost	503949		
Area with regeneration potential	1144010	which is in percent:	69.42%

As a result of fires, damage by mammals and heavy grazing only 69,42% of the total forest area has regeneration potential.

Total annual increment (MAI*area with regeneration potential) 85801

Transfer of land

Total area transferred in hectares: 61160

Volume reduction due to transfer of land for non forest purpose (area transferred*growing stock per h

m3 fuelwood species/hectare	10.17
m3 lost due to transfer of land	621881

Calculations timber/hardwood

Fire damage

% of the area with serious or fatal damage caused by fire: 24,88%

Total area with trees:	1647959
Total area with serious or fatal damage from fire: 24,88%*1647959 ha=	410012
Fire damage= (MAI*percentage of area affected by the forest fire): 0,1304*410012=	53466

Damage by mammals

According to the Caprivi inventory report moderate damage caused by wild mammals were found on 3,67% of the area.

Total area damaged by mammals: 3,67%*1647959ha=	60480
Damage by mammals= (MAI*percent.of area damaged by mammals): 0,1304*60480ha	7887

Grazing

Area subjected to heavy grazing:

Area	Hectares
Caprivi	33456

Volume lost due to grazing, (area subjected to heavy grazing*MAI)= 4363

Natural growth

Cause for volume reduction	Hectares
Fire damage	410012
Damage by mammals	60480
Grazing	33456
Total volume lost	503949

Area with regeneration potential	1144010	which is in percent:	69.42%

As a result of fires, damage by mammals and heavy grazing only 69,42% of the total forest area has regeneration potential.

Total annual increment (MAI*area with regeneration potential) 149179

Transfer of land

Total area transferred in hectares: 61160

Volume reduction due to transfer of land for non forest purpose (area transferred*growing stock per h

m3 hardwood species/hectare	10.7036
Area in ha lost due to transfer of land	654631

Caprivi 1998, physical accounts in m3

Activity / Forest type	Firewood	Timber/hardwood	Total
Opening stocks	16067204	15539016	31606219
Changes due to economic activity	-114773	0	-114773
Depletion (-)	-114773	0	-114773
Logging/harvest market prod.	-2910	0	-2910
Logging/harvest non-market prod.	-111863	0	-111863
Illegal logging	0	0	0
Logging damage	0	0	0
Afforestation (+)	0	0	0
Other volume changes (+/-)	-34947	-60761	-95707
Reductions (-)	-34947	-60761	-95707
Forest fires	-29610	-51481	-81091
Mammals damage	-4368	-7594	-11962
Stand mortality, insects, diseases	0	0	0
Animal grazing	-969	-1685	-2655
Other accumulations (+/-)	-537818	-508473	-1046292
Additions (+)	84063	146158	230221
Natural growth (mean annual incre.)	84063	146158	230221
Transfer of land to other activities	-621881	-654631	-1276513
Net volume change	-687538	-569234	-1256772
Closing stocks	15379666	14969782	30349448

Calculations fuelwood

Fire damage

According to the Caprivi inventory report fire damage was found on 88,1% of the area.
Most of the damages were mild, 45,3%, causing only noticeable but not serious damages to the trees.
% of the area with serious or fatal damage caused by fire: 24,88%
Total area with trees in ha: 1647959-61160 1586799
Total area with serious or fatal damage from fire: 24,88%*1586799 ha= 394796
Fire damage= (MAI*percentage of area affected by the forest fire): 0,075*394796= 29610

Damage by mammals

According to the Caprivi inventory report moderate damage caused by wild mammals was found on 3,67% of the area.
Total area damaged by mammals: 3,67%*1586799ha= 58236
Damage by mammals= (MAI*percent.of area damaged by mammals): 0,075*58236ha= 4368

Grazing

Area subjected to heavy grazing:

Area	Hectares
Caprivi	12925

Volume lost due to grazing, (area subjected to heavy grazing*MAI)= 969

Natural growth

Cause for volume reduction	Hectares
Fire damage	394796
Damage by mammals	58236

Grazing	12925
Total volume lost	465957

Area with regeneration potential 1120842 which is in percent: 70.64%

As a result of fires, damage by mammals and heavy grazing only 70,64% of the total forest area has regeneration potential.

Total annual increment (MAI*area with regeneration potential)= 84063

Transfer of land

Total area transferred in hectares: 61160

Volume reduction due to transfer of land for non forest purpose (area transferred*growing stock per ha)

m3 fuelwood species/hectare	10.17
m3 lost due to transfer of land	621881

Calculations timber/hardwood

Fire damage

% of the area with serious or fatal damage caused by fire: 24,88%
Total area with trees in ha: 1586799.0
Total area with serious or fatal damage from fire: 24,88%*1586799 ha= 394796
Fire damage= (MAI*percentage of area affected by the forest fire): 0,1304*394796= 51481

Damage by mammals

According to the Caprivi inventory report moderate damage caused by wild mammals were found on 3,67% of the area.
Total area damaged by mammals: 3,67%*1586799ha= 58236
Damage by mammals= (MAI*percent.of area damaged by mammals): 0,1304*58236= 7594

Grazing

Area subjected to heavy grazing:

Area	Hectares
Caprivi	12925

Volume lost due to grazing, (area subjected to heavy grazing*MAI)= 1685

Natural growth

Cause for volume reduction	Hectares
Fire damage	394796
Damage by mammals	58236
Grazing	12925
Total volume lost	465957

Area with regeneration potential 1120842 which is in percent: 70.64%

As a result of fires, damage by mammals and heavy grazing only 70,64% of the total forest area has regeneration potential.

Total annual increment (MAI*area with regeneration potential)= 146158

Transfer of land

Total area transferred in hectares: 61160
Volume reduction due to transfer of land for non forest purpose (area transferred*growing stock per ha)

m3 hardwood species/hectare	10.7036
Area in ha lost due to transfer of land	654631

Tsumkwe, Okakarara and Otjinene 1997, monetary accounts, 1000 N$

Activity / Forest type	*Firewood*	*Hardwood*	*Total*
Opening stocks	4726924	17130510	21864086
Changes due to economic activity	-11634	-28658	-40292
Depletion (-)	-11634	-28658	-40292
Logging/harvest market prod.	-2813	-725	-3539
Logging/harvest non-market prod.	-8821	0	-8821
Illegal logging	0	-27932	-27932
Logging damage	0	0	0
Afforestation (+)	0	0	0
Other volume changes (+/-)	-16426	-149567	-165992
Reductions (-)	-16426	-149567	-165992
Forest fires	-8196	-52769	-60965
Mammals damage	-6014	-96798	-102812
Stand mortality, insects, diseases	0	0	0
Animal grazing	-2215	0	-2215
Other accumulations (+/-)	85484	1461837	1547321
Additions (+)	86029	1463814	1549843
Natural growth (mean annual incre.)	86029	1463814	1549843
Transfer of land to other activities	-545	-1977	-2523
Net volume change	57424	1283613	1341037
Revaluation term	0	0	0
Closing stocks	4784348	18378457	23169200

Calculations

Value of grazing (included in the total account)

Goats in the area	110855
Value per goat, N$	120
Total value of goats in the area, jan-1997	13302600
50% nutrition derived from browsing gives value derived from the forest (0,50*13302600)	6651300
Value of grazing in the beginning of 1997	6651300
Value of grazing in the end of 1997	6394980

Firewood

Net price per m3,1997	155.30

Timber

Net price per m3 1997, (infl. 8,8%)	1437.65

Tsumkwe, Okakarara and Otjinene 1998, monetary accounts, 1000 N$

Activity / Forest type	*Firewood*	*Hardwood*	*Total*
Opening stocks	4784348	18378457	23169200
Changes due to economic activity	-10406	-349	-10755
Depletion (-)	-10406	-349	-10755
Logging/harvest market prod.	-1442	-349	-1791
Logging/harvest non-market prod.	-8964	0	-8964
Illegal logging	0	0	0
Logging damage	0	0	0
Afforestation (+)	0	0	0
Other volume changes (+/-)	-16339	-149550	-165889
Reductions (-)	-16339	-149550	-165889
Forest fires	-8196	-52763	-60959
Mammals damage	-6013	-96787	-102800
Stand mortality, insects, diseases	0	0	0
Animal grazing	-2130	0	-2130
Other accumulations (+/-)	85989	1465003	1550992
Additions (+)	86104	1465003	1551107
Natural growth (mean annual incre.)	86104	1465003	1551107
Transfer of land to other activities	-115	0	-115
Net volume change	59245	1315104	1374348
Revaluation term	0	0	0
Closing stocks	4843593	19658865	24508853

Calculations

Value of grazing (included in the total account)

Goats in the area	106583
Value per goat, N$	120
Total value of goats in the area, jan-1998	12789960
50% nutrition derived from browsing gives value derived from the forest (0,50*12789960)	6394980
Value of grazing in the beginning of 1998	6394980
Value of grazing in the end of 1998	6394980

(assume constant stock of goats in the area during 1998, since information on the amounts of goats in 1999 is not available yet.)

Firewood

Net price per m3,1997 155.30

Timber

Net price per m3 1997, (infl. 8,8%) 1437.65

Caprivi, 1997, monetary accounts, 1000 N$

Activity / Forest type	Firewood	Hardwood	Total
Opening stocks	2602325	25358816	27962311
Changes due to economic activity	-17943	-2198005	-2215948
Depletion (-)	-17943	-2198005	-2215948
Logging/harvest market prod.	-849	-2194411	-2195260
Logging/harvest non-market prod.	-17094	0	-17094
Illegal logging	0	-3594	-3594
Logging damage	0	0	0
Afforestation (+)	0	0	0
Other volume changes (+/-)	-5870	-88203	-94073
Reductions (-)	-5870	-88203	-94073
Forest fires	-4776	-76865	-81640
Mammals damage	-704	-11338	-12043
Stand mortality, insects, diseases	0	0	0
Animal grazing	-390	0	-390
Other accumulations (+/-)	-83254	-726664	-809918
Additions (+)	13325	214467	227792
Natural growth (mean annual incre.)	13325	214467	227792
Transfer of land to other activities	-96579	-941131	-1037710
Net volume change	-107067	-3012872	-3119939
Revaluation term	0	0	0
Closing stocks	2495258	22339672	24835382

Calculations

Value of grazing (included in the total account)

Goats in the area	19501
Value per goat, N$	120
Total value of goats in the area, jan-1997	2340120
50% nutrition derived from browsing gives value derived from the forest (0,50*2340120)	1170060
Value of grazing in the beginning of 1997	1170060
Value of grazing in the end of 1997	452040

Firewood

Net price per m3,1997	155.30

Timber

Net price per m3 1997, (infl. 8,8%)	1437.65

Caprivi, 1998, monetary accounts, 1000 N$

Activity / Forest type	*Firewood*	*Hardwood*	*Total*
Opening stocks	2495258	22339672	24835382
Changes due to economic activity	-17824	0	-17824
Depletion (-)	-17824	0	-17824
Logging/harvest market prod.	-452	0	-452
Logging/harvest non-market prod.	-17372	0	-17372
Illegal logging	0	0	0
Logging damage	0	0	0
Afforestation (+)	0	0	0
Other volume changes (+/-)	-5427	-84930	-90357
Reductions (-)	-5427	-84930	-90357
Forest fires	-4598	-74012	-78611
Mammals damage	-678	-10917	-11596
Stand mortality, insects, diseases	0	0	0
Animal grazing	-151	0	-151
Other accumulations (+/-)	-83524	-731007	-814531
Additions (+)	13055	210124	223179
Natural growth (mean annual incre.)	13055	210124	223179
Transfer of land to other activities	-96579	-941131	-1037710
Net volume change	-106775	-815937	-922712
Revaluation term	0	0	0
Closing stocks	2388482	21521312	23910246

Calculations

Value of grazing (included in the total account)

Goats in the area	7534
Value per goat, N$	120
Total value of goats in the area, jan-1998	904080
50% nutrition derived from browsing gives value derived from the forest (0,50*904080)	452040
Value of grazing in the beginning of 1998	452040
Value of grazing in the end of 1998	452040

(assume constant stock of goats in the area during 1998, since information on the amounts of goats in 1999 is not available yet.)

Firewood

Net price per m3,1997	155.30

Timber

Net price per m3 1997, (infl. 8,8%)	1437.65