Contribution of Uganda's Forestry Sub-sector to the National Economy: Natural Resource Accounting Approach

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Abstract Forests and forest products have a high monetary and nonmonetary value in Uganda. Over 90% of total energy resources used in the country is derived from fuelwood. Forests offer provisioning ecosystem services which include wood products, non-timber forest products such as honey, medicinal plants and raw materials for small industry, amongst others. Forests also provide regulatory ecosystem services such as soil protection, maintenance of the hydrological cycle and sequestration of greenhouse gases.

Keywords Uganda forests • Green accounting • Forest ecosystem services

1 Introduction

The National Statistical Abstract (UBOS 2010) estimates the contribution of forest sub-sector to national income (GDP) was Ugandan shillings (Ushs) 1,038 billion in 2010. This amount is disputed as being too small and under-representing the actual contribution of the sub-sector. For example, Slade and Weitz (1991) pro-

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duced evidence that the environment and natural resources, including forests, contributed about 4–11% of the country's national income. Similarly, Yaron et al. (2003) indicated contributions of between 6% and 7%. In 2005, an attempt was made to develop national forest resource accounts to provide improved information on the true annual contribution of forests to the economy. This process stalled because the necessary data was not available. Subsequent studies estimated the Total Economic Value (TEV) of limited parts of the country's forest estate (Moyini 2006). A comprehensive annual estimate of the economic value of forests was however not made. The urgency of a national estimate of the contribution of the forestry sub-sector to the national economy was highlighted in the National Development Plan (NDP) for Uganda (GoU 2009). The present study aims to determine the annual contribution of the country's forestry resources to the national economy.[1]

Under this overall objective of establishing the contribution of the country's forestry resources to the national economy, the following specific objectives have been pursued:

1. To determine the physical stock and flow of forestry resources and their ecosystem services in Uganda
2. To determine the monetary value of the physical stocks and flows of forestry resources in Uganda
3. To estimate the aggregate contribution of forestry resources to the national economy

What we present in this chapter is based on desk study, review of existing data and literature and intense consultations with key actors in the country's forestry sector. The results reflect estimates based on the national biomass surveys, reports and secondary data held by public and private actors in the country's forestry sub-sector. The study serves as a starting point to more comprehensive natural resource accounting and provides an indicative estimate of the true contribution of the sub-sector for national, subnational and sectoral planning purposes in the country.

This report is divided into six sections. The next section describes the methodology followed and tools for collecting data and analysis. Physical and monetary stock and flow forestry resource accounts in the country are described in Sects. 3 and 4, respectively. Section 5 derives aggregate contributions of the forestry subsector at the national economy, and Sect. 6 concludes with implications for policy and research.

[1] The study to determine the economic value of forest resources in Uganda and their contribution to the national economy was carried out between October 2010 and May 2011 under the supervision of the National Environment Management Authority (NEMA) with support from the World Bank and national stakeholders including the National Forestry Authority (NFA), Uganda Wildlife Authority (UWA), the National Planning Authority (NPA) and Uganda Bureau of Statistics (UBOS) and Wildlife Conservation Society (WCS), while ENR Africa Associates provided technical expertise.

2 Methodology

The economic value of forestry resources in Uganda was established following the forest natural resource accounting methodology described in Lange (2004). This United Nations System of Integrated Economic and Environmental Accounts for Forestry – SEEAF (Lange 2004) requires specific types of data as summarised in Table 1 below.

Major data issues, however, constrained full implementation of the SEEAF in Uganda. Forestry resource data for Uganda was last collected in 1990 and then in 2005. Such extremely long interval makes it difficult to undertake conventional forest resource accounts for that period, and hence a compromise was made. Under the inventorying plan of the National Forestry Authority (NFA), comprehensive data are collected every 5 years if sufficient resources are available. Although resources were not fully available, extrapolations and simulations were carried to produce plausible estimates of the state of Uganda's forests between 2005 and 2010. This provided the basis for our forest accounts.

The needed data were collected from various secondary and primary sources, with the former being the dominant activity. The process benefited enormously from the National Biomass Survey 2005 (NFA 2009). Additionally, discussions with NFA staff yielded additional data on forest physical stocks. Further data was obtained through estimates generated together with the staff of the NFA, NEMA, Uganda Wildlife Authority (UWA), WCS and Uganda Bureau of Statistics (UBOS). All the stakeholders provided secondary data available to them. Data for Non-Wood Forest Products (NWFPs) was compiled based on discussions with key actors in the product value chain in the country.

This study employed the Net Price (NP) methodology for constructing the forest monetary accounts corresponding to the developed physical accounts. The NP method derives the stumpage value (resource rent) as the residual of the selling price of harvested timber (P) after deducting all production (silvicultural costs for cultivated plantations), harvesting, transport and capital costs (C) (Hassan 2000). This method calculates net accumulation in asset values (D) as the following simple product of the NP ($P_t - C_t$) and net change in standing stocks ($S_{t+1} - S_t = G_t - H_t$, i.e. additions minus extractions):

$$D_t = (G_t - H_t) \times (P_t - C_t)$$

where

- P_t and C_t refer to per unit resource price and extraction costs, respectively
- S_t is the stock of the asset at t
- G_t denotes growth from natural regeneration and other additions
- H_t refers to extraction (harvesting, damage etc.)

Table 1 Components of forest resource accounts

1. Forest-related asset accounts
Wooded land: land area and economic value by main species, natural and cultivated forest land, available for wood supply or not available, etc.
Standing timber: volume and monetary value of, by main species, natural and cultivated forest land, available for wood supply or not available, etc.
Depletion and depreciation of standing timber
Flow accounts: forest goods and services (volume and economic value)
2. Forestry and logging products (market and nonmarket production)
Non-timber products (output of game, edible plants, medicinal plants, etc.)
Forest services
Direct intermediate inputs to other sectors, e.g. livestock grazing
Recreation and tourism
Carbon sequestration
Protective services: biodiversity and habitat preservation; protective services such as preventive soil erosion
Supply and use tables for wood products, forestry and related industries
Degradation of forests due to forestry and non-forestry activities, e.g. soil erosion from logging, water and air pollution from wood processing industries
3. Expenditure on forest management and protection
Government expenditures and private sector expenditures
4. Macroeconomic aggregates
Value of forest depletion and degradation
Measures of national wealth, national savings and net domestic product adjusted for forest depletion or accumulation
Memorandum item employment; households dependent on NWFP; rights of forest exploitation, stumpage fees, taxes or subsidies; and manufactured assets, e.g. roads, equipment for forestry, logging and other

Source: Lange (2004)

The following additional assumptions were used to develop the forest resource accounts for Uganda:

- Forested land was calculated using the Net Present Value (NPV) method at a 10% social discount rate (World Bank 2007). The land value/ha/year was based on lease rates (Ushs 199,000) charged for commercial forest operators by the NFA and land rent on farms for private forest land at Ushs 240,000/ha/year. A 49-year discounting period was used as is common in forestry leases and land leases in Uganda. Leases were considered because public land transactions also include leasehold tenure transactions.
- Value of non-wood forest products (NWFPs) were determined based on the net price method using current market prices. The term wood was preferred over forest in the description of these products because of the need to correctly distinguish timber from other wood products.
- Biodiversity values were extrapolated based on estimates of the annual contributions of biodiversity in Uganda (Moyini 2006). Similarly, estimates of value of

butterflies and bees as pollinators were adapted from a recent PhD thesis research (Munyuli 2010).
- Carbon stocks and changes since 2005 were adapted from NFA figures (FAO 2010).
- Recreational services were estimated using the Travel Cost Method (TCM). Estimates were extrapolated from estimated costs of wildlife and forestry tourism in the Murchison Falls Conservation Area (NEMA 2010). The cost of forestry recreational services was calculated as product of proportion of nature-based tourists that target forestry resources and full expenditure for experience including transportation and expenses at tourism sites.
- All other wood products, ecosystem services were valued using the net price method.

3 Physical Forest Resource Accounts

3.1 Stock of Forested Land and Standing Biomass Volumes

The physical stock accounts consist of area and volume accounts. Area accounts projected change in physical stocks of forested land based on the findings of the national biomass survey which estimated an annual deforestation rate of 1.86% (NFA 2009). Accordingly, the area accounts suggest that aggregate forested land in Uganda declined from 3.6 to 3.3 million ha between 2005 and 2010 (Table 2).

Total above-ground volume of wood biomass was projected to have dropped from 280 million m^3 in 2005 to 277 million m^3 by 2010. This represents an annual decline rate of 0.6% (Table 2). However, biomass under Tropical High Forests (THFs) is believed to have increased despite the fall in overall biomass volumes. The overall decline was attributed to the high deforestation in the woodland areas.

3.2 Wood Available and Wood Not Available for Supply

National estimates have been made of timber yield from central forest reserves (MWE 2002; Odokonyero 2005; Namaalwa et al. 2009). The most recent estimates have only covered a fraction of the forest estate eligible for harvest (Table 3). Currently, only five central forest reserves of Budongo and Bugoma in the mid-west, Kalinzu and Itwara in south-western and Mabira in central Uganda have been designed for commercial wood harvesting. The estimated net volume available for harvest is 1.6 million m^3 from 5.3 million m^3 as net volume of production (NFA 2010).

About two-thirds of the country's forest estate is found on private land, and production is controlled by private citizens on that land. Therefore, estimates of

Table 2 Stock and changes in stock of forested land area and volume of standing wood biomass in Uganda (2005–2010)

Forested land area (ha)						
Summary	Total forested land	Broad-leaved plantation	Conifer plantation	THF well stocked	THF low stocked	Woodland
Opening stock (2005)	3,594,462	14,841	16,536	542,787	201,644	2,816,423
Annual rate of increase in forested area (%)	−0.02	0.13	0.13	−0.01	−0.02	−0.02
Est. change forested land area 2005–2010	−285,420	12,382	13,796	−29,248	−17,145	−262,974
Est. closing stock 2010	3,309,042	27,223	30,332	513,539	184,499	2,553,449
Standing wood biomass volume ('000 m^3)						
Summary	Total biomass	Broad-leaved plantations	Conifer plantations	THF well stocked	THF low stocked	Woodlands
Opening stock 2005	280,414	1,438	2,576	162,098	30,883	85,996
Average annual reduction in biomass	−1,583	−12	8	1,280	164	−2,001
Estimated reduction in biomass (2005–2010)	−7,913	−61	2,148	6,402	822	−10,004
% Annual change	−0.56%	−0.85%	–	0.79%	0.53%	−2.33%
Est. closing stock 2010	277,227	1,377	4,725	168,499	31,704	75,992

Adapted from NFA (2009) and FAO (2010)

Table 3 Harvestable wood volume in Uganda based on 30-year cycle and removal of 20 m^3/ha

Forest	Stocked area (ha)	Net vol/ha (m^3)	Net volume (m^3)	Available harvest volume (m^3)	Annual allowable cut (m^3)	Area for annual removal (ha)/ISSMI area	Net volume retained (forest integrity)
Budongo	29,445	62.5	1,839,826	588,900	19,630	982	1,250,926
Bugoma	24,550	76.8	1,699,447	491,000	16,367	818	1,208,447
Mabira	13,640	75.0	1,028,045	272,800	9,093	455	755,245
Kalinzu	7,035	70.0	490,262	140,700	4,690	235	349,562
Itwara	4,496	60.0	266,056	89,920	2,997	150	176,136
Total	**79,166**	**68.9**	**5,323,636**	**1,583,320**	**52,777**	**2,639**	**3,740,316**

Source: NFA (2010)

production have often been based on actual wood flows rather than changes in standing timber. Odokonyero (2005) estimated sustainable yield of about 19.68 million m^3 of timber from tropical high forests (280,000 m^3), woodlands (19,300,000 m^3) and plantations (100,000 m^3). However, production from woodlands has generally declined with their degradation, and current production mainly comes from tropical high forests and plantations. A clear picture is described in the section for wood product flows below.

3.3 Flows of Wood Products

Estimates of wood product flows were based on production figures provided by the National Forestry Authority (NFA) and the Uganda Bureau of Statistics (UBOS 2010) and reports of international timber trade (SPGS 2010; FAOSTAT 2010). The figures from the National Statistical Abstract (UBOS 2010) indicated that timber production in the country grew at a rate of 4.25% annually, between 2003 and 2007.

Total wood production was projected to increase from 31.6 to 39.1 million m^3 between 2005 and 2010 (Table 4). Only one-third (31–34%) of the wood production was for commercial purposes, and the rest was generally for meeting domestic energy needs. About 95% of the flows of wood products were fuelwood and charcoal, while sawn timber production contributed only 5% of the total (UBOS 2010).

Whereas, officially, export of roundwood timber is prohibited in order to avoid depleting the indigenous stock, trade data from Uganda Revenue Authority (URA) showed export and import of roundwood do take place (SPGS 2010). About 17,000 m^3 of roundwood were exported annually between 2008 and 2010 (FAO 2010). The roundwood imports mainly consisted of softwood, while the majority of exports were exotic hardwood species such as eucalyptus (SPGS 2010). Industrial roundwood imports comprise softwoods from the Democratic Republic of Congo (DRC).

Table 4 Timber flows based on natural production in Uganda ('000 m^3)

Description flows	2005	2010
Monetary		
Sawn timber ('000 m^3)	902	1,029
Poles ('000 m^3)	253	288
Wood fuel ('000 m^3)		
Households	802	914
Commercial	676	771
Industrial	1,562	1,632
Charcoal ('000 m^3)	6,080	6,978
Total wood production monetary	10,274	11,612
Nonmonetary		
Poles ('000 m^3)	555	601
Wood fuel ('000 m^3)		
Household	18,219	19,576
Commercial	2,219	2,328
Industrial	346	361
Total wood production nonmonetary ('000 m^3)	21,339	22,866
Total wood production		
Sawn timber ('000 m^3)	902	1,029
Poles ('000 m^3)	808	889
Wood fuel ('000 m^3)		
Household	19,021	20,491
Commercial	2,895	3,099
Industrial	1,908	1,993
Charcoal ('000 m^3)	6,080	6,978
Total wood production ('000 m^3)	31,614	39,061
Sawn timber and poles (%)	5.4	4.9
Total wood fuel production (%)	94.6	95.1

Source: Adapted from UBOS (2010)

The Forest Monitor (2007) indicated that imports into Uganda of 40,000 m^3 of roundwood from the DRC with 20,000 m^3 moving on to Kenya and the rest consumed within the country.

Exports of poles to neighbouring countries increased to 1,400 tons while imports declined to 350 tons in 2009 from about 800 tons in 2007 (Table 5). Other products traded included veneer, plywood, particle boards, fibreboards and carpentry and joinery (SPGS 2010). Veneer is used in plywood and furniture manufacturing. About 117 tons were imported, while 31 tons of veneer was exported. Similarly, 2,414 tons of plywood imported and 1,715 tons were exported mostly to the neighbouring countries of Sudan, DRC, Kenya and South Africa. Particle board and fibreboard imports were about 1,900 and 747 tons, respectively, while exports of carpentry and joinery were estimated at 200 tons (FAOSTAT 2010).

Table 5 Other wood product flows, 2010

	Volume of other wood products ('000 m^3)	
Product	Exports	Imports
Roundwood	1,691	401
Poles	1,400	350
Veneer	117	31
Plywood	1,715	2,414
Particle boards	2,055	1,924
Fibreboards	43	747
Carpentry and joinery	200	0
Totals	**7,221**	**5,867**

Source: FAOSTAT (2010); SPGS (2010)

3.4 Non-wood Forest Products

Non-wood forest products (NWFPs) consist of food products and food additives, medicinal products, clothing and product used for house construction, amongst other uses. For the purpose of this report, 15 main NWFPs were explored. Those were butterflies, pet animals, honey, aloe vera, drums and fiddles, tonic root (*Mondia whitei*), bark powder from *Prunus africanas*, bark tree (*Warburgia ugandensis*), bamboo shoots, shea butter, tamarinds (*Tamarindus indica*), African tulip (*Spathodea campanulata*), gum arabic, mushrooms (*Termitomyces aurantiacus*), and rattan cane.

3.4.1 Pet Animals

The economic contribution of pet animals was explored in terms of international pet trade, as pet trade within the country is not recorded. Pet animal exports from Uganda consisted of about 69 species of birds, 12 species of chameleons, 6 species of tortoises and turtles, 11 species of lizards and 19 species of snakes between 2003 and 2008 period (NEMA and ACODE 2008). The actual total exports over the 6-year period were 13,176 birds; 11,169 chameleons; 3,977 tortoises and turtles; 1,167 lizards, geckos and skinks; and 2,811 snakes captured outside national parks and wildlife reserves (UWA 2004).

In 2009, it was estimated that wildlife contributes US$3 million per year to the national revenues (Parliament of Uganda 2009; MTTI 2010). These revenues derive from exports of crocodile skins, snakes, chameleons and butterflies, all of which are raised on private land but obtain breeding stock from protected areas.

3.4.2 Honey and Bee Products

Apiculture involves keeping of bees to get honey and wax (Parliament of Uganda 2009 – Committee on Tourism, Trade and Industry). Uganda is endowed with a rich variety of bees, e.g. *Apis mellifera scutellata*, *A. mellifera adansonii* and *A. mellifera*

monticola and several species of stingless bees (Ogaba 2002). Honey production in Uganda ranges between 4,000 and 9,000 metric tonnes. Uganda's honey production potential is estimated at 100,000–200,000 metric tonnes of honey per year (Maku 2004). In 2009, it was reported that apiculture contributed about $17m (about sh15.5b) to the national economy.

Whereas the market for honey is considered to be available in Uganda, information about it is not as readily available. Arua Park is the main honey-trading place in Kampala City. Traders travelling with honey from different parts of the country converge at Arua Park (Maku 2004). Some of the buyers come from neighbouring countries mostly from Rwanda and Kenya. Some beekeepers and traders travel to sell their honey in Nairobi as they complain of delays and cheap prices of buyers in Kampala.

3.4.3 Aloe Vera

There are about 130,000 aloe vera farmers in 26 districts in Uganda. The majority of the country's aloe vera production comes from central and western Uganda (Sessanga 2007). At an average yield of 20 tonnes/ha total annual production of 7,200 tonnes is obtainable from the 380 ha under production. Aloe vera and its by-products are used for the manufacture of toothpaste, medicinal liquids, cosmetics (soaps and skin creams) and as animal feed. Aloe vera is one of the leading raw materials for Uganda's cosmetics industry (UEPB/Biotrade 2005).

3.4.4 Drums and Fiddles

Drum making is based on extraction and processing of stems of soft species and current utilisation concentrated on softwood species and means less competition with timber harvesters (Omeja et al. 2004). Drums and fiddles in Uganda are produced mainly from the central Uganda District of Mpigi with additional production reported in Masaka District further to the west of central Uganda and some production in eastern Uganda. According to the drum makers groups in Mpambire Town, Mpigi District, drums and fiddles generally mean a collection of nine main items: traditional drums (eng'oma), tube or cylindrical drums (e'ngalabi), xylophones (amadinda), one-string fiddles (e'ndingidi), bowl lyre (e'ntongoli), nine-string harps (adungu), shakers (e'biseso), beads (e'nsaasi) and small tube drums (e'jjembe).

The wood carving industry in Uganda produces mainly musical instruments. Between September 1999 and October 2000, drums sales from Mpambire Town in Mpigi District amounted to US$11,000. This revenue was important in complimenting income from agriculture (Samula 2001). From discussions held with drum makers at Mpambire Town, Mpigi District and drum sellers in Kampala, the following estimates were made about drum production in Uganda (Table 6).

Table 6 Estimates of production of drum and fiddles and prices in Uganda

Item	Sub-items	Est. production number (every 4 months)	Price range for each item (Ushs)
Drums	1–11 in.	1,000	3,000–30,000
	10–11 in.	4,000	30,000–35,000
	12–16 in.	2,000	35,000–60,000
	16–17 in.	1,000	60,000
	18–20 in.	1,000	60,000–100,000
Tube drums	Small	500	10,000
	Ordinary	2,800	60,000
	Decorated	800	100,000
Xylophones	15 in.	200	100,000
	12 in.	200	75,000
	9 in.	200	50,000
One-string fiddles		1,000	10,000
Bowl lyre		400	10,000–15,000
Sets of 9-string bowl harp	Seven harps in a set	500	400,000
Shakers		200	5,000–10,000
Beads (in a gourd)		120	10,000–15,000
Very small tube drums	6–12 in.	2,000	10,000–100,000

Source: Authors own estimates

3.4.5 Tonic Root (*Mondia whitei*)

Tonic root is the economic part of *Mondia whitei*, and they are largely perceived as sexual stimulant, appetiser, flavours for food and drinks and stimulant for milk production in lactating mothers. Chewing the roots is also believed to help clear hangovers from beers as well as controlling stomach ache. The roots are also reportedly used for treating gonorrhoea and also for contracting the uterus in women after delivery. Based on the work of Agea et al. (2008), this study estimated that over 1 tonne of *M. whitei* roots are consumed every month in Kampala City. Men and adolescent boys are the main consumers although there is a lot of 'hidden' consumption by women and adolescent girls.

Retailers mainly buy the roots directly from collectors and sell to consumers. The prices charged per piece and kilogram increase from collectors, middlemen and to the retailers. The average retail price was US$0.12 per piece of the root and US$1.50 per kg, while collectors charge US$0.06 and 0.60 per piece and kilogram, respectively. A survey undertaken in Kampala showed that *Mondia whitei* consumed in Uganda generally is sourced from Luwero, Mityana and Mubende districts in central Uganda. Wholesale traders estimated that the Kampala market could consume about 5–6 bags per month, approximately 360 kg/month at a price of Ushs

30,000/kg. The highest season of production and consumption is the peak first rain season months of March to June. At the national scale, the market was estimated to be on average 1.2 metric tonnes per month (although this may fluctuate in the dry season when the production is lower).

3.4.6 *Prunus africana:* Bark Powder for Medicinal Purposes

Prunus africana is classified by the World Alliance for Nature (IUCN) as vulnerable species, which led to its listing in the Appendix II of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES). This decision had a significant impact on the revenues produced from this non-wood forest product in the range countries (Cunningham and Mbenkun 1993). Commercial production is in the districts of Kasese, Bundibugyo, Kabarole, Mukono, Jinja and Mbale. The bark is traded internationally with major importers in Europe, Asia and USA. The bark powder is used to treat prostate cancer, as well as beer fermentation troughs 'beer boats', traditional medicine, fuelwood, building poles and timber (Betti 2008).

Uganda exported only 50 kg in 2003 for entire period (1995–2003). In 1992, prior to CITES App. II listing, Uganda exported *Prunus africana* bark to France via Kenya, but this was stopped due to destructive effects on Kalinzu-Maramagambo Forest Reserve. Uganda has recently applied for a CITES permit. This needs to be considered with caution. The Kalinzu-Maramagambo Forest Reserve has high conservation value but is under threat by illegal activity (hunting, charcoal burning, small-scale gold panning) (Howard et al. 1996), and Bwindi Impenetrable National Park has recovering *Prunus africana* stocks and vulnerable mountain gorilla populations; this recent request from Uganda needs to be carefully considered (Betti 2008). The biotrade programme reported on the country has a potential for producing 50 kg, *Prunus africana*, per annum and more if policies have been established to ensure the sustainable management of forests having *Prunus africana* stands in them (UEPB/Biotrade 2006).

3.4.7 Bark Cloth

Bark cloth is a unique fabric produced in parts of central and eastern Africa. In Uganda, specifically central Buganda, bark cloth production started way back in the thirteenth century and played significant cultural, financial and social roles. Locally known as Mutuba, (*Ficus natalensis*), it is a tropical fig tree species that is indigenous, widely grown and part of the traditional agroforestry system (Katebalirwe 2010). Bark cloth is also exported. It is sold in Germany (Bark Cloth Oliver Heintz Germany), Europe, and to designers in the UK and Netherlands (Mugula et al. 2010). Bark cloth is made in two types: the very good quality 'kimote' and the average quality type. The 'kimote' type is used regularly for clothing and fashion designs

both for men's and women's wear for official functions in Uganda especially in central Uganda. Because of its softness and tenderness, 'kimote' is regular used in designs for wrapping and to add style and texture in other industries. The ordinary average quality bark clothing is used for traditional functions and well as clothing for wrapping corpses before burial.

Bark cloth is produced through central Uganda although production is centred in Masaka and Rakai districts. The cultural leaders within central Uganda are encouraging the growth of the art of bark cloth making. The wholesale market for bark cloth in Uganda is difficult to estimate because traders are in many places and monitoring production is poor. Generally, traders believe that the total production of the good quality 'kimote' is about 5,000 pieces of cloth coming to Kampala every 3 months. The price for kimote ranges between Ushs 50,000 and 80,000; however, prices reduce as the quality fades to about Ushs 25,000. For the average quality, bark cloth production is estimated at about 20,000 pieces every 3 months, and the price ranges between Ushs 15,000 and Ushs 25,000.

3.4.8 Bamboo

Bamboo is a product of great importance to most village populations in Uganda. Rural people collect bamboo for use as a building material and its shoots for consumption and selling (Inbar 2009). Houses in some rural areas are constructed using bamboo for roofs, wall partitions, panelling, mats, ladders, blinds and furniture. Bamboo is also used in the production of certain fishing tools and paper and is sometimes used to make musical instruments such as flute and guitar. In Uganda, most of the country's bamboo resources are located in a few major sites, namely, the north-western district of Arua, the western and south-western districts of Hoima and Kabale, respectively, in addition to significant portion of the resource in the eastern district of Mbale. Most of the bamboo resources are located in protected areas under government control. *Arundinaria alpina* is one of the species that generally offers high utilisation potential and is abundant in most of the sites (Buyinza 2009).

Bamboo harvesting and processing in Uganda is concentrated in the Mt. Elgon forest in Mbale district in the eastern part of Uganda, Rwenzori in the west and Echuya, Bwindi and Mgahinga in Kabale district in the south-western corner of the country. There are also other small pockets of bamboo vegetation scattered in various parts of Uganda. The importance of bamboo has long been recognised by several cultures in the country. In particular, bamboo shoots are a major source of income to communities adjacent to bamboo forests such as the Gishu in Mbale where they are regarded as a traditional delicacy (Buyinza 2009). So far, a total of 52 species have been documented. The mountainous northern part of Mt. Elgon is one of the richest areas for bamboo. Surveys show it holds at least 50 species, 30 of which differ from those in central and southern Uganda.

3.4.9 Shea Butter

Shea nut trees widely and wildly grow in northern and north-eastern Uganda. The tree is also found along the borders of Congo (north of Lake Albert) and Sudan, with a small and isolated population in Nakasongola. Shea nut products, the solid fat (butter) and liquid oil (olein), are ideal raw materials in cooking oil, margarine, cosmetics, soap, detergents and candles. The production of shea nut products remained traditional, until 1994 when USAID started financing a community-based programme for processing shea nut oil in northern Uganda as well as a conservation programme for the shea nut trees. Shea butter and its products are also exported and sold in Europe and Japan where it is used in cosmetic industries (soaps, creams, moisturisers, hair conditioners and shampoo) and chocolate production. In the Ugandan shea production area, a Vaseline type product is used for babies and for other quasi-religious ceremonies.

The variety of shea nut, which grows in Uganda, is *Vitellaria nilotica* preferred for the cosmetic industry due to its higher olein fraction (Ferris et al. 2001). The variety is primarily grown in northern Uganda. The commercial development of shea products in Uganda remains at an embryonic stage, with little documentation on the market dynamics of the crop in Uganda and its surrounding countries.

Potential shea nut production in Uganda is estimated to be between 70,000 and 385,000 metric tonnes; this would yield between 15 and 80 million litres of oil using traditional methods at a value of US$30 million. However, current estimates show that the total quantity of shea nuts traded through the northern Ugandan markets per year is approximately 6,000 tonnes equivalent to US$0.66 million (Ferris et al. 2001; NEMA 2008).

3.4.10 Tamarinds (*Tamarindus indica*)

Tamarind (*Tamarindus indica*) is a valuable tree species in Uganda for fruit, timber, leaves and shade. In Uganda, it is mainly found in the eastern part of the country. Household surveys carried out in eastern Uganda from July 2004 to February 2005 estimated mean production of *T. indica* at 127 kg/ha/year and 84 kg/ha/year from open woodland and cropland areas, respectively, a statistically significant difference (Buyinza 2010). The net present value from *T. indica* products was US$893/ha in woodland and US$684/ha in cropland. In terms of foreign export earnings, *T. indica* juice from woodland and cropland was estimated to generate US$0.03/ha and US$0.02/ha, respectively. Returns from alternative land-use activities of agricultural cropping were highest for maize and lowest for finger millet in both open woodland and cropland sites. Sensitivity analysis revealed that an increase in the real discount rate from 9.86% (base case) to 15% decreases the financial NPVs of both the open woodland and cropland areas by 24%.

3.4.11 African Tulip (*Spathodea campanulata*)

Like *Mondia whitei*, *Spathodea campanulata* is an aphrodisiac for women. It is called kifabakazi in the Luganda language, and it is believed that when it is consumed or added in the food for women, it enhances their sexual desire. According to traders in Kampala, Spathodea was sourced (produced) from Masaka, Wakiso and the Busoga region of eastern Uganda. Based on the units used in the market, about ten bags every month in Owino market in Kampala and trader estimate that elsewhere in Kampala about ten extra (60 kg) bags could be sold per month. Throughout the country, and largely based on information from central Uganda, overall market supply would be about 40 bags every month. The price is quite low at Ushs 20,000 per bag.

3.4.12 Gum Arabic

Gum arabic is a product used in confectioneries, soft and alcohol drinks, pharmaceuticals, printing, ceramics and textile industries and as an ingredient in local medicine. In Uganda, it is mainly produced in Karamoja. The main tree species that are used to produce gum arabic are *Balanites aegyptiaca*, *Acacia senegal*, *A. seyal*, *A. sieberiana*, *A. gerrardii* and *Lanea humilis*, but the dominant species producing gum arabic are *A. senegal*, *A. seyal* and *A sieberiana*. The local uses of gum arabic are food, gumming spears and pots, gluing arrows, gluing broken stools, calabashes and joining leather (Egadu et al. 2007).

Karamoja has the potential to produce 20,000 tonnes of gum arabic. However, recent investor interest estimates that current production is only likely to reach 7,700 tonnes in the short term under the Uganda Gum Arabic Cooperative Society (TUGACS). TUGACS brings together 2,018 farmers in Moroto District with capacity to produce 4,700 tonnes under *Acacia senegal* and 3,000 tonnes of Acacia seyal trees (New Vision – February 2010)

3.4.13 Mushrooms (*Termitomyces aurantiacus*)

Another important NWFP are wild edible and farmed mushrooms, which are generally consumed in the local diet. Whereas estimates of commercial mushroom production can be made, the greater contribution of mushrooms is to the subsistence diet at household level. Subsistence consumption of mushrooms in Uganda is generally unknown. Nevertheless, we were able to make estimates of mushroom use based on discussions held in the markets in Kampala and the related supply chain simulations based on discussions with traders.

Wild (and farmed) mushrooms sold in Kampala are generally sourced from Mityana, Mubende, Luwero and parts of Mukono, Buikwe and Kayunga districts in central Uganda. However, production is known to exist throughout the country

especially in moist forest areas. Supply of mushrooms in Kampala markets is estimated at 4 metric tonnes/month. It is sold in containers known as debe. Estimates of sales are equivalent to about 15–20 bags/month for the 20 main markets in Kampala. A 15–20 kg Debe of mushrooms is sold at Ushs 60,000.

3.4.14 Rattan Cane

Rattan is a climbing palm native to tropical forest regions such as sub-Saharan Africa. It is estimated that over 650 species exist worldwide but 20 are most common in Africa all under four genera (Laccosperma, Eremospatha, Oncocalamus and Calamus) (Inbar 2006). In the past, many forests in Uganda supported large stocks of wild rattan, but the rattan has been rapidly declining due to commercial exploitation (Environmental Alert 2008). As such, out of the four traditional producing districts, Masindi, Mukono, Mpigi and Hoima, only Bugoma (Hoima) and Budongo (Masindi) remain as producers (Forestry Research Institute 2000; Environmental Alert 2008).

Overall production of rattan is estimated at about 4.8 tonnes in 2010 down from about 11 tonnes between 2000 and 2005 (Forestry Research Institute 2000; Inbar 2010). Although actual estimates for the producing districts, Mpigi, Mukono and Hoima, were about 4,068 bundles produced in 2005 (Table 7), only Hoima maintained production in 2010 (Environment Alert 2008; Inbar 2010).

3.5 Biodiversity Stocks

Forest accounting for biodiversity conservation services takes into account both stocks and flows of biodiversity from Uganda's forestry resources. Accounting for forest biodiversity in Uganda concentrates on the three main components of biodiversity stock in Uganda. They are (1) diversity of species, (2) genetic diversity and (3) ecosystem diversity. This report will concentrate on the first component of diversity of species due to current data limitations.

A series of studies were conducted under the auspices of the forest department aimed at providing a comprehensive account of the state of knowledge of the flora and fauna in Uganda's central forest reserves (MWLE/Forest Department 1996). The studies covered 65 of Uganda's major reserved forest, which together accounted for 1.2 million ha of land managed by government as permanent forest estate. The studies indicated that Uganda is one of the most biologically diverse countries in Africa, with much of its biodiversity represented in a system of 10 national parks, 10 wildlife reserves and 710 forest reserves covering 33,000 km^2 (14%) of the country's area (Howard et al. 2000). In the late 1980s, a policy was instituted to dedicate half the area of forest reserves to sustainable timber production and the other half to environmental protection (with 20% nature reserves). The results represented in the report included 14 forests that together with existing national parks accounted for 96% of species

Table 7 Rattan cane supplied annually by district

	Volume produced (bundles)		Value of production (Ushs)		Value of supply (US$)	
District	2005	2010	2005	2010	2005	2010
Mpigi	1,500	–	1,800,000		987.7	–
Mukono	1,800	–	14,400,000		7,901.3	–
Hoima	768	768	3,072,000	11,059,200	1,685.6	4,790.4
Totals	**4,068**	**768**	**19,272,000**	**11,059,000**	**10,574.6**	**4,790.4**

Source: Forest Research Institute (2000); Environmental Alert (2008); Inbar (2010)

represented in protected areas. The 14 forests were classified as 'prune' and 'core' sites and were selected for the establishment of large native reserves (averaging 100 km^2). The addition of 25 smaller 'secondary' forest nature reserves (averaging 32 km^2) would protect more than 99% of the indicator species (Howard et al. 2000). For Uganda total, there were 1,259 species of trees and shrubs, 1,011 species of birds, 75 species of rodents (small mammals), 1,245 species of butterflies, 115 species of hawk moth (large moths) and 96 species of silk moths (Forest Department 1996).

3.6 Carbon Sequestration Services

Carbon storage was calculated using a factor multiplied by the biomass (0.5) to determine the carbon stock and another factor (44/12) to determine the carbon dioxide equivalent (CO_2e^-) (FAO 2010). Total carbon stock declined by 2%, from 564.5 to 556 MtC, while the tons of carbon equivalent declined from 2,070 to 2,040 (Table 8). The management cycle for Uganda's forests is based on a 30-year cycle. If the carbon stock is assumed to have been accumulated over the 30-year cycle, therefore in the most recent year of the cycle, carbon accumulated would be 18.5 MtC (equivalent to 68 $MtCO_2e$).

The decline in carbon storage mirrors similar declines in forested area and biomass over the project period. Therefore, the decline in carbon stocks of about 2% is comparable with the 3% for biomass from a 9% decline in forested land (FAO 2010; NFA 2009).

3.7 Recreational and Aesthetic Services

Recreational services (and products) from the country's forest resources and wildlife reserves (and national parks) include forest walks, chimpanzee tracking, community walks, bird watching, butterfly watching and long-distance walking (4–5 days). Recreational and aesthetic services from Uganda's forest resources are generally bundled, and disparate data is collected on revenues received for different activities (UWA 2010; UEPB/Biotrade 2006; NFA 2010).

Table 8 Estimates of stock of carbon storage in Uganda's forest estate, 2005 and 2010

	Carbon sequestered (million MtC)				Overall total		CO_2e (MtC * 44/12)	
Type of biomass	2005	2010	2005	2010	2005	2010	2005	2010
Above-ground biomass	97.6	85.6	13.5	15.9	111.1	101.5	407.4	372.2
Below-ground biomass	26.4	23.1	3.7	4.3	30.1	27.4	110.4	100.5
Carbon in litter	7.2	6.3	6	7.1	13.2	13.4	48.4	49.1
Subtotal					0	0	0	0
Soil carbon	222.9	194.2	187.2	219.9	410.1	414.1	1,503.7	1,518.4
Total	**354.1**	**309.2**	**210.4**	**247.2**	**564.5**	**556.4**	**2,069.8**	**2,040.1**

Source: Adapted from NFA (2009); FAO (2010)

Table 9 Number of visitors to national parks and wildlife reserves by category

Categories	Numbers of visitors
Non-resident foreign tourists	61,000
Resident students	42,000
Foreign residents	14,000
Local adults	31,000
Transit	3,000
VIPs	1,000
Totals	**152,000**

Source: MTTI (2010)

The Ministry of Tourism Trade and Industry (MTTI) Statistical Abstract (MTTI 2010) stated that while Uganda received about 817,000 tourist visitors, only 16% were interested in leisure and recreational activities. In 2009, only 152,000 people visited the country's national parks and forest reserves up from 138,000 the previous year (Table 9). The contribution of forestry sector to tourism is estimated based on tourist numbers, assuming that about one-third of overall tourist visitors are interested in forestry-based tourism (MTTI 2010).

3.8 Soil Protection Services

Soil and water protection services provided by forests include soil stabilisation through soil erosion reduction, maintenance of soil organic matter and increasing water infiltration and storage. Trees take atmospheric inputs in the air as part of greenhouse gases (GHGs) mitigation (van Noordwijk et al. 2002). Forests also contribute to water supply protection through filtering water pollutants and regulating water yield and flow, enhancing precipitation and moderating floods, reducing surface erosion and sedimentation and trapping aerial pollutants. For the forest accounts of Uganda, there will be one major consideration contribution towards soil erosion control, therefore soil nutrient protection.

The soil protection services to soil nutrient were determined as the loss in stock of soil nutrients reduced or prevented as a result of maintaining forest cover loss compared to stock soil nutrients retained elsewhere where the forest cover was removed, replaced or converted. To determine the annual soil nutrient loss from THF and surrounding lands due to soil erosion, findings were taken from soil nutrient losses due to erosion in Mabira Forest Reserve. Mabira was used because several studies were conducted in the forest under FOREAIM initiative (Kizza et al. 2005). On the other hand, estimates of soil nutrient losses associated with soil erosion were based on studies conducted in the eastern and central Uganda (Wortmann and Kaizzi 1998; Nkonya et al. 2005; Zake et al. 2002; de Jager et al. 2003; Bekunda and Manzi 2003; McArthur and Sachs 2011). Kizza et al. (2005) estimated soil and nutrient losses from Mabira forest restored blocks.

Table 10 Soil nutrient losses from land-use change, forests to agriculture

Cause of soil nutrient losses	Soil nutrients in central forest reserve (FR) (NPK) (tons/ha)	Soils in neighbouring areas (NPK) (tons/ha/year)	Difference NPK (kg/ha)	Land area 2010 ('000 ha)	Total losses of NPK (2010) (tons)
Soil erosion losses THF and plantations	0.13	0.03	0.105	755.59	78,733
Reduction in stock woodlands	0.60	0.44	0.157	2,553.45	400,407
Total					**479,130**

Source: Adapted from Nabalegwa et al. (2006) de Jager et al. (2003); Wortmann and Kaizzi (1998); Kizza et al. (2005)

For forests converted to agriculture, Wortmann and Kaizzi (1998) estimated average NPK losses of more than 130 kg/ha/year in maize, potato and soya bean in central and eastern Uganda although losses sometimes exceeded 200 kg/ha/year. These losses of NPK were much higher than the 30 kg/ha/year estimated in Wakiso (Zake et al. 2002) or the 54 kg/ha/year estimated NPK loss in central Uganda (Magunda et al. 2003). However, de Jager et al. (2003) also found soil nutrient losses on farmlands of 200 kg/ha/year of NPK in Kabarole, western Uganda, a district equally rich in THFs. Therefore, a modest estimate of 130 kg/ha/year NPK loss was adopted for THF (Table 10).

For the purpose of this study, the aggregate soil nutrient losses due to erosion in the areas surrounding forests during the short and long rains were taken for stable forest areas older than 10 years. Therefore, aggregate nutrient losses were calculated as 7.94 kg/ha/ N, 0.43 kg/ha P and 17.44 kg/ha K, which is equal to 25.81 kg/ha NPK loss from the areas surrounding forests (Kizza et al. 2005).

For woodlands, estimates were drawn from a study on changes in soil chemical and physical properties due to land-use conversion in Nakasongola District. Nabalegwa et al. (2006) compared fallowed woodland areas where regeneration occurred over a 10 (and 5)-year period with areas left open for grazing. Results showed losses of 157 kg/ha/year (Table 10).

4 Monetary Forest Accounts

4.1 Monetary Value of Forest Land

Estimation of the monetary value of the forested land was based on the valuation system applied for leasing land for commercial timber plantations or other industrial use by the National Forestry Authority (NFA) and Uganda Wildlife Authority (UWA). The current rate is Ushs 199,000/ha/year, which was the uniform rate

Table 11 Uganda's opening and closing stock of forested land value (2005 and 2010)

	Total forested area ('000 ha)		Annual land lease and rent value (million US$)[a]		Present value (million US$)	
Description of land use	2005	2010	2005	2010	2005	2010
Central forest reserves (CFRs)	627.9	593.3	67.5	51.4	7,203.5	5,489.0
National parks, wildlife reserves, animal sanctuary	641.1	629.01	70.	54.5	7,471.2	5,819.8
Dual joint management (DJM)	30.7	28.9	3.4	2.5	358.3	267.3
Local forest reserves	1.211	1.1	0.1	0.1	14.1	10.3
Private forested land	2,293.6	2,035.3	302.0	212.8	32,232.9	22,708.5
Total value	3,594,462	3,287.89	443.0	321.4	47,280.0	34,294.7

[a]USD = UGX 1,822.48; 2,308.60 (BoU 2005, 2010)
Source: Adapted from NFA (2009) and BOU (2005, 2010)

applied for all public land in this study, while the rental rate for land commonly used in the country averages at about Ushs 240,000/ha/year (SPGS 2008). In estimating the forested land, we are interested in determining the present value of the land based on the lease agreements. The most common lease period used for public land is 49 years. The 49-year lease period was also simulated for the rent of land. The NPV of forested land assets was accordingly derived using a social discount rate of 10% commonly applied by the World Bank (World Bank 2007)

The present value of total forested land declined from US$47 (in 2005) to US$34 billion (2010) (Table 11). The forested land value declined because forested land also decreased by about 300,000 ha of forested land between 2005 and 2010.[2] However, for the purpose of annual accounting, our interest was in the annual value of US$321.4 million in 2010.

4.2 Value of Standing Timber

The value of timber in Uganda's forest estate was estimated by multiplying the value of timber (plantations and tropical high forests) Ushs 41,798/m^3 by the volume of standing timber and the value of the poles (Ushs 18,800), the common product from woodlands by the volume of standing timber in woodlands. The value of standing timber was estimated as US$4,362 million (Ushs 10,051 billion) a slight increase from US$4,275 million (Ushs 9,850 billion) estimated for 2005 (Table 12).

[2] USD = Ushs 1,822.48 and 2,308.60, respectively, for 2005 and 2010 (BoU 2005, 2010). Total value of forest area actually declined by a small fraction of the observed reduction of about 28% of the total value of forested land. This was due to the fall in exchange rate by 20% between 2005 and 2010 whereas forested area declined by 8%.

Table 12 Monetary value of standing timber in Uganda's forests (2005 and 2010)

Summary		Total biomass	Broad leaved plantations	Conifer plantations	THF well stocked	THF low stocked	Woodlands
Value in 2005	(Million Ushs)	9,850,721.8	60,105.5	107,671.6	6,775,372.2	1,290,847.6	1,616,724.8
	Million US$	4,275.2	26.1	46.7	2,940.5	560.2	701.7
Value in 2010	(Million Ushs)	10,051,786.0	57,555.8	197,495.6	7,042,921.2	1,325,163.8	1,428,649.6
	Million US$	4,362.47	24.98	85.71	3,056.62	575.12	620.03

Source: Authors own calculations

4.3 Value of Wood Flows

The monetary value of forest products recorded in the national accounts (UBOS 2010) increased from Ushs 235,202 to 258,965 million between 2005 and 2010. Our calculations, however, indicate an actual decline from US$129.06 to 112.17 million (Table 13). The nonmonetary wood products had a higher value than the monetary products. Because the producers use these products at a subsistence level, the likelihood of low estimates of value are high.

For internationally traded forest products, the trade balance for 2010 was about Ushs 1 billion or US$437,000. However, this underestimates the true level of activity, which is substantially higher. Total exports were Ushs 9.4 billion (US$4.1 million), while total imports were about Ushs 8.4 billion (US$3.6 million) (Table 14). There are some illegal imports especially from the Democratic Republic of Congo and exports which cannot be effectively tracked (Forest Monitor 2007).

4.4 Value of Carbon Sequestration Services

Forest resource activities mitigating atmospheric carbon emissions in developing countries include reforesting degraded lands, implementing sustainable agricultural practices on existing lands and slowing tropical deforestation. Niles et al. (2002) proposed that in calculating the carbon sequestration services, the estimation will rely on a central price of $10/metric tonne of carbon and a discount of 3%. The State of the Voluntary Carbon Markets Report 2010 (Hamilton et al. 2010) established that prices for verified emission reductions ranged between $7.6 and 12.1/mt$CO_2$e. However, often only one-third of the value is captured for forest projects in developing countries (Hamilton et al. 2010). For the Environmental Conservation Trust in Uganda (ECOTRUST), lower carbon prices are associated with low scores on permanence (Rainforest Alliance 2009). Similarly, CDM carbon credits from forestry are priced lower because they are not permanent. Therefore, the estimated US$4/mt$CO_2$e is only a fraction earned by permanent carbon emission reductions (CERs), estimated at US$12–24 in 2010 (Forbes India Magazine 2010). The voluntary carbon standards available in Uganda include Plan Vivo and the Climate, Community and Biodiversity Standard (CCBS), which are applied in agricultural landscapes and involve planting trees and especially aimed at enhancing or maintaining local biodiversity and high co-benefits. Therefore, a conservative price of US$4/mtC was used to value carbon in this study. The annual value of carbon stored in the country's forest estate including estimates of both above and below biomass declined from US$276 to 118 million from 2005 to 2010 (Table 15).

Table 13 Monetary value of wood product flows in Uganda (2005 and 2010)

Description	Value of forest product flows (million Ushs)		Value of forest product flows (million US$)	
	2005	2010	2005	2010
Monetary				
Sawn timber	37,648	43,012	20.66	18.63
Poles	4,758	5,414	2.61	2.35
Wood fuel				
Household	5,794	6,412	3.18	2.78
Commercial	4,884	5,343	2.68	2.31
Industrial	11,290	12,319	6.19	5.34
Charcoal	36,545	41,825	20.05	18.12
Total monetary flows	**100,919**	**114,325**	**55.37**	**49.52**
Nonmonetary				
Poles	10,419	11,288	5.72	4.89
Wood fuel				
Household	105,323	113,602	57.79	49.21
Commercial	16,044	17,095	8.80	7.40
Industrial	2,499	2,656	1.37	1.15
Total nonmonetary	**134,282**	**144,640**	**73.68**	**62.65**
Total wood production	**235,202**	**258,965**	**129.06**	**112.17**

Source: UBOS (2010)

Table 14 Value of flows of other forest products in 2010

Wood products	Flows of other forest products 2010 (‘000 Ushs)	Flows of other forest products 2010 (‘000 US$)
Exports		
Sawn timber	2,587,941	1,121
Poles	31,663	14
Veneer	309,352	134
Plywood	2,731,074	1,183
Particle boards	3,003,489	1,301
Fibreboards	73,875	32
Carpentry and joinery	692,580	300
Total exports	9,429,974	4,085
Other imports		
Sawn timber	517,126	224
Poles	6,648.768	2.88
Veneer	143,133	62
Plywood	4,432,512	1,920
Particle boards	2,338,612	1,013
Fibreboards	983,464	426
Carpentry and joinery	0	0
Total imports	8,421,496	3,648
Trade balance	1,008,478	437

Source: FAOSTAT (2010)

Table 15 Monetary value of carbon sequestered in Uganda's forests (2005 and 2010)

	Carbon sequestered (million tCo_2e)		Value of tCo_2e (millions US$)	
Type of biomass	2005	2010	2005	2010
Above-ground biomass	13.6	12.4	54.3	49.6
Below-ground biomass	3.7	3.3	14.7	13.4
Carbon in litter	1.6	1.6	6.5	6.5
Soil carbon	50.1	50.6	200.5	202.4
Total	69.0	68	276.0	272.0

Source: Adapted from FAO (2010)

4.5 Value of Forest Biodiversity Services

Biodiversity richness of a forest generally represents an option value because it is perhaps one of the least translated into tangible benefits (Bush et al. 2004). In addition to undisclosed plant-based pharmaceuticals, there is considerable genetic potential especially for farmed or domesticated species (Howard 1995). Various estimates have been used to show the value of biodiversity in sub-Saharan Africa. Ruitenbeek (1989) estimated a biodiversity value of £0.1/ha/year for the Korup Park, although Howard (1995) suggested that Uganda's forests might be less biodiverse than Cameroon's Korup Park. Similarly, Pearce and Moran (1994) suggested that the average value of tropical forests ranges between US$0.1 and 21/ha/year. Nonetheless, a commonly used average value for biodiversity in Uganda's forests is US$1.5/ha/year (Bush et al. 2004; Moyini 2006).

Annual contribution of biodiversity in Uganda's forests was determined by multiplying the estimated annual value per hectare by the area of natural forest in Uganda. The value increased from Ushs 9.2 billion in 2005 to 10 billion in 2010. However, this should be distinguished from the present value of the cumulative contribution of biodiversity, which is often much higher. As Bush et al. (2004) noted, biodiversity value is enormously underestimated because much of the tangible values of pharmaceuticals, agricultural technology and other traditional uses have not been closely examined.

There have been separate attempts to establish the contribution of butterflies and bees to the national economy (Munyuli 2010). Munyuli's estimates were based on a global finding that pollinators contribute ecological services estimated to be over €150 billion per year (US$200 billion). The presence of forest patches in fringe zones of agricultural matrices was found to diversify bee and butterfly communities delivering pollination services to nearby agricultural fields. Munyuli's study was undertaken in the coffee-banana farming system of central Uganda Munyuli (2010). It was established that bees contributed to over 60% of coffee (Coffea robusta) fruit set. Bee biodiversity, foraging activities and services delivery to coffee (fruit set) were found to be driven by several local, landscape and regional level factors. Coffee potential yield and bee contribution to fruit set were positively related to bee abundance, species richness, foraging rate, percentage young fallow in the vicinity of

Table 16 Value of biodiversity in Uganda's forest (2005 and 2010)

Description	Area ('000 ha)		Rate (US$/ ha/year)	Value of biodiversity ('000 US$)		Value of biodiversity (million Ushs)	
	2005	2010		2005	2010	2005	2010
Natural forests	3,398	2,937	1.5	5.097	4.405	9,290.0	10,170.5
Pollinator services of bees and butterflies					149.4		344,904.84
Total					154.8		357,371.3

Source: Adapted from FAO (2010) and Moyini (2006)

coffee fields and proportion of seminatural habitats within 1 km^2 of coffee fields. About 0.3–0.5 million tonnes of coffee were produced in central Uganda during year 2007 for a mean economic value of US$214 million from which US$149.4 million (62%) were attributable to pollination services delivered by bees (Table 16). This pollinating service value was equivalent to 24% of annual earnings from export of agricultural products and 2.99% of GDP.

The pollinator services of bees and butterflies towards coffee and banana, US$149.4 million, were added to the value of biodiversity, although pollinator services have not been previously considered in the valuation of forest ecosystem services (Munyuli 2010; Moyini 2006; Yaron et al. 2003). Therefore, the total value of biodiversity was estimated as US$154.8 million (Table 16).

4.6 Value of Non-wood Forest Products

The total flow of non-wood forest products (NWFPs) was estimated at Ushs 65 billion (US$22 million) in 2010 (Table 17). The highest contribution was from honey, where the reported value is dominated by exports. The value of honey in the domestic market especially the noncommercial use is envisaged to be higher than reported. Shea butter also contributes about US$0.66 million annually to the national economy, making it the second highest earning NWFP after honey. The value of NWFPs generally relies on production from natural forest estate. There has been limited effort to consider optimal production of NWFPs in the country.

4.7 Recreational Services

The monetary value of recreational services was calculated based on tourist visitors to the country and data generated from a recent survey undertaken in the Murchison Falls Conservation Area (NEMA 2011; MTTI 2010). In Sect. 3.7 of this report, it

Table 17 Monetary value of non-wood forest products flows for 2010

Non-wood forest products	Monetary value (million Ushs)	Monetary value (US$)
Pet animals and butterflies	6,470.7	3,000,000
Honey	39,246.2	17,000,000
Aloe vera	2,104.0	911,377
Drums and fiddles	807.5	349,779
Tonic root (white's ginger)	129.6	56,138
Prunus africana	6.9	3,000
Bark cloth	8.7	3,769
Bamboo	922.7	40,000
Shea butter	15,225.3	660,000
Tamarinds	36.4	1,577
African tulip	9.6	4,158
Gum arabic	29.7	12,859
Mushrooms	216.0	93,563
Rattan cane	11.1	4,790
Total	**65,224.4**	**22,141,010**

Source: Adapted from NEMA and Acode (2008), UWA (2006), UEPB/Biotrade (2005), (2009)

was indicated that the number of tourists visiting national parks, wildlife reserves and forest reserves was 152,000 people. Of these 61,000 depended on foreign travel, while 91,000 generally relied on local travel. NEMA (2011) established four ranges of travel costs covering transportation, air travel and/or road, park fees and accommodation for foreign non-resident tourists and tourists travelling with local transportation (Table 18). Overall foreign non-residents paid between US$1,000 and 5,000, while local travel tourists paid between US$300 and 801.

When the survey findings were applied to the number of national tourists visiting national parks and forest reserves, the value of forestry tourism could be estimated. Overall, 91,000 tourists used local transportation, while 61,000 travelled as foreign non-residents. The findings of NEMA (2011) have been used to estimate the average travel cost for tourists to destinations in Uganda and when multiplied with the number of tourists gives an estimate of the overall nature-based tourism to the country (Table 19).

However, Moyini (2006) indicated that the whole package of tourism in Uganda so often referred to as nature-based tourism is generally shared between the forestry and wildlife sectors. Moyini proposed that only three of the conventional nine components of the package can be attributed to forestry alone (Table 20).

Similarly, NEMA (2011) found that 80% of the tourists indicated that they visited all the attractions. Therefore, the estimate of the forestry-based tourism can be estimated by multiplying the total monetary value of national park and forest reserve tourism with a coefficient that introduces the two adjustments above (US$297,111,050 * 0.8 * 3/9). The result gives the monetary value of tourism to the country's forest resources of US$79,150,384.

Table 18 Travel cost ranges for foreign non-residents and local travel tourists

Travel cost ranges for foreign non-resident ranges	Proportion of tourists (%)
Less than up to US$1,000	2
Between US$1,001 and 3,000	24
Between US$3,001 and 5,000	33
Above US$5,001	40
Tourists using local travel	
Less than up to US$300	20
Between US$301 and 500	29
Between US$501 and 800	35
Above US$801	15

Source: NEMA (2011)

Table 19 Estimated monetary value of forestry tourism to Uganda

Categories of tourist	No. of tourists	Average travel cost	Value (US$)
Foreign non-resident tourism	61,000	(1,000 * 0.02) + (3,000 * 0.24) + (4,000 * 0.33) + (5,001 * 0.4)	247,684,400
Local tourist travel	91,000	(300 * 0.2) + (400 * 0.29) + (650 * 0.35) + (801 * 0.15)	49,426,650
Total			**297,111,050**

Source: Authors own estimates

Table 20 Revenues received by Uganda wildlife authority from recreational services

Recreational categories for UWA	Revenues (Ushs)
Chimpanzee viewing	1,363,580,913
Mountain gorilla tracking	9,650,939,069
Hiking and biking	41,798,061
Nature walks	158,844,874
Lodging and accommodation	9,710,797
Birding, butterfly viewing and primate walks	168,000,000

Source: UWA (2010)

Forestry tourism revenue captured by UWA and the NFA was reported as Ushs168 million (Table 19) and 18.6 million, respectively (UWA 2010; NFA 2010). This was only 10.2% of the entire revenue calculated. It would seem that most of the revenue remained within the value chain and is shared by travel agencies, airlines and hotels.

4.8 Soil Protection Services

From Sect. 3.8, it was indicated that losses of NPK from farmlands surrounding tropical high forest and plantation areas were about 104.2 kg/ha/year, while losses from farmlands surrounding woodlands were about (156.81 kg/ha over a 10-year

Table 21 Estimated value of forest soil nutrient protection from avoided soil erosion

Forest categories	Area 2010	NPK losses (kg/ha)	Est. NPK losses (tons)	Price ('000 Ushs/ton)	Monetary value (million Ushs)	Monetary value (million US$)
THF	698.04	0.1042	72,736	1,400	101,830	44
Woodlands	2,553.45	0.15681	400,407	1,400	560,569	243
Plantations	57.55	0.1042	5,997	1,400	8,395	4
Total					**670,794**	**291**

period) 156.81 kg/ha/year (Nabalegwa et al. 2006; de Jager et al. 2003; Wortmann and Kaizzi 1998; Kizza et al. 2005). These losses were carried forward to 2010. The price of NPK was reported as Ushs 70,000 per 50 kg bag in 2010 (MAAIF, personal communication). According to these, the monetary value of forest nutrient protection service through avoided soil erosion in the area under forest cover was estimated at US$291 million (Ushs 671 billion) (Table 21). The largest proportion of the losses was from soil erosion in woodlands especially from keeping large numbers of livestock, which trample the soil exacerbating soil erosion (Nabalegwa et al. 2006).

5 Economic Aggregates for Uganda Forest Sub-Sector

This section derives selected aggregates summarising information on the supply and use of forest resources within the economy; indices related to forest management services, employment and research; and measures of the contribution of forest subsector to the national economy.

5.1 Supply and Use Table

This study made an attempt to use available data to compile supply and use tables for Uganda's forest resources. These, however, are not comprehensively developed for data limitations. Much of the work needed for a comprehensive quantitative value chain analysis for the sector has not been undertaken yet. This section uses information from the NFA and the Sawlog Production Grant Scheme (SPGS) on the contributions of different actors in the sector to develop indicative supply and use tables for 2010. SPGS has commissioned a study to establish a comprehensive database of the forestry economy within the country.

The physical and monetary wood and wood products supply and use through the entire value chain are presented in the Appendix A. It is estimated that 1 million m^3 of sawlogs, 889,000 m^3 of poles and 25 million m^3 of fuelwood were supplied and used in Uganda in 2010. As indicated in Table 13, there were some exports, but these formed a very small fraction of 1–5% of the entire volume and monetary value of wood supplied and used in the country.

5.2 Other Forest Management Services

5.2.1 Accounting for Employment Management Services

A submission made by the National Forestry Authority (FAO 2010) indicated that Uganda's forestry sub-sector directly employed 201,000 people (Table 22). However, there was little clarity about the value of employment and whether or not the people worked in the public or private sector. Instead an alternative review based on the institutional arrangements, particularly in public sector, was used to determine the contribution of forestry management services to the sub-sector in Uganda.

The NFA and FSSD

The Ministry of Water and Environment (MWE) sector performance report (MWE 2010) indicated that public expenditure towards supporting the activities of the Forestry Support Services Department (FSSD) and the NFA was Ushs 40.8 and 9.5 billion in 2009/2010, respectively (Table 23). The financing for FSSD also included funds for implementing the Farmer Income Enhancement and Forestry Conservation (FIEFOC) project. The FIEFOC project supports afforestation, agroforestry and watershed management within farming communities and areas as a means of income enhancement for participating farmers.

In addition to the public finance support, the NFA received financial support from development partners and generates its own revenue from licences, timber auctions and fines and charges (NFA 2009). Preliminary estimates for 2010 indicate that nontax revenue (NTR) contributed 67% of the total revenue resources available to the NFA, while development partners and government funding was 24% and 7%, respectively (Table 24) (MWE 2010).

District Forest Service

The District Forest Service in local governments governs 64% of the forest estate delivering decentralised forest services for managing local forest reserves and private and customary forests, in essence supervising forestry activities outside protected areas. Although both NFA and DFS were meant to complement one another, it is only the NFA, which is significantly funded. UWA, on the other hand, has resources to effectively execute its mandate in national parks and wildlife reserves. However, FSSD and DFS receive very little funding and so have not taken up their position adequately. The total financing for forestry activities in Uganda remains under Ushs 0.8 billion for the DFS (MFED-BTTB 2010). These resources were shared amongst over 100 districts.

Table 22 Employment in the forestry sub-sector of Uganda (2010)

Categories of employment	No. of employees
Firewood and charcoal production	89,000
Household production	71,000
Commercial and industrial wood production	36,000
Plantation establishment and management	1,400
Institutions	2,600
Pole production	1,000
Total	**201,000**

Source: FAO (2010)

Table 23 Central government financing for forestry management at national level

Agencies financed by central government	Amount of financing (Ushs)		
	Budget	Actual release	Expenditure
Budgetary allocations for the Forestry Support Services Department (FSSD) including FIEFOC funds for District Forest Service	40.827	26.714	20.101
NFA	9.512	5.18	1.94

Source: MWE (2010)

5.2.2 Education and Research

There are two institutions of higher education that teach forestry management in Uganda; Makerere University Faculty of Forestry and Nature Conservation (FFNC, now under the College of Agricultural and Environmental Sciences) and Nyabyeya Forestry College in Masindi District.

The Makerere University Fact Book (Munyuli 2010) stated that there were 212 students at different stages of their education in the FFNC at Makerere University and 43 staff. On the other hand, the student population at Nyabyeya was 385 in 2010 (Okoija 2010). Estimated public expenditure for the Nyabyeya Forestry College, the only technical forestry college in the country, was about Ushs 960,562,794.

At Makerere University's Faculty of Forestry and Nature Conservation, the expenditure was estimated based on the estimated cost per student. The cost is spread to include education, practical living expenses, lecture salaries and other wages and expenses. The cost per student is Ushs 6,000,000 usually also quoted as US$3000 per student (Students' Guide of Uganda 2010). For the 212 students, the cost was Ushs 1,272,000,000 (or US$636,000). On the other hand, public expenditure

Table 24 NFA annual revenue by source (2004/2005–2009/2010) billion UGX

Period	2005	2006	2007	2008	2009	Budget. 2009–2010	Prel. 2010
Total revenue (TR)	12.26	13.91	14.30	14.08	17.28	27.51	16.54
Nontax revenue (NTR)	5.42	6.44	8.26	11.34	15.04	18.00	11.34
Forest products	4.06	4.44	4.94	6.84	7.82	7.35	9.16
Revenue from plantations	3.91	4.6	5.50	7.23	9.50	9.95	6.21
Revenue from plantations % of TR	32	33	38	51	55	36	38
Revenue from plantations % of NTR	72	72	67	64	63	55	55
Government subvention	0.164	0.194	0.024	0.042	0.176	1.200	1.175
Development partners	6.679	7.289	6.013	2.700	2.069	8.276	4.028
%NTR	44	46	58	81	87	65	67
% Development partners	55	52	42	19	12	30	24
% GoU subvention	1.3	1.4	0.2	0.3	1.0	4.4	7.1
Personnel costs as % of NTR	94	87	63	53	40	45	37

Source: MWE (2010)

on forestry research at the National Forestry Resources Research Institute (NaFORRI) was Ushs.8 billion.

The total expenditure on forestry management and regulation, education and research was estimated as US$23.85 million (or Ushs 55 billion) per year in 2010 (Table 25). This cost does not include private sector investments as well as investments from development partners under programmes such as the Sawlog Production Grant Scheme (SPGS) although the projected production is captured under plantations in the component on timber available and not available for production.

5.3 Contribution of Forestry to the National Economy of Uganda

Based on the above described forest accounts, conservative estimates were established on the total contribution of the forestry sub-sector to the national economy which amounted to approximately US$1,277 million in 2010 (Ushs 2,960 billion) (Table 26). When compared with the GDP of 2009 at current prices of Ushs 34,166

Table 25 Estimated expenditure on forestry management, education and research

Category	Expenditure Ushs	Expenditure in US$
Management and regulation		
FSSD	20,101,000,000	8,707,009
NFA	16,540,000,000	7,164,515
DFS	800,000,000	346,530
Local government FIEFCO	7,200,000,000	3,118,773
Education		
Makerere University Faculty of Forestry and Nature Conservation	1,272,000,000	636,000
Nyabyeya Forestry College	960,562,794	416,080
Research		
National Forestry Resources Research Institute	8,000,000,000	3,465,304
Totals	**54,873,562,794**	**23,854,211**

Table 26 Summary of monetary value of forest products, services and management

Description of forest products, services, management and regulatory components	Value (million Ushs)	Monetary value (million US$)	% of total
1. Forested land	741,984.04	321.4	25.17%
2. Timber flows recorded in statistical abstract	258,955.66	112.17	8.78%
3. Other timber trade exports	9,430.63	4.09	0.32%
4. Less other timber trade imports	−8,421.77	−3.65	−0.29%
5. Non-wood forest products	65,224.40	22.14	1.73%
6. Carbon sequestration service	627,939.20	272	21.30%
7. Biodiversity conservation service	357,371.30	154.8	12.12%
8. Recreational services	182,726.58	79.15	6.20%
9. Soil protection services	670,794.00	291	22.79%
10. Hydrological services	–	–	–
11. Forestry management, regulation, education and research	54,873.56	23.85	1.87%
Estimated total contribution of sub-sector	**2,960,877.60**	**1,276.95**	**100.00%**

billion, the forestry sector was equivalent to 8.7% of that amount (BOU 2010). One must remember that some of the values reported in Table 26 are already included in the SNA GDP estimates, e.g. timber trade values and forest management services. The value of other important components of the estimated contributions while do form part of the current SNA, their values are attributed to the wrong sectors. Those include regulating services which provide intermediate input services to the production of many economic goods traded and valued in the SNA such as carbon

sequestration (21%), pollination and soil protection services (23%), whose values are captured as part of agricultural production and other sectors' values. The most important element in the estimated forest values is the annual value of forested land (25%). Adjustments of the SNA to correct for this value should be through adjusting change in wealth and savings' accounts (e.g. net national product) for depreciation of forest assets as part of total wealth of the nation. Some of the estimated values are ordinarily missing from the current measures of GDP such as some non-wood forest products (2%) and informal timber trade (0.6%).

6 Conclusions and Recommendations

The Uganda forest accounts were developed to establish the annual contribution of the country's forestry sub-sector to the national economy. The national forest accounts show that forest resources contribute significant values to the national economy some of which are missing from the current SNA and others are captured by other sectors of the economy.

The study revealed that there is dearth of data on forest products and service value chains, and this limits a complete description of the forestry sector. Some studies have been undertaken with limited scope. Indeed, only a countrywide survey can effectively measure the extent of the forestry economy in the country. The national biomass surveys done by the NFA were extremely useful in undertaking this study. In some areas, projection data was used when primary or processed data could be provided; however, the constraints in assembling all the resources needed limited the usefulness of NFA data.

Whereas the NFA and MWE have made considerable effort at the national level, many institutions have not published information about their recurrent expenditures, forestry management, research and educational activities.

Therefore, if the natural resource accounting methodology is to be effectively used for forest resources management and policy design, more effort in developing the capacity of institutions generating information on the supply and use of forest resources is needed. This report provides a first step towards strengthening the discussion on the greening of national accounts in Uganda. This would require that not only forests but all other major natural resources must also be accounted for such as soils, wetlands and water, amongst others.

The study makes some immediate and long-term actions to improve the utility of green accounting for improved policy design and resource management decisions. One immediate action of this study is to design a strategy for disseminating these findings and share them with a number of resource sector ministries and the Ministry of Finance, Planning and Economic Development (MFPED) and Uganda Bureau of Statistics, amongst others. While timber, non-wood forest products and wood fuel are already major items but have poorly developed supply and value chains, the supply and value chains for carbon sequestration, non-wood forest products, recreational services and other ecosystem services are quite inadequately developed.

Key conservation messages from this study relate to enhancing soil protection services of forests, better use of carbon markets and trade, enhancing hydrological services, biodiversity conservation especially in relation to recreational services and protection of important habitats. New tools are emerging such as the REDD plus, payments for ecosystem services and environmental financing mechanisms, all of which can enhance conservation while also contributing to economic development.

The findings of this study can be refined further through research to integrate other values such as hydrological services and conducting field studies to improve current results. More importantly, that natural resource accounting should be extended to all other major natural resources. Rather than creating a parallel process, it is important to realise that the backbone for generating data already exists at the MWE, NFA, UWA, NEMA, UBOS and District Forest Services. However, there are weaknesses in existing institutional capacity to implement these both in terms of human capacity and the infrastructure and regular financing resources to effectively strengthen existing institutions.

Appendix A Uganda's Supply and Use Tables (2010)

Table A1 Physical wood and wood products supply table

	Forestry and logging	Wood products	Pulp and paper	Printing	Recycling	Total	Imports	Total
Standing timber ('000 m^3)	27,501						0	27,501
Sawlogs ('000 m^3)	1,029						0.40	1,029
Poles ('000 m^3)	889						0.35	889
Fuelwood ('000 m^3)							0	
Household	20,491						0	20,491
Commercial	3,099						0	3,099
Industrial	1,993						0	1,993
Pulpwood ('000 m^3)								
Wood and wood products ('000 m^3)								
Veneer		–					0.031	–
Plywood		–					2.414	–
Particle boards		–					1.924	–
Fibreboards		–					0.747	–
Carpentry and joinery		–					0	
Pulp ('000 t)		–					0	
Paper ('000 t)		–					0	
Wood waste as a product ('000 t)		–					0	

Table A2 Physical wood and wood products use table

Products	Forestry and logging	Wood products	Pulp and paper	Printing	Recycling	Total	Exports	Total
Standing timber ('000 m^3)	27,501						0	27,501
Sawlogs ('000 m^3)	1,029						1.70	1,030.7
Poles	889						1.40	890.4
Fuelwood ('000 m^3)								
Household	20,491						0	20,491
Commercial	3,099						0	3,099
Industrial	1,993						0	1,993
Pulpwood ('000 m^3)								
Wood and wood products ('000 m^3)								
Veneer ('000 m^3)							0.12	–
Plywood ('000 m^3)							1.72	–
Particle boards ('000 m^3)							2.06	–
Fibreboards ('000 m^3)							0.04	–
Carpentry and joinery ('000 m^3)							0.20	–
Pulp ('000 t)								
Paper('000 t)								
Wood waste as a product ('000 t)								

Table A3 Monetary wood and wood products supply table

	Forestry and logging	Wood products	Pulp and paper	Printing	Recycling	Other	Total	Imports	Total
Standing timber	94.06								498.88
Sawlogs	18.63							0.22	
Poles	7.24							0.003	
Fuelwood									
Household	52								
Commercial	10								
Industrial	6								
Pulpwood									
Wood and wood products									
Veneer								0.062	
Plywood								1.92	
Particle boards								1.013	
Fibreboards								0.426	
Carpentry and joinery								0	
Pulp									
Paper									
Wood waste									

Table A4 Monetary wood and wood products use table

	Forestry and logging	Wood products	Pulp and paper	Printing	Recycling	Other	Total	Final consumption	Capital formation	Exports	Total
Standing timber	94.06										94.06
Sawlogs	18.63									1.12	19.75
Poles	7.24									0.014	7.23
Fuelwood											
Household	52										
Commercial	10										
Industrial	6										
Pulpwood											
Wood and wood products											
Veneer										0.134	
Plywood										1.183	
Particle boards										1.301	
Fibreboards										0.32	
Carpentry and joinery										0.30	
Pulp											
Paper											
Wood waste											

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