NATURAL RESOURCE ACCOUNTING IN KENYA
A CASE STUDY OF FORESTRY SECTOR
(Timber resources in plantation forest)

BY

OMONDI MATHEWS COLLINS

REG. NO: C/50/7668/03

SUPERVISORS

MR. J. OKELO
MR. P. MACHYO

A Research Paper submitted to the Department of Economics, University of Nairobi, in partial fulfillment for the Degree of Master of Arts in Economics.

SEPTEMBER, 2005

THIS RESEARCH PAPER IS MY ORIGINAL WORK AND HAS NOT BEEN PRESENTED FOR A DEGREE IN ANOTHER UNIVERSITY

------------------------------------ 8/9/05
OMONDI MATHEWS COLLINS Date

THIS PAPER HAS BEEN SUBMITTED FOR EXAMINATION WITH OUR APPROVAL AS UNIVERSITY SUPERVISORS

------------------------------------ 03/09/05
MR. J. OKELO Date

------------------------------------ 8.9.2005
Mr. P. MACHYO Date

ACKNOWLEDGEMENT

I am grateful to the Department of Economics for making it possible for me to undertake this MA course. My special thanks to my supervisors Mr. J. Okelo and Mr. P. Machyo and take this opportunity to thank them for devoting much of their time to guide me through the entire paper. The advice, constructive criticisms and valuable suggestions helped me a lot in writing this paper. Thanks also goes to the Ministry of Planning and National Development through the Director of Statistics, Mr. A.K. Kilele for the financial support and granting me a study leave to undertake this course.

I am also grateful to the African Economic Research Consortium (AERC) for sponsoring us for the CMAP. May I also take this opportunity to thank the then Chairman, Department of Economics Prof. Germano Mwabu for the fatherly advice he offered us during the study. I wish also to express my thanks to all my MA classmates for their material and moral support. Many thanks go to the entire Centre for Environmental Economics and Policy in Africa (CEEPA) team which includes Prof. Hassan, Dr. Mungatana, Prof. J. Vincent, Prof. Maler and Prof. Marie Glen among others for inviting me to a training workshop on Natural Resource Accounting in Mozambique which was an eye opener to this work and also for the opportunity to present my proposal for comments.

Let me also take this opportunity to thank my brother Mr. Paul Opanga for being there for me in terms of advice and linking me to the relevant resource persons in the forestry world. Thanks also goes to the Chief Conservator of forest and the entire staff of Forestry Department for enabling me access the much needed information.

I wish to register my sincere thanks and gratitude to my dear wife Mrs. Sarah M. Omondi for not only her patience, encouragement and moral support but also taking care of our daughter Caitlyn when I was not there fully for her.

DEDICATION

To my parents Mr. John M. Opanga

and the late Mrs. Agnetah Akinyi Opanga,

My dear wife Ms. Sarah Mbithi

My daughters Michelle and Caitlyn.

TABLE OF CONTENTS *Page No.*

LIST OF TABLES AND FIGURES

ACRONYMS

GDP	-Gross Domestic product
SNA	-System of national Accounts
EDP	-Environmentally adjusted Domestic product
EDI	- Environmentally adjusted Disposable Income
GNP	-Gross National Product
NNP	-Net National product
CBS	-Central Bureau of statistics
IUCN	-International Union for Conservation of Nature
KEFRI	-Kenya Forestry Research Institute
KIFCON	-Kenya Indigenous Forest Conservation project
FAO	-Food and Agricultural Organization
UNEP	-United Nations Environmental Programme
ANDP	-Adjusted net Domestic Product
SEEA	- System of Environmental and Economics Accounting
CEEPA	-The Centre for Environmental Economics and Policy in Africa

GLOSSARY

Accumulation accounts in the SNA: One of the economic accounts compiled under the SNA. Accumulation accounts are flow accounts that record the acquisition and disposal of financial and non-financial assets and liabilities, by institutional units or as a result of other events

Biomass: Total living weight (generally in dry weight) of all living organisms in a particular area of habitat. It is sometime expressed as weight per unit area of land or per unit of water.

Bequest benefit: This is derived from the continued existence of elements of the environment that are not currently in use, but one day may provide use benefits to those not yet born, e.g. for maintaining a rain forest to protect future sources of genetic material for drugs and agricultural crops.

Deforestation: The clearing of tree formations and their replacement by non-forest land uses.

Degradation: Deterioration in the quality of the environment or natural resources as a result of surrounding concentration of pollutants and other activities and processes, such as improper land use and natural disasters.

Depletion: Reducing in the quantity of a natural resource. For renewable resources, depletion refers to the part of the harvest (e.g. logging) or catch that is above the sustainable level of the resource stock. For non-renewable resources, depletion refers to the quantity of resources extracted.

Direct use benefits: These are derived from the use of the environmental assets as sources of materials, energy or space for input into human activities. Also included here is the non-consumptive use of the environment, such as recreation. Direct-use benefits include non-economic direct use, such as the benefit received from the aesthetic appreciation of the environment.

Ecosystem: Living organisms, their physical environment, and their interrelationships within a particular part of the environment. Examples of the ecosystem include coastal and forest ecosystems.

Environmental accounting: A combination of the natural resource accounts under SEEA framework, which consists of stock and flow accounts in physical terms and the monetary valuation of these accounts.

Existence benefits: This is derived from an environmental entity without any prospect of being useful to humans now or in future, where it is desirable to maintain the existence of that entity.

Indirect use benefits: These arise from a passive use of a service that the environment renders free of charge. These benefits are always non-economic – there are no market transactions associated.

Option benefits: This relates to the continued existence of elements of the environment that are currently not in use, but may one day provide use benefits.

Satellite accounts: Accounts that are linked to a set of central core accounts and that enable attention to be focused on a certain field or aspect of economic, environmental and social life in the context of national accounts. Satellite accounts under the SNA framework are commonly compiled for the environment, tourism and unpaid housework.

System of Environmental and Economic Accounts (SEEA): The SEEA was developed by the United Nations statistical Division as a satellite system of the SNA for incorporation of the environmental concerns in national accounts. The SEEA is intended to be a system with global application and standards, suitable for all countries and all aspects of the environment.

ABSTRACT

The use of natural resource in Kenya while undoubtedly enhances our economic growth, has not left the state of our natural resource and the environment at large, unaltered because of an increasing pressure on natural resource from the economic and population expansion which has led to environmental degradation and natural resource depletion. This study therefore applies some of the theoretical adjustments suggested in the natural resource accounting literature to the forestry sector in Kenya.

The problem is that the macroeconomic policy making in Kenya is highly insensitive to the reality of natural resource depletion and degradation. While SNA would capture the annual depreciation of harvesting and processing equipment used to manufacture commercial wood products and commercial logging of fuel wood, it does not capture the depreciation of natural capital.

This paper will enhance an appreciation of the need to improve SNA by incorporating natural resource degradation and depletion through coming up with the framework for the natural resource accounting in the commercial forestry sector through the use of satellite account. In this study an attempt will be made to use the net price method for the net accumulation as it is much applicable to the existing data in the country despite the weaknesses it faces.

The results of this study show very clearly how forest can be mismanaged and overexploited leading to resource depletion and degradation as a result of excluding or underestimating the true contribution of such resources to human well being.

CHAPTER ONE

1.0 Background

Kenya economy is heavily dependent on its natural resource base of upto 30 percent of GDP. The natural resource includes agriculture, forestry fisheries, energy, water resources wetlands and marine. Ignoring or underestimating these immense contribution of the environmental and natural resources to the economy of Kenya is tantamount to creating conditions for destroying the foundation upon which these are but based upon. The use of natural resource in Kenya while undoubtedly enhances our economic growth, has not left the state of our natural resource and the environment at large, unaltered. This is because of an increasing pressure on natural resource from the economic and population expansion which has led to environmental degradation and natural resource depletion.

Despite the numerous institutions and policies put in place to safeguard the sustainable management of resources, environment and natural resources in Kenya continues to be degraded, thus jeopardizing the livelihoods of millions who rely on them. This is witnessed from the poverty assessments undertaken in the region that confirm that it is the rural people that are poorest section of the population and plunging them into further poverty will be detrimental to the economic development and social stability of the country.

This has led to the promotion of understanding of the links between economy and the environment. The current system of National Accounts promoted by the United Nations is a historical artifact, heavily influenced by the theories of John Keynes in 1930s which paid little attention to the possibility of natural resource scarcities. The major motivation of this study therefore comes from a growing awareness among economists that standard measures of national income reported in the System of National Accounts (SNA) suffer several shortcomings as a measure of economic welfare. An important problem is that the standard measures do not reflect the short and long term economic impacts of environmental degradation and natural resource depletion. For example, the extraction of oil from the environment increases Gross Domestic product (GDP), as this creates additional economic production. However, no account is taken for the fact that oil is a non-renewable resource, and stock levels are being depleted. Similarly a country could appear to enjoy high economic growth as it depleted its forests or fisheries, followed by economic collapse when these resources were exhausted because the depletion of natural capital was not accounted for.

Lutz and Munasinghe (1991) identified three weaknesses in the current national accounts. The first was that national accounts may not represent welfare accurately because the balance sheets do not fully include environmental and natural resources and therefore important changes in the status of such resources are neglected. The second problem identified was that the true cost of using natural resources in human activity are not recorded in the conventional national accounts. The depletion or degradation of natural capital (such as the stock of water, soil, air, minerals and wilderness areas), which occur in the course of productive activity is not included in terms of current costs or depreciation of natural wealth. Lastly the abatement or cleanup activities (expenditures incurred to restore environment) often serve to inflate national income, but the offsetting environmental damages are not included.

National level decision makers and macroeconomic planners routinely rely on the conventional SNA to formulate economic policies. Thus, a supplementary environmentally adjusted SNA and corresponding performance indicators would encourage such policy makers to reassess the macroeconomic situation in light of environmental concerns and to trace the links between economy wide policies and natural resource management (Muzondo et al 1990).

African development indicators (World Bank, 2004) talks of increasing emphasis on the links between the environment and development, both at the national and international levels, reflected in the growing number of scientific and analytical studies challenging the hegemony of the SNA national income accounting conventions, numerous scholarly endevours are underway to integrate environmental consequences into national income calculations. The argument is made that the SNA methodology overstates national income levels because it does not account for both the direct and indirect cost of drawing down natural resources and it counts expenditure on resources for environment protection as income.

Like many other countries in sub Saharan Africa, Kenya's forest stocks generate a wide range of timber and non timber products and services directly and indirectly benefiting the population. In recent years however, the apparent depletion of some natural resources has shifted the country focus towards sustainable development[1].

One way to therefore overcome these deficiencies then is to develop a SNA that is capable of yielding an Environmentally adjusted net Domestic Product (EDP) and Environmentally adjusted Disposable Income (EDI).

This study therefore applies some of the theoretical adjustments suggested in the natural resource accounting literature to the forestry sector in Kenya. The principle concern of sustainability and of environmental accounting is the impact of our ill informed social choices on intergenerational equity, which requires that opportunities of the future generations measured by their total national wealth including natural capital, should not decline overtime (Hartwick, 1977; Solow 1974, 1986, 1992). Therefore economic accounts provide a way to measure total wealth and to monitor changes in this indicator of sustainability. (Lange et al)

1.1 Statement of the problem

National income accounting is very important both as an analytical and policy formulation tool; that is as a measurement of economic performance expost and as a basis for useful policy proposals. On the other hand, information generated from the current national accounts misleads resource and environmental policies, causing underinvestment and mismanagement, which endanger sustainable development.

---

[1] In this case we define sustainable development as development that meets the needs of the present without compromising the ability of future generation to meet their own needs ((WCED 1987).

The problem is that the macroeconomic policy making in Kenya is highly insensitive to the reality of natural resource depletion and degradation. While SNA would capture the annual depreciation of harvesting and processing equipment used to manufacture commercial wood products and commercial logging of fuel wood, it does not capture the depreciation of natural capital. Generally the national accounts are intended to record economic transactions that have been observed and can be expressed in monetary terms. This approach has the disadvantage of failing to identify either the scale of environmental damage or the extent of the resource depletion caused by these transactions.

The data in Kenya's SNA does not consider depreciation of natural assets and also does include any valuation of many of the natural resource utilized in the economy such as forestry and hence do not offer any indication of the real costs of natural resource based market activity. This captured data also do not contain a comprehensive valuation of the many natural resource-based non-market activities, for example collection of wood for household fuel in communal areas. No allowance is also made for the depletion of resource stocks. While environmental repair causes income to rise, environmental damage is not seen to affect national income at all as it is not captured anywhere in the accounts.

In order to therefore appreciate whether or not the development path is sustainable, we need a measure of stock changes as SNA emphasizes on the flows and in particular ignores the stock of environmental capital.

We can therefore say that lack of natural resource accounting[2] makes us not to fully comprehend and appreciate the specific interaction between the environment and the economy.

Thus the major objective of natural resource and environmental accounting is to develop a system of accounts that can appropriately reflect more, if not all changes in uses, roles, and capacities of natural resources and the environment in terms of their possible effect on sustainable development

1.2 Objectives of the study

The overall purpose of this study is to establish the value of Timber resources in plantations in Kenya.

Specifically the study will:

a) Construct the physical resource accounts to access the stock of the timber resources in the plantation or commercial forests in the country.

b) Use the environmental accounting approach to obtain the values of timber stocks for the plantation forests or commercial forests.

c) Provide information on improved measures of economic performance and indicators of sustainable development to improve the design of long term development planning strategies and policy formulation.

---

[2] Natural Resource accounting generally defined is a methodology for the production, presentation and eventual analysis of environmental resource and economic information whose aim parallels and extends that of national income accounting.

Grassland	2.1
Desert	13.7
Farmland and Urban Development	16.5
Total	**100**

Source: Wass, 1995

Most of the area of forest reserves (1.06 hectares equal to 64 per cent) is covered by the indigenous forests. A significant 25 per cent (0.42 hectares) of the area in forest reserves is covered by non-forest vegetation while 9 per cent (0.16 hectares) is plantation forests (Wass, 1995).

In also another study by Price Waterhouse (1997), plantations are assumed to occupy not less than an effective 120,000 hectares. Plantations are reserved for exotic fast growing softwood species and some selected hardwood species for commercial use by both timber pulp and paper industries.

Traditionally, economic planners, politicians and other policy makers tend to consider the direct use value of environmental resources including the raw materials and some subsistence use value of natural forests, fisheries, wetlands and other form of biodiversity. This leads to a situation in which land and resource management systems will focus only on the commercial level extraction of resources, at the expense of other less tangible values or wider socio economic development goals. The table below shows the total economic value of forests which is divided into Use value and Non-use value.

Table 1.2 Total Economic value of forests

USE VALUE			NON-USE VALUE
Direct values	**Indirect values**	**Option values**	**Existence values**
Output that can be consumed directly, such as timber, medicine, food, recreation etc	Ecological services, such as watershed protection, flood control, storm protection, carbon sequestration, climatic control, etc	The premium placed on maintaining resources and landscapes for future possible direct and indirect uses, some of which may not be known now	The intrinsic value of resources and landscapes, irrespective of their use such as cultural, aesthetic, bequest significance, etc

Whereas it is important to look at all the forest resources in the country, the study will attempt to estimate for the use values and in particular concentrate on the direct values of timber from the plantation forests.

1.5 Contribution of forests to the National Economy

It is estimated that forest products and services contribute about 11.0 billion shillings to the economy, and employ 50,000 people directly and another 30,000 indirectly. The sector contributes about US $ 4 million to Kenya's GDP, approximately 1 percent of the monetary economy and 13 per cent of non-monetary economy. Direct use values in terms of timber, fuelwood and polewood are estimated at about KShs 3.64 billion where timber alone accounts for 75 per cent of the value (Emerton and Karanja 2001).

Other direct use of forest and forest products include tourism, human habitat and the use of genetic materials from plant and animal species for food, pharmaceuticals and industrial purpose. The indirect values of forests include the benefits accrued from them in water catchment's protection, and carbon sequestration. Other values include the option and existence values (Emerton and Karanja 2001). In study by Wass (1995), it is estimated that 40 percent of large mammals, 30 percent of birds and 35 per cent of butterflies found in Kenya occur in forests, and over half of Kenya's threaten mammals and birds are forest dependent,

Forests in Kenya are important particularly through their linkage with agriculture and tourism, which are the mainstay of national economy. The agriculture sector contributes between 24-26 per cent of the GDP and provides the main livelihood for about 80 per cent of the population. It employs 70 per cent of the labour force, provides a large portion of the national food requirements and is a major source of export earnings.

1.6 Forest Management

1.6.1 Gazetted forests Reserves on government land

These areas are land that has been surveyed, demarcated and gazetted either as forest reserves, national parks, national reserves and national monuments. The gazetted area can either be from Trust land or unaliented government land.

1.6.2 Forest reserves

In 1994, gazetted forest reserves accounted for 1,687,390 hectares 80 per cent of theses forest reserves are on government land while 20 per cent are on trustland. Included in this category are the majority of large, closed canopy forest units such as the Aberdares, Mt.

Kenya, Mt. Elgon, Mau and plantations. The management of gazetted forest reserves is vested in the forest department.

1.6.3 Forests in National parks

There are also closed canopy forests gazetted as National parks and national reserves

Table 1.3 Indigenous forests in National parks and Reserves

Category of gazettment	Total number	Total area (ha.)	Area under indigenous forest (ha.)	% of area under indigenous forests
National parks	22	2,904,690	63,000	2.17%
*National reserves	28	1,537,174	14,000	0.91%
** Marine parks and reserves (Mangroves)	8 (4 parks and 4 reserves)	51,000	14,000	27.45%
Total		**4,492,864**	**91,000**	**2.03%**

Source: KWS Summary of national parks and reserves (1999) and Wass (1995)

1.6.4 Forest Gazetted as National monuments

Since the early 1990s certain forests of cultural and biodiversity significance were gazetted as national monuments under the Antiquities and monuments Acts and their management vested in the National Museum of Kenya. Key among these are Kaya sacred forests found in the coast province; City Park, Gede Ruins, the Nyuri Njeke in meru and the Mukurwe Wa Nyagathanga in Muranga. Gazette notices between 1990 and 1999 indicate that an estimated 2,124 ha were gazetted as national monuments

1.6.5 Forest on Trust land

Approximately 20% of Gazetted Forest reserves are gazetted from trust land. In addition, an estimated 100,000 hectares of forest are found in trust land and vested in the respective local Authorities under the Ministry of Local Government. Much of this land has been proposed for gazettment as forest reserves for some time (Wass 1995).

1.6.6 Forest on Private Land

There are also indigenous forest areas under ownership, either as units held individually or within group ranches. Many of this usually small holding are important for catchment and streamline conservation purposes as well as providing subsistence and small-scale commercial produce.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1.0 THEORETICAL FRAMEWORK

The idea of adjusting the system of national accounts to incorporate the losses due to the use of natural resources is closely related to the concept of sustainability as an indicator of sustainable development[3]. The productive capacity of an economy therefore depends on the stock of capital available as well as on its productivity which implies that if some capital is used up and not replaced, the possibilities of future production is decreased as is the case with natural capital which cannot be created by mankind.

The economic theory gives two different approaches that looks at how much of the natural capital productive base can be used sustainably. The first approach was derived in Hartwick (1997) which was later to be known as Hartwicks rule, where he showed that so long as the capital stock of an economy did not decline over time. Then non-declining consumption was possible. This is illustrated by considering a simple economy consisting of two types of capital. Let

K_t denote the physical capital

R_t denote the natural capital

The net investment in this economy is given by the gross investment minus depreciation in each of the form of capital, i.e.

$$I_t^N = {dK_t}/{dt} + {dR_t}/{dt}$$

[3] Although there are many definitions of sustainable development, economic definitions have focused on sustainable development as non-declining per capita welfare over time (Pearce and Atkinson, (1995))

If the net investment is greater than or equal to zero, the country can at least sustain its actual consumption level. Therefore if a country produces a non-renewable resource, non-declining consumption is possible by reinvesting all Hotellings rents from the exhaustible resources in physical capital. In this case however, there are two critical assumptions where the first assumes close substitution between the physical capital and the natural capital. The second is that the model assumes that an individual only derives utility from the consumption of goods and not directly from the environment.

The second approach was developed from the work of Weitzman (1976) on net domestic product (NDP).

We can define NDP for an economy with balanced trade as,

$$NDP_t = C_t + I_t^N .$$

Weitzman (1976) demonstrated that under optimal growth, NDP should be thought of as income in the Hicksian sense, interpreted as a long run measure of economic well-being, that is, the stationary equivalent of future consumption. Weitzman proved that Net National Product (NNP) in any year t is equal to the discount rate multiplied by wealth,

$$NNP(t) = \rho W(t)$$

He argued that a true measure of NDP should include the value of changes in resource stocks. Consequently, the net investment should be defined taking into account the depreciation in all types of capital. These results are also based on two critical assumptions, where the first is that a country growth path is optimal and the second that social welfare equals consumption.

If optimality conditions do not hold and substitution possibilities between physical capital and natural capital are restricted, then the above approaches face critisms on the basis of sustainability views. These approaches are regarded as based on the weak sustainability principle which sustains that natural capital can be permanently substituted by the physical capital. This idea is not widely accepted. For some natural resources serving as production factors, there could be thresholds, carrying or assimilative capacity, causing some types of natural capital to be hardly substitutable. Many assets are essential to human being survival in the long run and this point of view is expressed in the strong sustainability concept, based on the conservation of many types of natural capital or recognition of their safe minimum standards.

2.1.1 Theoretical approaches to account for depletion

Several theoretical approaches have been put forward on how to account for the depletion of natural resources.

a) The Change in Value Method

In this change in value method, depreciation of an asset over a period of time can be calculated as the value of the asset in the beginning of the period minus the value of the same asset in the end of the period. Adopting the definition of income as the level of consumption that could be enjoyed without diminishing the capital stock, then depreciation can be defined as the consumption of the assets in excess of this amount. Depreciation exists when there is degradation of a resource. If we have the value of a resource at the end of a period and the value at the beginning of a period, we can calculate the depreciation of the resource as the difference between the two values, i.e.

$$D_t = V_{t+1} - V_t$$

Defining the value of a resource as the discounted sum of the resource rents that are generated over time as:

$$V(t) = \sum_{s=t}^{T} (1+i)^{t-s} \left[pq(s) - C(q(s)) \right];$$

where p is the price of one unit of the extracted resource (constant overtime), $q(s)$ is the quantity extracted at period t, $C(q(s))$ is the total cost of extraction and T is the period when the resource is exhausted. Note that expression $pq(s) - C(q(s))$ represents the current resource rent.

Using some mathematical manipulation, depreciation of an asset is expressed as:

$D(t) = iV(t+1)/(1+i) - \left[pq(t) - C(q(t) \right]$ for discrete time and

$\dot{V} = rV(t) - \left[pq(t) - C(q(t)) \right]$ for the continuous time

Carrying out of the above calculation in practice has many complications as it would require projection of the future flow of rents, i.e. we need prices, quantities extracted and cost schedules into future finite stream.

b) Total Hotelling Rent as Depreciation

Hotelling rent is defined as the rent that exists on the marginal quantity of an exhaustible resource (price minus marginal cost) and it is considered a measure of the intertemporal scarcity of that resource. The rent exists because the resource is exhaustible and consequently, the owners of the resource extract less than the amount that would equate marginal revenue to marginal cost. Therefore multiplying the hotelling rent by the quantity extracted of the resource, gives the total Hotelling rent.

Hartwick (1988) proved that along dynamically efficient paths of extraction, hotelling rent and Economic depreciation (with negative sign) are equals. It is however important to note that this equivalence is only correct under certain conditions namely: a) resource extracted optimally, b) price of extracted resource constant over time; C) marginal cost as an increasing function of the amount extracted, unrelated to the size of the reserve and constant over time; d) constant discount rate over time.

c) The Net Price Method (NPM

Previous studies used this method to calculate depreciation of natural capital. The net price method uses the hotelling rent as an approximation of the depreciation of natural capital. The depreciation of natural capital from the NPM can be expressed as

$$D(t) = -[p - C'(q(t)]q(t)$$

In theory this method would be easier to apply than the change on value method but in practice the data on marginal cost is not generally available. It therefore replaces the data on marginal cost with data on average cost and calculates depreciation as :

$$D(t) = -[p - C(q(t))/q(t)]q(t)$$

The problem with net price method is that the use of average net price overstates the net accumulation unless *MC=AC*

d) The El Serafy Method (ESM

El Serafy (1989) developed a method to calculate depreciation based on the concept of user cost, where he equated the finite stream of rents earned by a resource to an annuity X earned forever. An example to this case is when one sells a mine and deposits the value of the mine(V) in a bank account. This can be expressed mathematically as:

$$R_t + [1/1+r]R_{t+1} + \ldots + [1/(1+r)^n]R_{t+n} = X + [1/1+r]X + \ldots + [1/(1+r)^\infty]X$$

where r is the discount rate, n+t is the last year of the extraction, X is the annuity received and R is the rent which is defined by:

$$R_t = p_t q_t - C(q_t)$$

the expression R-X is a measure of depreciation. Assuming that the rent is constant over time, El Serafy simplifies the equation to:

$$R - X = R\left[1/(1+r)^{n+1}\right]$$

e) Vincent and Hartwick Approach

Vincent and Hartwick (1997) suggested a transformation which when applied to average cost in order to get a consistent estimate of depreciation. Assuming a functional form for the total extraction cost as

$C(q(t)) = \alpha q(t)^{1+\beta}/(1+\beta)$, they show that $MC = (1+\beta)AC$

From the above, we can express the expression for the Hotelling as

$$D(t) = [p - (1+\beta)C(q(t))/q(t)]q(t)$$

where β is the elasticity of the marginal cost curve with respect to the quantity extracted. In practice however it is much simpler to find data on average cost than for the marginal cost. The other complication is the estimation of β which is practically complicated as it varies from the nature of resource and the type of industries. It also varies over time and over place.

Hartwick J (1989) looks at the treatment of the national accounts to incorporate exhaustible resources as distinct capital goods. He looks at each type of natural resources capital separately by netting out from Gross National Product (GNP) the current value of the use up of the capital stock for each of the three types of natural resources namely non renewable (exhaustible), Renewable and environmental. It shows that there is an explicit economic depreciation of natural resources capital which should be deducted from GNP to arrive at the correct estimate of Net National Product (NNP). The correct approach according to Hartwick would be to reprice the environmental services by appropriate scarcity or shadow prices and any declines (increases) in the corresponding stock should be netted out (added) to GNP to obtain NNP. The result shows that to arrive at the Net National product all hotelling rents from resource extraction have to be deducted from GDP. This is consistent with the depreciation or net price approach to natural resource accounting as in Repetto et al (1989)

However El Serafy (1989) criticizes the depreciation method and instead proposes an alternative approach whereby a fraction of current total (as opposed to hotelling) rents are deducted from the GDP to arrive at a sustainable growth indicator. El serafy's main critism to the depreciation approach is that since all resource rents are deducted from GDP, a country with a large endowment of natural resources would not seem to have an income (i.e. permanent consumption) advantage over other countries. This result would obviously be flawed.

Andres Gomez (2001) tries to compare between the net price method and user cost approach. In his argument, he shows that that the user cost method is incorrect and misleading since its original proponent implicitly had the context of a small open economy in mind. From his analysis, he concludes that in a small open economy, to arrive at a sustainable NNP figure changes in foreign assets must be accounted for. Once this is done, the main critism to the depreciation method –that resource rich countries would not have a consumption advantage over resource poor countries can be shown to be wrong.

2.2 EMPERICAL REVIEW

Little work is recorded in less developed countries because of a number of problems. Most common problems to these countries do include:

- Insufficient data: Resource accounting demands a lot of data. The cost of compiling such data is highly prohibitive to these countries. The little data that is available tend to be over general. The data are also discontinuous, isolated and not localized. Qualitative data are virtually non-existent. There is also lack of qualified personnel in the plurality of disciplines required to work on these account.
- Dispersed and compartmentalized data: Some data exist, appearing as by products of sectoral surveys, project evaluations and various research studies. These data are presented in various non-standardized forms (statistical series, files, maps etc) and are neither published nor widely disseminated. As a result, we have diversified and scattered data in various ministries, organizations institutes and agencies.
- Political demand for this activity is still low due to more pressing short run problems (priority structure) related to the basic survival of millions of people in rural areas.

However despite these short comings, a few developing countries have tried to come up with natural resource accounting for various sectors in their respective countries.

Mabugu, et al (1998) applies the natural resource accounting methods in a case study of fuelwood consumption in Zimbabwe. The study which builds on previous work, especially Crowards (1994) tries to estimate values of economic depreciation of timber stocks using the more refined approach of Vincent and Hartwick (1997) where the main difference in approach is in the valuation of physical stocks which is obtained by multiplying the net depletion of the resource by an estimate of the rent. This differs from most studies which uses average net price as a measure of rent while Vincent and Hartwick uses marginal net price. The study proves that the use of average net price prices can make worse the bias in calculating net depreciation values of stocks. The general conclusion based on these data only is that the economy could have actually consumed more per capita and still not jeopardized sustainable development. The results shown that that economic depreciation of timber stocks from fuelwood alone represents about 0.16 percent of annual GDP.

Repetto et al (1989) did a study on timber in natural forests and plantations in Indonesia. They constructed the physical accounts and did valuation of timber by use of the net price method.

An environmentally-sensitive growth accounting framework is developed and applied to Ghana's system of national income accounts for the period 1970 to 1987 by Baytas A and Rezvani F. (1993). Although the study is narrower in its scope, it is similar to the Indonesia's case. It attempts to set up both physical and monetary accounts for timber resources. The tables generated can then be used either as satellite accounts or fully incorporated into conventional accounts, depending on the objectives.

Hassan et al (2002) did a study to attempt to account for true contribution of forest and woodland resources to economic well being in Swaziland using the natural resource and environmental accounting approach. The study uses the net price (NP) method to determine the forest resource rent or stumpage value. The results showed very clearly how forest and woodland resources can be mismanaged and overexploited leading to resources depletion and degradation as a result of excluding or underestimating the true contribution of such resources to human well being.

Mabugu and Chitiga (2002) applied some of the theoretical adjustments suggested in the natural resource accounting literature to the forest sector in Zimbabwe. Apart from creating physical timber accounts for commercial forestry, the study also used the environmental accounting approach to obtain values of forest stocks for the commercial forest using both the change in asset value and the net depletion method. The study showed that the estimation from the two methods differed as net depletion method tends to overstate both the appreciation of young forests and the depreciation of mature forests by a factor of 1.2 on average.

The natural resource accounting has also been applied to the non renewable resource as is in the case of Botswana looking at it from the sustainable development. Lange G and Wright M (2002) looks at the process of wealth transformation for Botswana as they describe the environmental accounts which were constructed for Botswana to asses the value of its mineral assets. They analyse the process by which mineral revenues have been transformed by the government into other forms of wealth. The purpose of this analysis was not only to improve the indicator of sustainability, but also to provide a more detailed information to improve the allocation of revenues from minerals among different types of public sector investment.

In another study Haripriya (2001) incorporated the forest resources into the national accounts for all the states. The study constructs accounts containing information on the opening stocks, changes due to economic activity (due to logging/illegal logging/afforestation), other accumulations (mean annual increment, regeneration and transfer to nonforest purposes), other volume changes (due to forest fires, stand mortality, animal grazing etc.) and the closing stocks. The value of depletion is obtained by deducting the value of opening stocks from the value of the closing stocks. The studies adjusted the NDP in two ways. First, adjustments were made in the forest sector to include non-market production of timber, fuelwood and non-timber forest products left out of NDP. This converts NDP to Adjusted Net Domestic Product (ANDP). Secondly, the study adjusts ANDP for the depletion of forest assets to derive environment adjusted domestic product (EDP). The forest accounts were limited to incorporating monetary benefits from timber, fuelwood, fodder and non-timber forest products. The study done for Maharashtra illustrates that the ratio of Environment adjusted state domestic product to Adjusted Net state domestic product is around 99.3 percent.

In examining the natural capital depletion in Ecuador from 1971 to 1990 Kellenberg (1996) in his doctoral thesis used the two natural resource accounting methodologies to measure the economic value of natural capital depletion in the petroleum sector. Calculating the Hicksian income from 1971 to 1990, the study indicates that the value of natural capital depletion derived using the Depreciation method equals $7.8 million (1987

US dollars), equal to 4.3 percent of GDP over the two decades. The user cost method indicates that the capital element of oil revenues over the two decades equals $16.2 billion, equal to 8.9 per cent of GDP over the two decades (1987 US dollars) which all results in a serious decline in domestic investment and genuine savings.

There are also several examples of forest resource accounts that include some nonmarket goods and services (Hultkrantz, 1992; Haener and Adamowicz, 2000; Kriström and Skanberg, 2001). One of the few examples of forest resource accounting that examines market and nonmarket accounts over time are Kriström and Skanberg (2001). In their study they define the value of the capital stock of timber and nontimber goods (berries, etc.) and define the depreciation in the capital stock arising from environmental change. This change in asset value is the appropriate value to include in Green NNP. They compute measures analogous to the appreciation/depreciation in timber accounts. Similarly, recreational trips are valued at what they assume to be marginal values per day (prices). The study provided one of the most carefully constructed market and non-market accounting exercises. It is clear, however, that several critical assumptions regarding physical and monetary measures had to be made in order to develop the accounts.

2.3 OVERVIEW OF THE LITERATURE

This chapter summarizes both the theoretical and empirical literature related to the natural resource accounting. Literature on depreciation accounting procedures of natural resource exhaustion is still open to debate about the most appropriate method (Vincent & Hartwick, 1998; Hartwick, 1988; Hotelling, 1931; El Serafy, 1989). As can be seen from both the theoretical and empirical literature, there are several methods used in the calculation of depreciation and valuation of resources with their weaknesses and strength highlighted for each method.

The most quoted method is the net price method (Hotelling, 1931) with a few adjustments to fit the data requirements for those countries. Since this is a first study in Kenya, majority of the studies looked are from the developing countries which also fit very well with the situation of Kenya.

In this study an attempt will be made to use the net price method for the net accumulation as it is much applicable to the existing data in the country despite the weaknesses it faces. Some of these weaknesses include difficulty in estimation of marginal cost and also does not take care of trees by their ages which end up overestimating the values.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Conceptual framework

Considering a general dynamic of a renewable resource and let $B(H_t)$ be the gross benefit from harvesting of a renewable resource, $C(H_t, S_t)$ be the cost function of harvesting and consider r to be the social consumption discount rate. *Ht* is the harvest in period t an S is the stock size. The objective is to maximize discounted social net benefits over an infinite horizon subject to a resource growth constraint The problem may be stated as

$$\text{Max} \int_0^\infty \{B(H_t) - C(H_t, S_t)\} e^{-rt} dt \tag{1}$$

Subject to

$$\frac{dS}{dt} = G(S_t) - H_t \tag{2}$$

where $G(S_t)$ is the resource growth function.

If we let the Hamiltonian be labeled as L, then the current-value Hamiltonian for this problem is given by

$$L_t = B(H_t) - C(H_t, S_t) + p_t(G(S_t) - H_t) \tag{3}$$

where *p* is a Lagrange multiplier, interpretable as the shadow net price of one unit of the stock of the renewable resource.

In this case the necessary conditions for a maximum are

$$\frac{\partial L_t}{\partial H_t} = 0 = \frac{dB}{dH_t} - \frac{\partial C}{\partial H_t} - p_t \tag{4}$$

and

$$\frac{dp_t}{dt} = rp_t - p_t\frac{dG}{dS_t} + \frac{\partial C}{\partial S_t} \quad (5)$$

and the resource net growth equation is given by

$$\frac{dS}{dt} = G(S_t) - H_t \quad (6)$$

It can be noted that equation (4) defines the relationship between the resource net price, gross price and the marginal cost. If we assume that there is an inverse demand function for the resource given by

$P_t = P(H_t)$, where P denotes the gross price of the resource. The demand function implies that $\frac{dB}{dH_t} = P_t$ and so equation (4) can be rewritten as

$$p_t = P_t - \frac{\partial C}{\partial H_t}$$

This states that the net price is equal to the gross price minus the marginal cost of a unit of resource harvested. This net price calculated above can be approximated by the stumpage fee or price.

From the above expressions, equation (5) gives the Hotelling efficient harvesting condition for a renewable resource in which costs depend upon the stock level which is also known as asset-equilibrium condition.

3.2. The structure of the forest resources accounts

Natural resource and environmental accounting approaches and tools will be used in the intended analysis. Different physical and monetary measures of the true contribution of timber resources to welfare will be developed within this framework which will involve the construction of physical and monetary accounts for the timber resources.

3.3 Physical resource accounts

Physical accounts are also useful to forest managers and are generally more comprehensible to the general public than many economic accounts. They are also required because they are not affected by market prices and other short term factors, and can be used to directly monitor long-run changes in the actual capacity of forest assets. These accounts detail the physical state and patterns of use of forests overtime through the construction of asset and flow accounts.

3.3.1 Asset accounts

The asset accounts provide information about changes and trends in the state and utilization of forest resources over the period of inquiry. While the main asset account for forest is that of standing timber stocks, other forest assets are often considered, e.g. non-produced biological and environmental assets such as carbon stocks. The timber asset account is structured as follows:

Timber stocks asset accounts

Closing Stocks = Opening Stocks – net physical change in standing Timber

Net Physical Change in Timber stocks = Additions – subtractions

Additions = Natural growth and regeneration + New afforestration

Subtraction = economic use (harvesting) + Other reductions in volume (damage factors such as fire, health stress, etc)

The physical timber stocks are generally measured in terms of volume in m^3/tons or area in ha. It should be noted that the adjustment in the SNA for omissions of such changes and utilization/depletion of forest resources is made to the assets accounts balance sheets in the same way the man made capital formation and depreciation are accounted for.

3.3.2 Flow accounts.

This accounts show the flow of the goods and services provided by forests and woodlands to the rest of the economy which includes the supply and use of timber and non-timber products and other services of forest as well as negative and positive externalities. Due to the unavailability of data, flow accounts will not be constructed.

3.4 Monetary resources accounts

Establish values for the various entries of the physical and determine the magnitude of the monetary contributions and state of forest resources. In this case, asset valuation methods are used rather than the market prices ruling at the time of transaction which are used to value flows of costs and benefits. Examples of commonly used asset valuation methods do include the resource rent and stumpage values.

There are various methods of valuing timber and some of the most important methods are discussed below.

3.4.1 Value of standing timber

The general expression for the value of an asset, V, in the base year, 0, is simply the sum of the net economic benefits it yields in each year t, over the lifetime, T, of the asset, discounted to present value by the discount rate, r.

$$V_0 = \sum_{t=0}^{T} \frac{p_t Q_t}{(1+r)^t}$$

where p is the unit rent (stumpage price) calculated as revenue minus the marginal cost of harvesting, and Q is the total harvest in a given period. SEEA identifies three alternative methods for valuation of standing timber:

1. Stumpage value method

The simplest of the three approaches, asset value of standing timber, V, is given as the product of total forest area in hectares, A, the stumpage price per cubic metre of timber, p, and the quantity of timber per hectare (cubic metres), Q:

$$V = ApQ$$

2. Consumption value method

This method expands the stumpage value method to account for the difference in value of trees of n different age or diameter classes, k:

$$V = \sum_{k=1}^{n} A_k p_k Q_k$$

3. Net present value method

The total value of standing timber, V, is the sum of vτ, the value per hectare of forestland of age class τ, weighted by Aτ, the total area in age-class τ, where T, is the actual cutting age, p t is the stumpage price, qT, is the timber yield at actual cutting age. The value is discounted at a rate, r, by the time remaining until harvest, T-τ.

$$V_t = \sum A_{t,\tau} v_{t,\tau} \qquad \text{for } \tau = 1, \ldots, T-1$$

$$v_{t,\tau} = \frac{p_t q_T}{(1+r)^{T-\tau}}$$

or,

$$V_t = \sum_{\tau=1}^{T-1} \frac{A_t p_t q_T}{(1+r)^{T-\tau}}$$

In the calculation of net accumulation of natural assets, a net price method will be used, whereas in the valuation of standing timber the method that is used in Kenya is the stumpage value method.

3.5 Linking Resource Accounts and the SNA

There are two approaches that dominate this linkage. These are:

- Direct approach
- Indirect approach

The direct approach emphasizes the need to correct the existing deficiency in the SNA. Some of the names associated with this emphasis include Repetto (1988), Hucting (1987), Leipert (1987) and Peskin (1975, 1976 1981). They all propose that such a correction or adjustment can be made by including imputed values for the environmental goods and services directly into the existing accounts. The contention is that environmental accounting would not have the same impact unless the accounts were monetized and integrated into the SNA to give an adjusted national income that is more sustainable. Since the environmental effects on income will be noticed, the direct approach may get macroeconomic policy makers to take account of the environmental implications of their recommendations.

The indirect approach advocates for the inclusion of environmental information in physical units, usually in separate satellite accounts. Some of the names associated with this indirect approach include Theys (1985), Alfsen et al (1987) and Gilbert Hafkamp (1986). Their aim is to use indicators of physical change (without linking to SNA) to influence public opinion and environmental policy process. Their argument is that in the absence of adequate data the direct approach carries risks.

Serafy and Lutz take a middle position as they advocate as an interim step, the construction of satellite accounts, linked to the SNA as afar as is possible. This is the approach that the following case study will take. This means that sustainable income measurements can be computed in satellite accounts which would not affect the historical continuity of GDP. This satellite accounts have greater chance of being used for policy analysis and prescription. This may actually spur national accountants to be serious about the issue of resource accounting. This study will try to use the indirect approach linkage to the SNA by constructing satellite accounts for the stock and flow of forest resources.

3.6 Data type and sources

Secondary data will be used in this research. The main source of data will be the Central Bureau of Statistics (CBS), Forestry department and World Resource Institute (WRI) of the World Bank. This will be supplemented by data/studies from Kenya Forestry Research Institute (KEFRI), International Union for Conservation of nature (IUCN), ICRAF, National Environmental Management Authority (NEMA) and various non governmental organizations dealing with forestry.

3.7 Scope of the study

This study looks SNA in Kenya with regards to its treatment of forest resources. The main interest in this study would be to look at commercial forests or cultivated forests. The resources from other main type of forest, which is the natural or indigenous forests, will be mentioned from the studies that had been done by other researchers. The focus is on the physical accounts, natural resource depletion rate. The study period will be from 1996-2004.

CHAPTER FOUR

4.1 Natural resource accounts for cultivated plantations.

While the contribution of these commercial forest and forest product activities are accounted for in the SNA as part of current income, a number of important benefits and costs of growing exotic plantations do not enter the national accounts. For example cultivated forests assets such as timber and carbon stocks do not enter the assets accounts balance sheets as part of national wealth. Accordingly the effect of net accumulation or depreciation in these assets on net national savings and capital formation is not captured. Moreover, cultivated forests replace natural vegetation such as grassland and hence alter the original ecosystems functions of the replaced vegetation. It is also noted that the value such as environmental externalities and costs are not accounted for in the SNA. This chapter makes an attempt to establish some of the said values currently missing from the national accounts. The study only focuses on net accumulation in timber and hence could not measure other environmental values such as water abstraction and biodiversity loss caused by the cultivated forests

4.2 The physical asset accounts

This section will also develop physical accounts for timber of cultivated plantations. Physical accounts are also required because they are not affected by market prices and other short-term factors, and they can be used to directly monitor long-run changes in the actual capacity of forest assets.

4.3 Timber stock accounts

The data on cultivated forests were obtained from the various sections within the forest department and the Central Bureau of Statistics. This data provided the basis for the construction of the physical accounts documenting changes in the standing stocks of timber in cultivated plantations and their utilizations.

The non availability of timber growth models enabled us to use the assumptions given below.

4.4 Assumptions

Since the fact that each tree specie do produce different volume of timber, the average figures from the Kenya Forestry Master plan report were used this analysis. The KFMP gives figures for the various years which were used to convert the hectares into volumes (as shown in appendix 1). In areas where the figures were missing an average of $300m^3/ha$ was used. This was given by the Inventory section of the forestry department. The fiscal year were changed to calendar year for the replanting and harvesting exercise, by taking two consecutive fiscal years and finding the average .

The harvesting was being done at an average rate of around 6000 hectares per year just before the logging ban of 1999 according to figures from the replantation section. After the ban harvesting is around 2500 hectares per year allowed only to the licensed companies which includes Pan African paper mills, Raiply wood of Eldoret and Timsales just to mention a few. Areas lost due to fire averages around 600 hectares each year although there are some years it goes to around 6000 hectares including the natural forests. Resettlement losses (excisions) was approximated to be around 40,000 hectares between the period 1994-2001 but it was not disaggregated to either natural or plantation forests. We assume that other represents not only the fire damage but other damages like logging damage, stand mortality. The Mean Annual Increment range (MAI) is used to calculate the new plantation growth by taking the average from the MAI for different species. We obtain an average of 25.667m^3/ha, which is multiplied by the annual new plantation area to get the new plantation in terms of volume. The growth in terms of volume is assumed to be 2.5m^3/ha from the World Bank data base for the developing countries. We therefore take the opening stock and multiply by this figure to get growth in volume terms

Using the available data on opening stocks for 1996 on the actual area (145,800ha) adjustments were done for annual additions (growth and plantings) and withdrawals (harvesting and damaging caused by fire and other factors) to calculate closing timber stocks. Actual data on new plantation areas was obtained from the forestry department as can seen in appendix (1).

Table 4.1 shows the physical accounts of the plantation forests in hectares. From this table, we see that the overall size of plantations have declined for the opening stocks from around 145,800 hectares in 1996 to around 118, 500 hectares in 2004. After the ban of 1999, the area of hectares that have been harvested declined over the period to average at around 2500 hectares as compared to an average of 6000 hectares being harvested before the ban. According to the forest department, the loss of forest due to damages is approximated to be around 0.6 hectares per year over the last seven years although in some years it goes beyond this figure. There is statistical discrepancy in terms of not able to account for some area. This is attributed to either underestimating or overestimation of new plantations, harvesting or other damages to the plantations forests.

Table 4.1 Timber stock accounts (in hectares).

Year	Opening Stocks '000 ha	New plantation growth '000 ha	Harvesting '000 ha	Damage '000 ha	Balancing item	Closing stocks '000 ha
1996	145.8	3	6	0.6	-1.2	143.4
1997	143.4	3	6	0.6	-0.8	140.6
1998	140.6	2	6	0.6	-1.5	137.5
1999	137.5	3	5.3	0.6	0.7	134.0
2000	134.0	4	2.8	0.6	4.5	130.2
2001	130.2	5.6	2.5	0.6	6.7	126.0
2002	126.0	7.1	2.5	0.6	6.8	123.2
2003	123.2	8.6	2.5	0.6	7.8	120.9
2004	120.9	9.243	2.5	0.6	8.5	118.5

Source: Authors calculation

The table 4.2 below gives the physical stock in volume terms. The stock of timber has been declining over the period of study to stand at 39.0 million m3 in 2004. Over the years considered, it is noted that there has been a reduction in volume due to harvesting as compared to volume of new plantations being planted. This is also attributed to government ban on harvesting and only restricting the harvesting to specific industries.

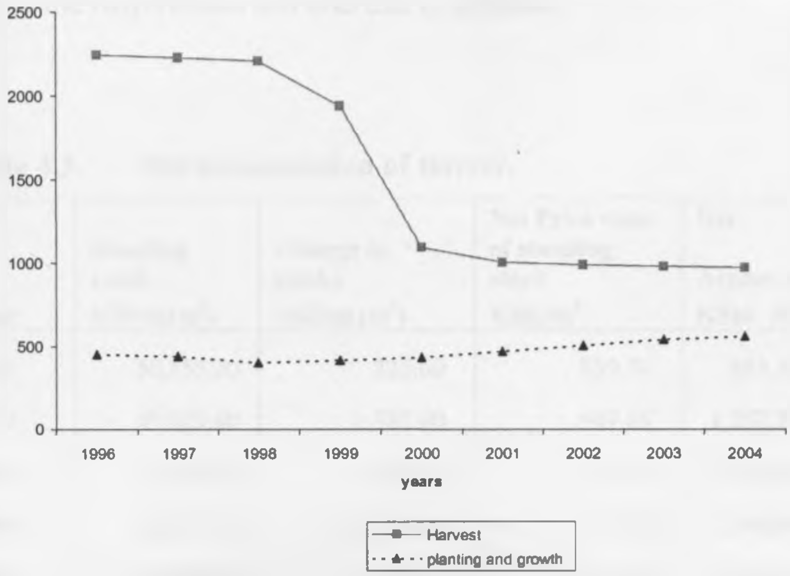
Table 4.2 Physical Accounts in volume.

Year	Opening Stocks '000 m³	Growth ('000m³)	New plantation Growth ('000m³)	Harvesting ('000 m³)	Others ('000m³)	Balancing item ('000 m³)	Closing stocks ('000 m³)
1996	50155.2	364.5	77.0	2064.0	180.0	-976.9	49329.6
1997	49329.6	358.5	77.0	2046.0	180.0	-405.5	47944.6
1998	47944.6	351.5	51.3	2028.0	180.0	-335.6	46475.0
1999	46475.0	343.8	77.0	1758.8	180.0	67.0	44890.0
2000	44890.0	335.0	102.7	913.0	180.0	1008.3	43226.4
2001	43226.4	325.5	143.7	822.5	180.0	1239.1	41454.0
2002	41454.0	315.0	181.0	807.5	180.0	799.3	40163.2
2003	40163.2	308.0	220.0	800.0	180.0	660.5	39050.7
2004	39050.7	302.3	237.2	792.5	180.0	697.7	37920.0

Authors' calculation

The graph below represents the pattern of harvest and damages versus new planting and growth of timber from the year 1996 to the year 2004. It can be seen clearly from the graph the prior to the ban, the volume of timber harvested was far much higher than that of replanting. Despite the fact that the volume of new plantation and growth has on the average been increasing over time, the volume of harvesting is still high implying that we have been depleting our resources over time. This has the impact of unsustainable development in terms of using our natural resources. Immediately after the ban, the volume of new plantation has been increasing steadily but has not reached the one of harvesting and damaging. This means that our reductions are still more than our increments in terms of volume. Continuing with the same trend of increasing the area of new plantations and reducing the area of harvest due to the ban gives an indication of sustainability in the sense that we are planting more than what is being harvested. This gain in timber accumulation can be attributed to the expansion in plantation relative to steady or equal harvests over the years after the ban.

Figure 1 **Graph of harvest and Plantations ('000 m³)**



4.5 Net Accumulation of timber.

The estimation of timber asset accounts was done using the net price method. Table 4.3 shows the net accumulation of timber calculated using the net price method. The average value of stumpage value is used as a proxy to economic rent which is derived by the method indicated the literature review of chapter 2. Figures for the stumpage prices were obtained from the forestry department (Economics and Royalty section). These figures are by type of timber species as shown in appendix (2). The change in stocks is simply the difference between the opening stocks and the closing stocks. In this case there has been a decline in standing timber volumes over the years being considered in this study. In terms of volume, there is much lost as compared to what is growing or what is being planted. The highest net accumulation was witnessed in 2001 while the lowest was in 1996. There is a steady increase in average stumpage price from KShs. 839.74 in 1996 to

KShs. 2167.60 in 2004. This can be attributed to either scarcity of timber because of the ban by the Government and also due to inflation.

Table 4.3. Net accumulation of timber.

Year	Standing stock million(m^3)	Change in stocks million (m^3)	Net Price value of standing stock KSh./m^3	Net Accumulation KShs. Million
1996	50,155.20	825.60	839.74	693,290.25
1997	49,329.60	1,385.00	907.86	1,257,388.52
1998	47,944.60	1,469.60	1,118.41	1,643,620.59
1999	46,475.00	1,585.00	1,353.28	2,144,954.94
2000	44,890.00	1,663.60	1,451.62	2,414,921.02
2001	43,226.40	1,772.40	1,521.70	2,697,061.70
2002	41,454.00	1,290.80	1,612.06	2,080,842.21
2003	40,163.20	1,112.50	1,794.29	1,996,151.24
2004	39,050.70	1,130.70	2,167.60	2,450,905.32

Authors calculation

4.6 Asset value of Timber

The asset value of timber is calculated by multiplying timber stock at the beginning or the end of the year times the corresponding average stumpage value. The table 4.4 below shows the approximated asset value of timber from the plantations. The net price in this case is also approximated by the average stumpage prices. It can be seen that the asset value of timber as been increasing over the period of study from KShs. 41,424,092.6 million in 1996 to KShs. 82,195,392.0 million in 2004. Over the period of study, the highest growth in value of 19.6 percent was witnessed in 1998 with the lowest being witnessed in 2001.

Table 4.4. Asset value of timber

Year	Closing stocks		Net Price value of Standing Stock (KSh./m3)	Asset value of timber
	'000 ha	'000 m³		
1996	143.4	49,329.6	839.7	41,424,092.6
1997	140.6	47,944.6	907.9	43,527,068.5
1998	137.5	46,475.0	1,118.4	51,978,270.9
1999	134.0	44,890.0	1,353.3	60,748,913.1
2000	130.2	43,226.4	1,451.6	62,748,462.4
2001	126.0	41,454.0	1,521.7	63,080,566.3
2002	123.2	40,163.2	1,612.1	64,745,337.6
2003	120.9	39,050.7	1,794.3	70,068,407.4
2004	118.5	37,920.0	2,167.6	82,195,392.0

Authors' calculation

4.7 Adjusting the National Accounts for net accumulation in timber.

The results of monetary accounts show that accumulation of natural capital in terms of timber stocks was about 3percent of total gross savings on average during the period 1998-2004. This can be seen from the table attached in the appendix 2. When the current measures of savings were corrected for the excluded value of net accumulation in terms of timber stocks in cultivated plantations, there was a reduction in saving by about 3 percent on average over the period of study. These results indicate a high magnitude of overestimation of the contribution of plantations forests to national wealth and capital formation in Kenya. One should note that this study did not correct for the negative externalities of plantation forestry such as water abstraction and erosion of biodiversity and also the carbon storage benefits of the cultivated plantations was not considered.

CHAPTER FIVE

5.1 Summary

The study generally presents the outcome of an analysis of the forest sector in Kenya with special emphasis on plantation forests. It describes the plantation forests and uses resource accounting techniques to determine how much of its forest resources in the plantation Kenya is losing and gaining. It also tries to attach monetary values to these changes. The study constructed physical accounts for the plantations or timber account from the plantations. Commercial timber stocks show a steady decline over the whole period. It is clear from the study that reduction to timber volume and additions in volume due to growth and replanting leads to net negative accumulation of stocks. As well as creating physical timber accounts for commercial forestry, the study also used the environmental accounting approach to obtain values of forest stocks for commercial forestry using the net depletion method. However the net depletion method tends to overstate both the appreciation of young forests and depreciation of mature forest. Within the area of forest resources, the main concern is to assess the depreciation or appreciation in the forest asset and to account for nonmarket consumption aspects arising from forest resource.

5.2 Conclusions

The paper has tried to address the basic deficiency of the current national income accounting system which arises out of the inconsistent treatment of man made capital and natural capital. As Lutz and Munasinghe (1991) suggested, we need measures which would account for the depreciation of all capitalas a result of economic activities. For development strategies that rely on conventional accounting methods are not likely to result in sustainable development. Although the resource accounting methods and techniques were applied to timber resource only, national balance sheets can be constructed that include other natural resources. Natural resource accounts provide a valuable picture of a nation's wealth at different points and time and enhance the evaluation of a nations future potential for sustained income generation.

5.3 Policy implications

The results of the forest resource accounting analysis presented above have important implications for the current measures of social well being and economic performance as well as the policies and strategies for sustainable management and exploitation of the natural resource base. The results of this study show very clearly how forest can be mismanaged and overexploited leading to resource depletion and degradation as a result of excluding or underestimating the true contribution of such resources to human well being. In order to generate proper indicators of welfare change, current measures of income and wealth must be corrected for net accumulation (depletion) in natural resources assets and the total value people directly or indirectly derive from their use. Genuine measures of sustainable income, savings and capital accumulation provide more appropriate information that is crucial for sustainable development planning and design of sound polices for economic efficient and sustainable use of natural resources such as the forests, fisheries, water soil and minerals.

The results in this study emphasis that using certain SNA aggregates as measures of welfare can be misleading. While the livelihoods of most people in Kenya are highly dependent on natural woodlands and forest resources, it is typical that all the mentioned values are excluded from conventional national accounts. Underestimation of the value of natural forests and woodlands is one of the major reasons leading to over conversion of these resources. Failure to attach a true value to the resource means the opportunity cost of conversion is grossly misstated. Likewise, the failure to capture forest assets values in the SNA leads to generation of incorrect measures of economic performance and well being such as the rate of savings and capital formation. The consequences could be severe by sending the wrong signals to policy makers. This can easily be seen by the Kenyan budget system through the new Medium Term Expenditure Framework (MTEF) process that is faced with serious funding constraints as all sectors scramble to bids for resources. The resources allocation to this sector is almost symbolic at about 5 percent of total government budget. This has also led to a situation whereby the prioritization process does not put the same weights to the environment and natural resources as in others e.g. health and education. Without good information on value of forests, policy makers are in a weak position to establish guidelines and institutions for addressing forestry management issues. As a result of these problems, incorrect policy decisions may be made regarding forestry development, resource management and land use. Development could be biased towards short-term goals, which could lead the country down to an unsustainable path. A clear understanding of the relationship between forest stand characteristics and the value must guide forest management and harvesting decisions.

5.4 Limitation of the study and area for further research

The study has several some limitations. There is difficulty in determining the hectare actually regenerated for the case of regeneration. Another problem is lack of validated growth and yield equations for all the species used for reforestation and regeneration that is there is lack of growth models for the various species.

Developing environmental accounts is by no means very simple. This is because of the huge data requirements. Especially in developing countries like Kenya there are several data limitations that may come in the way of accurate accounting of the environment.

Another problem is that environmental accounting needs a more localized approach as this enables you to fill the gaps that are missing from start. It will also enable us to know the contribution of each of the forest and any particular time.

Valuation of natural assets is also a problem. There are several valuation methods and no method so far is perfect and some of the methods are controversial. Hence the research on this issue does suffer from several limitations.

The account constructed does not cover all types of forest resources of the country. To complete the picture, we need to include all the other types of forests such as natural forests, dry land, farming forests and all the others. The economic and environmental value of goods and services flowing from Kenya's forest ecosystems is not limited to timber and sawn wood products. Tropical forests also are capable of producing other goods and services with economic value particularly for local communities and forest dwellers. Forest areas also provide ecological and environmental services for the country. It serves as sinks for the carbon dioxide, it reduces soil erosion, creates habitats for fauna, converses nutrients, and provides goods for domestic consumption. Each of these goods and services plays a functional role in the development process of the forestry sector, strengthening linkages with related sectors and the national economy.

It is in this regard that it is important to also do a study on the other benefits of forests and not only to look at timber. Valuation of these services will be important, as it will show a clear picture of the total value of forest in Kenya. Natural resource accounting can also be constructed for the other natural resources. This includes water, fisheries, minerals, soil among others. With the inclusion of all these natural resources into the main stream of the national accounts will enable us know the true value of our natural resources and also appreciate the importance of these resources in terms of sustainable development.

APPENDIX

Appendix 1: Wood related land uses ('000 ha) and wood biomass inventory.

Year	Forest Department inventory ('000ha)	Wood biomass inventory (m^3/ha)
1996	145.8	344.0
1997	143.4	341.0
1998	140.6	338.0
1999	137.5	335.0
2000	134.0	332.0
2001	130.2	329.0
2002	126.0	326.0
2003	123.2	323.0
2004	120.9	320.0
2005	118.5	317.0

Source: Forest Department

Appendix 2 Adjusting the National Accounts for Net accumulation in timber.

Year	1998	1999	2000	2001	2002	2003	2004
GDP at market prices	850,808.3	906,928.2	967,838.0	1,025,918.0	1,038,764.0	1,141,780.0	1,273,716.0
Total Consumption	799,283.5	855,535.0	903,428.0	971,805.0	988,216.0	1,071,484.0	1,171,212.0
1. Gross Domestic savings	51,524.8	51,393.2	64,410.0	54,113.0	50,548.0	70,296.0	102,504.0
2. Net accumulation of timber stocks	693.3	1,257.4	1,643.6	2,145.0	2,414.9	2,697.1	2,080.8
3. Accumulation of timber as % of saving	1.3	2.4	2.6	4.0	4.8	3.8	2.0
4. Genuine Savings	50,831.5	50,135.8	62,766.4	51,968.0	48,133.1	67,598.9	100,423.2

Author's calculations

Appendix 3 Average Stumpage prices by product

Product	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04
Sawtimber(Softwood)	530	681	681	791.9	1022.5	1169	1182	1129.5	1208	1301.5
Sawtimber (hardwood)	1060	1157.7	1157.7	1344.7	1738.25	2000	2009.4	2500	2500	3250
Pulpwood(soft/hardwood)	305	305	305	357	305	638	305	305	305	740
Fuel wood	81.5	81.5	102.15	126.55	163.5	187	212	212	220	230
Charcoal (45Kg)	40	60	80	100	120	150	150	200	250	300
Transmission poles	318	442.65	442.65	514.15	664.6	734.2	734.2	734.2	785.2	845.65

Source: Forest department

Appendix 4 Timber Asset Accounts

Year	Opening Stocks		Growth	New plantation growth		Harvesting		Others		Balancing item		Closing stocks	
	'000 ha	'000 m³	'000 m³	'000 ha	'000 m³	'000 ha	'000 m³	'000 ha	000 m³	'000 ha	'000 m³	'000 ha	'000 m³
1996	145.8	50,155.2	364.5	3.0	77.0	6.0	2,064.0	0.6	180.0	(1.2)	(976.9)	143.4	49,329.6
1997	143.4	49,329.6	358.5	3.0	77.0	6.0	2,046.0	0.6	180.0	(0.8)	(405.5)	140.6	47,944.6
1998	140.6	47,944.6	351.5	2.0	51.3	6.0	2,028.0	0.6	180.0	(1.5)	(335.6)	137.5	46,475.0
1999	137.5	46,475.0	343.8	3.0	77.0	5.3	1,758.8	0.6	180.0	0.7	67.0	134.0	44,890.0
2000	134.0	44,890.0	335.0	4.0	102.7	2.8	913.0	0.6	180.0	4.5	1,008.3	130.2	43,226.4
2001	130.2	43,226.4	325.5	5.6	143.7	2.5	822.5	0.6	180.0	6.7	1,239.1	126.0	41,454.0
2002	126.0	41,454.0	315.0	7.1	181.0	2.5	807.5	0.6	180.0	6.8	799.3	123.2	40,163.2
2003	123.2	40,163.2	308.0	8.6	220.0	2.5	800.0	0.6	180.0	7.8	660.5	120.9	39,050.7
2004	120.9	39,050.7	302.3	9.2	237.2	2.5	792.5	0.6	180.0	8.5	697.7	118.5	37,920.0

Authors calculation

Appendix 5 Replanting and Harvesting of timber

Fiscal years

Year	Planting	Harvesting
1998/99	3000	7500
1999/2000	3000	3000
2000/2001	5000	2500
2001/2002	6200	2500
2002/2003	7900	2500
2003/2004	9243	2500

Source: Forest department

Calendar year

Year	Planting	Harvesting
1999	3000	5250
2000	4000	2750
2001	5600	2500
2002	7050	2500
2003	8571.5	2500

Authors calculation

Appendix 6 Mean Annual Increments (MAI)

Species	Minimum	Maximum	Average
Cypress	13	25	19
Pine	17	29	23
Eucalyptus	21	49	35
Average	17.0	34.3	25.7

Source: Forest Department

REFERENCES

Baytas, A. and Rezvani, F. (1993). 'Forest Resource accounting in Ghana, 1970-1987,' *Center for Economic Research on Africa ERAF.*

Common, M.S. and Norton, T.W. (1997) 'Biodiversity, Natural Resources and Ecological Monitoring,' Biodiversity Conservation, Kluwer Academic Publishers

El Serafy, S, Lutz E and Ahmad, J.Y., (1989), 'Environmental accounting for sustainable Development', World Bank publication

El Serafy, S. (1989) 'The proper calculation of income from depletable natural resources'. In Y. Ahmed, S. El Serafy and E. Lutz (Eds). "Environmental accounting for Sustainable Development." The World Bank, Washington, DC. 86-102

Emerton, L. and Karanja, F. (2001). "Valuation of forest resources in East Africa," ACTS and IUCN-EARO, Nairobi, Kenya

Gomez, A. and Lobo, E. (2001) "Sustainable development and natural Resource Accounting in small open economy: A methodological clarification." *Estudios de Economia. Vol 28 No. 2 Decemder 2001. pages 203-216*

Haripriya, G.S (2001) "Accounting for the Forest Resources in the national accounts of India," *Environmental and Resource Economics,* Vol. 19(1), pp. 73-95

Haripriya, G.S. (2000) Integrating Forest Resources into system of National Accounts in Maharashtra, *Environmental and Development Economics,* 5: 143-156

Hartwick, J.M. (1977) 'Intergenerational equity and the investing of Rents from Exhaustible Resources,' *American Economic Review* 66: 972-974

Hartwick, J.M. (1978) 'Substitution among Exhaustible Resources and Intergenerational Equity,' *Review of Economic Studies*, 45:347-354

Hartwick, J.M. (1989), 'Natural Resources, National accounting and Economic Depreciation,' *Journal of Public Economics*

Hassan, R.M. et al (2002). 'Accounting for Stock and Flow values of woody Land Resources,' Published by the Centre for Environmental Economics and policy in Africa (CEEPA), University of Pretoria.

Hassan, R.M. et al (2002) 'Natural Resource accounts for the state and economic contribution of forests and woodland resources in Swaziland.' CEEPA Discussion Paper Series, The Centre for Environmental Economics and Policy in Africa, Pretoria

Hotelling, H. (1931) 'The Economics of Exhaustible resources,' *The Journal of Political Economy,* Vol. 39, Issue 2, pp 137-175

Hulkrantz, L. 1992. 'National Accounts of Timber and Forest Environmental Resources in Sweden.' *Environmental and Resource Economics 2*: 283-305.

IUCN (1996). 'Forest cover and Forest Reserves in Kenya: Policy and Practice.' IUCN, The World Conservation Union, Eastern Africa Regional office, Nairobi, Kenya

Kellenberg, J. (1996) 'Accounting for Natural Resources in Ecuador: Contrasting Methodologies, Conflicting Results,' Environment Department papers, Environmentally sustainable Development, The World Bank.

Kriström, B. and K. Skanberg. 2001. 'Monetary Forestry Accounting Including Environmental Goods and Services.' *Investigación Agraria: Sistemas y Recursos Forestales 1: 7-26.*

Lange, G. and Wright, M. (2002). 'Sustainable Development in Mineral Economies: The example of Botswana.' CEEPA Discussion Paper, The Centre for Environmental Economics and Policy in Africa

Lange, G. M., Hassan R., Hamilton K., 'Environmental Accounting in Action –A case studies from Southern Africa', Edward Elger Publishing Limited.

Lutz, E., and Munasinghe M., (1991) 'Accounting for the Environment,' *Finance and Development* Vol 28, 1991 pp 19-21

Mabugu, et al (2000), 'Incorporating fuelwood production and consumption into the National Accounts,' A case study for Zimbabwe, FAO publication

Mabugu, R. and Chitiga, M. (2001). 'Accounting for forest resources in Zimbabwe,' CEEPA Discussion Paper, The Centre for Environmental Economics and Policy in Africa, Pretoria.

Matiru, V. (2000) 'Forest Cover and Forest Reserves in Kenya: Policy and practice.' IUCN-The World Conservation Union, Eastern Africa Regional Office, Nairobi, Kenya

Muzondo, T.R., Miranda, K.M., Borenberg, A.L., (1990) 'Public Policy and the environment,' *International Monetary Fund*, Washington D.C

Patriquin, M.N. et al (2004), 'Accounting for natural resources in the foothills model forest,' Information Report NOR-X-398, Canadian Forest service.

Price Waterhouse (1997), 'Re-Organization of the Management of Industrial Plantations and Restructuring Options for the Forest Department,' Nairobi, Kenya

Republic of Kenya (1994), 'Kenya Forestry Masterplan: Development Programmes.' Ministry of Environment and natural Resources: Nairobi, Kenya

Solow, R.M. (1974), 'The Economics of Resources or the Resources of Economics,' *The American Economic Review*, Vol. 64 pp 1-14

Solow, R.M. and Wan, F.Y. (1976), 'Extraction costs in the theory of Exhaustible resources,' *The Bell Journal of Economics,* Vol. 7, issue 2, 359-370

Statistics New Zealand (2002), 'Natural Resource accounts for New Zealand Overview Document', [Online], available: www.newzealand.co.ke

Vincent, J. and Hartwick, T. (1997) 'Accounting for the benefits of forest resources: Concepts and experience.' *Draft report.* Commissioned by the FAO Forestry Department, Food and Agricultural Organization (FAO) Rome

Vincent, J.R. (1999) 'Net Accumulation of Timber Resources,' *Review of Income and Wealth.*

Wass, P. (1995). 'Kenya's Indigenous Forests: Status, Management and Conservation.' IUCN and ODA, Gland, Switzerland and Cambridge, U.K.

Xu, Z., Bradley, D.P.; Jakes, P.J. (1994) 'United States Department of Agriculture,' Forest service General Technical Report NC-171