UGANDA BUREAU OF STATISTICS

THE REPUBLIC OF UGANDA

TOWARDS ECOSYSTEM ACCOUNTS FOR UGANDA

UGANDA NATURAL CAPITAL ACCOUNTING PROGRAM

WAVES

WORLD BANK GROUP

October 2020

FOREWORD

Between October 2018 and November 2020, the Government of Uganda with the support of the World Bank-led Wealth Accounting and the Valuation of Ecosystem Services (WAVES) Global Partnership Program implemented the Uganda Natural Capital Accounting (NCA) program. The NCA program aimed to mainstream natural capital into development policy dialogue and planning by integrating a set of accounts to inform the Third National Development Plan (NDPIII), the National Land Policy (2013) and the Uganda Forestry Policy (2001), among others. The NCA program also increased understanding on the real contribution of natural assets and the ecosystem services to the economy and how the economy and its sectors affect the natural asset base. The report "Towards Ecosystem Accounting for Uganda" is a benchmarking report that shows the progress on developing Experimental Ecosystem Accounts for forest and wetland ecosystems one of the products proposed under the NCA program.

The report on "Towards Ecosystem Accounting in Uganda" describes the results of the first iteration for experimental ecosystem accounts in Uganda using the Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) model. The work on ecosystem accounting has indicated how information in ecosystem accounts could be used to support policy making and ecosystem management. The examination of the land cover accounts in combination with the information of on National Parks and Wildlife Reserves allowed the representativeness of these conservation areas to be assessed and showed that woodlands were better represented than other forest types in all river basins.

As the Government of Uganda continues to develop and implement policies to meet the Vision 2040, it seems that ecosystem accounts could help set realistic baselines, track progress, demonstrate trends, quantify trade-offs, and ensure the most effective synergies between environmental, social and economic policies. Going forward, extending the ecosystem service accounts to cover more services, and in particular cultural and recreational services, will need to occur for the accounts to have maximum impact.

On behalf of the Government of Uganda, the Uganda Bureau of Statistics would like to thank the World Bank WAVES program for the technical and financial support provided in developing Uganda's Towards Ecosystem Accounting Report. The report provides a sound basis for strengthening ecosystem accounting in the country.

....

Chris N. Mukiza, PhD

Executive Director
Uganda Bureau of Statistics

ACKNOWLEDGEMENTS

The Government of Uganda's Natural Capital Accounting initiative extends gratitude to the ministries, agencies and local government authorities who participated in the developing the report on "Towards Ecosystem Accounts in Uganda". The Government is especially grateful to the Ministry of Finance, Planning and Economic Development (MoFPED) and the National Planning Authority (NPA) for their leadership; to the National Forestry Authority (NFA), the Wetland Management Department (WMD) and Forestry Sector Support Department (FSSD) in the Ministry of Water and Environment (MWE), the National Environment Management Authority (NEMA) and the Uganda Wildlife Authority (UWA) for compiling the physical data. The Government of Uganda also extends gratitude to the Uganda Bureau of Statistics (UBOS) for developing the accounts themselves and to the Technical Working Group for their guidance and support. In-depth reviews by Statistics Netherlands and Statistics Canada are also gratefully acknowledged.

The work received technical and financial support from the World Bank's Wealth Accounting and the Valuation of Ecosystem Services (WAVES) Partnership Program.

TABLE OF CONTENTS

LIST OF FIGURE

LIST OF TABLES

EXECUTIVE SUMMARY

Uganda has begun the task of creating ecosystem accounts, using data, modelling tools and capacity that are readily available. This report outlines the progress on the production of ecosystem accounts, including experimental accounts and the challenges of producing them, along with a plan for their ongoing production and potential use. All accounts were in physical metrics as time and resources did not allow monetary measures to be developed.

The primary objective of this was to assess if ecosystem accounts could be developed for Uganda. This was to demonstrate the general set-up of ecosystem accounts, determine the feasibility of their production, and assess their policy relevance – particularly for key ecosystems of interest like forests and wetlands that provide a range of benefits to people as well as being rich in biodiversity.

The process and methods used built on previous work and in particular the work and land and forest accounting in Uganda and the SEEA–Experimental Ecosystem Accounting framework, which notes that land cover can be used as a proxy for ecosystems. Using these and other information sources, such as the Wetland Atlas in combination with modelling tools, a suite of accounts covering the eight river basins that make up Uganda were produced for the years 1990, 2005, 2010 and 2015. This information revealed changes in land cover and in particular the loss of nearly 2.8 million hectares of woodland across the country between 1990 and 2015 with much converted to farmland. The river basin that lost the most woodland was Aswa, losing more than 0.8 million hectares

The land cover information was integrated with other information to produce accounts examining wetlands and forest management in the country. The wetland accounts highlighted large changes in the extent of different land covers within wetlands as defined in national Wetland Atlas. In particular, temporary wetland showed large variation between years and the net change between 1990 and 2015 revealed that just over 0.4 million ha of wetland had become farmland. Similarly, the forest account showed changes is the use of forest all five forest types. For example, the extent of forests in National Parks and Wildlife Reserves had decreased from the 831,000 ha in 1990 to 640,000 ha in 2015.

Modelling was used to generate estimates of physical flows related to ecosystem services. The modelling enabled an experimental ecosystem service account to be designed and populated for the supply side for each of the eight major watersheds. In this, physical estimates of carbon storage, carbon sequestration, water yield and sediment retention were mapped. The estimates were made for the years matching the land cover account: i.e., 1990, 2005, 2010, and 2015. There were differences between river basins and the services they supplied. For example, nationally there was an increase in the amount of carbon stored from 769 million tonnes in 1990 to 804 million in 2015 but there were differences between river basins, with the amount of carbon stored being less in four river basins. Water yield also increased nationally and with five basins showing increases in yield, while 3 showed decreases. The changes in these four physical flows measured were related to changes in land cover.

The work developing the accounts revealed that there were differences in data sources that needed to be reconciled. This was most apparent in the information for wetlands, where differences in the definitions and methods underpinning that data sources were apparent. Data quality assessment was also a challenge with data from many sources being used for purposes for which they were not designed. Going forward these challenges will need to be addressed. A clear positive benefit was that staff from different professions and different agencies were able to work together on the production of accounts and an ongoing formal process for guiding the development, production and use of ecosystem accounts will be needed.

The work on ecosystem accounting has indicated how information in the accounts could be used to support policy making and ecosystem management. In principle, the accounts can support land use planning, climate change mitigation, biodiversity conservation, water supply and agricultural policies.

The examination of the land cover accounts in combination with the information of on National Parks and Wildlife Reserves allowed the representativeness of these conservation are to be assessed, and showed that woodlands were better represented than other forest types in all river basins. They also showed that the amount of forest within national parks was decreasing owing to changes in land cover which were probably driven by human activity

As the Government of Uganda continues to develop and implement policies to meet the Vision 2040, it seems that ecosystem accounts could help set realistic baselines, track progress, demonstrate trends, quantify trade-offs, and ensure more effective synergies between environmental, social and economic policies. Going forward, extending the ecosystem service accounts to cover more services, and in particular cultural and recreational services, will need to occur for the accounts to have maximum impact.

The utility of the ecosystem accounts would be considerably improved if monetary measures related to ecosystem assets and services were also developed. As such, economic valuation of ecosystem services is a critical next step and will require greater integration with both Uganda's land accounts and national economic accounts. Previous Ugandan work on the valuation of ecosystem services would be a useful starting point.

The work demonstrates that, while there are challenges, the data sources, methods and capacity currently available to Uganda can be used to produce ecosystem accounts. Over time the work will need to expand and be mindful of the need to address the policy and management needs of the government and private sector.

ACRONYMS AND ABBREVIATIONS

BSU	Basic Statistical Unit
CNDPF	Comprehensive National Development Planning Framework
CFR	Central Forest Reserve
CICES	Common International Classification of Ecosystem Services
CWA	Community Wildlife Reserve
DJM	Dual Joint Management
EAU	Environmental Accounting Unit
GIS	Geographic Information System
GoU	Government of Uganda
InVEST	Integrated Valuation of Ecosystem Services and Trade-offs
IUCN	International Union for the Conservation of Nature
LFR	Local Forest Reserve
MDAs	Ministries, Departments and Agencies
MoFPED	Ministry of Finance, Planning and Economic Development
MWE	Ministry of Water and Environment
NBS	National Biomass Survey
NCA	Natural Capital Accounting
NDP	National Development Plan
NEMA	National Environment Management Authority
NFA	National Forestry Authority
NPA	National Planning Authority
NP-AEEA	National Plan for Advancing Environmental Economic Accounting
SDGs	Sustainable Development Goals
SEEA CF	System for Environmental Economic Accounting Central Framework
SEEA EEA	System for Environmental Economic Accounting Experimental Ecosystem Accounts
SNA	System of National Accounts
UBOS	Uganda Bureau of Statistics
UGGDS	Uganda Green Growth Development Strategy
UNSD	United Nations Statistical Division
UWA	Uganda Wildlife Authority
WAVES	Wealth Accounting and the Valuation of Ecosystem Services
WCMC	World Conservation Monitoring Centre
WMD	Wetlands Management Department

CHAPTER ONE: INTRODUCTION

1.1 Country and policy context

Uganda is rich in biodiversity, harboring a number of iconic species, including over 50% of the world's gorilla population (Pomeroy et al. 2017). Uganda is also rich in water and forest resources. However, these biodiversity, forests and water resources are increasingly under pressure (NEMA 2019). Land conversion and habitat losses are among the main threats and some two-thirds of Uganda's forests were lost since 1990. The Government of Uganda is addressing these concerns in the national policy framework (GoU/NPA 2017).

The Government of Uganda approved the Comprehensive National Development Planning Framework (CNDPF) in 2007 (GoU/ NPA 2013). The CNDPF is strategic plan that's main elements are: the 30-year national vision (Vision 2040); 10-year national development plan; the 5-year national development plans, and; annual plans and budgets. In July 2020, the third National Development Plan (NDP III 2020/21 – 2024/2025) replaced the NDP II 2015/16 – 2019/2020 (NDP II).

Article 27 of Uganda's National Constitution states that natural resources are to be managed and utilized in a sustainable manner and the government would take all possible measures to prevent or minimize damage and destruction to environment resulting from pollution and other causes. The government is also mandated to create and develop parks, reserves and recreation areas and ensure conservation of natural resources and promote rational use to safeguard and protect the country's biodiversity (GoU 1995).

In 2017, the Government of Uganda completed the Uganda Green Growth Development Strategy (UGGDS) where natural capital management and development is one of the five focus areas (GOU/NPA 2017). The UGGDS harmonized the aspiration of Uganda's Constitutional position on natural resource management, the Vision 2040, NDP II and the Sustainable Development Goals (SDGs), among others, and made natural capital accounting a priority for realizing sustainable development in the country.

Under the structure of the CNDPF, Ministries, Departments and Agencies (MDAs) are required to prepare sector policies and master plans, consistent with the long-term national development goals and objectives. The sector policies shall set out, among other things, the strategic direction of the sector for the next five years and ensure that the sectors' strategic roles in national development are sustained and enhanced in light of new and emerging challenges.

In order to streamline the inclusion of natural capital accounting into MDA plans, the government through the Uganda Bureau of Statistics (UBOS), and with support from the United Nations Statistics Division (UNSD) and the World Bank developed a National Plan for Advancing Environmental Economic Accounting in Uganda (NP-AEEA). The NP-AEEA provides guidance on how sectors can initiate and integrate statistics on natural capital with other indicators used by different sectors, ministries, departments and agencies. The NP-AEEA provides a streamlined pathway for implementing environmental-economic accounting and for integrating accounting information into annual work plans and budgets as well as sector policies and master plans.

To fulfill the aim of integrating natural capital into the planning and management process used in the country, the government with support of the World Bank and the UNSD launched the NP-AEEA, the Uganda Land Physical Asset Accounts, and the Water Accounts in November 2019. The National Wood Asset and Forest Resources Accounts were launched in September 2020.

1.2 Project background

The Government of Uganda (GOU) is implementing the Natural Capital Accounting (NCA) program through the UBOS, the Ministry of Finance, Planning and Economic Development (MoFPED), the Ministry of Water and Environment (MWE) and the National Planning Authority (NPA). The NCA program seeks to mainstream natural capital into development policy dialogue and planning by integrating a set of accounts that will inform the Third National Development Plan (NDPIII) and other national and sectoral policies. The program aims to increase understanding of the contribution of natural assets and the ecosystem services to the economy and the impact of the economy and other human actions on the natural asset base. NCA Program implementation is supported by the World Bank-led Wealth Accounting and the Valuation of Ecosystem Services (WAVES) Global Partnership Program.

The NCA program is organized in three components:

(i) Accounts development, with the objective to strengthen UBOS capacity for the production and dissemination of NCA by developing land accounts, forest resource accounts, ecosystem accounting, and supporting the production and dissemination of the National Compendium of SEEA;

(ii) Studies and activities to enhance accounts development, with the objective to address gaps that need special attention for future NCA implementation by developing an assessment of ecosystem services in the Albertine Rift, several issue papers (on wood fuels, macroeconomic indicators, and linkages between NCA and NDPIII, working on narratives to include Natural Capital in MOFPED dialogues and reports; and

(iii) Institutional engagement, professional development and policy dialogue, with the objective to raise awareness and increase understanding on the possible policy applications of NCA through a strong communication strategy, hosting a series of training events and knowledge sharing activities, and fostering inter-institutional dialogue on NCA.

1.3 Objective, aims and scope of report

The objective of this report is to provide an update on the development of ecosystem accounts for Uganda, focusing on basic building blocks for the accounts and what could be developed in the short term with the available data and modelling tools. This is in order to show the general set-up of ecosystem accounts, determine the feasibility of their production, identify data gaps and assess their policy relevance.

The three key aims of this report are to explore:

(1) The production of ecosystem asset accounts;
(2) The production of ecosystem service accounts;
(3) How such accounts can be used to inform policy and management in

For the accounts for ecosystem assets, the available land cover and land use information was compiled at a national scale for the purpose of developing national level accounts as well as for the eight major river basins of Uganda (Figure 1). A very small area of Uganda is found outside of these eight river basins and for accounting purposes these are included in the national tables as a balancing item. The land cover information was then related to other on information on wetlands as well as the management of forests and wetlands.

The development of ecosystem services accounts requires the modelling of physically flows and then determining the use of these flows by people. With time and resources limited only a few ecosystem services could be estimated. As climate change, water supply and agricultural management are important policy areas in Uganda four related ecosystem services related to these areas were chosen: carbon storage, carbon sequestration, water provisioning, and erosion control.

Carbon storage and sequestration contribute to mitigating climate change, while erosion control is the contribution of ecosystems to mitigating sedimentation of reservoirs used for power generation and irrigation as well as the erosion of agricultural land.

In this report the ecosystem services were only estimated in physical units. Water provisioning is modeled in this report in a generic way as the difference between the rainwater per pixel and the loss of water through evapotranspiration. In this case, the potential ecosystem service of water supply can be more accurately linked, in physical points, to the site where water is extracted from an ecosystem (e.g. a drinking water well). The generation of water by rainfall minus evapotranspiration is a physical flow feeding into the ecosystem service. Given the lack of data on water abstraction, this indicator is used to approximate the potential ecosystem service 'water provisioning'. Linking this information to the existing water accounts (GOU 2019) would reveal actual uses of much of the water (e.g. for hydroelectricity generation). The valuation of the ecosystem services consistent with the SEEA would require the application of exchange values to each of the ecosystems services reported here.

1.4 Outline of report

The report is broken into six sections, with five appendices. Section 1 is the Introduction. Section 2 provides the details of the framework used to organize information and the data sources and methods used to populate the accounts. Section 3 provides summary results in a range of figures and maps and briefly highlights key data. Section 4 discusses the results, including policy relevance and the data limitations, while Section 5 is conclusions. This is followed by the references and the Annexes which contain more detail on the data sources used in modelling as well as the detailed accounting tables.

CHAPTER TWO: FRAMEWORK, DATA SOURCES AND METHODS

2.1 The SEEA framework

The framework and concepts underpinning this study are from the SEEA (UN et al. 2014a, 2014b). The SEEA-EEA has been designed to enable countries to analyze and monitor changes in their ecosystem capital and the relation between ecosystems and economic activities (UN et al., 2014b). The SEEA EEA is a spatially explicit framework that includes a range of information on the physical extent and condition of ecosystems, the ecosystem services they supply, and the monetary value of the ecosystem assets and services. The SEEA-EEA also covers the basic spatial units of the accounts and their aggregation. Supporting the SEEA-EEA is a set of Technical Recommendations (UN 2017). The terminology of the SEEA-EEA and Technical Recommendations are followed in this report.

Ecosystem accounting relies on three spatial categorizations: the Basic Spatial Unit (BSU), the Ecosystem Type (previously called 'Land Cover Ecosystem Unit or LCEU) – and the Ecosystem Accounting Area (EA), previously called Ecosystem Account Unit (see UN et al. 2014a and UN, 2017). The BSU is the smallest, relatively homogenous unit in the map. The BSU used in the land cover account is a hectare. The use of hectares is aligned with national indicators for wetlands, which are presented in the Vision 2040 and NDP III.

The SEEA EEA is complementary to the SEEA Central Framework (UN et al., 2014b), which is a (non-spatial) statistical standard broadly used to measure, among other things, stocks of individual natural resources, including land, mineral and biological assets and environmental expenditures. Both the SEEA EEA and the SEEA Central Framework are connected to the System of National Accounts (SNA), the statistical standard applied in almost all countries worldwide, including in Uganda, to produce economic and other statistics. The combination of all three frameworks allows a rich suite of information to be produced. One limitation of the SNA and SEEA Central Framework is that sub-national data are usually not available. However, the SEEA EEA is a spatial framework and focuses on ecosystems assets services at sub-nation levels: the Ecosystem Accounting Areas and in the case of Uganda these were the eight river basins (Figure 1). The SEEA Central Framework covers various elements that are not part of the SEEA EEA, such as air emissions and solid wastes flowing to the environment and environmental expenditures, among others.

The SEEA EEA consists of an interlinked set of maps and accounting tables. The accounts that are part of the SEEA EEA are:

(i) the ecosystem extent account specifying ecosystem type and area covered by each ecosystem type;
(ii) the ecosystem condition account, including a set of scalable physical indicators that allow monitoring changes in ecosystem state or health;
(iii) the ecosystem services supply and use account specifying actual flows of ecosystem services, and the uses of ecosystems by economic sector in physical and monetary terms; and,
(iv) the monetary ecosystem asset account, specifying the monetary value of 'stocks' of ecosystem capital.

There are associated SEEA EEA accounts are for land cover, biodiversity, water and carbon (UN et al., 2014b; UN, 2017). Note that comprehensive accounts for all of these aspects are not yet compiled in Uganda, although accounts for land cover (UBS 2019), water (GOU 2019) and some aspects of biodiversity (IUCN-WCMC 2017) are available. The SEEA EEA also includes the possibility to extend the framework with information on the capacity of ecosystems to supply these services in a sustainable manner, however there is not yet a generally agreed methodology within SEEA EEA to do so.

2.2 Land cover and ecosystem accounting

In the SEEA accounting framework, the land account includes accounts for land cover, land use or management (e.g. protected forest versus production forest), land tenure (e.g. public or private ownership), soil type, as well as for ecosystems. Land cover is often used as a proxy for ecosystem extent and the land accounts for Uganda (UBOS 2019) were the starting point for the work in this report which is consistent with the SEEA EEA (UN et al., 2014b) and Technical Recommendations (UN, 2017). Experimental accounts for wetlands as an ecosystem, rather than wetlands as a land cover, were also investigated (See Section 2.3).

The wetlands are of particular policy interest as Uganda is a signatory to the Ramsar Convention with some 454,000 ha is listed under the convention. The Uganda Wetland Atlas Volume II (GOU 2016) defines a wetland as "an area of land that is permanently or seasonally saturated with water" which is different from how wetlands are defined in the land cover account.

Uganda's has 13 land cover types[1]. These are: (i) Broadleaved forest plantations, (ii) Coniferous forest plantations, (iii) Tropical High Forests (THF) well-stocked, (iv) THF low-stocked, (v) Woodlands, (vi) Bushlands, (vii) Grasslands, (viii) (permanent) Wetlands, (ix) Small-scale farmlands, (x) Commercial farmlands, (xi) Built up areas, (xii) Open water, and (xiii) Impediments (e.g. bare earth) (UBOS 2019).

In the case of accounting for ecosystem services in Uganda, the use of land cover types rather than ecosystem types is not expected to lead to major limitations, since the biophysical processes and properties underlying the ecosystem services of interest can be estimated from land cover data (e.g. standing biomass, evapotranspiration).

Uganda's land cover accounts were based on the National Biomass Survey (NBS) database 2017. The data in this database are derived from remotely sensed data and field surveys and much is available online[2]. An earlier report outlines the data sources and methods used in the survey of forests (NFA 2009). Through joint work between the National Forestry Authority (NFA) and the Wetland Management Department (WMD) in the Ministry of Water and Environment (MWE) the NBS database was updated to include a layer on the drainage basins. The land cover accounts were then developed from the updated database, with data aggregated by drainage basins rather than the areas of aggregation shown in the previously published land accounts (UBOS 2019).

[1] It should be noted the classification used covers aspects of both land cover and land use but for ease of reference this is abbreviated to "land cover accounts".
[2] See National Forest Monitoring System Portal – Uganda: http://154.72.199.254:8008/

Figure 1: Major river basins within Uganda

Source: Adapted from MWE 2020

The land cover accounts were produced at national scale and for each individual drainage basin (Figure 1). The spatial organization and analysis of information was conducted with technical contributions from the Geographical Information System (GIS) and Inventory teams at the NFA and the WMD of the MWE. The drainage data were developed by the WMD, while the BSU and ET as well as the land cover and land use attributes were developed from the National Biomass Database by the NFA. The spatial analysis was used to produce physical data and maps of wetland cover and use between 1990 and 2015, as well as the land cover and use for forests over the same period. The accounts were compiled with Microsoft Excel, which allowed for the conversion of the source data into a format that is used for the compilation of the accounts. The physical data from the National Biomass Survey was synthesized using pivot tables and change matrices using the Microsoft Excel extensions of Power Pivot.

2.3 Accounting for wetlands and forest uses

Information for the wetland accounts was drawn for the data sources underlying the Uganda Wetland Atlas Volumes 1 and 2 (GOU 2016) and aligned to the river basin areas and land cover classes used for the land cover accounts. The balancing area was included in the results. In this, the wetland accounts in Uganda were split into permanent and seasonal wetlands. The Uganda definition of wetlands has evolved overtime to reflect changes in the policy, regulations and physical measurements of the wetland area and its use. The 1995 National Policy for the Conservation and Management of Wetland Resources defined wetlands in Uganda as an area where plants and animals have become adapted to temporary or permanent flooding by saline, brackish or fresh water. Therefore, wetlands in Uganda include permanently flooded areas with sedge or grass swamp, swamp forest or high-altitude mountain bog, as well as seasonal flood plains and depressions without flow (GoU 1995). The classification into permanent and seasonal wetlands is a consolidation of the Ramsar Classification of Wetland Types. The Ramsar classification includes 42 types of wetlands, which belong to one of the three broad categories: Inland wetlands; Marine/coastal wetlands; Human-made wetlands (Ramsar Convention Secretariat, 2011). Uganda's wetlands fall almost entirely within the Inland wetlands classification of Ramsar. It is important to note the wetland area, as defined in the wetlands accounts (Section 3.2), fall into in a range of land covers, including grasslands, wetlands, small scale farmland and open water, as defined in the land cover accounts (Section 3.1). This difference is discussed later in the report.

Uganda's forest uses are classified based on the system of administration. Forests on private land are forests in non-protected areas which includes private lands and public institutional lands which are not gazette as protected areas. Central Forest Reserves (CFRs) as defined under the National Forestry and Tree Planting Act (2003) are protected areas managed by the National Forestry Authority (NFA). CFRs represent a permanent forest estate, a component of the permanent forest estate the Local Forest Reserves (LFRs) is managed by District Local Governments, it is also a protected area. The forestry legislation also recognizes forests located in wildlife protected areas including Community Wildlife Area (CWA), Dual Joint Management (DJM) area a buffer zone between National Parks and CFRs, National Parks, Wildlife Reserves and Wildlife Sanctuaries. Wildlife protected areas are managed by the Uganda Wildlife Authority (UWA). With the exception of CFRs and LFRs, which are gazetted as forest protected areas, forest ecosystems in Uganda refers to the five forest cover classes of Broad leaved plantations, Coniferous plantations, Tropical High Forest (THF) well stocked, THF low stocked and woodlands were considered forests. The entire area under CFRs and LFRs is a forest protected area, and therefore a forest ecosystem based on the National Forestry and Tree Planting Act (2003). Therefore, CFRs and LFRs contain all 13 land cover classes.

2.4 Accounting for ecosystem services

The physical flows relating to ecosystem services were calculated using the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) model version 3.7.0, developed by the Natural Capital Project. InVEST is free and open-source, has relatively low data requirements, and is well suited for large spatial-scales (Sharp et al. 2015). Each InVEST module is functionally unique and represents distinct ecological and hydrological processes. The InVEST software suite is the leading tool for incorporating natural capital information into decisions. Between 2012 and 2014, the tool was used 43,000 times in 104 different countries (Posner et al. 2016), and has informed decisions relating to spatial planning, payment for ecosystem services, climate adaptation planning, impact assessments for infrastructure development, corporate risk mitigation, coastal planning, and ecosystem restoration. Outputs of the InVEST models include maps (raster grids) which can be used to estimate the aggregate service provision for a region of interest, such as a watershed or administrative district. The list of the data sources considered is found at Annex 1.

InVEST was used to estimate the physical flows relating to the ecosystem services of: (i) carbon storage, (ii) carbon sequestration; (iii) water provisioning; and (iv) sediment retention. The information on the supply or potential supply of these services was, subsequently, transformed into tables for the year 2015. In the discussion section of this report, the changes, accuracy and policy relevance of these flows are analyzed. It is also discussed how this information can be transformed in full physical and monetary accounts for the supply and use of ecosystem services. Among other things, the latter requires measuring the monetary valuation of ecosystem services.

For all four ecosystem services and the related physical flows, InVEST was run using a land cover map for each year. These land cover maps were developed by the NFA based on aerial imagery from 1990, 2005, 2010, and 2015 (Figure 2) and is the same information used for Uganda's national land cover account (UBOS 2019). Trends in physical flows over time were assessed by comparing the 2005, 2010, and 2015 outputs with the outputs from 1990. These trends were summarized at both the national-level and the basin-level. The outputs metrics for each ecosystem service model are described in Table 1.

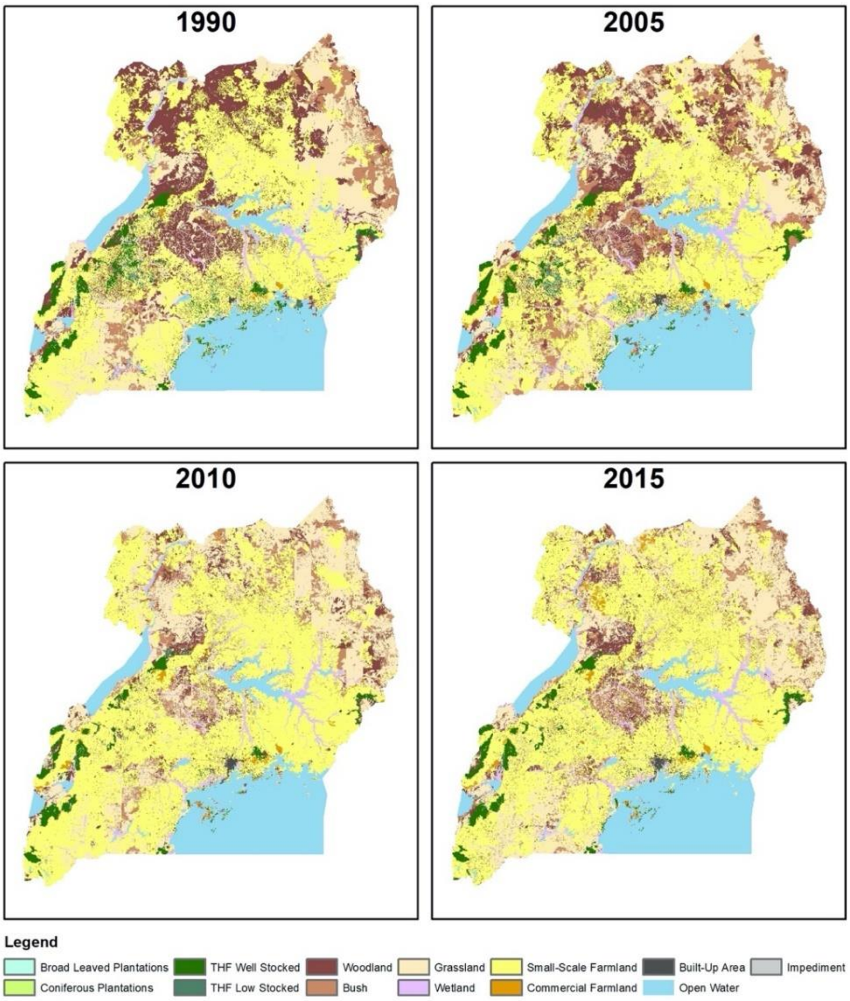
Note that the services were only estimated for the eight basins and not for the area covered under the balancing item. Therefore, the whole country is not covered by the accounts and national total is not provided. While the area of the balance item is small, this should be done as part of future work.

Table 1. InVEST model outputs.

InVEST Model	*Output Metric*	*Description*
Carbon storage & carbon sequestration	Map of carbon storage (Mg C / pixel)	Sum of all carbon stocks for a given land cover class and net changes in these stocks
Annual water yield	Map of annual water yield (mm / pixel)	Average annual precipitation, minus average annual evapotranspiration
Sediment Delivery Ratio	Map of sediment retention (tons sediment / pixel)	Sediment retention with reference to a watershed where all land cover classes are converted to bare ground

The input data required to run InVEST were gathered from a combination of local and global sources (see Annex 1). Land cover data are the most critical input to the model and were provided by the NFA. The land cover data used are shown in Figure 2 below. Note that the use of global data brings a degree of uncertainty in the results since these are not necessarily representative at a national scale.

Figure 2. Land use and land cover in Uganda, 1990, 2005, 2010 and 2015.



The output data on the physical flows related to the four ecosystem services of carbon storage and sequestration, water provisioning, and erosion control are outlined below

Carbon storage is assessed in terms of the biomass contained in the ecosystem, including both above ground (e.g. stem, branches, leaves) and below ground (soil carbon) biomass. ***Carbon sequestration*** is the net change in the carbon stored. The related ecosystem service can go by a number of names. In the Common International Classification of Ecosystem Services (CICES Version 5.1[3]), which is the recommended in the SEEA-EEA (2014a), it is recorded under the class "Atmospheric composition and conditions". It was previously known as climate regulation (CICES Version 4.3), which is the term adopted here. In the developing SEEA ecosystem framework the climate regulation service is recognized as being both the storage and sequestration of carbon.

Estimates of carbon stocks are available for four specific years, and the changes in stocks can be assessed for Uganda, noting that these are net changes in stocks, i.e., they consist of carbon losses in some areas and carbon gains in other areas. In the SEEA EEA revision process there is as yet no final guidance on how to integrate sequestration and storage (or potentially avoided losses due to storage) in a single

[3] CICES Version 5.1 https://cices.eu/

indicator of climate regulation. As such both stocks (carbon storage) and changes in stocks (carbon sequestration) are shown in this report.

Since climate regulation is of benefit to all people, all of the amount of carbon stored or sequestered could be considered an ecosystem service. The supply of this service could be shown by the various land cover types or river basin, while the use could be recorded as a use by government, signifying the climate regulation service's collective benefit.

Water provisioning is related to annual water yield. The yield measure is a relatively simple indicator that depicts the difference between annual precipitation and evapotranspiration. Potentially, specific landscape elements can have a higher evaporation than precipitation in case the vegetation is able to use surface or groundwater sources; however, this is not included in the InVEST module. Hence, the difference is between annual precipitation and evapotranspiration is the water that is transported to streams and rivers downslope or ends up in shallow aquifers or deep groundwater reservoirs. Part of the water that is percolating to shallow aquifers also ends up in rivers, where aquifers lead to river sources. As such, the difference between annual precipitation and evapotranspiration as calculated with InVEST is a very crude approximation of water that ends up in streams and rivers. This water, in turn, can be used for irrigation or hydropower, even though the specific contribution to hydropower or irrigation strongly depends upon the seasonal variability of water flows (inter-annual variability).

In should also be recognized that forests act as sponges thereby reducing peak flows and sustaining dry season base-flows. However, evapotranspiration is high in forests relative to other ecosystems. Hence, higher annual water yield is correlated with deforestation. The positive contribution of forests to distributing water flows more evenly over the year will need to be considered when more comprehensive accounts for the ecosystem service of water provisioning are produced.

Finally, water that is lost from the forest through evapotranspiration is contributing water to the atmosphere and thus to the generation of rainfall in other places, i.e. downwind of the forests. Hence, the maintenance of rainfall is an indirect flow from forests, which is disregarded when water that is evapo-transpired is interpreted as ‘lost’. These limitations are further discussed in chapter 4.

As the InVEST module used only estimates annul water yield, the current estimate of flows is not enough to assess the ecosystem services of water provisioning, which would be the water used by people. The water accounts (GOU 2019) show the use of water industry and households and could be used to help determine the supply and use of the water provisioning service in Uganda.

Erosion control is linked to sediment retention. InVEST estimates erosion rates, and avoided erosion, based on the Revised Universal Soil Loss (RUSLE) equation that was developed based on measured erosion rates as a function of vegetation cover, soil type, rainfall characteristics and slope properties. An issue with RUSLE is that even though it estimates erosion rates, it does not properly include the deposition of sediments on-slope. Where eroded soil is transported downstream and downstream the slope is less steep, and/or more vegetated, part or all of the sediments will be deposited. In this case, the sediments will not end up in a stream or river. Furthermore, the model only captures rill erosion processes[4], and does not estimate other forms of erosion, such as gully or streambank erosion[5] (Sharp et

[4] Rill erosion occurs when runoff water forms small channels as it concentrates down a slope. These rills can be up to 0.3m deep.

[5] Gully erosion is the removal of soil along drainage lines by surface water runoff. Streambank erosion occurs when streams cut deeper and wider channels.

al. 2015). Hence, only part of the erosion processes are measured by InVEST. It is not known how important rill erosion is compared to the other types of erosion in Uganda. Despite this limitation, the sediment retention model can still be used to detect relative changes in rill erosion. The various constraints are further discussed in chapter 4.

Bearing these limits in mind, the physical flows of sediment estimated by InVEST provide an approximation of the avoided sedimentation in streams and rivers. The related ecosystem service of erosion control are gained by avoiding damage to human activity (e.g. sediments can affect functioning of hydropower systems by clogging up reservoirs or, in extreme cases, damaging equipment), reduction in agricultural output but these remain to be estimated.

For all physical flows estimated by InVEST, it is clear that the accuracy, especially at local scale, is limited. Moreover, no field data has been used to validate the models. Therefore, the InVEST model, and consequently any ecosystem accounts that result from its use, will provide only approximations of the flows, and the data can only be used at aggregated (not local) scales, i.e. river basins or national.

InVEST outputs were used to prepare tables for these physical flows relating to ecosystem services. The tables include the physical values for these flows in each year of the analysis, as well as changes between years. Given the uncertainties involved, and in line with the policy practices in Uganda, values were aggregated by river basin.

CHAPTER THREE: RESULTS

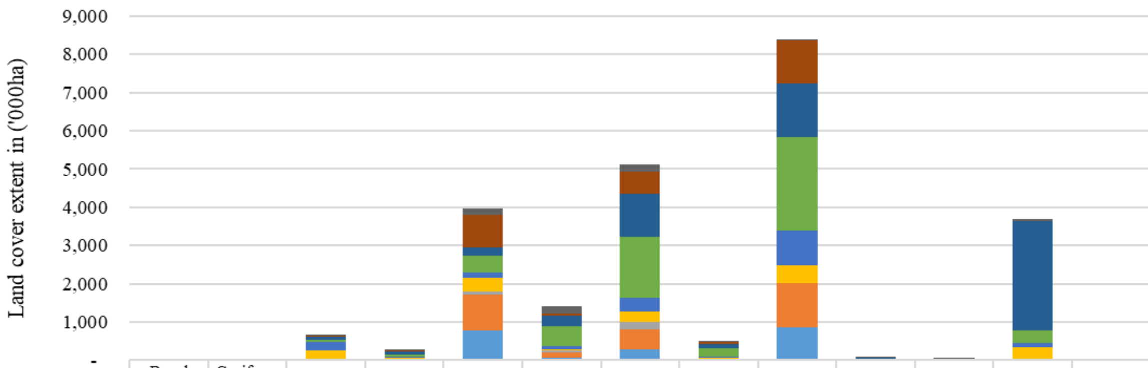
3.1 Land cover by river basin

The accounts for land cover by drainage basin for the years 1990, 2005, 2010 and 2015 are shown in Appendix 2 and graphically in Figures 3 to 6. The overall trends were an increased use of land for agriculture and a decline of forest cover particularly for woodlands. The grasslands increased largely at the expense of bushlands possibly because the grasslands are used as foraging area for livestock as well as numbers of wildlife increasing. Between 1990 and 2015 commercial farmlands expanded by 3.8 times and built up areas by 3.7 times mostly at the expense of wetlands[6].

Figure 3 shows that out of Uganda's eight drainage basins, the Lake Victoria basin was the largest with 6.2 million hectares, equivalent to 26% of the land in Uganda. The Lake Kyoga basin was the second largest with 5.7 million ha or 24% of the national area. The Kidepo basin was the smallest with 318,000 ha, equivalent to 1.3% of the national area. Descriptions of the accounts for each of the individual reference years are found in the following paragraphs.

In 1990 the largest land cover class was small scale farmlands with 35% of national land cover, equivalent to 8.4 million ha (Figure 3). Grasslands had the second largest cover with 5.1 million ha equivalent to 21% of national cover. Woodlands were the third largest covering nearly 4 million ha (16%) while open water was at 3.7 million ha or 15% of national cover.

Figure 3: Land cover extent by basin 1990 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0	1	4	5	162	192	193	2	35	1	0	37	0
Victoria Nile	1	3	19	33	870	64	572	68	1,132	9	5	17	0
Lake Victoria	6	3	105	95	200	262	1,118	89	1,404	9	14	2,861	1
Lake Kyoga	6	2	51	50	451	529	1,600	231	2,444	28	10	320	1
Lake Edward	3	3	223	15	150	98	352	28	898	10	3	107	1
Lake Albert	1	2	247	75	350	24	282	29	459	11	1	316	0
Kidepo	0	-	-	-	70	42	190	-	15	-	0	-	0
Aswa	0	0	-	-	940	135	528	-	1,153	0	1	1	1
Albert Nile	2	2	1	0	781	76	279	37	859	1	2	29	0
Total	19	16	651	273	3,974	1,422	5,115	484	8,400	68	37	3,689	4

Land cover classes by drainage basin

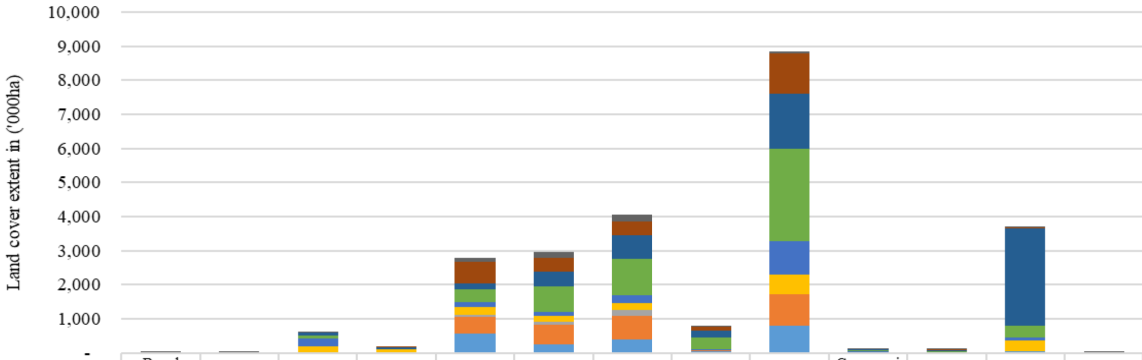
Land cover by drainage basin in 2005 is shown in Figure 4. The most significant increase in land cover was the 55 percent increase in wetlands from 484,000 ha in 1990 to 753,000 ha in 2005. Small scale farmers increased by 5 percent from 8.4 million ha to 8.8 million ha while bushlands doubled from 1.4 million ha to 3.0 million ha between 1990 and 2005. In contrast woodlands and grasslands decreased by

[6] As defined in the land cover accounts

30 percent from 4.0 million ha to 2.8 million ha while grasslands decreased by 21 percent from 5.1 million ha to 4.0 million ha.

Land cover by drainage basin for 2010 is shown in Figure 5. In 2010 woodlands had decreased by 42 percent from the 1990 with woodland area of 2.3 million ha in 2010 compared to 4.0 million ha in 1990. Grasslands in 2010 were 30 percent less in area than 1990, decreasing from 5.1 million ha to 3.6 million ha. In contrast small scale farmlands were 12 percent larger in 2010 at 9.4 million hectares, more than the 8.4 million ha in 1990. Similarly, bushlands expanded by 2.3 times from1.4 million ha to 3.3 million ha in 2010. Wetlands also increase by 6 percent from 753,000 ha in 1990 to 798,000 ha in 2010.

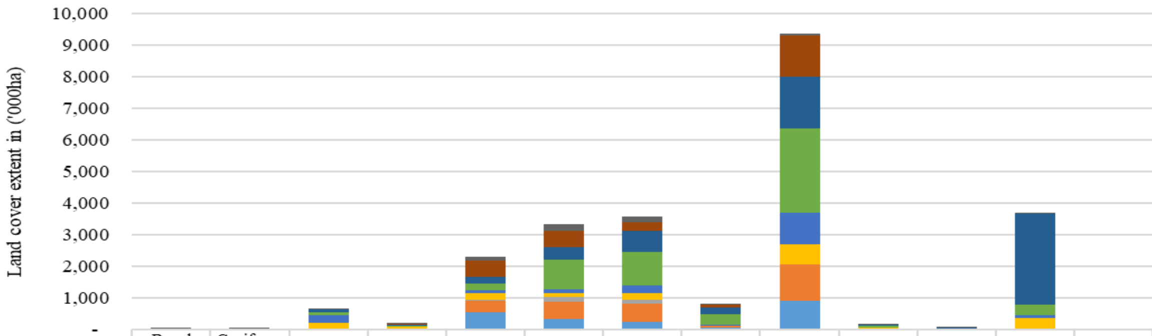
Figure 4: Land cover extent by basin 2005 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0	0	12	-	116	189	208	1	67	1	0	38	0
Victoria Nile	2	3	1	26	632	411	395	108	1,172	9	17	18	0
Lake Victoria	4	5	83	61	174	424	705	189	1,620	19	32	2,848	1
Lake Kyoga	2	5	77	9	364	739	1,063	343	2,717	38	22	343	1
Lake Edward	4	2	242	4	148	133	224	34	963	27	5	107	1
Lake Albert	0	1	184	92	228	172	198	14	577	11	2	316	1
Kidepo	-	-	-	-	51	67	186	-	14	0	0	-	1
Aswa	0	0	-	0	512	594	705	9	919	0	14	3	2
Albert Nile	2	2	2	0	553	238	379	54	798	1	6	33	0
Total	15	19	601	192	2,778	2,968	4,063	753	8,847	107	97	3,706	8

Land cover classes by drainage basin

Figure 5: Land cover extent by basin 2010 (1,000 ha)

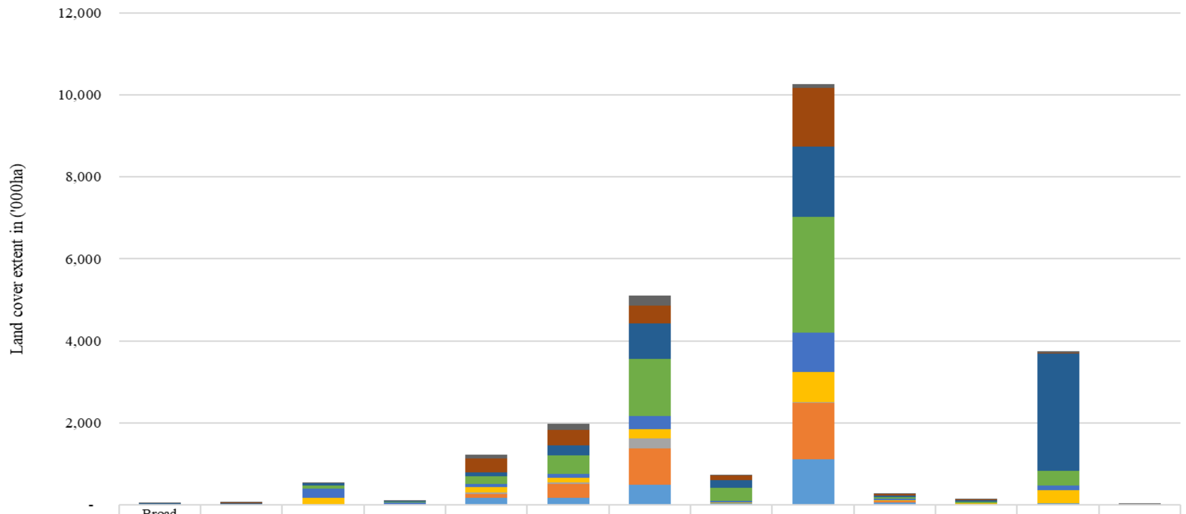


	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	1	1	9	1	115	220	172	3	72	1	0	38	0
Victoria Nile	2	9	11	32	522	503	260	109	1,299	18	14	16	0
Lake Victoria	8	9	101	42	201	389	676	193	1,643	23	19	2,863	0
Lake Kyoga	3	4	82	18	217	943	1,068	342	2,655	44	14	332	0
Lake Edward	4	2	243	17	99	114	247	24	1,007	21	3	109	2
Lake Albert	3	2	199	75	204	129	209	22	622	14	2	317	0
Kidepo	-	-	-	-	44	150	116	0	8	-	0	-	0
Aswa	0	0	-	-	355	566	585	64	1,168	14	5	1	0
Albert Nile	2	2	1	1	538	313	229	41	892	19	5	27	0
Total	21	29	646	185	2,294	3,328	3,562	798	9,366	154	63	3,704	4

Land cover classes by drainage basin

In 2015 there was a woodland area of 1.2 million ha (Figure 6), 69 percent less than the 4.0 million ha in 1990. In contrast, in the same period the small-scale farmlands expanded by 22 percent from 8.4 million ha to 10.3 million ha. The grassland cover was almost recovered from a 30 percent decrease between 1990 and 2010 to just 0.4 percent less than the 1990 cover in 2015. Bushlands decreased by 41 percent while wetlands decreased by10 percent between 2010 and 2015.

Figure 6: Land cover extent by basin 2015 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0	1	9	2	90	147	242	3	99	2	0	37	0
Victoria Nile	5	23	1	6	336	379	423	114	1,425	31	33	18	1
Lake Victoria	14	21	46	30	97	236	881	181	1,720	30	38	2,872	1
Lake Kyoga	4	10	75	19	186	451	1,394	328	2,822	48	32	354	0
Lake Edward	8	5	232	23	76	91	310	31	964	33	5	110	3
Lake Albert	8	3	166	21	137	116	233	28	743	20	4	318	1
Kidepo	-	-	-	-	33	36	234	-	14	-	0	-	0
Aswa	0	0	-	-	91	340	893	2	1,379	37	12	3	0
Albert Nile	4	1	0	2	166	170	488	29	1,105	56	12	37	1
Total	44	63	529	102	1,213	1,967	5,097	715	10,272	256	136	3,749	8

Land cover classes and drainage basins

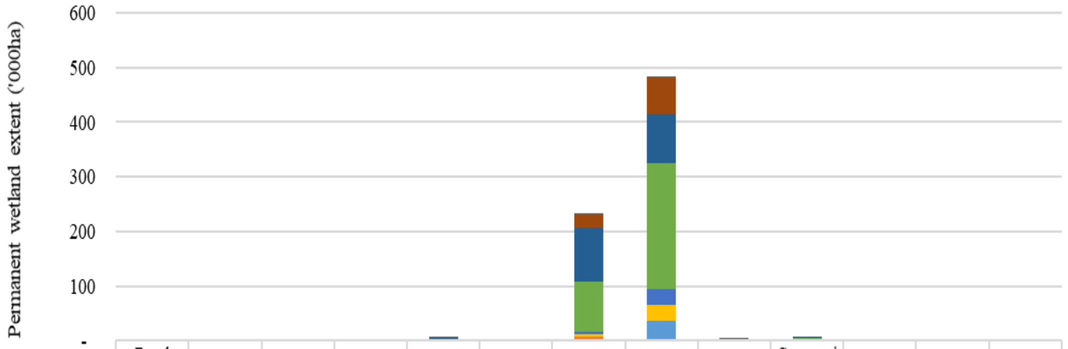
3.2 Wetland ecosystem extent by basin

This section presents information on wetlands in Uganda using the definition aligned with Ramsar Convention and the listing of wetlands under government laws and regulations. The definition for wetlands in Uganda was developed from adapted to cover wetland cover and use, under both permanent and seasonal wetlands. The refined definition for wetlands as adopted by the National Environment Act (No.5 of 2019) states that wetlands mean areas permanently or seasonally flooded by water, where plants and animals have become adapted and gazetted as such. Uganda has 3,141,140 ha of wetland, which is equivalent to 13.0 percent of Uganda's surface area, and the remaining land area is referred to as normal (dry land). These wetlands are further subdivided into permanent (732,521 ha), seasonal (2,408,619) wetlands and wetlands on normal (dry land). There occurrence of the permanent wetlands in the 13 land cover classes used in the land cover accounts by river basin for the years 1990, 2005, 2010 and 2015 is shown in Figures 7 to 10. Similar information for the seasonal wetlands is shown in Figures 11 to 14. From these it can been seen that over time the amount wetlands in each of the 13 classes of land cover changes. The wetland extent was designated and benchmarked in the National Policy for Conservation and Management of Wetland Resources (1995) based on the National Biomass Survey of 1990. In addition, the National Environment (Wetlands, River Banks and Lake Shores Management) Regulations, No. 3/2000 ensure that the Government and local governments hold in trust for the people and protect wetland for the common good of the citizens of Uganda, and that the wetlands shall not be leased out or otherwise alienate any wetland. Therefore, wetland extent was differentiated from cover and use, and management was differentiated manner from normal (dry land). In subsequent National

Biomass Surveys, in 2000, 2005, 2010 and 2015; however, some areas that were classed as normal (dry land) transformed, both intentionally and/or naturally, into permanently or seasonally flooded by water, where plants and animals have become adapted. The normal (dry land) areas that became transformed into wetlands are referred to as wetlands on dryland.

The accounts show that by 2015 the area of seasonal wetland under small scale farmlands expanded by 3.7 times to 868,000 ha from 232,000 ha in 1990, indicating an increase use of wetlands for agriculture production. Over the same period the seasonal wetlands in woodlands land cover classification decreased by 73 percent from 514,000 ha to 141,000 ha.

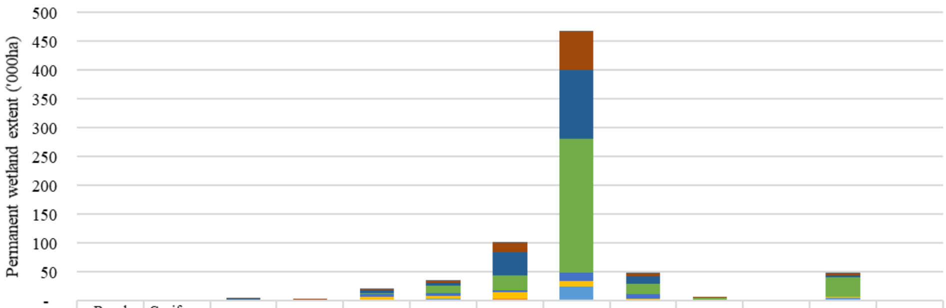
Figure 7: Permanent wetland extent by land cover and basin in 1990 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	-	-	-	-	0	0	1	2	0	-	-	-	-
Victoria Nile	-	-	0	-	0	0	26	68	0	-	-	0	-
Lake Victoria	-	-	0	1	3	0	97	89	1	0	-	-	-
Lake Kyoga	-	-	-	-	2	1	93	231	1	5	-	0	-
Lake Edward	-	-	-	-	-	-	5	28	2	-	-	0	-
Lake Albert	-	-	-	-	0	-	4	29	-	-	-	0	-
Kidepo	-	-	-	-	-	-	-	-	-	-	-	-	-
Aswa	-	-	-	-	-	-	6	-	-	-	-	-	-
Albert Nile	-	-	-	-	0	0	1	37	0	-	-	0	-
Total	-	-	0	1	5	1	232	484	4	5	-	0	-

Land cover classes by drainage basin

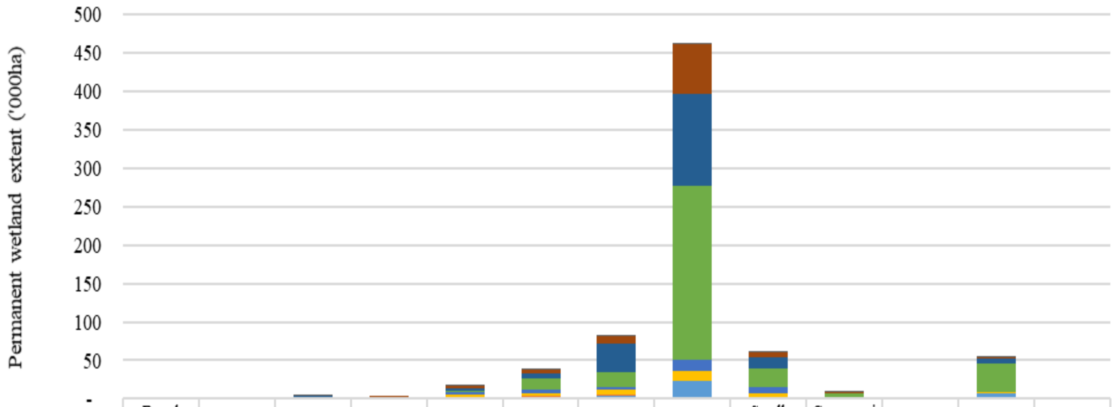
Figure 8: Permanent wetland extent by land cover class and basin in 2005 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	-	0	0	-	0	1	1	1	0	-	-	0	-
Victoria Nile	0	-	0	0	3	3	15	65	5	0	0	2	-
Lake Victoria	0	0	2	1	5	5	40	120	12	0	0	4	0
Lake Kyoga	0	-	2	0	1	13	27	233	17	6	0	34	0
Lake Edward	0	0	0	0	6	4	3	14	8	0	0	1	-
Lake Albert	-	0	0	1	4	5	11	9	3	0	0	1	-
Kidepo	-	0	0	0	0	0	0	0	0	0	0	0	0
Aswa	-	-	-	-	1	1	2	1	1	-	0	0	-
Albert Nile	0	-	-	-	2	4	2	25	1	-	-	6	0
Total	0	0	4	2	21	36	101	467	47	6	1	47	0

Land cover classes by drainage

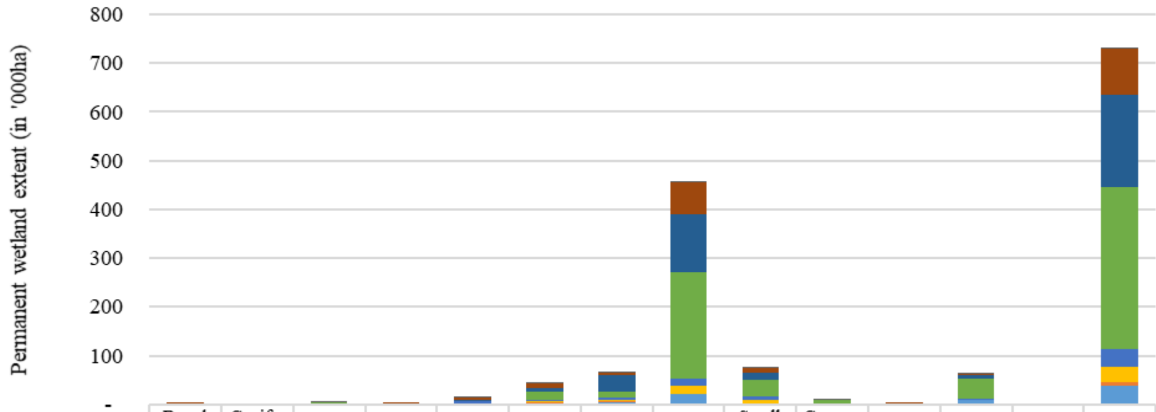
Figure 9: Permanent wetland extent by land cover class and basin in 2010 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	-	0	0	-	0	1	1	1	0	0	-	0	-
Victoria Nile	0	0	0	0	3	6	10	65	7	0	0	2	0
Lake Victoria	0	0	1	1	4	6	37	119	14	1	1	6	0
Lake Kyoga	0	0	2	0	1	15	20	226	25	6	0	38	0
Lake Edward	0	0	0	0	4	4	3	14	8	0	0	1	0
Lake Albert	0	0	1	0	3	3	8	13	4	0	0	1	0
Kidepo	-	0	0	0	0	0	0	0	0	0	0	0	0
Aswa	-	-	-	-	1	2	2	0	1	0	0	0	-
Albert Nile	0	0	0	-	1	3	3	23	1	0	0	7	0
Total	1	0	4	2	17	39	83	462	60	8	1	54	0

Land cover classes by drainage area

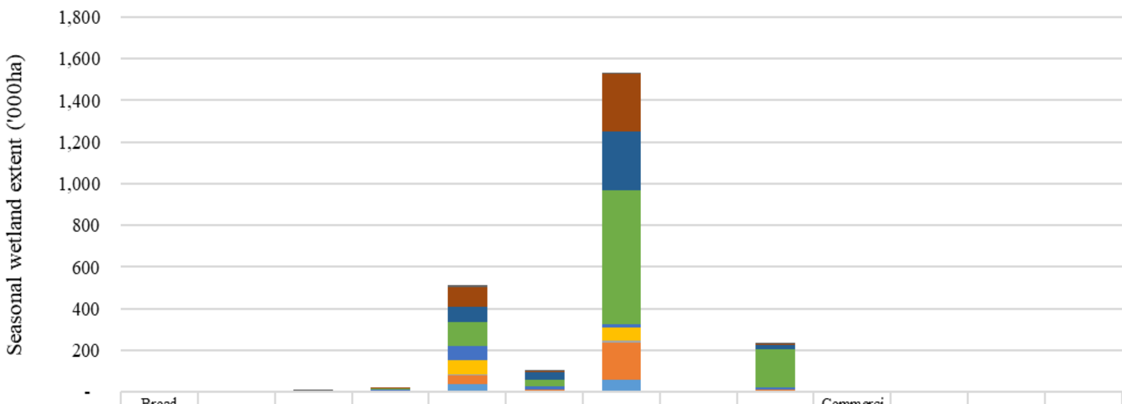
Figure 10: Permanent wetland extent by land cover class and basin, 2015 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments	Total
Balancing area	-	-	0	-	0	0	1	1	0	0	-	0	-	3
Victoria Nile	0	0	0	0	3	9	5	66	8	0	0	2	0	94
Lake Victoria	1	0	0	1	3	7	33	119	16	2	1	7	0	190
Lake Kyoga	0	0	2	0	1	17	13	219	32	7	0	41	0	333
Lake Edward	0	0	1	1	3	4	3	13	9	1	0	1	0	35
Lake Albert	0	0	1	0	2	2	4	17	6	0	0	1	0	33
Kidepo	-	0	0	0	0	0	0	0	0	0	0	0	0	0
Aswa	-	-	-	-	0	2	1	0	2	0	0	0	-	6
Albert Nile	0	0	0	-	1	2	5	22	1	0	0	8	0	38
Total	1	0	4	2	13	43	65	458	74	10	1	62	0	733

Land cover classes by drainage area

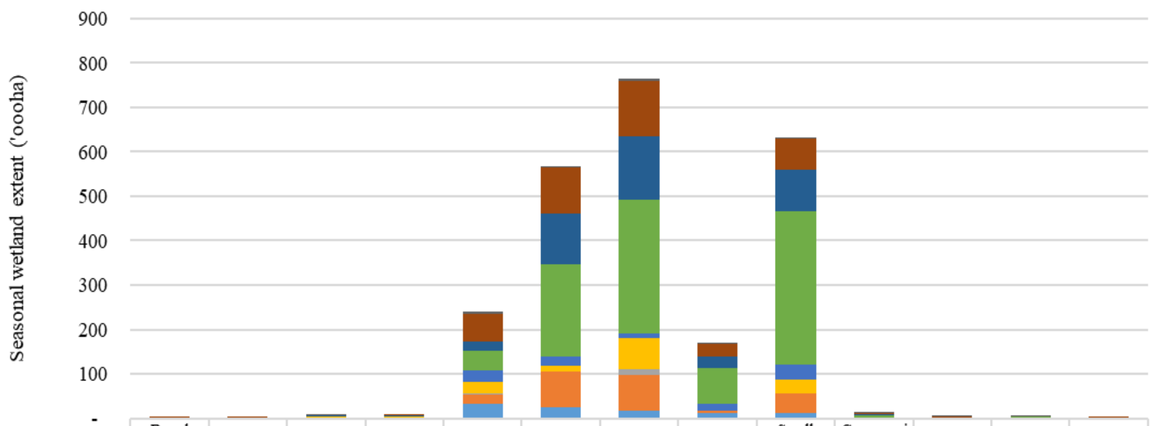
Figure 11: Seasonal wetland extent by land cover class and basin in 1990 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	-	-	0	-	8	2	3	-	1	-	-	-	-
Victoria Nile	-	-	-	4	96	6	280	0	8	-	-	-	-
Lake Victoria	0	-	1	1	74	33	279	0	19	0	-	-	-
Lake Kyoga	0	-	1	5	114	35	644	0	185	3	-	0	-
Lake Edward	-	-	0	4	66	12	18	-	9	-	-	-	-
Lake Albert	-	-	2	7	72	3	63	0	2	-	-	-	-
Kidepo	-	-	-	-	5	0	12	-	-	-	-	-	-
Aswa	-	-	-	-	43	3	177	-	6	-	-	0	-
Albert Nile	-	-	-	-	35	7	56	0	3	-	-	-	0
Total	0	-	4	22	514	101	1,533	0	232	3	-	0	0

Land cover classes by drainage area

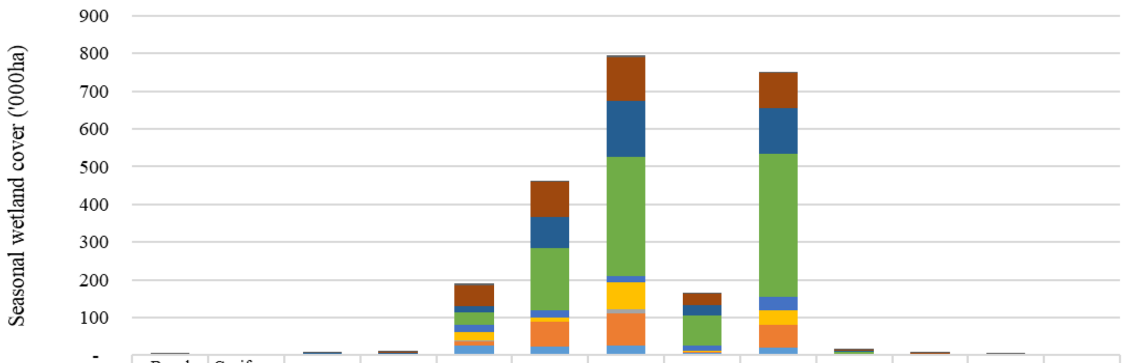
Figure 12: Seasonal wetland extent by land cover and basin, 2005 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	-	-	0	-	5	3	6	0	1	0	0	0	0
Victoria Nile	0	0	0	3	63	102	126	28	71	0	1	0	0
Lake Victoria	0	0	2	3	20	115	142	26	93	4	1	0	0
Lake Kyoga	0	0	0	0	44	207	301	80	345	6	1	2	0
Lake Edward	0	0	1	1	25	23	10	15	33	0	0	0	0
Lake Albert	0	0	3	3	26	12	71	2	32	0	0	0	0
Kidepo	-	-	-	-	4	1	12	-	0	-	-	-	0
Aswa	0	-	-	-	19	78	81	5	43	-	0	1	0
Albert Nile	0	0	0	-	33	26	18	11	13	0	0	1	0
Total	1	0	7	10	240	567	766	168	631	10	3	4	0

Land cover classes by drainage area

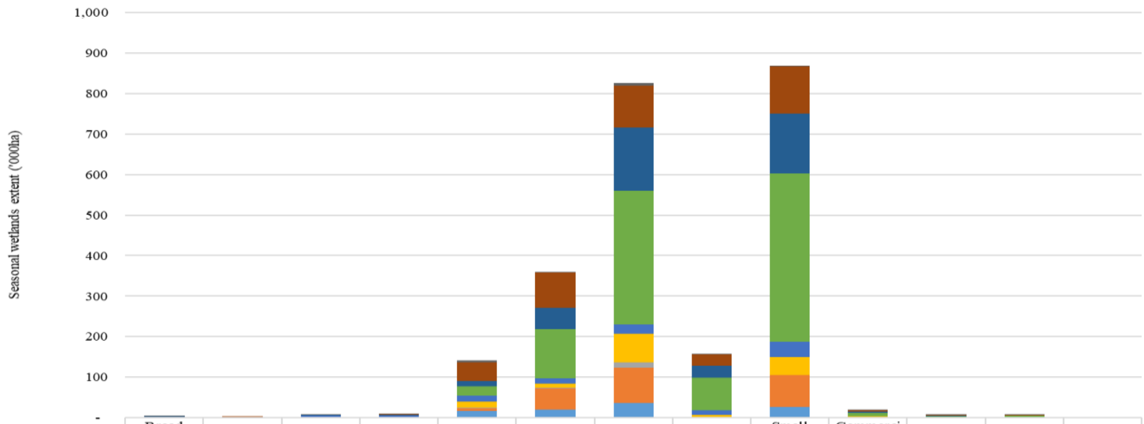
Figure 13: Seasonal wetland extent by land cover and basin, 2010 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0	-	0	0	4	3	6	1	1	0	0	0	0
Victoria Nile	0	1	0	3	55	94	115	28	94	2	2	0	0
Lake Victoria	1	0	2	2	16	84	149	28	120	3	1	1	0
Lake Kyoga	1	0	0	0	33	165	315	80	380	7	2	2	0
Lake Edward	1	0	2	2	20	17	17	13	36	1	0	0	0
Lake Albert	0	0	3	3	20	11	71	3	38	0	0	0	0
Kidepo	-	-	-	-	3	2	12	-	0	-	-	-	0
Aswa	0	0	-	-	13	65	84	3	61	1	0	1	0
Albert Nile	0	0	0	0	25	23	27	6	19	1	0	0	0
Total	3	2	7	10	190	464	796	162	750	14	5	5	0

Land cover classes by drainage area

Figure 14: Seasonal wetland extent by land cover extent by basin, 2015 (1,000 ha)

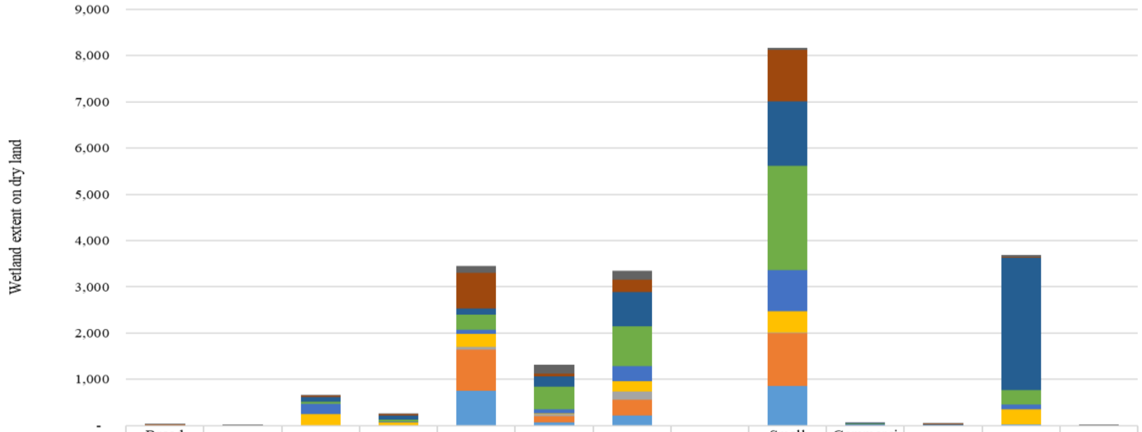


	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0	-	0	0	4	2	7	1	1	0	0	0	-
Victoria Nile	0	2	0	2	47	87	105	29	117	3	3	0	0
Lake Victoria	1	1	2	1	12	52	156	30	147	3	1	1	0
Lake Kyoga	1	0	0	0	23	123	329	80	416	8	3	3	0
Lake Edward	1	0	2	4	15	12	24	12	38	1	0	0	0
Lake Albert	1	0	2	2	14	10	71	4	44	1	0	0	0
Kidepo	-	-	-	-	2	3	13	-	0	-	-	-	0
Aswa	0	0	-	-	7	52	86	1	80	1	0	1	0
Albert Nile	0	-	0	0	16	20	36	2	26	1	0	0	0
Total	1	0	7	10	240	567	766	168	631	10	3	4	0

Land cover classes by drainage area

The permanent and seasonal wetland cover in 1990 was used retrospectively as benchmark for wetland extent, and normal (dry land) was separate from wetland area. Between 1990 and 2015 (Figures 15-18), there was an expansion of wetland area on the areas that were classified (retrospectively as normal (dry land) in 1990). The wetland area on dryland increased from the 0 ha benchmark in 1990 to 118,000 ha in 2000 before declining to 100,000 ha in 2015. This expansion of wetland on normal (dry land) area represents improvement; however, it is countered by the increased use of designated wetland area for other uses including as farmlands, forests and built up areas, among others.

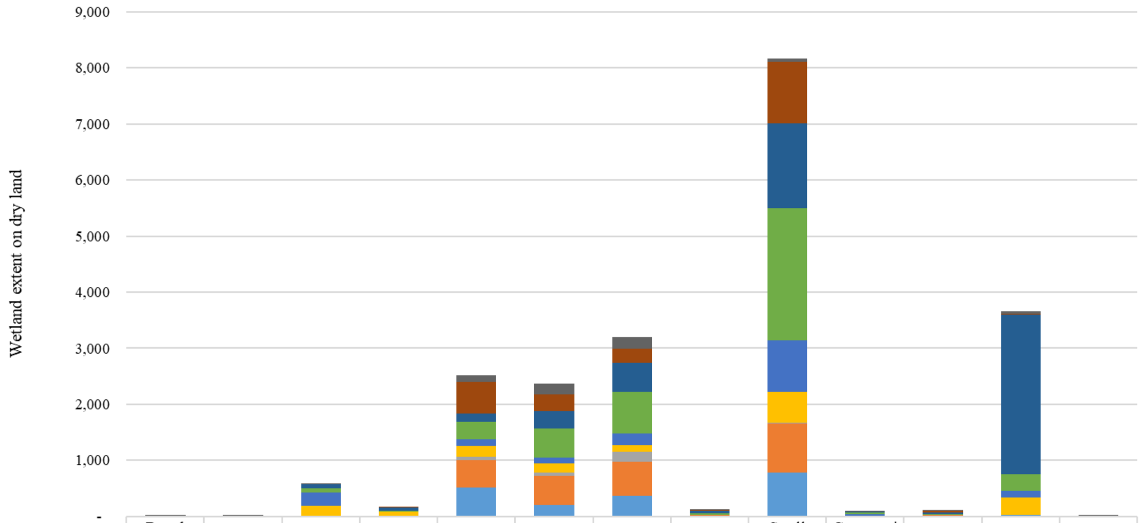
Figure 15: Normal (dry land) extent by basin, including wetland extent on dryland, 1990 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0	1	4	5	153	190	189	0	34	1	0	37	0
Victoria Nile	1	3	19	29	774	58	266	0	1,124	9	5	17	0
Lake Victoria	6	3	104	93	123	230	742	-	1,384	9	14	2,861	1
Lake Kyoga	6	2	50	45	335	493	863	0	2,258	20	10	320	1
Lake Edward	3	3	223	11	84	86	329	0	888	10	3	107	1
Lake Albert	1	2	245	68	278	21	216	0	457	11	1	316	0
Kidepo	0	-	-	-	65	42	179	-	15	-	0	-	0
Aswa	0	0	-	-	897	132	345	-	1,147	0	1	1	1
Albert Nile	2	2	1	0	745	68	222	0	856	1	2	29	0
Total	19	16	647	250	3,455	1,319	3,350	0	8,164	61	37	3,689	4

Land cover classes by drainage area

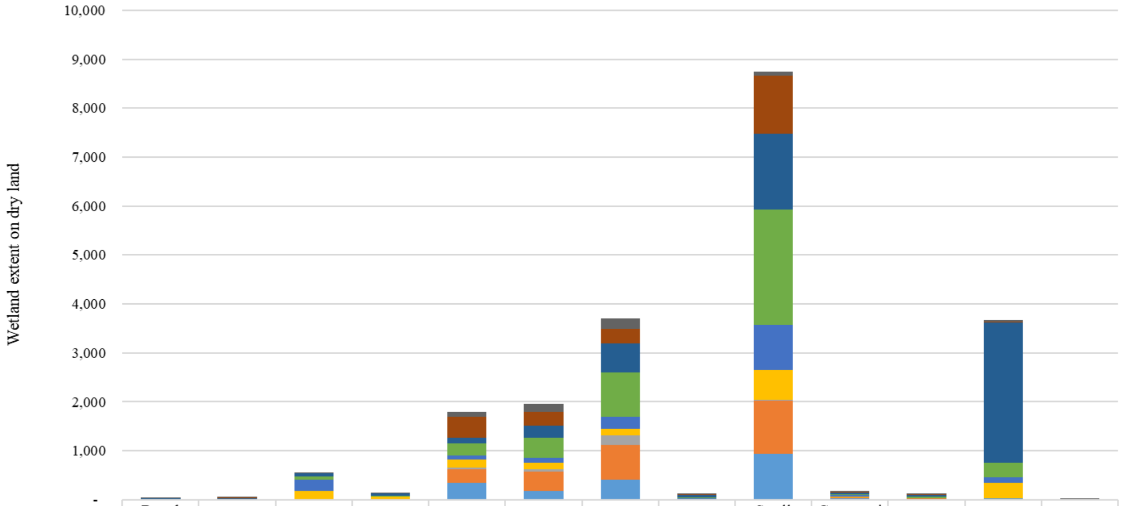
Figure 16: Normal (dry land) extent by basin, including wetland extent on dryland, 2005 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0	0	12	-	111	184	201	0	66	1	0	38	0
Victoria Nile	2	2	1	22	566	306	254	16	1,096	9	16	16	0
Lake Victoria	3	5	79	57	150	304	523	44	1,515	15	30	2,844	1
Lake Kyoga	2	5	75	9	319	520	735	30	2,354	26	21	308	1
Lake Edward	3	2	240	3	117	106	212	5	922	26	5	106	1
Lake Albert	0	1	181	88	198	156	115	4	543	11	2	315	1
Kidepo	-	-	-	-	47	66	174	-	13	0	0	-	1
Aswa	0	0	-	0	492	514	621	3	876	0	13	2	2
Albert Nile	2	2	2	0	518	208	360	18	785	1	6	27	0
Total	13	18	590	179	2,517	2,365	3,196	118	8,169	90	93	3,656	8

Land cover classes by drainage area

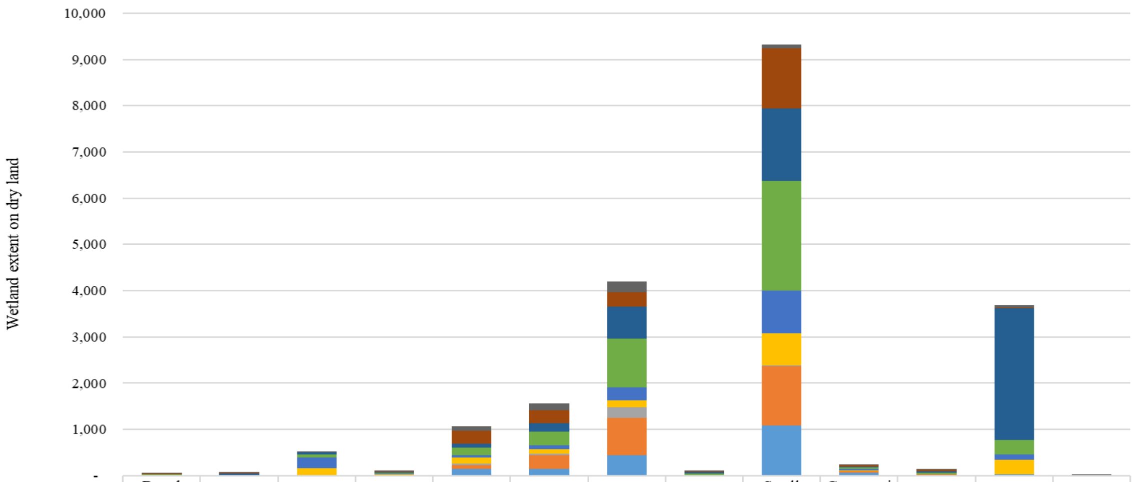
Figure 17: Normal (dry land) extent by basin, including wetland extent on dryland, 2010 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0	1	10	1	98	164	218	0	82	2	0	38	0
Victoria Nile	3	12	1	13	426	294	284	18	1,198	18	23	16	0
Lake Victoria	8	13	61	43	116	241	608	38	1,536	20	33	2,853	1
Lake Kyoga	3	7	74	14	240	416	893	29	2,364	29	25	309	1
Lake Edward	5	3	235	10	87	91	247	5	919	29	5	107	2
Lake Albert	4	2	172	53	160	130	137	5	618	15	3	316	1
Kidepo	-	-	-	-	39	50	197	-	14	0	0	-	0
Aswa	0	0	-	0	288	400	714	2	1,086	18	12	2	1
Albert Nile	3	1	1	1	334	178	403	12	932	28	9	27	0
Total	26	39	554	135	1,788	1,965	3,701	109	8,750	159	110	3,668	7

Land cover classes by drainage area

Figure 18: Normal (dry land) extent including wetland extent on dryland by drainage basin, 2015 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0	1	9	2	86	144	234	0	98	2	0	37	0
Victoria Nile	4	21	0	4	286	283	313	20	1,301	27	30	16	1
Lake Victoria	12	20	44	28	81	177	692	32	1,557	25	36	2,863	1
Lake Kyoga	3	9	73	19	162	312	1,052	29	2,375	32	29	310	0
Lake Edward	7	5	230	18	58	76	283	5	917	32	5	109	3
Lake Albert	7	3	163	19	121	104	159	7	693	19	4	316	1
Kidepo	-	-	-	-	32	34	221	-	14	-	0	-	-
Aswa	0	0	-	-	84	286	806	1	1,297	36	11	2	0
Albert Nile	4	1	0	2	149	148	447	5	1,079	55	12	28	1
Total	39	60	519	91	1,059	1,564	4,206	100	9,330	227	127	3,681	7

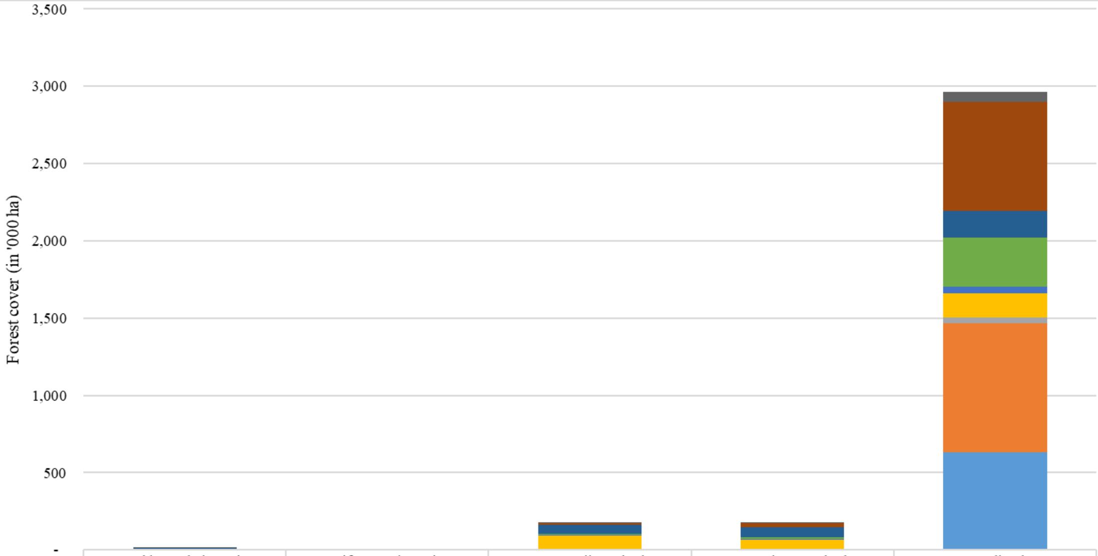
Land cover classes by drainage area

3.3 Forest extent by administrative land use class

Accounts for the occurrence of forests and other land cover types by administrative land use class and river basin can be found in Appendix 4 for the years 1990, 2005, 2010 and 2015. In this, there are the accounts for private land, CFR, LFR, and National Parks and Wildlife Reserves. The forest land covers consist of broad-leaved plantations, coniferous plantation, THF low stocked, THF well stocked and woodlands. Figures 15 to 18 show the forest extent on private land for the years 1990, 2005, 2010 and 2015. The forest extent on private land has decreased by 77 percent from 3.3 million ha in 1990 to 766,000 ha in 2015. The largest percentage decrease occurred in Aswa river basin from 834,000 ha to 59,000 ha.

The composition of the forest land covers on private land in 2015 was: 33,000 ha or 4 percent in broad leaf plantations; 13,000 ha or 2 percent in coniferous plantations; 34,000 ha or 4 percent in THF well stocked; 40,000ha or 5 percent in THF low stocked, and; 646,000 ha or 84 percent in woodlands (Figures 19-22). Woodlands accounted the largest amount of forest in private land in 1990 as well, at 3.0 million ha or 89 percent of total.

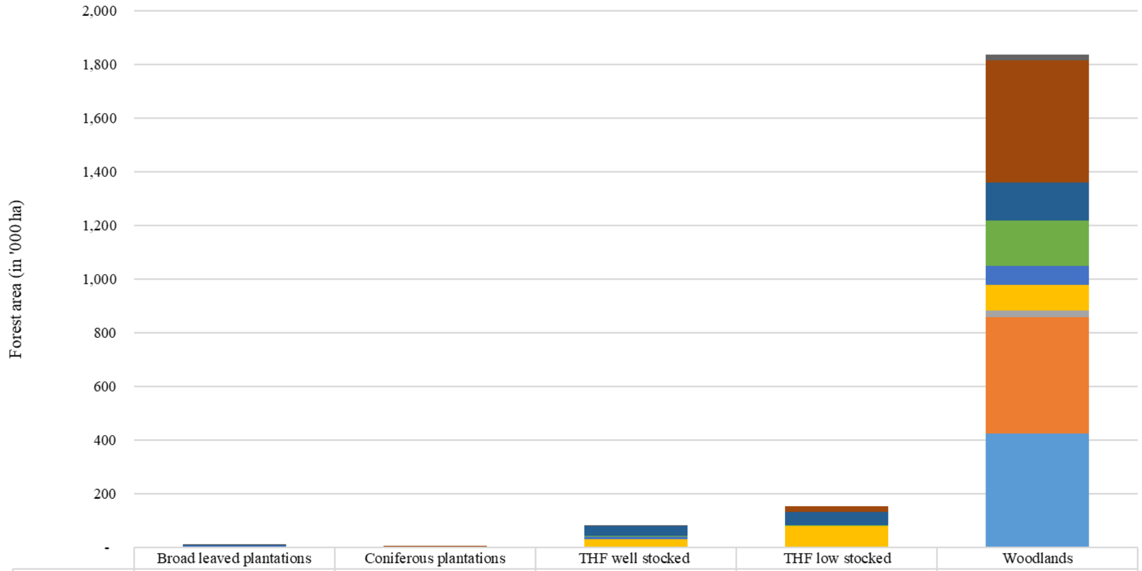
Figure 19: Forest extent on private land by cover class and basin in 1990 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands
Balancing area	0	0	0	0	64
Victoria Nile	0	0	12	27	704
Lake Victoria	5	0	57	65	174
Lake Kyoga	1	0	4	13	315
Lake Edward	3	0	10	4	44
Lake Albert	1	0	91	66	158
Kidepo	0	-	-	-	39
Aswa	0	0	-	-	834
Albert Nile	2	0	0	0	630
Total	12	1	174	176	2,963

Forest cover classes by basin

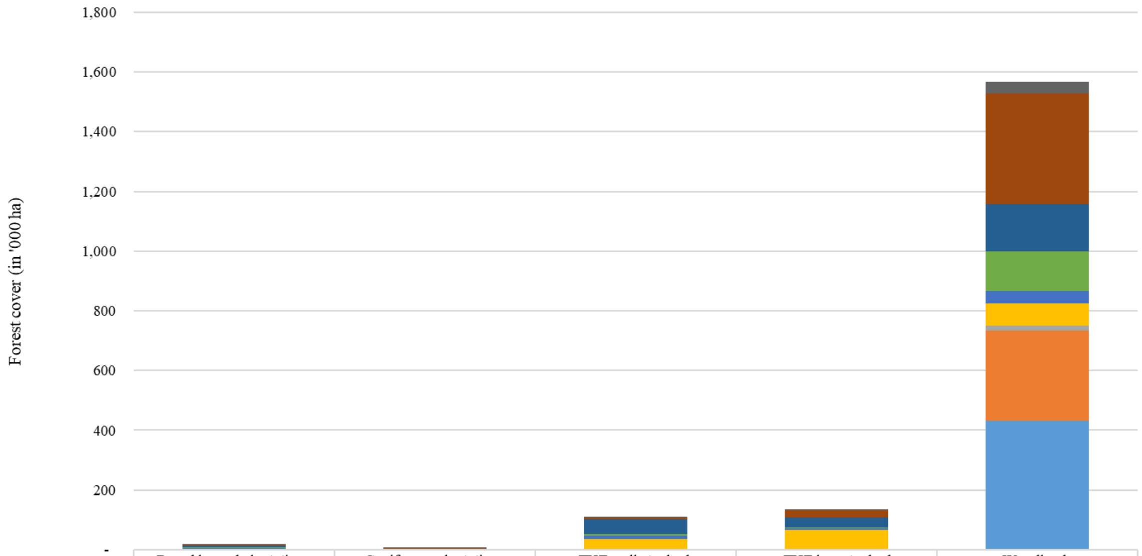
Figure 20: Forest extent on private land by cover class and basin in 2005 (ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands
Balancing area	0	0	0	-	22
Victoria Nile	1	0	1	20	454
Lake Victoria	2	0	38	51	142
Lake Kyoga	1	1	1	2	168
Lake Edward	3	0	11	1	72
Lake Albert	0	0	29	79	94
Kidepo	-	-	-	-	26
Aswa	0	0	-	0	435
Albert Nile	2	0	0	0	424
Total	10	2	80	153	1,836

Forest covers by drainage basin

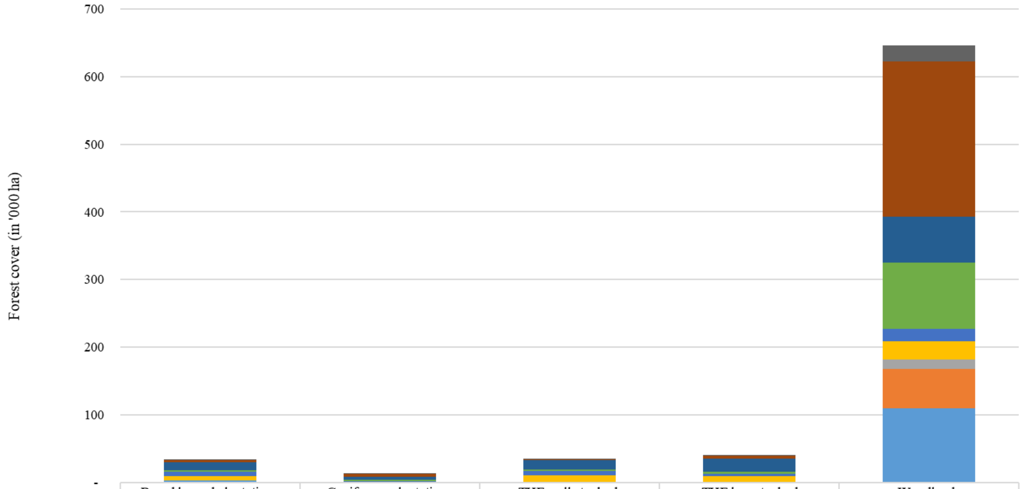
Figure 21: Forest extent on private land by cover class and basin in 2010 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands
Balancing area	0	0	0	0	38
Victoria Nile	1	2	7	25	372
Lake Victoria	6	2	51	33	157
Lake Kyoga	1	1	4	4	131
Lake Edward	3	1	11	4	42
Lake Albert	2	0	36	67	75
Kidepo	-	-	-	-	17
Aswa	0	0	-	-	302
Albert Nile	1	0	0	0	431
Total	15	5	109	132	1,566

Forest cover class by basin

Figure 22: Forest extent on private land by land cover class and basin in 2015 (1,000 ha)

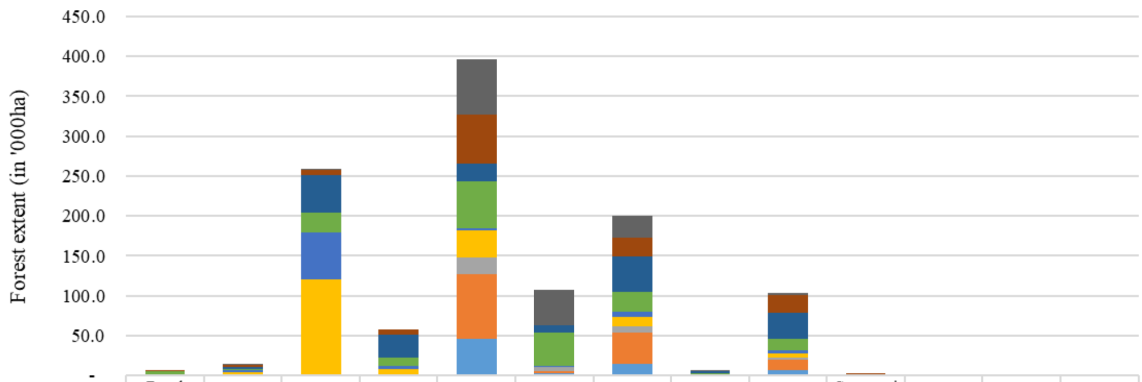


	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands
Balancing area	0	0	0	0	24
Victoria Nile	3	4	0	4	229
Lake Victoria	11	4	15	19	68
Lake Kyoga	2	2	2	3	98
Lake Edward	6	2	7	3	18
Lake Albert	7	0	10	10	27
Kidepo	-	-	-	-	13
Aswa	0	0	-	-	59
Albert Nile	3	0	-	0	109
Total	33	13	34	40	646

Forest cover classes by basin

The extent of forests in Central Forest Reserves by river basin is shown in Figures 23 to 26 for the years 1990, 2005, 2010 and 2015. The total extent of CFR was 1.15 million ha in 1990 and did not change over time. Seventeen percent of the CFR area was located in the Lake Victoria basin, 16 percent in each of Lake Kyoga basin and the Lake Albert basin, 12 percent in the Aswa basin and the balancing area outside the eight basins, 11 percent in the Victoria Nile basin, and 6 percent in the Albert Nile basin (Figure 23).

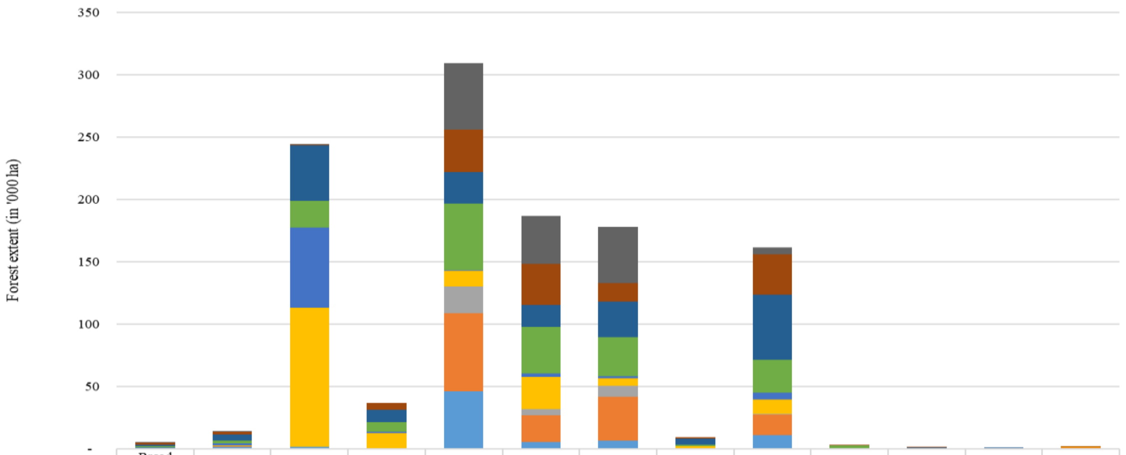
Figure 23: Forest extent for CFRs by land cover class and drainage basin in 1990 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	-	0.5	0.2	-	68.9	44.1	26.6	0.0	2.4	-	-	-	0.1
Victoria Nile	0.2	2.4	7.0	6.1	61.3	0.6	24.7	0.8	22.7	0.1	0.0	-	-
Lake Victoria	1.1	2.6	47.5	29.5	22.1	8.9	43.5	2.5	32.5	0.2	0.1	0.8	0.0
Lake Kyoga	3.9	1.3	24.2	10.7	59.4	42.3	25.7	0.6	14.4	0.5	0.1	0.0	0.1
Lake Edward	0.2	2.5	59.5	3.3	2.2	0.7	5.8	0.0	3.2	0.2	0.1	0.1	0.0
Lake Albert	0.2	2.2	118.5	8.2	33.8	0.3	12.5	1.9	5.8	0.2	0.0	-	0.0
Kidepo	-	-	-	-	21.3	5.0	7.8	-	2.3	-	-	-	0.0
Aswa	0.1	0.1	-	-	81.0	3.1	39.0	-	13.4	-	0.0	0.0	0.1
Albert Nile	0.3	1.9	1.4	-	46.0	2.1	14.4	0.0	6.6	-	0.0	0.0	0.1
Total	6.0	13.3	258.3	57.9	395.9	107.2	200.0	5.9	103.5	1.2	0.3	0.9	0.4

Land cover classes by drainage area

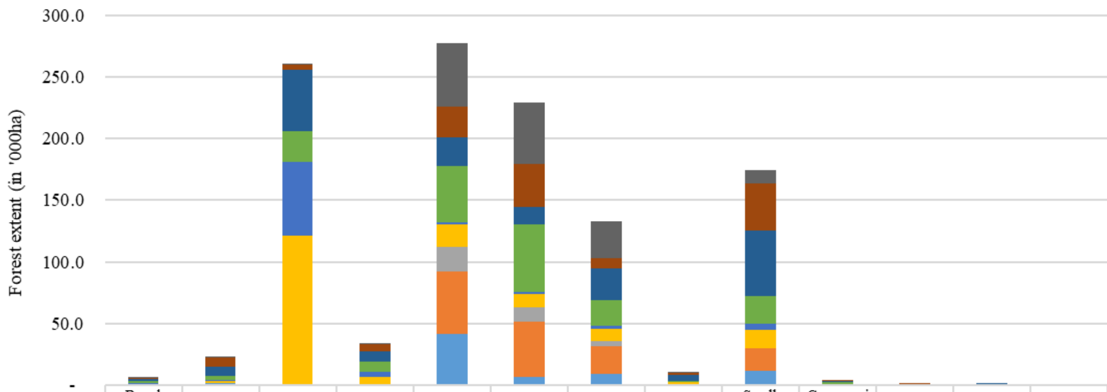
Figure 24: Forest extent for CFRs by land cover class and basin in 2005 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0	0	0	-	53	38	45	-	6	-	-	-	-
Victoria Nile	2	2	1	5	34	33	15	1	32	0	0	-	0
Lake Victoria	1	5	44	10	25	18	28	5	53	0	1	1	0
Lake Kyoga	1	2	22	7	53	37	31	1	26	2	0	0	0
Lake Edward	1	2	64	1	0	3	2	0	5	1	0	0	-
Lake Albert	0	1	112	13	13	26	6	2	11	0	0	-	0
Kidepo	-	-	-	-	22	5	9	-	1	-	-	-	0
Aswa	-	0	-	-	63	21	35	0	17	0	0	0	1
Albert Nile	1	2	2	-	46	6	7	0	11	-	0	0	0
Total	5	14	244	37	309	187	178	9	162	3	1	1	1

Land cover classes by basin

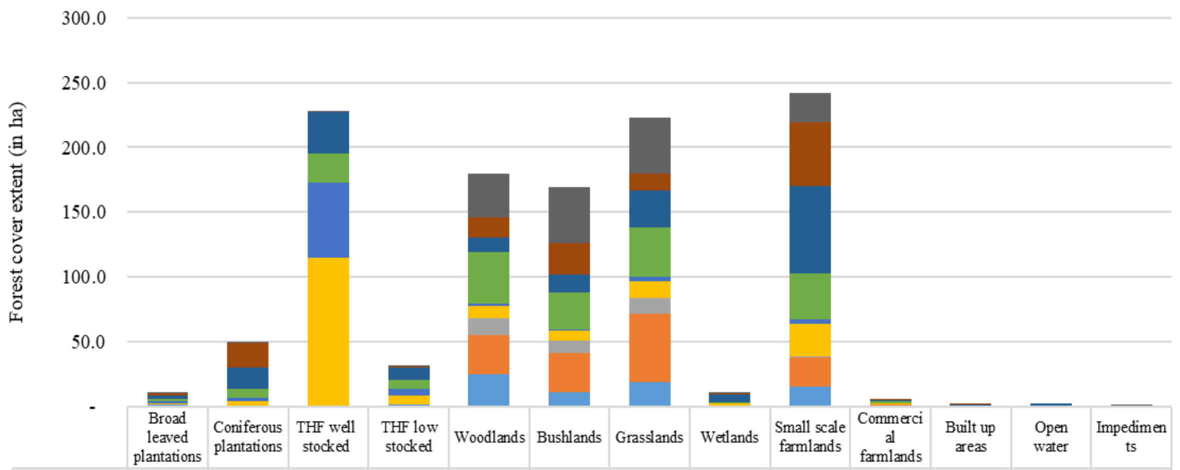
Figure 25: Forest extent for CFRs by land cover class and basin in 2010 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0.1	0.4	0.2	0.1	51.7	49.6	29.5	0.0	11.3	-	-	-	0.0
Victoria Nile	0.7	7.5	3.8	6.5	24.9	35.1	8.4	1.0	37.4	0.5	0.1	-	0.0
Lake Victoria	1.4	7.4	49.7	8.0	23.5	13.9	26.1	5.3	53.2	0.6	0.4	1.5	0.1
Lake Kyoga	1.8	2.8	25.1	8.2	45.0	55.0	20.2	0.8	22.6	1.3	0.2	0.0	0.0
Lake Edward	0.6	1.2	60.0	4.1	2.0	1.6	2.7	0.2	5.0	0.3	0.0	0.0	0.0
Lake Albert	0.5	1.9	120.1	6.0	17.9	10.7	9.8	1.9	14.8	0.2	0.0	0.0	0.0
Kidepo	-	-	-	-	20.0	11.3	4.5	-	0.6	-	-	-	-
Aswa	0.0	0.0	-	-	50.5	44.9	22.4	0.3	18.0	0.5	0.1	0.0	0.0
Albert Nile	0.4	1.4	1.0	0.8	41.8	6.8	9.1	0.1	11.5	0.0	0.0	0.0	0.0
Total	5.5	22.6	259.9	33.7	277.3	228.9	132.7	9.6	174.4	3.4	0.8	1.6	0.1

Land cover classes by drainage area

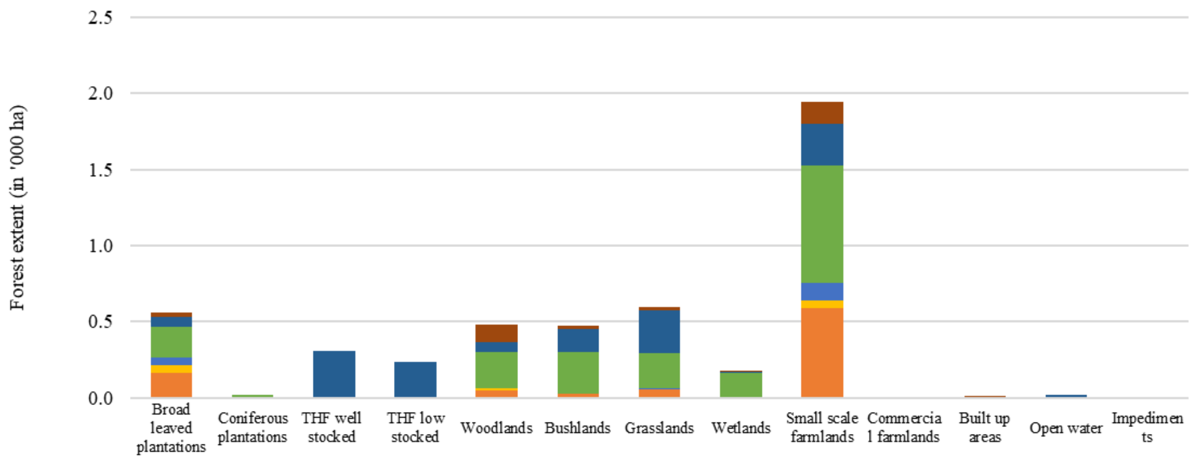
Figure 26: Forest extent for CFRs by land cover class and basin in 2015 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0.1	0.3	0.2	0.0	33.9	42.6	42.7	0.1	22.9	-	-	-	0.0
Victoria Nile	1.6	18.8	0.2	0.4	15.0	24.9	13.0	1.6	49.4	0.9	0.2	-	0.0
Lake Victoria	3.0	16.8	31.7	9.4	11.4	13.2	28.5	5.5	67.6	0.9	1.0	1.8	0.2
Lake Kyoga	2.0	6.6	22.8	7.4	39.9	28.5	38.2	0.6	35.5	1.5	0.2	0.1	0.0
Lake Edward	1.3	3.1	57.9	5.0	2.2	0.9	3.8	0.3	2.9	0.5	0.1	0.0	0.0
Lake Albert	1.4	2.7	114.6	6.7	8.8	8.5	12.8	2.1	25.4	0.4	0.0	0.0	0.1
Kidepo	-	-	-	-	13.7	9.3	12.3	-	1.1	-	-	-	-
Aswa	0.0	0.1	-	-	30.3	30.2	52.5	0.0	22.0	1.6	0.2	0.1	0.0
Albert Nile	0.9	0.8	-	1.5	24.3	10.8	18.9	0.1	15.4	0.0	0.0	0.0	0.1
Total	10.3	49.1	227.4	30.4	179.5	168.9	222.6	10.3	242.2	5.8	1.7	2.0	0.3

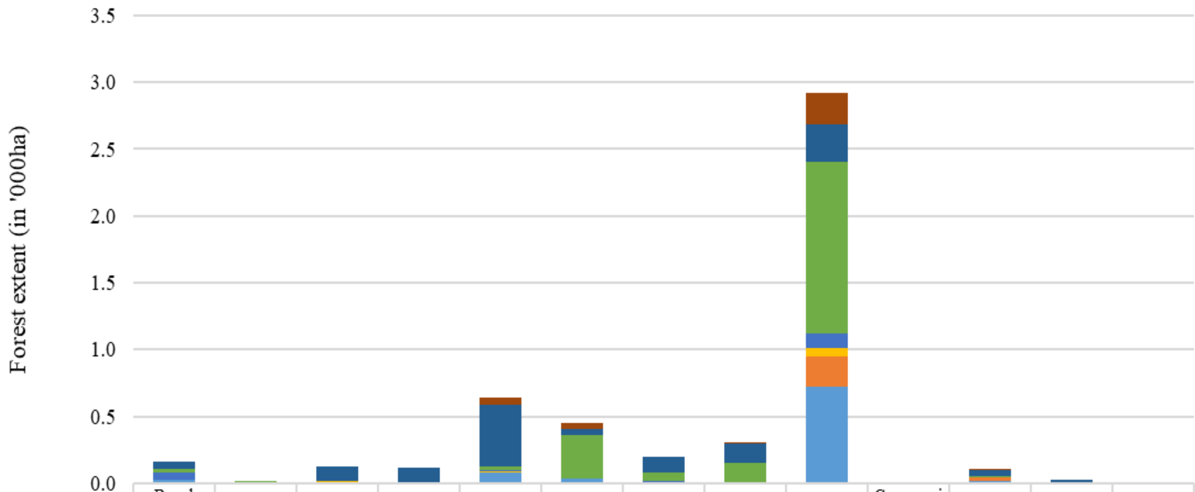
The extent of Local Forest Reserves by river basin is shown in Figures 27 to 30 for the years 1900, 2005, 2010 and 2015. The area of LFR is small and remained constant over time at 5,100 ha.

Figure 27: Forest extent for LFRs by land cover class and basin in 1990 (1,000 ha)



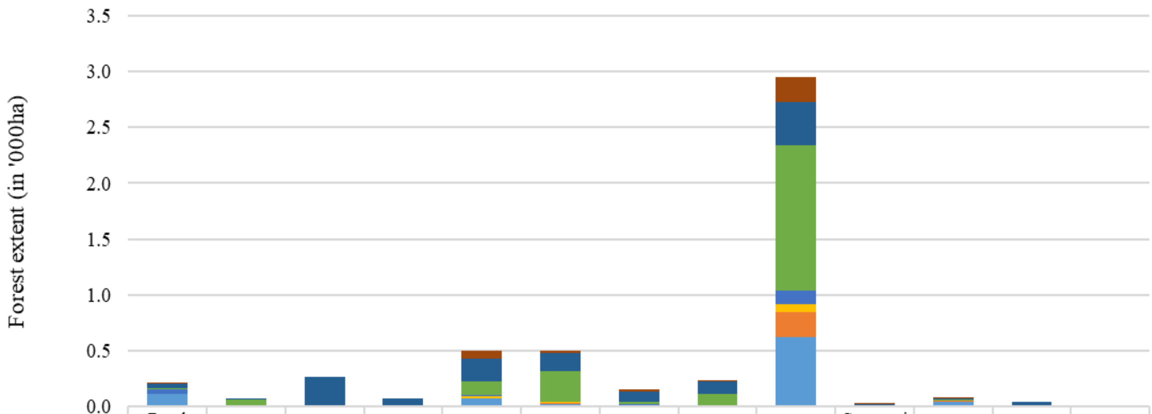
	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Victoria Nile	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Lake Victoria	0.1	0.0	0.3	0.2	0.1	0.2	0.3	0.0	0.3	0.0	0.0	0.0	0.0
Lake Kyoga	0.2	0.0	0.0	0.0	0.2	0.3	0.2	0.2	0.8	0.0	0.0	0.0	0.0
Lake Edward	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Lake Albert	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Kidepo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aswa	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.6	0.0	0.0	0.0	0.0
Albert Nile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.6	0.0	0.3	0.2	0.5	0.5	0.6	0.2	1.9	0.0	0.0	0.0	0.0

Figure 28: Forest extent for LFRs by land cover class and basin in 2005 (1,000ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Victoria Nile	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Lake Victoria	0.1	0.0	0.1	0.1	0.5	0.1	0.1	0.1	0.3	0.0	0.0	0.0	0.0
Lake Kyoga	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.1	1.3	0.0	0.0	0.0	0.0
Lake Edward	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Lake Albert	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Kidepo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aswa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Albert Nile	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0
Total	0.2	0.0	0.1	0.1	0.6	0.4	0.2	0.3	2.9	0.0	0.1	0.0	0.0

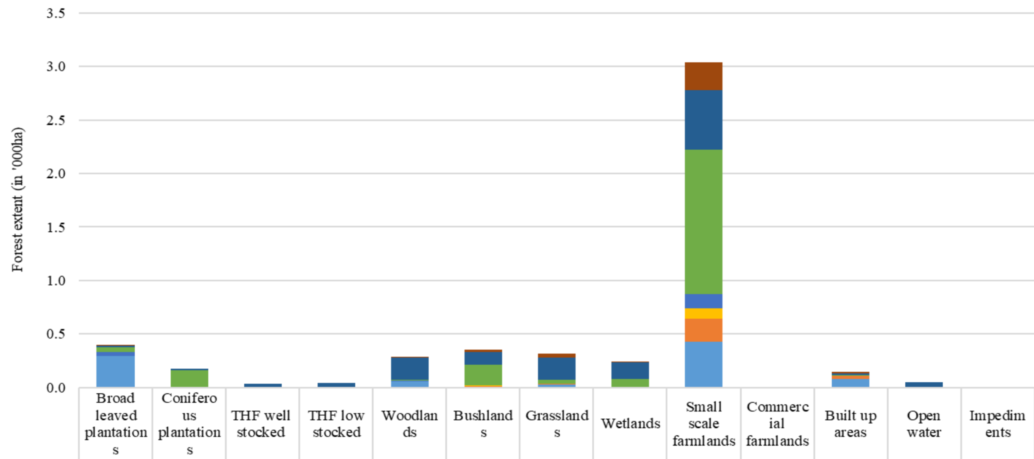
Figure 29: Forest extent for LFRs by land cover class and drainage basin in 2010 (1,000ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Victoria Nile	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Lake Victoria	0.0	0.0	0.3	0.1	0.2	0.2	0.1	0.1	0.4	0.0	0.0	0.0	0.0
Lake Kyoga	0.0	0.1	0.0	0.0	0.1	0.3	0.0	0.1	1.3	0.0	0.0	0.0	0.0
Lake Edward	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Lake Albert	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Kidepo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aswa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Albert Nile	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0
Total	0.2	0.1	0.3	0.1	0.5	0.5	0.1	0.2	3.0	0.0	0.1	0.0	0.0

Land cover classes by drainage area

Figure 30: Forest extent for LFRs by land cover class and drainage basin in 2015 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands	Bushlands	Grasslands	Wetlands	Small scale farmlands	Commercial farmlands	Built up areas	Open water	Impediments
Balancing area	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Victoria Nile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Lake Victoria	0.0	0.0	0.0	0.0	0.2	0.1	0.2	0.2	0.6	0.0	0.0	0.0	0.0
Lake Kyoga	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.1	1.4	0.0	0.0	0.0	0.0
Lake Edward	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Lake Albert	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Kidepo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aswa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Albert Nile	0.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.4	0.0	0.1	0.0	0.0
Total	0.4	0.2	0.0	0.0	0.3	0.4	0.3	0.2	3.0	0.0	0.1	0.0	0.0

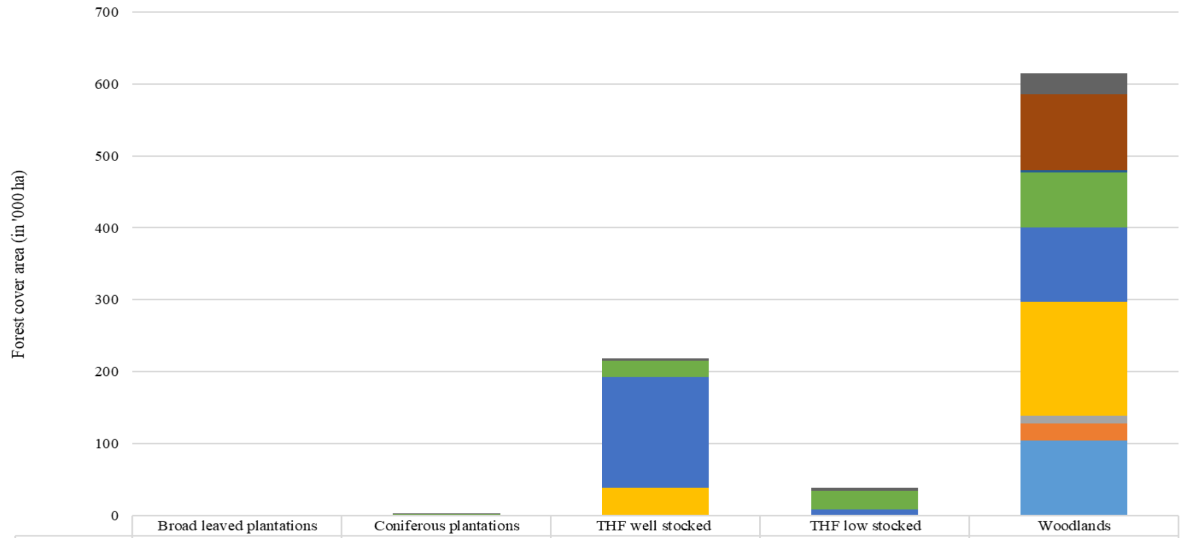
Land cover class by draainage area

National Parks and Wildlife Reserves by river basin is shown in Appendix 4 for the years 1990, 2005, 2010 and 2015 and similar information in shown in Figures 31 to 34. The extent of forests in National Parks and Wildlife Reserves had decreased from the 831,000 ha in 1990 to 640,000 ha in 2015.

The composition of forests in National Parks and Wildlife Reserves in 2015 was 53 percent woodlands, 42 percent THF well stocked, 5 percent THF low stocked and 0.4 percent forest plantation. Between 1990 and 2015, the THF well stocked had increased by 22 percent from 218,000 ha to 268,000 ha while the woodlands and THF low stocked had decreased respectively by 41 percent from 571,000 ha to 338,000 ha and by 18 percent from 39,000 ha to 32,000 ha. The forest plantations remained stable at 2,300 ha, over the same period.

In 2015, 37 percent of the forests in National Parks and Wildlife Reserves were located in the Lake Edward basin, 29 percent in the Lake Albert basin, 15 percent in the Victoria Nile basin, 13 percent in the Lake Kyoga basin, 5 percent in the Albert Nile basin, 3 percent in the Lake Victoria basin, 1 percent in the Kidepo basin and less than 1 percent in the Aswa basin. The balancing area has a forest ecosystem extent of 4 percent.

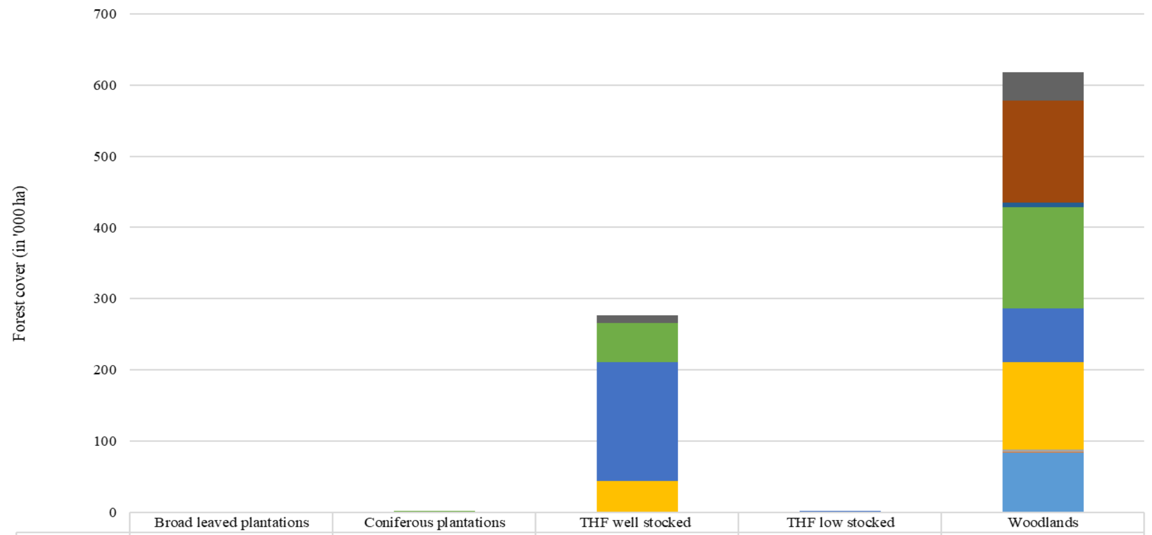
Figure 31: Forest extent for National Parks and Wildlife Reserves by land cover class and basin in 1990 (1,000ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands
Balancing area	0	1	4	5	29
Victoria Nile	0	0	0	0	105
Lake Victoria	0	0	0	0	4
Lake Kyoga	0	1	23	26	76
Lake Edward	0	1	154	7	104
Lake Albert	0	0	38	1	158
Kidepo	0	0	0	0	10
Aswa	0	0	0	0	24
Albert Nile	0	0	0	0	104
Total	0	2	218	39	615

Forest cover classes by basin

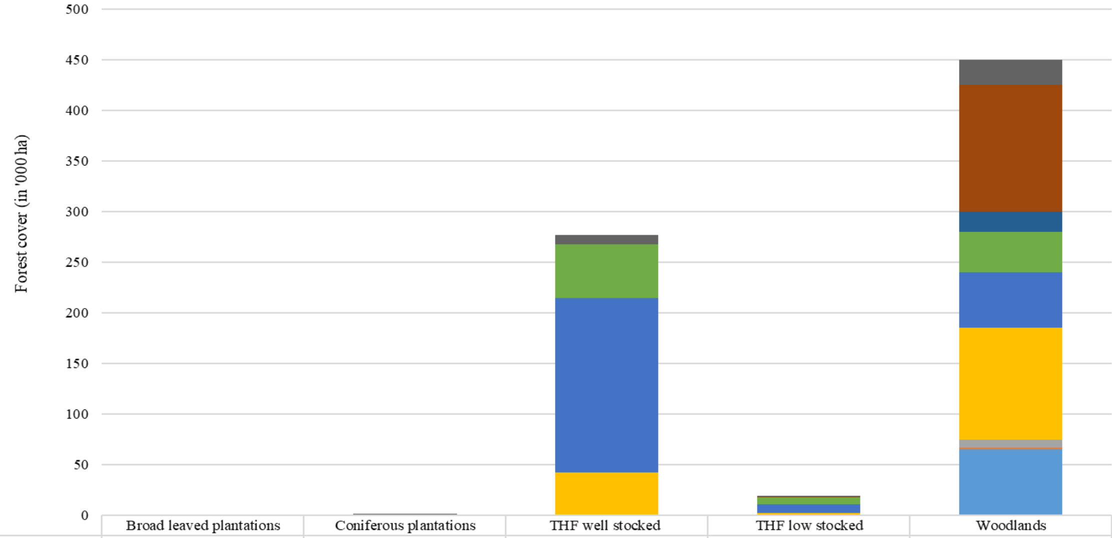
Figure 32: Forest extent for National Parks and Wildlife Reserves by land cover class and basin in 2005 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands
Balancing area	0	0	11	0	41
Victoria Nile	0	0	0	0	143
Lake Victoria	0	0	0	0	6
Lake Kyoga	0	2	54	0	142
Lake Edward	0	0	167	2	75
Lake Albert	0	0	44	0	122
Kidepo	0	0	0	0	3
Aswa	0	0	0	0	2
Albert Nile	0	0	1	0	84
Total	0	2	277	2	619

Forest cover classes by basin

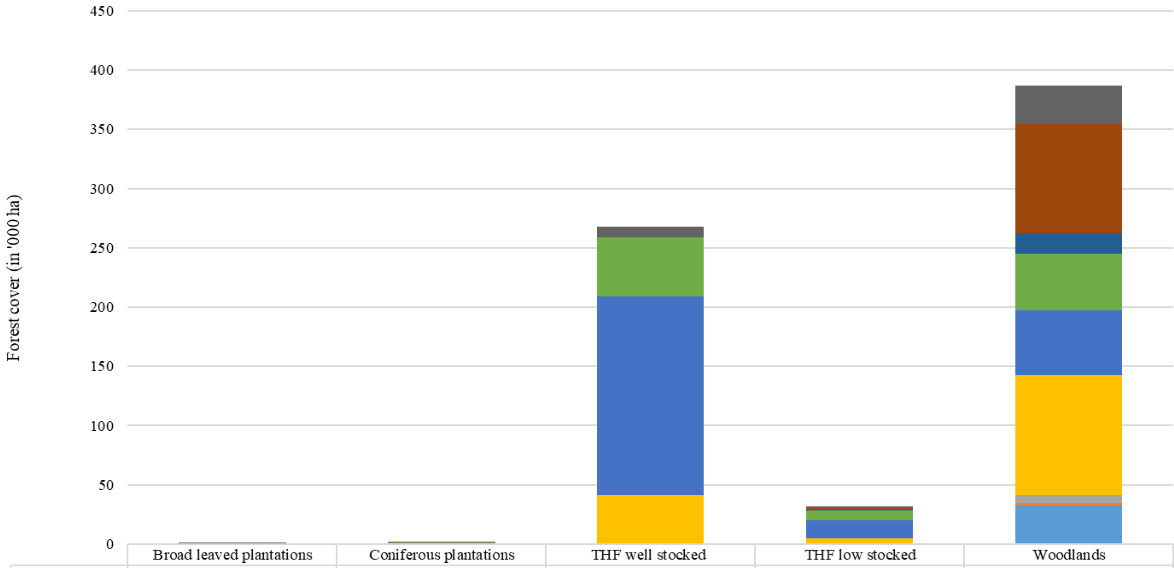
Figure 33: Forest extent for National Parks and Wildlife Reserves by land cover class and basin in 2010 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands
Balancing area	0	0	9	1	25
Victoria Nile	0	0	0	0	125
Lake Victoria	0	0	0	0	20
Lake Kyoga	0	1	53	6	40
Lake Edward	0	0	172	9	55
Lake Albert	0	0	42	2	110
Kidepo	0	0	0	0	7
Aswa	0	0	0	0	2
Albert Nile	0	0	0	0	65
Total	1	1	277	19	450

Forest cover classes by basin

Figure 34: Forest extent for National Parks and Wildlife Reserves by land cover class and basin in 2015 (1,000 ha)



	Broad leaved plantations	Coniferous plantations	THF well stocked	THF low stocked	Woodlands
Balancing area	0	1	9	2	32
Victoria Nile	0	0	0	1	92
Lake Victoria	0	0	0	1	17
Lake Kyoga	0	1	50	8	48
Lake Edward	0	0	168	15	55
Lake Albert	0	0	41	5	101
Kidepo	0	0	0	0	6
Aswa	0	0	0	0	2
Albert Nile	0	0	0	0	33
Total	1	2	268	32	387

Forest cover classes by basin

3.4 Physical flows and ecosystem service accounts

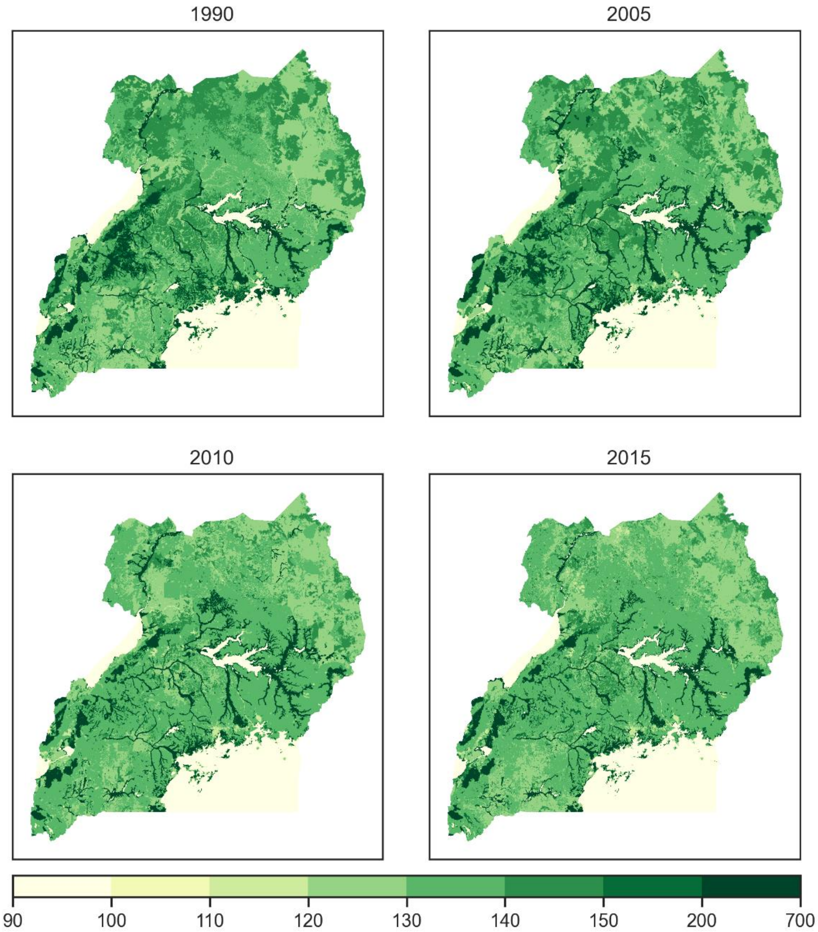
3.4.1 Carbon storage and carbon sequestration

Figure 35 shows the volume of carbon stored in 1990, 2005, 2010, and 2015, with values ranging from 90 to 700 tons carbon per hectare. In all river basins, except Albert Nile, Aswa, Kidepo, and Lake Albert, carbon storage increased between 1990 and 2015. Between 1990 and 2015, gains in carbon storage were greatest in the Lake Kyoga, Lake Victoria, and Victoria Nile basins. In particular, carbon storage in the Lake Kyoga basin increased by 5.6 percent between 1990 and 2015. In the Lake Albert basin, carbon storage between 1990 and 2015 decreased by 7 percent.

Despite the loss in forest cover between 1990 and 2015, carbon stored still increased due to the gains in wetland area. Wetland soils have relatively high carbon storage potential, and as such, were able to offset losses in tree biomass. However, as deforestation increased between 2005 and 2015, overall carbon storage decreased in that period. These change needs to be interpreted cautiously owing to questions about the accuracy of the methods used to measure the extent of wetlands and this is issue is discussed later (Section 4.1)

The findings highlight importance of the baseline year that is used as a reference point for future years. When 1990 is used as a baseline, the amount of carbon stored is shown to increase by 2015 due to an increase in carbon capture in permanent wetlands. However, if 2005 is used as the baseline the increase in carbon storage in 2015 is much smaller. Changes in the estimates of carbon stored are related, in particular, to the conversion of forests and woodlands to agricultural lands, with agricultural lands storing less carbon.

Figure 35. Carbon storage in Uganda, 1990, 2005, 2010 and 2015 (ton C/ha) by year.

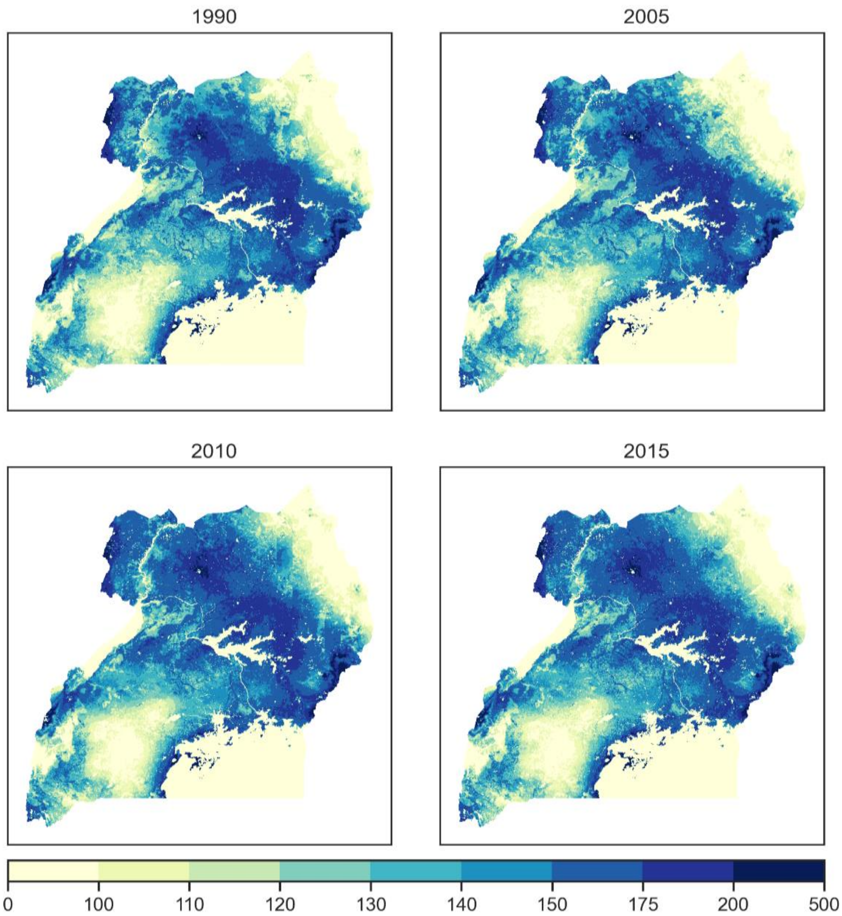


3.4.2 Water yield

Maps of annual water yield for the years 1990, 2005, 2010, and 2015 are shown in Figure 36. In all basins, except Lake Edward, Lake Kyoga, and Lake Victoria, annual water yield increased between 1990 and 2010, with greatest gains in the Albert Nile, Aswa, Kidepo, and Lake Albert basins. In particular, annual water yield in the Albert Nile basin increased by 4.5 percent between 1990 and 2010. In the Lake Edward and Lake Kyoga basins, annual water yield remained relatively constant between 1990 and 2015, decreasing slightly, by 0.2 percent and 0.3 percent, respectively.

When using 1990 as the baseline year of comparison, water yield nationally decreased by 0.1 percent in 2005, but increased by 2.2 percent and 1.9 percent in 2010 and 2015, respectively. This probably reflects a loss of forest cover, as forests have a relatively high evapotranspiration rate. Since forests typically have higher rates of evapotranspiration than other land cover types, a lower proportion of annual goes to runoff and infiltration. However, some evidence suggests that over long periods of time, deforestation can diminish the overall water budget, thus decreasing annual water yield (Bonan 2008; West et al. 2010). Also, over seasonal or monthly time scales, increased forest cover has been shown to increase baseflows during periods of drought and mitigate peak flows during flood events (Brauman et al. 2007). In order to capture these long-term and seasonal dynamics, long-term monitoring and regional climate modeling is required.

Figure 36. Annual water yield, Uganda, 1990, 2005, 2010 and 2015 (mm water / hectare / year).



3.4.3 Sediment retention and exports

Maps of sediment retention in 1990, 2005, 2010, and 2015 are shown in Figure 37, with values ranging from 0 to 5,000 tons of sediment retained (i.e. erosion avoided) per hectare per year. Compared to 1990, sediment retention nationally decreased by 0.02 percent in 2005, 1.2 percent in 2010, and 0.6 percent in 2015. In all basins, except Kidepo, sediment retention decreased between 1990 and 2010, and between 1990 and 2015. The greatest decreases were in the Victoria Nile, Lake Albert, and Albert Nile basins (see Annex 2). In particular, sediment retention in the Victoria Nile basin decreased by 2.9 percent between 1990 and 2010. In the Kidepo basin, sediment retention increased by 0.8 percent between 1990 and 2015. This change is related to changes in land cover, whereby land covers less capable of controlling erosion (e.g. farmlands) are replacing land covers (e.g. forests) that are better able to control erosion

Related to sediment retention is the indicator 'sediment export' (e.g. Yang et al., 2003). Sediment export indicates a negative externality from ecosystems and such flows are not recorded in an ecosystem account (although they could be shown in SEEA Central Framework waste account). It is important to keep in mind that the amount of sediment exported is a function of land cover, slope steepness and length, and rainfall variables such as rainfall intensity. Hence, the relation between the two, for any given pixel, is expressed as follows:

Erosion rate of bare soil (as a function of slope, soil and rainfall) = sediment eroded (as a function of slope, soil, rainfall and actual vegetation cover) + sediment retained (as a function of slope, soil, rainfall and actual vegetation cover)

As per the equation given above, sediment export is negatively correlated with sediment retention. Consequently, in basins where sediment retention increased from 1990, sediment export decreased; conversely, sediment export increased in basins where sediment retention decreased from 1990 (Figure 33). Given that sediment export is potentially a policy relevant indicator, it is also included in the report, in the form of maps (Figure 34).

3.4.5 Ecosystem services accounts

By combining the information on the physical flows of carbon, water and sediment with other information on the use of these flows by people, ecosystem service accounts can be produced. However, full ecosystem service accounts could not be produced. Table 2 shows the structure of the account for the supply and supply and use of ecosystems services related to the physical flows measured in 2015 for each river basin. As noted in the data sources and methods, the flows of carbon are of benefit to all people as they mitigate climate change and as such this use is recorded as a use by government. Annex 3 shows an alternative tabular presentation with the supply of ecosystem services being shown by land cover type, rather than by river basin – no data are included in this table. It is also possible to show the supply and use of ecosystem services for each river basin by land cover type.

The water accounts (Government of Uganda 2019) could be used with the information on the physical flows of water to estimate the use of the water provisioning service by business and households at the national level. In water account (Government of Uganda 2019, Table 4, p. 33) total water use (including groundwater) by people in 2015 was 236,994,549,748 thousand m^3, while the InVest modelling show total flows of 28,197,881 thousand m^3 (see Annex 5), which is a very large difference that requires further research. Potentially, an explanation is that some of the water used is from rivers flowing into Uganda. Information about the location of reservoirs or other water sources used to supply water to households and industry, as well as some assumptions about the location of agricultural activity using water, could be used to allocate the supply of water provisioning services to particular land covers and river basins. Similarly, converting the information on retention of sediment to a supply and use of an ecosystem services would require additional information and assumptions.

Figure 37. Sediment retention in Uganda, 1990, 2005, 2010 and 2015 (ton/ha/year).

Figure 38. Sediment export in Uganda, 1990, 2005, 2010 and 2015 (ton/ha/year).

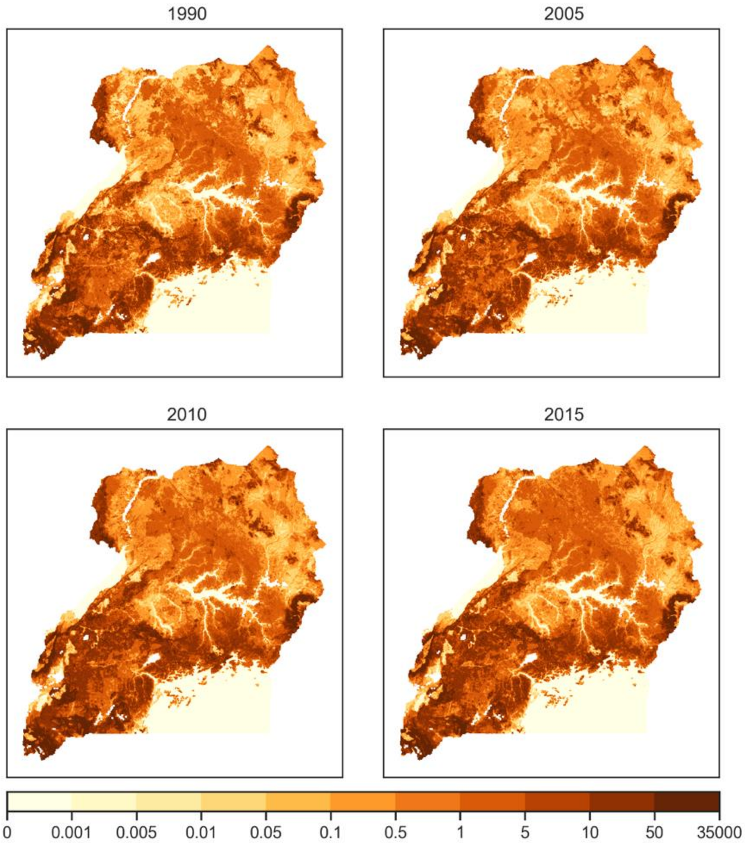


Table 2. Experimental ecosystem services account, Uganda by river basin, 2015

		River basin									Industry or sector								
Supply																			
	Units	Kidepo	Aswa	Lake Kyoga	Albert Nile	Victoria Nile	Lake Albert	Lake Edward	Lake Victoria	Balancing item	Agriculture	Mining	Manufacturing	Electricity	Water supply	Other	Households	Government	Total
Carbon stored	1000 t carbon	40,766	363,767	935,572	289,352	441,425	269,066	298,915	804,269	No data									
Carbon sequestration	1000 t carbon	-42	98	701	336	217	-311	2168	3464										
Water provisioning	1000 m3	300,418	4,142,780	7,972,611	3,251,703	4,115,193	2,052,613	2,286,548	4,076,015										
Erosion control	1000 t sediment	68,685	275,514	757,211	186,420	265,067	447,649	1,014,013	792,958										
Use																			
Carbon stored	1000 t carbon																		
Carbon sequestration																			
Water provisioning	1000 m3																		
Erosion control	1000 t sediment																		

Note: carbon sequestration is expressed as the net change in carbon stock, annual average over the period 2010-2015

CHAPTER FOUR: DISCUSSION

4.1 Policy implications

The accounts can support policy making in several ways. First, the accounts show how land cover, a proxy for ecosystem extent, has changed over time. In particular, the extent accounts show how forest cover has decreased and agricultural land has expanded by river basin. This means specific river basins may be targeted for action (i.e. the ones losing the largest percentage of forest) and well the management of forests, with much forest lost from the national park network. Similarly, wetland management may be targeted as many temporary wetlands have been converted to farmland. Second, the modelling of the physical flows shows that land cover changes have led to changes in physical flows and this will be related to changes in ecosystem services as well. The development of policy relating to payments for ecosystems could be one option to explore, particularly for forests and wetlands in private ownership. However, some uncertainties related to the modelling and data sources mean that caution is needed in interpreting the data on physical flows (see Section 4.2 below) and hence its suitability to support payment schemes may be limited at present.

While noting the limits of the data and modelling, the physical measures of carbon storage and sequestration were able to be transformed into ecosystem services related to climate regulation. Beneficiaries of these service could be identified as government, recognizing the collective benefit of climate regulation and payments for these might be usefully further explored. Overall, carbon storage and sequestration is increased from 1990 to 2015 (Table A5.1) but in forests it is declining, with the modelling suggesting that carbon is increasingly being stored in wetlands, but this latter element needs to be verified.

The loss of carbon in forests is consistent between the extent account (that shows declining forest cover) and the services account, that shows a decline in carbon storage from 2005 onwards. These changes in carbon stocks, and potential opportunities to protect and restore forests are relevant for the national climate change policies including the implementation of the policies leading toward reaching Nationally Determined Contributions (NDCs) in the context of the Paris Agreement.

The impact of deforestation is also reflected in the annual water yield (Figure 36). It is not known how water distribution has changed *within* the years, but the loss of forest cover means a reduction in overall evapotranspiration, leading to an increase in water flow, in particular during the rainy season (but not during the dry season) and a reduction in the return of water vapor to the atmosphere where it can contribute to rainfall. In many areas on the planet, deforestation has been associated with a decline in rainfall (Creed and Van Noordwijk, 2018). Given the deforestation in Uganda and neighboring countries, it is likely that this will affect rainfall and thereby rain-fed agriculture at some point in the future. This would be highly relevant for Ugandan food security and agricultural economic activities and it is recommended examining this further (see Section 4.3).

4.2 Uncertainties and limitations

Biophysical models like InVEST simplify extremely complex ecological and hydrological processes that vary spatially and temporally. The simplified representation of these processes within InVEST allows the model to be run over large spatial scales using widely available datasets. While it is clear that there is uncertainty in the model outputs, it not possible to quantify or qualify that uncertainty without more information on data sources and better understanding of the modelling platform. It is therefore important to be cautious when assessing the model outputs and to understand how they must be interpreted with caution.

Steps can be made to enhance the models used. For example, validation of the amount of carbon stored and sequestered could be done using field-based measurements of carbon in the aboveground and belowground biomass, dead woody biomass, and the soil. In the short term, it may also be possible to validate the annual water yield model based on discharge values collected by stream gages. However, this type of monitoring program would ideally need to occur over a period of decades, if there is to be reliable estimates of average annual values (Redhead et al. 2016). It is not possible to validate outputs from the sediment retention model. As this model only captures rill erosion processes[7], and does not estimate other forms of erosion, such as gully or streambank erosion[8] (Sharp et al. 2015), comparing InVEST outputs with monitoring data would be invalid.

One issue is the coarse temporal resolution of the water yield module used. In principle, InVEST allows assessing seasonal water flows, however in the case reported here only the annual water yield module was used. That means that water storage and release, and assessing quickflow versus baseflow, was not possible. In the future, models providing enhanced temporal resolution or the seasonal version of InVEST, or more detailed hydrological models that better allow calibration and validation (but also require more data and effort) could be used.

The land cover accounts show that there is an increase in wetland area, which is subsequently leading to an increase in carbon stocks. It is interesting to compare the information on the land cover class wetlands to the other information on wetlands, which uses a different definition of wetlands. This works highlights the difference between land cover accounts and ecosystem accounts and show that while land cover may be a reasonable proxy for ecosystem type, it is not exactly the case for wetlands in Uganda. Regardless of the definition, Ugandan wetlands are increasingly converted to agriculture. When this happens the wetland areas are no longer flooded and in the future may no longer qualify as wetlands. At what point the change from wetland to agriculture becomes irreversible is unknown. It seems likely that the wetland area as defined by ecosystem type will decreases rather than increases over time. Potentially, an increase in the area of wetlands as picked up in the land cover accounts may reflect a positive change in the extent and condition wetland ecosystems due to either natural processes (e.g. rainfall and regeneration) or better management (e.g. limiting grazing). This aspect requires further investigation.

4.3 Future opportunities

There are many opportunities to develop the Uganda ecosystem accounts in the future. The specific options selected will depend on the policy priorities of the Government of Uganda, as well as on the resource available, data availability and the development of account producing capacity, both the technical skills of staff (e.g. in modelling) and the processes used by agencies involved. Options are available for developing ecosystem accounting in Uganda, include:

1. Establishment of an ongoing process for the leadership and management of ecosystem account production and use
2. Developing ecosystem accounts that go beyond using land cover as an approximation for ecosystem extent
3. Converting the estimates of physical flows into full accounts of ecosystem services which will require the identification of the users of the services
4. Expanding the number ecosystem services included in the accounts.
5. Undertaking economic valuations to develop monetary estimates of ecosystem services and assets.
6. Developing ecosystem condition accounts which will require a broad set of indicators for the quality of wetlands, forest, water and other ecosystems.

---

[7] Rill erosion occurs when runoff water forms small channels as it concentrates down a slope. These rills can be up to 0.3m deep.

[8] Gully erosion is the removal of soil along drainage lines by surface water runoff. Streambank erosion occurs when streams cut deeper and wider channels.

7. Enhancing the hydrological model either by using the seasonal water yield module of InVEST, or by replacing the InVEST hydrological module with a regular hydrological model, such as SWAT. maintain dry season streamflow (i.e. baseflow).
8. Analyzing how forests contribute to maintaining rainfall patterns in Uganda and Africa more generally.

An ongoing process for the leadership and management of ecosystem account production is needed for Uganda. The work done to date has relied on the existing processes. Uganda's National Plan of Action on Environmental Economic Accounting (NP-AEEA), provides a basis for this and is a recognized 'roadmap' for systematic NCA development in Uganda. The NP-AEEA was completed before the work on ecosystem accounting was done and hence could be re-visited to provide a more specific plan for ecosystem accounting which will require the inputs from a range of government agencies and would benefit from the involvement of the private, NGO and academic sectors.

Other factors to consider is possible economic instruments that could be used by government to encourage change in management. Payments for ecosystem services, and in particular for climate regulation services, would be an example of this. Such instruments could encourage international investment in Uganda and provide an alternative income source to small-scale farmers. Consideration of the economic instruments would also help with the development of economic valuations to develop monetary estimates of ecosystem services and assets which is a critical next step and will require greater integration with both Uganda's land and national economic accounts.

On the technical side, developing ecosystem accounts that go beyond using land cover as an approximation for ecosystem extent. The work on accounting for wetlands highlighted the difference is definitions from different data source. In is also apparent the data from remote sensing used for producing the land cover maps and accounts, needs to be supported by ground-based observations, that in addition to confirming land cover type can also assess the species and vegetation structure of sites.

Converting the estimates of physical flows into full accounts of ecosystem services will require the identification of the users of the services which in turn will require the integration of data from other sources or even the collection of new data. In this, physical flows should be mapped to economic units in the economy. This could be relatively easy for large users of services, such as large-scale commercial water or timber suppliers, but would be harder for small scale agricultural producers or fuelwood suppliers.

Expanding the number ecosystem services included in the accounts would expand the possible uses and users of the accounts. Currently, only four services are included. Others that could be added include the provisioning services for non-timber forest products not currently included in the forest accounts, flood retention, water purification and cultural and recreational services. For example, tourism related services including wildlife viewing, hiking and watersports.

Developing ecosystem condition accounts will require a broad set of indicators on the quality of wetlands, forest, water and other ecosystems. These indicators need to be defined for each ecosystem, for example forest ecosystem indicators could include aspects such as standing biomass, biodiversity, quality of the forest (old growth versus degraded forests), while the quality of wetlands might depend on species present, soil moisture, etc.

For the existing ecosystem services, enhancing the hydrological model either by using the seasonal water yield module of InVEST, or by replacing the InVEST hydrological module with a regular hydrological model, such as SWAT would be useful. The former has the advantage that it is fairly straightforward and could be achieved with relatively limited resources. The advantage of the latter is that this will allow a much more accurate modeling of the hydrological regulation by forests (given that the model can be calibrated and validated against actual streamflow data). In addition, this allows the model to indicate how forests maintain dry season streamflow (i.e. baseflow). A disadvantage is that this requires considerable effort, data and time. Given that SWAT requires modeling entire river basins, including the Nile in SWAT or a comparable hydrological model may require modeling the entire Nile basin upstream of Uganda. Furthermore, Ugandan hydrology is complex, with multiple relatively small watersheds draining into Lake Victoria and a large number of wetlands that each have a specific impact on river hydrology depending upon their land use (and in particular depending upon if they are seasonally flooded or if they are closed off with a dyke so that they remain arable throughout the year). It is estimated that this option would take around 6 to 12 months of work and require streamflow data from water monitoring stations across Uganda.

Finally, analyzing how forests contribute to maintaining rainfall patterns has clear policy relevance as rainfall is essential for Ugandan food production and food security. Since Uganda is located more than 600 km from the Ocean, a major part of its rainfall is derived from the so-called secondary rainfall cycle, i.e. rainfall that originated from evapotranspiration by especially forests and lakes (and to a much lower extent other vegetation types). In other words, forests are essential to maintain rainfall in Uganda. Further deforestation in Eastern Africa will likely lead to reduced rainfall in Uganda. The forests that maintain rainfall are located not only in Uganda but also in Tanzania, the Democratic Republic of the Congo and Kenya. An existing model developed at Wageningen University simulates rainfall across Africa in daily time steps and the relation between forest cover and rainfall can be assessed with this. This model could test how Ugandan rainfall depends upon forests both in Uganda and in neighboring countries (i.e. it could be calculated by how much rainfall in Uganda would decline should all or part of these forests be lost). It is important to note that some of Ugandan rainfall originates from evaporation in Lake Victoria (which is included in the model). The model allows adding an additional regulating service to the account, corrects for an omission in the current InVEST modeling (that assumes that water leaving the ecosystem through evapotranspiration is 'lost') and would be highly policy relevant.

CHAPTER FIVE: CONCLUSIONS

This report presents the work on the development of ecosystem accounts in Uganda. The report includes a land cover extent account, how land cover is related to wetland and forest management, estimates of physical measures related to four ecosystems services along with a partial ecosystem services account. The work was done at national scale but is also available for the eight river basins within Uganda.

The work demonstrates that current data sources, methods and capacity enable the partial implementation of United Nations System of Environmental Economic Accounting (SEEA) – Experimental Ecosystem Accounting.

The Extent account uses land cover to classify ecosystem types, and shows how land cover has changed in the period 1990 to 2015, with maps and accounting tables for the four years 1990, 2005, 2010, and 2015. The account shows the major changes that took place by drainage basin. The most striking change is the strong reduction in woodlands, and the increase in small-scale farmland. There has also been an increase in commercial farming, but small-scale farming remains the dominant land use in Uganda.

The partial ecosystem services account shows how estimates of physical measures for carbon storage, carbon sequestration, water yield and sediment retention can be transformed into an assessment of ecosystem services. The physical flows are shown by drainage basin and the partial ecosystem service account show four services: (i) carbon storage; (ii) carbon sequestration); (iii) water provisioning; and (iv) erosion control. The climate regulation services (carbon storage and sequestration) increased between 1990 and 2005, but declined in the period 2005 to 2015. This is caused, in particular, by deforestation including the conversion of woodland to farmland. The water yield increased over time, meaning that more rainwater ends up in rivers, however changes in rainfall patterns have not been considered in this analysis. Soil retention declined over time. This is also related to the conversion of woodlands into farmland, which are somewhat more prone to erosion, especially in the beginning of the growing season when there is still not full ground cover in the fields.

The accounts are not complete but demonstrate the amount of effort and data needed for compiling accounts and how the information in the accounts could be used to support policy making. The accounts are, in principle, useful to support land use planning, climate change and agricultural policies, among others. It is possible to extend the biophysical measures with a monetary component or more detailed analysis of how the economy is using the physical flows and ecosystem services. Further applications and policy linkages are likely to be revealed as the accounts are developed, increasing their accuracy and coverage.

Economic valuation to develop monetary estimates of ecosystem services and assets is a critical next step and will require greater integration with both Uganda’s land and national economic accounts. Although simple valuation is possible using, for example, the social cost of carbon, more sophisticated but data-intensive approaches to value ecosystem services like sediment retention would be more informative for decision-making.

As the Government of Uganda plans for ambitious future policies laid forth by the Vision 2040, ecosystem accounts can help track progress, quantify trade-offs, and set realistic baselines from which to develop comprehensive and linked environmental-economic policies. Furthermore, ecosystem accounts can illustrate linked trends and previously unidentified trade-offs in the environment, economy, and human well-being of other rapidly changing African nations.

REFERENCES

Bagstad, K.J., J. Carter Ingram, G.M. Lange, M. Masozera, Z.H. Ancona, et al., 2019. Towards ecosystem accounts for Rwanda: Tracking 25 years of change in flows and potential supply of ecosystem services. 2019, https://doi.org/10.1002/pan3.10062

Bonan, G.B., 2008. Forests and climate change: forcings, feedbacks, and the climate benefits of forests. science 320: 1444-1449.

Brauman, K.A., G.C. Daily, T.K. Duarte, H.A. Mooney, 2007. The nature and value of ecosystem services: An overview highlighting hydrologic services. Annual Review of Environment and Resources 32: 67-98.

Creed, I.F. and M. van Noordwijk, 2018. Forest and Water on a Changing Planet: Vulnerability, Adaptation and Governance Opportunities. A Global Assessment Report. International union of forest research organizations.

Diaz, S., S. Demissew, J. Carabias, C. Joly, M. Lonsdale et al., 2015. The IPBES Conceptual Framework — connecting nature and people. Current Opinion in Environmental Sustainability 14, Pages 1-16

Duku, C, H Rathjens, S J Zwart, and L Hein, 2015. “Towards Ecosystem Accounting: A Comprehensive Approach to Modelling Multiple Hydrological Ecosystem Services.” Hydrology and Earth System Sciences, 2015, 3477–3526. https://doi.org/10.5194/hessd-12-3477-2015.

Food and Agriculture Organization, 2012. Harmonized World Soil Database. in FAO editor., Rome, Italy.

GoU (Government of Uganda), 2016. Uganda Wetland Atlas Volume II, Ministry of Water and Environment, United Nations Environment Programme (UNEP), and the United Nations Development Programme (UNDP), MWE, Kampala, available at http://www.mwe.org

GoU (Government of Uganda), 2019. Uganda Water Accounts Report 2015-2018. https://www.wavespartnership.org/en/knowledge-center/uganda-water-accounts-report-2015-2018

Hamel, Perrine, Rebecca Chaplin-Kramer, Sarah Sim, and Carina Mueller, 2015. “A New Approach to Modeling the Sediment Retention Service (InVEST 3.0): Case Study of the Cape Fear Catchment, North Carolina, USA.” Science of the Total Environment 524–525 (2015): 166–77.

Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones, A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International journal of climatology 25: 1965-1978.

Leh, M.D., M.D. Matlock, E.C. Cummings, L.L. Nalley, 2013. Quantifying and mapping multiple ecosystem services change in West Africa. Agriculture, ecosystems & environment 165: 6-18.

Lehner, B., K. Verdin, A. Jarvis, 2006. HydroSHEDS Technical Documentation. World Wiuldlife Fund US, Washington, DC.

Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-Being. Island Press Washington, DC.

Mu, Q., F.A. Heinsch, M. Zhao, S.W. Running, 2007. Development of a global evapotranspiration algorithm based on MODIS and global meteorology data. Remote Sensing of Environment 111: 519-536.

NFA (National Forestry Authority), 2009. National Biomass Study Technical Report 2005. NFA, Kampala. https://www.nfa.org.ug/images/reports/biomasstechnicalreport2009.pdf

Polasky, S., B. Bryant, P. Hawthorne, J. Johnson, B. Keeler, D. Pennington, 2015. Inclusive wealth as a metric of sustainable development. Annual Review of Environment and Resources 40: 445-466.

Pomeroy, D. Tushabe, H. and Loh, J. 2017. The State of Uganda's Biodiversity 2017. National Biodiversity Data Bank. Makerere University. Kampala. http://www.natureuganda.org/downloads/presentations/BD%202017%20Indicators%20Report.pdf

Posner, S., G. Verutes, I. Koh, D. Denu, T. Ricketts, 2016. Global use of ecosystem service models. Ecosystem Services 17: 131-141.

Ramsar Convention Secretariat, 2011. The Ramsar Convention Manual: a guide to the Convention on Wetlands (Ramsar, Iran, 1971), 5th ed. Ramsar Convention Secretariat, Gland, Switzerland.

Redhead, J., C. Stratford, K. Sharps, L. Jones, G. Ziv, D. Clarke, T. Oliver, J. Bullock, 2016. Empirical validation of the InVEST water yield ecosystem service model at a national scale. Science of the Total Environment 569: 1418-1426.

Sharp, R., H.T. Tallis, T. Ricketts, A.D. Guerry, S.A. Wood, E. Chaplin-Kramer, R., Nelson, D. Ennaanay, et al., 2018 "InVEST 3.6.0 User's Guide".

UBOS (Uganda Bureau of Statistics), 2019. National Land Physical Asset Account for Uganda: Technical Report. Uganda National Capital Accounting Program

UN (United Nations), 2017. Technical Recommendations in support of the System of Environmental-Economic Accounting 2012— Experimental Ecosystem Accounting. New York. ST/ESA/STAT/SER.M/97. Available at: https://seea.un.org/sites/seea.un.org/files/documents/EEA/seriesm_97e.pdf

UN (United Nations), European Union, Food and Agriculture Organization of the United Nations, International Monetary Fund, Organisation for Economic Co-operation and Development and the World Bank, 2014a. System of Environmental-Economic Accounting 2012--Central Framework. New York. ST/ESA/STAT/Ser.F/109.

UN (United Nations), European Union, Food and Agriculture Organization of the United Nations, Organisation for Economic Co-operation and Development, World Bank Group, 2014b. "System of Environmental-Economic Accounting 2012 Experimental Ecosystem Accounting". Available at: https://seea.un.org/sites/seea.un.org/files/seea_eea_final_en_1.pdf

Vrieling, A., J.C. Hoedjes, M. Van Der Velde, 2014. Towards large-scale monitoring of soil erosion in Africa: Accounting for the dynamics of rainfall erosivity. Global and Planetary Change 115: 33-43.

WAVES. 2019. Uganda Adjusted Macroeconomic Indicators and Measures of Comprehensive Wealth - Technical Report. Macroeconomic Policy Department

West, P.C., G.T. Narisma, C.C. Barford, C.J. Kucharik, J.A. Foley, 2010. An alternative approach for quantifying climate regulation by ecosystems. Frontiers in Ecology and the Environment 9: 126-133.

Willcock, S., O.L. Phillips, P.J. Platts, A. Balmford, N.D. Burgess, J.C. Lovett, A. Ahrends, J. Bayliss, N. Doggart, K. Doody, 2012. Towards regional, error-bounded landscape carbon storage estimates for data-deficient areas of the world. PloS one 7: e44795.

Yang, D., S. Kanae, T. Oki, T. Koike, K. Musiake, 2003. Global potential soil erosion with reference to land use and climate changes. Hydrological processes 17: 2913-2928.

ANNEXES

Annex 1: Data inputs for InVEST model

Datasets					*Requirements for InVEST Models*		
Dataset Name	**Dataset Acronym**	**Dataset Description**	**Required Format**	**Required Units**	**Carbon Storage**	**Annual Water Yield**	**Sediment Retention**
Spatial Datasets							
Land use / land cover	LULC	A GIS raster dataset, with an integer LULC code for each cell. These LULC codes must match lucode values in the Biophysical table.	GeoTIFF Raster	Categorical	x	x	x
Average annual precipitation	----	A GIS raster dataset with a non-zero value for average annual precipitation for each cell.	GeoTIFF Raster	mm		x	
Average annual reference evapotranspiration	ET_0	A GIS raster dataset, with an annual average evapotranspiration value for each cell. Reference evapotranspiration is the potential loss of water from soil by both evaporation from the soil and transpiration by healthy alfalfa (or grass) if sufficient water is available.		mm			
Root restricting layer depth	----	A GIS raster dataset with an average root restricting layer depth value for each cell. Root restricting layer depth is the soil depth at which root penetration is strongly inhibited because of physical or chemical characteristics.	GeoTIFF Raster	mm		x	
Plant Available Water Content	PAWC	A GIS raster dataset with a plant available water content value for each cell. Plant Available Water Content fraction (PAWC) is the fraction of water that can be stored in the soil profile that is available for plants' use.	GeoTIFF Raster	Percent (0 to 1)		x	
Digital elevation model	DEM	Raster dataset with an elevation value for each cell. Make sure the DEM is corrected by filling in sinks, and compare the output stream maps with hydrographic maps of the area. To ensure proper flow routing, the DEM should extend beyond the watersheds of interest, rather than being clipped to the watershed edge.	GeoTIFF Raster	Meters			x

Datasets					*Requirements for InVEST Models*		
Dataset Name	**Dataset Acronym**	**Dataset Description**	**Required Format**	**Required Units**	**Carbon Storage**	**Annual Water Yield**	**Sediment Retention**
Rainfall Erosivity Index	R	Raster dataset, with an erosivity index value for each cell. This variable depends on the intensity and duration of rainfall in the area of interest. The greater the intensity and duration of the rain storm, the higher the erosion potential. The erosivity index is widely used, but in case of its absence, there are methods and equations to help generate a grid using climatic data.	GeoTIFF Raster	MJ * mm / (ha * h * yr)			x
Soil Erodibility	K	Raster dataset, with a soil erodibility value for each cell. Soil erodibility, K, is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff.	GeoTIFF Raster	Tons * ha * h / (ha * MJ * mm)			x
Watersheds	----	A shapefile of polygons. This is a layer of watersheds such that each watershed contributes to a point of interest where water quality will be analyzed. Format: An integer field named *ws_id* is required, with a unique integer value for each watershed.	ESRI Shapefile	N/A		x	x
Land Cover Coefficients							
Aboveground carbon	----	Carbon density in aboveground biomass	Floating point value	Mg / ha	x		
Belowground carbon	----	Carbon density in belowground biomass	Floating point value	Mg / ha	x		
Soil carbon	----	Carbon density in soil	Floating point value	Mg / ha	x		
Dead biomass carbon	----	Carbon density in dead matter	Floating point value	Mg / ha	x		

Datasets					*Requirements for InVEST Models*		
Dataset Name	**Dataset Acronym**	**Dataset Description**	**Required Format**	**Required Units**	**Carbon Storage**	**Annual Water Yield**	**Sediment Retention**
Cover management factor	C-factor	Cover-management factor for the USLE, a floating point value between 0 and 1.	Floating point value	0 to 1 index			x
Support practice factor	P-factor	Support practice factor for the USLE, a floating point value between 0 and 1.	Floating point value	0 to 1 index			x
Maximum root depth	----	The maximum root depth for vegetated land use classes, given in integer millimeters. This is often given as the depth at which 95% of a vegetation type's root biomass occurs. For land uses where the generic Budyko curve is not used (i.e. where evapotranspiration is calculated from Eq. 2), rooting depth is not needed. In these cases, the rooting depth field is ignored, and may be set as a value such as -1 to indicate the field is not used.	Integer	mm		x	
Plant evapotranspiration coefficent	Kc	Plant evapotranspiration coefficient for each LULC class, used to calculate potential evapotranspiration by using plant physiological characteristics to modify the reference evapotranspiration, which is based on alfalfa. The evapotranspiration coefficient is a decimal in the range of 0 to 1.5 (some crops evapotranspire more than alfalfa in some very wet tropical regions and where water is always available).	Floating point value	0 to 1.5 index		x	

Datasets					*Requirements for InVEST Models*		
Dataset Name	**Dataset Acronym**	**Dataset Description**	**Required Format**	**Required Units**	**Carbon Storage**	**Annual Water Yield**	**Sediment Retention**
Other Parameters							
Threshold flow accumulation	TFA	The number of upstream cells that must flow into a cell before it is considered part of a stream, which is used to classify streams from the DEM. This threshold directly affects the expression of hydrologic connectivity and the sediment export result: when a flow path reaches the stream, sediment deposition stops and the sediment exported is assumed to reach the catchment outlet. It is important to choose this value carefully, so modeled streams come as close to reality as possible. See Appendix 1 for more information on choosing this value. Integer value, with no commas or periods - for example "1000".	Integer	N pixels			x
Maximum sediment delivery ratio	SDR_{max}	The maximum SDR that a pixel can reach, which is a function of the soil texture. More specifically, it is defined as the fraction of topsoil particles finer than coarse sand (1000 µm; Vigiak et al. 2012). This parameter can be used for calibration in advanced studies. Its default value is 0.8.	Floating point value	0 to 1 index			x
Z parameter	Z	Floating point value on the order of 1 to 30 corresponding to the seasonal distribution of precipitation.	Floating point value	0 to 30 index		x	

Annex 2. Land cover extent by drainage basin

Table A2.1: Land cover extent by drainage basin 1990 (thousands hectares)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area*	Total
Broad leaved plantations	2	0	0	1	3	6	6	1	0	19
Coniferous plantations	2	0	-	2	3	2	3	3	1	16
THF well stocked	1	-	-	247	223	51	105	19	4	651
THF low stocked	0	-	-	75	15	50	95	33	5	273
Woodlands	781	940	70	350	150	451	200	870	162	3,974
Bushlands	76	135	42	24	98	529	262	64	192	1,422
Grasslands	279	528	190	282	352	1,600	1,118	572	193	5,115
Wetlands	37	-	-	29	28	231	89	68	2	484
Small scale farmlands	859	1,153	15	459	898	2,444	1,404	1,132	35	8,400
Commercial farmlands	1	0	-	11	10	28	9	9	1	68
Built up areas	2	1	0	1	3	10	14	5	0	37
Open water	29	1	-	316	107	320	2,861	17	37	3,689
Impediments	0	1	0	0	1	1	1	0	0	4
Total	2,070	2,759	318	1,799	1,891	5,723	6,166	2,795	632	24,152

**The balancing item is the area of land in Uganda that is inside the national boundary but outside of the other drainage area*

Table A2.2: Land cover extent by drainage basin 2005 (thousand hectares)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area*	Total
Broad leaved plantations	2	0	-	0	4	2	4	2	0	15
Coniferous plantations	2	0	-	1	2	5	5	3	0	19
THF well stocked	2	-	-	184	242	77	83	1	12	601
THF low stocked	0	0	-	92	4	9	61	26	-	192
Woodlands	553	512	51	228	148	364	174	632	116	2,778
Bushlands	238	594	67	172	133	739	424	411	189	2,968
Grasslands	379	705	186	198	224	1,063	705	395	208	4,063
Wetlands	54	9	-	14	34	343	189	108	1	753
Small scale farmlands	798	919	14	577	963	2,717	1,620	1,172	67	8,847
Commercial farmlands	1	0	0	11	27	38	19	9	1	107
Built up areas	6	14	0	2	5	22	32	17	0	97
Open water	33	3	-	316	107	343	2,848	18	38	3,706
Impediments	0	2	1	1	1	1	1	0	0	8
Total	2,070	2,759	318	1,799	1,891	5,723	6,166	2,795	633	24,153

**The balancing item is the area of land in Uganda that is inside the national boundary but outside of the other drainage area*

Table A2.3: Land cover extent by drainage basin 2010 (thousand hectares)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area*	Total
Broad leaved plantations	2	0	-	3	4	3	8	2	1	21
Coniferous plantations	2	0	-	2	2	4	9	9	1	29
THF well stocked	1	-	-	199	243	82	101	11	9	646
THF low stocked	1	-	-	75	17	18	42	32	1	185
Woodlands	538	355	44	204	99	217	201	522	115	2,294
Bushlands	313	566	150	129	114	943	389	503	220	3,328
Grasslands	229	585	116	209	247	1,068	676	260	172	3,562
Wetlands	41	64	0	22	24	342	193	109	3	798
Small scale farmlands	892	1,168	8	622	1,007	2,655	1,643	1,299	72	9,366
Commercial farmlands	19	14	-	14	21	44	23	18	1	154
Built up areas	5	5	0	2	3	14	19	14	0	63
Open water	27	1	-	317	109	332	2,863	16	38	3,704
Impediments	0	0	0	0	2	0	0	0	0	4
Total	2,070	2,759	318	1,798	1,891	5,723	6,166	2,795	633	24,152

**The balancing item is the area of land in Uganda that is inside the national boundary but outside of the other drainage area*

Table A2.4: Land cover extent by drainage basin 2015 (thousand hectares)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area*	Total
Broad leaved plantations	4	0	-	8	8	4	14	5	0	44
Coniferous plantations	1	0	-	3	5	10	21	23	1	63
THF well stocked	0	-	-	166	232	75	46	1	9	529
THF low stocked	2	-	-	21	23	19	30	6	2	102
Woodlands	166	91	33	137	76	186	97	336	90	1,213
Bushlands	170	340	36	116	91	451	236	379	147	1,967
Grasslands	488	893	234	233	310	1,394	881	423	242	5,097
Wetlands	29	2	-	28	31	328	181	114	3	715
Small scale farmlands	1,105	1,379	14	743	964	2,822	1,720	1,425	99	10,272
Commercial farmlands	56	37	-	20	33	48	30	31	2	256
Built up areas	12	12	0	4	5	32	38	33	0	136
Open water	37	3	-	318	110	354	2,872	18	37	3,749
Impediments	1	0	0	1	3	0	1	1	0	8
Total	2,070	2,759	318	1,798	1,891	5,723	6,166	2,795	632	24,152

**The balancing item is the area of land in Uganda that is inside the national boundary but outside of the other drainage area*

Table A2.5: Net land cover change by drainage basin, 1990 to 2015 (thousand hectares)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area*	Total
Broad leaved plantations	2	0	0	7	5	-2	8	4	0	25
Coniferous plantations	-1	0	0	1	2	8	18	20	0	47
THF well stocked	-1	0	0	-81	9	24	-59	-18	5	-122
THF low stocked	2	0	0	-54	8	-31	-65	-27	-3	-171
Woodlands	-615	-849	-37	-213	-74	-265	-103	-534	-72	-2761
Bushlands	94	205	-6	92	-7	-78	-26	315	-45	545
Grasslands	209	365	44	-49	-42	-206	-237	-149	49	-18
Wetlands	-8	2	0	-1	3	97	92	46	1	231
Small scale farmlands	246	226	-1	284	66	378	316	293	64	1872
Commercial farmlands	55	37	0	9	23	20	21	22	1	188
Built up areas	10	11	0	3	2	22	24	28	0	99
Open water	8	2	0	2	3	34	11	1	0	60
Impediments	1	-1	0	1	2	-1	0	1	0	4
Total	0	0	0	-1	0	0	0	0	0	0

**The balancing item is the area of land in Uganda that is inside the national boundary but outside of the other drainage area*

Annex 3 Wetland extent by land cover class

Table A3.1: Permanent wetland extent by land cover class and drainage basin 1990 (1,000 ha)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area*	Total
Broad leaved plantations	-	-	-	-	-	-	-	-	-	-
Coniferous plantations	-	-	-	-	-	-	-	-	-	-
THF well stocked	-	-	-	-	-	-	0	0	-	0
THF low stocked	-	-	-	-	-	-	1	-	-	1
Woodlands	0	-	-	0	-	2	3	0	0	5
Bushlands	0	-	-	-	-	1	0	0	0	1
Grasslands	1	6	-	4	5	93	97	26	1	232
Wetlands	37	-	-	29	28	231	89	68	2	484
Small scale farmlands	0	-	-	-	2	1	1	0	0	4
Commercial farmlands	-	-	-	-	-	5	0	-	-	5
Built up areas	-	-	-	-	-	-	-	-	-	-
Open water	0	-	-	0	0	0	-	0	-	0
Impediments	-	-	-	-	-	-	-	-	-	-
Total	38	6	-	33	35	333	190	94	3	732

**The balancing item is the area of land in Uganda that is inside the national boundary but outside of the other drainage area*

Table A3.2: Permanent wetland extent by land cover class and drainage basin in 2005 (1,000 ha)

Land cover classes	**Albert Nile**	**Aswa**	**Kidepo**	**Lake Albert**	**Lake Edward**	**Lake Kyoga**	**Lake Victoria**	**Victoria Nile**	**Balancing area***	**Total**
Broad leaved plantations	0	-	-	-	0	0	0	0	-	0
Coniferous plantations	-	-	0	0	0	-	0	-	0	0
THF well stocked	-	-	0	0	0	2	2	0	0	4
THF low stocked	-	-	0	1	0	0	1	0	-	2
Woodlands	2	1	0	4	6	1	5	3	0	21
Bushlands	4	1	0	5	4	13	5	3	1	36
Grasslands	2	2	0	11	3	27	40	15	1	101
Wetlands	25	1	0	9	14	233	120	65	1	467
Small scale farmlands	1	1	0	3	8	17	12	5	0	47
Commercial farmlands	-	-	0	0	0	6	0	0	-	6
Built up areas	-	0	0	0	0	0	0	0	-	1
Open water	6	0	0	1	1	34	4	2	0	47
Impediments	0	-	0	-	-	0	0	-	-	0
Total	38	6	0	33	35	333	190	94	3	732

**The balancing item is the area of land in Uganda that is inside the national boundary but outside of the other drainage area*

Table A3.3: Permanent wetland extent by land cover class and drainage basin in 2010 (1,000 ha)

Land cover classes	**Albert Nile**	**Aswa**	**Kidepo**	**Lake Albert**	**Lake Edward**	**Lake Kyoga**	**Lake Victoria**	**Victoria Nile**	**Balancing area***	**Total**
Broad leaved plantations	0	-	-	0	0	0	0	0	-	1
Coniferous plantations	0	-	0	0	0	0	0	0	0	0
THF well stocked	0	-	0	1	0	2	1	0	0	4
THF low stocked	-	-	0	0	0	0	1	0	-	2
Woodlands	1	1	0	3	4	1	4	3	0	17
Bushlands	3	2	0	3	4	15	6	6	1	39
Grasslands	3	2	0	8	3	20	37	10	1	83
Wetlands	23	0	0	13	14	226	119	65	1	462
Small scale farmlands	1	1	0	4	8	25	14	7	0	60
Commercial farmlands	0	0	0	0	0	6	1	0	0	8
Built up areas	0	0	0	0	0	0	1	0	-	1
Open water	7	0	0	1	1	38	6	2	0	54
Impediments	0	-	0	0	0	0	0	0	-	0
Total	38	6	0	33	35	333	190	94	3	733

**The balancing item is the area of land in Uganda that is inside the national boundary but outside of the other drainage area*

Table A3.4: Permanent wetland extent by land cover class and drainage basin in 2015 (1,000 ha)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area*	Total
Broad leaved plantations	0	-	-	0	0	0	1	0	-	1
Coniferous plantations	0	-	0	0	0	0	0	0	-	0
THF well stocked	0	-	0	1	1	2	0	0	0	4
THF low stocked	-	-	0	0	1	0	1	0	-	2
Woodlands	1	0	0	2	3	1	3	3	0	13
Bushlands	2	2	0	2	4	17	7	9	0	43
Grasslands	5	1	0	4	3	13	33	5	1	65
Wetlands	22	0	0	17	13	219	119	66	1	458
Small scale farmlands	1	2	0	6	9	32	16	8	0	74
Commercial farmlands	0	0	0	0	1	7	2	0	0	10
Built up areas	0	0	0	0	0	0	1	0	-	1
Open water	8	0	0	1	1	41	7	2	0	62
Impediments	0	-	0	0	0	0	0	0	-	0
Total	38	6	0	33	35	333	190	94	3	733

**The balancing item is the area of land in Uganda that is inside the national boundary but outside of the other drainage area*

Table A3.5: Seasonal wetland extent by land cover and drainage basin in 1990 (1,000 ha)

	Albert Nile	**Aswa**	**Kidepo**	**Lake Albert**	**Lake Edward**	**Lake Kyoga**	**Lake Victoria**	**Victoria Nile**	**Balancing area**	**Total**
Broad leaved plantations	-	-	-	-	-	0	0	-	-	0
Coniferous plantations	-	-	-	-	-	-	-	-	-	-
THF well stocked	-	-	-	2	0	1	1	-	0	4
THF low stocked	-	-	-	7	4	5	1	4	-	22
Woodlands	35	43	5	72	66	114	74	96	8	514
Bushlands	7	3	0	3	12	35	33	6	2	101
Grasslands	56	177	12	63	18	644	279	280	3	1,533
Wetlands	0	-	-	0	-	0	0	0	-	0
Small scale farmlands	3	6	-	2	9	185	19	8	1	232
Commercial farmlands	-	-	-	-	-	3	0	-	-	3
Built up areas	-	-	-	-	-	-	-	-	-	-
Open water	-	0	-	-	-	0	-	-	-	0
Impediments	0	-	-	-	-	-	-	-	-	0
Total	102	229	17	149	109	986	407	394	15	2,408

Table A3.6: Seasonal wetland extent by land cover drainage basin in 2005 (1,000 ha)

Land cover classes	**Albert Nile**	**Aswa**	**Kidepo**	**Lake Albert**	**Lake Edward**	**Lake Kyoga**	**Lake Victoria**	**Victoria Nile**	**Balancing area**	**Total**
Broad leaved plantations	0	0	-	0	0	0	0	0	-	1
Coniferous plantations	0	-	-	0	0	0	0	0	-	0
THF well stocked	0	-	-	3	1	0	2	0	0	7
THF low stocked	-	-	-	3	1	0	3	3	-	10
Woodlands	33	19	4	26	25	44	20	63	5	240
Bushlands	26	78	1	12	23	207	115	102	3	567
Grasslands	18	81	12	71	10	301	142	126	6	766
Wetlands	11	5	-	2	15	80	26	28	0	168
Small scale farmlands	13	43	0	32	33	345	93	71	1	631
Commercial farmlands	0	-	-	0	0	6	4	0	0	10
Built up areas	0	0	-	0	0	1	1	1	0	3
Open water	1	1	-	0	0	2	0	0	0	4
Impediments	0	0	0	0	0	0	0	0	0	0
Total	102	229	17	149	109	986	407	394	15	2,408

Table A3.7: Seasonal wetland extent by land cover extent and drainage basin in 2010 (1,000 ha)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	0	0	-	0	1	1	1	0	0	3
Coniferous plantations	0	0	-	0	0	0	0	1	-	2
THF well stocked	0	-	-	3	2	0	2	0	0	7
THF low stocked	0	-	-	3	2	0	2	3	0	10
Woodlands	25	13	3	20	20	33	16	55	4	190
Bushlands	23	65	2	11	17	165	84	94	3	464
Grasslands	27	84	12	71	17	315	149	115	6	796
Wetlands	6	3	-	3	13	80	28	28	1	162
Small scale farmlands	19	61	0	38	36	380	120	94	1	750
Commercial farmlands	1	1	-	0	1	7	3	2	0	14
Built up areas	0	0	-	0	0	2	1	2	0	5
Open water	0	1	-	0	0	2	1	0	0	5
Impediments	0	0	0	0	0	0	0	0	0	0
Total	102	229	17	149	109	986	407	394	15	2,408

Table A3.8: Seasonal wetland extent by land cover class and drainage basin in 2015 (1,000 ha)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	0	0	0	1	1	1	1	0	0	1
Coniferous plantations	0	0	0	0	0	0	1	2	0	0
THF well stocked	0	0	0	2	2	0	2	0	0	7
THF low stocked	0	0	0	2	4	0	1	2	0	10
Woodlands	16	7	2	14	15	23	12	47	4	240
Bushlands	20	52	3	10	12	123	52	87	2	567
Grasslands	36	86	13	71	24	329	156	105	7	766
Wetlands	2	1	0	4	12	80	30	29	1	168
Small scale farmlands	26	80	0	44	38	416	147	117	1	631
Commercial farmlands	1	1	0	1	1	8	3	3	0	10
Built up areas	0	0	0	0	0	3	1	3	0	3
Open water	0	1	0	0	0	3	1	0	0	4
Impediments	0	0	0	0	0	0	0	0	0	0
Total	102	229	17	149	109	986	407	0	15	2,408

Table A3.9: Net change is permarmanent wetland by land cover class and drainage basin, 1990 to 2015 (1,000 ha)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	0	0	0	0	0	0	1	0	0	1
Coniferous plantations	0	0	0	0	0	0	0	0	0	0
THF well stocked	0	0	0	1	1	2	0	0	0	4
THF low stocked	0	0	0	0	1	0	0	0	0	1
Woodlands	1	0	0	2	3	-1	0	3	0	8
Bushlands	2	2	0	2	4	16	7	9	0	42
Grasslands	4	-5	0	0	-2	-80	-64	-21	0	-167
Wetlands	-15	0	0	-12	-15	-12	30	-2	-1	-26
Small scale farmlands	1	2	0	6	7	31	15	8	0	70
Commercial farmlands	0	0	0	0	1	2	2	0	0	5
Built up areas	0	0	0	0	0	0	1	0	0	1
Open water	8	0	0	1	1	41	7	2	0	62
Impediments	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	1

Table A3.10: Net change is seasonal wetland by land cover class and drainage basin, 1990 to 2015 (1,000 ha)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	0	0	0	1	1	1	1	0	0	1
Coniferous plantations	0	0	0	0	0	0	1	2	0	0
THF well stocked	0	0	0	0	2	-1	1	0	0	3
THF low stocked	0	0	0	-5	0	-5	0	-2	0	-12
Woodlands	-19	-36	-3	-58	-51	-91	-62	-49	-4	-274
Bushlands	13	49	3	7	0	88	19	81	0	466
Grasslands	-20	-91	1	8	6	-315	-123	-175	4	-767
Wetlands	2	1	0	4	12	80	30	29	1	168
Small scale farmlands	23	74	0	42	29	231	128	109	0	399
Commercial farmlands	1	1	0	1	1	5	3	3	0	7
Built up areas	0	0	0	0	0	3	1	3	0	3
Open water	0	1	0	0	0	3	1	0	0	4
Impediments	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	-394	0	0

Annex 4: Forest extent by land use

Table A4.1: Forest extent on private land by land cover class and drainage basin in 1990 (1,000 ha)

	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved	1.52	0.04	0.00	0.67	2.66	1.49	5.10	0.46	0.07	12
Coniferous	0.09	0.00	-	0.23	0.03	0.16	0.07	0.12	0.00	1
THF well stocked	0.00	-	-	90.56	9.80	4.14	57.13	12.28	0.09	174
THF low stocked	0.00	-	-	65.75	4.28	13.46	65.16	27.21	0.12	176
Woodlands	630.41	834.36	38.70	158.29	44.18	314.98	174.19	703.72	64.00	2,963
Total	632.03	834.40	38.71	315.51	60.95	334.23	301.65	743.79	64.29	3,326

Table A4.2: Forest extent on private land by land cover class and drainage basin in 2005 (1,000 ha)

	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved	2	0	-	0	3	1	2	1	0	10
Coniferous	0	0	-	0	0	1	0	0	0	2
THF well stocked	0	-	-	29	11	1	38	1	0	80
THF low stocked	0	0	-	79	1	2	51	20	-	153
Woodlands	424	435	26	94	72	168	142	454	22	1,836
Total	425	435	26	202	87	173	234	476	22	2,081

Table A4.3: Forest extent on private land by land cover class and drainage basin in 2010 (1,000 ha)

	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved 2010	1	0	-	2	3	1	6	1	0	15
Coniferous 2010	0	0	-	0	1	1	2	2	0	5
THF well stocked 2010	0	-	-	36	11	4	51	7	0	109
THF low stocked 2010	0	-	-	67	4	4	33	25	0	132
Woodlands 2010	431	302	17	75	42	131	157	372	38	1,566
Total 2010	432	302	17	181	61	141	249	406	38	1,827

Table A4.4: Forest extent on private land by land cover class and drainage basin in 2015 (1,000 ha)

Land cover classes	**Albert Nile**	**Aswa**	**Kidepo**	**Lake Albert**	**Lake Edward**	**Lake Kyoga**	**Lake Victoria**	**Victoria Nile**	**Balanci ng area**	**Total**
Broad leaved 2015	3	0	-	7	6	2	11	3	0	33
Coniferous 2015	0	0	-	0	2	2	4	4	0	13
THF well stocked 2015	-	-	-	10	7	2	15	0	0	34
THF low stocked 2015	0	-	-	10	3	3	19	4	0	40
Woodlands 2015	109	59	13	27	18	98	68	229	24	646
Total 2015	113	59	13	54	36	107	117	242	24	766

Table A4.5: Forest extent for CFRs by land cover class and drainage basin in 1990 (1,000 ha)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	0	0	-	0	0	4	1	0	-	6
Coniferous plantations	2	0	-	2	3	1	3	2	0	13
THF well stocked	1	-	-	118	60	24	48	7	0	258
THF low stocked	-	-	-	8	3	11	29	6	-	58
Woodlands	46	81	21	34	2	59	22	61	69	396
Bushlands	2	3	5	0	1	42	9	1	44	107
Grasslands	14	39	8	12	6	26	43	25	27	200
Wetlands	0	-	-	2	0	1	2	1	0	6
Small scale farmlands	7	13	2	6	3	14	32	23	2	103
Commercial farmlands	-	-	-	0	0	0	0	0	-	1
Built up areas	0	0	-	0	0	0	0	0	-	0
Open water	0	0	-	-	0	0	1	-	-	1
Impediments	0	0	0	0	0	0	0	-	0	0
Total	73	137	36	184	78	183	191	126	143	1,151

Table A4.6: Forest extent for CFRs by land cover class and drainage basin in 2005 ((1,000 ha)

Land cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	1	-	-	0	1	1	1	2	0	5
Coniferous plantations	2	0	-	1	2	2	5	2	0	14
THF well stocked	2	-	-	112	64	22	44	1	0	244
THF low stocked	-	-	-	13	1	7	10	5	-	37
Woodlands	46	63	22	13	0	53	25	34	53	309
Bushlands	6	21	5	26	3	37	18	33	38	187
Grasslands	7	35	9	6	2	31	28	15	45	178
Wetlands	0	0	-	2	0	1	5	1	-	9
Small scale farmlands	11	17	1	11	5	26	53	32	6	162
Commercial farmlands	-	0	-	0	1	2	0	0	-	3
Built up areas	0	0	-	0	0	0	1	0	-	1
Open water	0	0	-	-	0	0	1	-	-	1
Impediments	0	1	0	0	-	0	0	0	-	1
Total	73	137	36	184	78	183	191	126	143	1,151

Table A4.7: Forest extent for CFRs by land cover class and drainage basin in 2010 ((1,000 ha)

2010	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	0	0	-	0	1	2	1	1	0	6
Coniferous plantations	1	0	-	2	1	3	7	8	0	23
THF well stocked	1	-	-	120	60	25	50	4	0	260
THF low stocked	1	-	-	6	4	8	8	6	0	34
Woodlands	42	51	20	18	2	45	24	25	52	277
Bushlands	7	45	11	11	2	55	14	35	50	229
Grasslands	9	22	4	10	3	20	26	8	30	133
Wetlands	0	0	-	2	0	1	5	1	0	10
Small scale farmlands	11	18	1	15	5	23	53	37	11	174
Commercial farmlands	0	1	-	0	0	1	1	0	-	3
Built up areas	0	0	-	0	0	0	0	0	-	1
Open water	0	0	-	0	0	0	2	-	-	2
Impediments	0	0	-	0	0	0	0	0	0	0
Total	**73**	**137**	**36**	**184**	**78**	**183**	**191**	**126**	**143**	**1,151**

Table A4.8: Forest extent for CFRs by land cover class and drainage basin in 2015 (1,000 ha)

Land cover classes	**Albert Nile**	**Aswa**	**Kidepo**	**Lake Albert**	**Lake Edward**	**Lake Kyoga**	**Lake Victoria**	**Victoria Nile**	**Balancing area**	**Total**
Broad leaved plantations	1	0	-	1	1	2	3	2	0	10
Coniferous plantations	1	0	-	3	3	7	17	19	0	49
THF well stocked	-	-	-	115	58	23	32	0	0	227
THF low stocked	2	-	-	7	5	7	9	0	0	30
Woodlands	24	30	14	9	2	40	11	15	34	180
Bushlands	11	30	9	8	1	28	13	25	43	169
Grasslands	19	52	12	13	4	38	29	13	43	223
Wetlands	0	0	-	2	0	1	6	2	0	10
Small scale farmlands	15	22	1	25	3	35	68	49	23	242
Commercial farmlands	0	2	-	0	0	2	1	1	-	6
Built up areas	0	0	-	0	0	0	1	0	-	2
Open water	0	0	-	0	0	0	2	-	-	2
Impediments	0	0	-	0	0	0	0	0	0	0
Total	73	136	36	183	77	183	192	126	143	1150

Table A4.9: Forest extent for LFRs by land cover class and drainage basin in 1990 (1,000 ha)

1990	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	-	0.2	-	0.0	0.1	0.2	0.1	0.0	-	0.6
Coniferous plantations	-	-	-	-	-	0.0	-	-	-	0.0
THF well stocked	-	-	-	-	-	-	0.3	-	-	0.3
THF low stocked	-	-	-	0.0	-	-	0.2	-	-	0.2
Woodlands	-	0.0	-	0.0	0.0	0.2	0.1	0.1	-	0.5
Bushlands	-	0.0	-	-	-	0.3	0.2	0.0	-	0.5
Grasslands	-	0.1	-	0.0	0.0	0.2	0.3	0.0	-	0.6
Wetlands	-	0.0	-	0.0	0.0	0.2	0.0	0.0	-	0.2
Small scale farmlands	-	0.6	-	0.1	0.1	0.8	0.3	0.1	-	1.9
Commercial farmlands	-	-	-	-	0.0	0.0	-	-	-	0.0
Built up areas	-	0.0	-	0.0	0.0	0.0	0.0	0.0	-	0.0
Open water	-	-	-	-	-	-	0.0	-	-	0.0
Impediments	-	-	-	-	0.0	-	-	-	-	0.0
Total	-	0.9	-	0.1	0.2	1.9	1.4	0.3	-	5.1

Table A4.10: Forest extent for LFRs by land cover class and drainage basin in 2005 (1,000 ha)

2005	**Albert Nile**	**Aswa**	**Kidepo**	**Lake Albert**	**Lake Edward**	**Lake Kyoga**	**Lake Victoria**	**Victoria Nile**	**Balancing area**	**Total**
Broad leaved plantations	0.0	-	-	-	0.1	0.0	0.1	-	-	0.2
Coniferous plantations	0.0	-	-	-	-	0.0	-	-	-	0.0
THF well stocked	-	-	-	0.0	-	-	0.1	-	-	0.1
THF low stocked	-	-	-	0.0	-	-	0.1	-	-	0.1
Woodlands	0.1	0.0	-	0.0	0.0	0.0	0.5	0.1	-	0.6
Bushlands	0.0	0.0	-	0.0	-	0.3	0.1	0.0	-	0.4
Grasslands	-	0.0	-	0.0	0.0	0.1	0.1	0.0	-	0.2
Wetlands	0.0	-	-	0.0	-	0.1	0.1	0.0	-	0.3
Small scale farmlands	0.7	0.2	-	0.1	0.1	1.3	0.3	0.2	-	2.9
Commercial farmlands	-	-	-	0.0	0.0	-	-	-	-	0.0
Built up areas	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	-	0.1
Open water	-	-	-	-	-	0.0	0.0	-	-	0.0
Impediments	-	-	-	-	-	-	-	-	-	-
Total	0.9	0.3	-	0.1	0.2	1.9	1.4	0.3	-	5.1

Table A4.11: Forest extent for LFRs by land cover class and drainage basin in 2010 (1,000 ha)

2010	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	0.1	-	-	0.0	0.0	0.0	0.0	0.0	-	0.2
Coniferous plantations	0.0	-	-	-	-	0.1	0.0	-	-	0.1
THF well stocked	-	-	-	-	-	-	0.3	-	-	0.3
THF low stocked	-	-	-	0.0	-	-	0.1	-	-	0.1
Woodlands	0.1	0.0	-	0.0	0.0	0.1	0.2	0.1	-	0.5
Bushlands	0.0	0.0	-	0.0	0.0	0.3	0.2	0.0	-	0.5
Grasslands	0.0	0.0	-	0.0	0.0	0.0	0.1	0.0	-	0.1
Wetlands	0.0	0.0	-	0.0	-	0.1	0.1	0.0	-	0.2
Small scale farmlands	0.6	0.2	-	0.1	0.1	1.3	0.4	0.2	-	3.0
Commercial farmlands	-	-	-	0.0	-	0.0	0.0	0.0	-	0.0
Built up areas	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	-	0.1
Open water	0.0	-	-	-	-	0.0	0.0	-	-	0.0
Impediments	-	-	-	-	-	-	-	-	-	-
Total	0.9	0.3	-	0.1	0.2	1.9	1.4	0.3	-	5.1

Table A4.12: Forest extent for LFRs by land cover class and drainage basin in 2015 (1,000 ha)

2015	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	0.3	-	-	0.0	0.0	0.0	0.0	0.0	-	0.4
Coniferous plantations	-	-	-	-	-	0.2	0.0	-	-	0.2
THF well stocked	-	-	-	-	-	-	0.0	-	-	0.0
THF low stocked	-	-	-	-	-	-	0.0	-	-	0.0
Woodlands	0.1	0.0	-	0.0	0.0	0.0	0.2	0.0	-	0.3
Bushlands	0.0	0.0	-	0.0	0.0	0.2	0.1	0.0	-	0.4
Grasslands	0.0	0.0	-	0.0	-	0.0	0.2	0.0	-	0.3
Wetlands	0.0	-	-	0.0	-	0.1	0.2	0.0	-	0.2
Small scale farmlands	0.4	0.2	-	0.1	0.1	1.4	0.6	0.3	-	3.0
Commercial farmlands	-	-	-	0.0	-	0.0	-	-	-	0.0
Built up areas	0.1	0.0	-	0.0	0.0	0.0	0.0	0.0	-	0.1
Open water	0.0	-	-	-	-	0.0	0.0	-	-	0.0
Impediments	-	-	-	-	-	-	-	-	-	-
Total	0.89	0.26	-	0.11	0.18	1.90	1.41	0.34	-	5.1

Table A4.13: Forest extent for National Parks and Wildlife Reserves by forest land cover class and drainage basin in 1990 (1,000 ha)

1990	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	-	-	-	-	0.03	0	0.01	-	-	0.04
Coniferous plantations	-	-	-	-	0.78	0.9	-	-	0.59	2.27
THF well stocked	0.01	-	-	38.18	153.91	22.75	-	-	3.63	218.48
THF low stocked	-	-	-	1.18	7.25	25.83	0.06	-	4.5	38.83
Woodlands	104.1	0.12	10.15	157.67	103.99	63.17	3.83	105.33	22.93	571.29
Total	104.1	0.1	10.2	197.0	266.0	112.7	3.9	105.3	31.7	830.9

Table A4.14: Forest extent for National Parks and Wildlife Reserves by forest land cover class and drainage basin in 2005 (1,000 ha)

2005	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	-	-	-	-	0.0	0.0	0.0	-	-	0.1
Coniferous plantations	-	-	-	-	0.0	2.4	-	-	-	2.4
THF well stocked	0.9	-	-	43.7	166.9	54.1	-	-	11.3	276.7
THF low stocked	-	-	-	0.2	1.6	-	-	-	-	1.8
Woodlands	83.7	0.0	3.4	120.7	75.2	29.1	6.2	143.2	4.4	465.9
Total	84.6	0.0	3.4	164.5	243.8	85.6	6.2	143.2	15.6	746.9

Table A4.15: Forest extent for National Parks and Wildlife Reserves by forest land cover class and drainage basin in 2010 (1,000 ha)

Forest cover classes	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	-	-	-	-	0.1	0.0	0.0	0.0	0.3	0.5
Coniferous plantations	-	-	-	-	0.1	0.8	0.0	-	0.3	1.1
THF well stocked	0.1	-	-	42.5	171.8	53.2	-	0.0	9.1	276.6
THF low stocked	0.0	-	-	2.1	8.8	6.4	0.3	0.4	1.2	19.2
Woodlands	65.2	0.1	7.4	109.6	55.0	19.7	20.2	125.0	8.6	410.8
Total	65.3	0.1	7.4	154.2	235.9	80.0	20.6	125.4	19.5	708.4

Table A4.16: Forest extent for National Parks and Wildlife Reserves by forest land cover class and drainage basin in 2015 (1,000 ha)

2015	Albert Nile	Aswa	Kidepo	Lake Albert	Lake Edward	Lake Kyoga	Lake Victoria	Victoria Nile	Balancing area	Total
Broad leaved plantations	-	-	-	-	0.4	0.0	0.1	-	0.1	0.6
Coniferous plantations	-	-	-	-	0.0	1.0	0.0	-	0.6	1.6
THF well stocked	0.2	-	-	41.3	167.5	50.0	-	0.1	8.5	267.6
THF low stocked	0.1	-	-	4.6	15.0	8.3	0.9	1.2	1.6	31.7
Woodlands	32.6	0.1	6.4	100.3	55.1	23.2	17.2	91.9	11.6	338.4
Total	32.8	0.1	6.4	146.2	238.1	82.4	18.2	93.2	22.5	639.9

Annex 5. Physical flows and ecosystem services by drainage basin

Table A5.1. Carbon stocks and carbon sequestration (net change) by drainage basin, Uganda, 1990, 2005, 2010 and 2015 (1000 ton C)

	Kidepo	*Aswa*	*Lake Kyoga*	*Albert Nile*	*Victoria Nile*	*Lake Albert*	*Lake Edward*	*Lake Victoria*
Carbon stock 1990	41,659	378,993	886,023	306,562	425,293	289,599	296,147	768,616
Net change	185	-178	66,243	6,079	19,817	-14,259	5,796	54,111
Carbon stock 2005	41,844	378,816	952,266	312,641	445,110	275,340	301,943	822,727
Net change	-984	-9,926	-10,578	-15,060	9,535	-11,735	-11,988	-23,362
Carbon stock 2010	40,860	368,890	941,688	297,582	454,645	263,605	289,955	799,365
Net change	-94	-5,122	-6,117	-8,230	-13,220	5,461	8,960	4,904
2015	40,766	363,767	935,572	289,352	441,425	269,066	298,915	804,269

Table A5.2. Water yield and net changes in water yield by drainage basin, Uganda 1990, 2005, 2010 and 2015 (1,000 m^3 per year)

	Kidepo	*Aswa*	*Lake Kyoga*	*Albert Nile*	*Victoria Nile*	*Lake Albert*	*Lake Edward*	*Lake Victoria*
1990	289,632	3,962,505	7,999,751	3,124,229	4,086,756	1,994,718	2,289,112	4,099,611
Net change	663	31,620	-88,518	29,422	-21,936	12,691	-12,941	-34,648
2005	290,296	3,994,125	7,911,232	3,153,651	4,064,820	2,007,409	2,276,171	4,064,963
Net change	9,256	137,018	99,398	113,268	106,959	54,378	15,751	11,867
2010	299,552	4,131,143	8,010,631	3,266,919	4,171,779	2,061,787	2,291,922	4,076,830
Net change	866	11,637	-38,019	-15,216	-56,586	-9,175	-5,374	-815
2015	300,418	4,142,780	7,972,611	3,251,703	4,115,193	2,052,613	2,286,548	4,076,015

Table A5.3. Sediment retention in Uganda by drainage basin, 1990, 2005, 2010 and 2015 (1000 ton sediment / year).

	KIDEPO	*ASWA*	*LAKE KYOGA*	*ALBERT NILE*	*VICTORIA NILE*	*LAKE ALBERT*	*LAKE EDWARD*	*LAKE VICTORIA*
1990	68,329	276,888	763,370	189,327	271,623	455,853	1,012,712	794,028
NET CHANGE	557	771	-2,827	-648	-3,062	657	233	-241
2005	68,886	277,659	760,543	188,680	268,562	456,510	1,012,945	793,787
NET CHANGE	7	-2,636	-6,836	-3,939	-4,577	-7,307	-9,774	-18,149
2010	68,893	275,023	753,707	184,741	263,984	449,203	1,003,171	775,638
NET CHANGE	-208	491	3,504	1,679	1,083	-1,554	10,841	17,320
2015	68,685	275,514	757,211	186,420	265,067	447,649	1,014,013	792,958

Figure A5.1. Percent change in water yield from 1990, by drainage basin. The color of the bars indicates the year for the change is estimated.

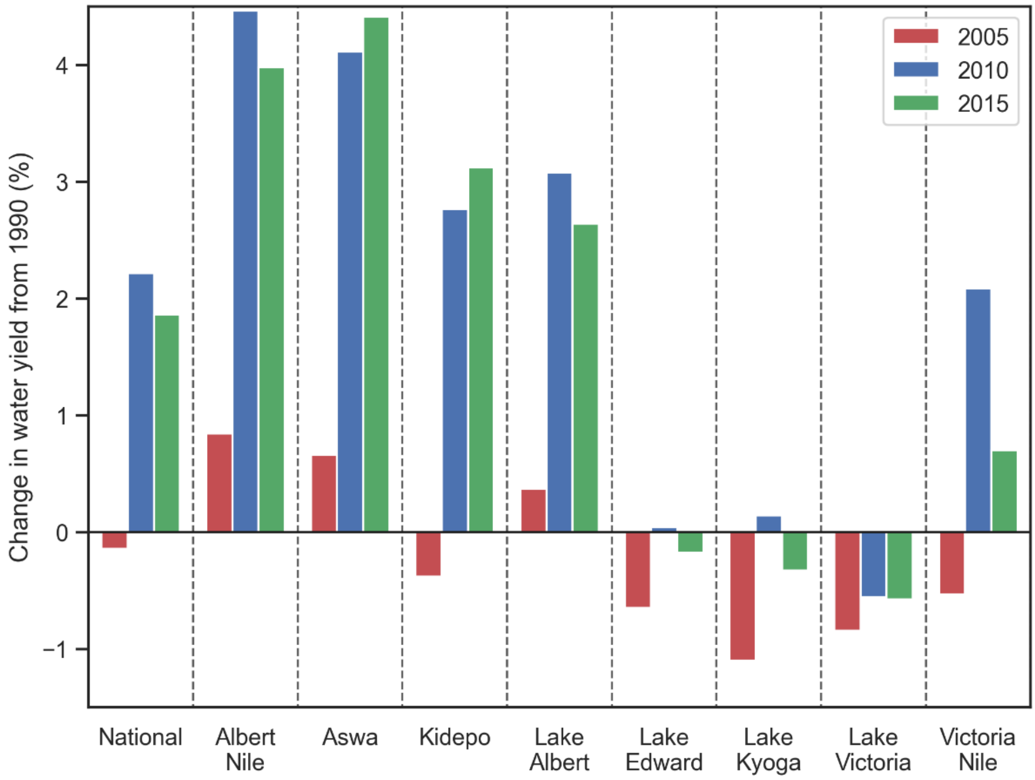


Figure A5.2. Percent change in sediment retention from 1990, by drainage basin. The color of the bars indicates the year for the change is estimated.

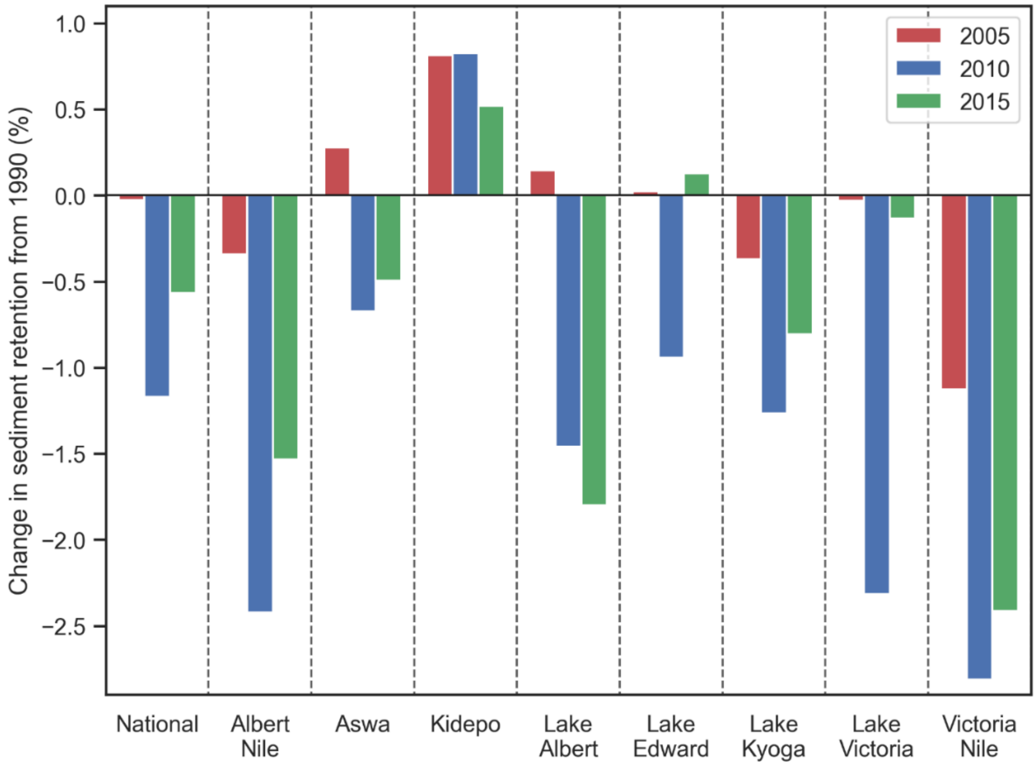


Figure A5.3. Percent change in sediment export from 1990, by drainage basin. The color of the bars indicates the year for the change is estimated.