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Ecosystem Service Supply, Use and Benefits in the Albertine Rift of Uganda

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CDI/ALTREC

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Introduction

Tullow Uganda Operations Pty Ltd (TUOP), Total E&P Uganda (TEPU), and China National Offshore Oil Corporation (CNOOC) (the Companies) plan to develop oilfields within the Albertine Rift of western Uganda and are currently in a transition phase from exploration to production.

Assessment of impacts and dependencies associated with ecosystem services is in line with "international best practice" (BSR, 2014) and the IFC Performance Standards, which require the value and functionality of "priority" ecosystem services and the benefits derived from them to be maintained when projects are developed, operated and then closed. In consultation with its partners, TUOP commissioned a preliminary Ecosystem Services Review for the landscape affected by their development activities. In line with good practice, this included areas outside their immediate footprint that could be exposed to indirect effects.

This report presents the baseline situation for selected ecosystem services that will affected by oil development. They were identified in partnership with national and local stakeholders in 2014 – 2015 because they are thought to be a particular priority in this area, requiring in depth consideration. There are many other important ecosystem services that may also be affected and that should be considered when Project-level environmental assessments are carried out. The dependence of people on multiple services to meet their overall needs also needs to be considered.

It is hoped that improved understanding of the relationships between supply and use of these ecosystem services will help to inform debate on how best to manage risks and opportunities associated with oil development in an area where ecosystem services are essential to support the livelihoods of many people and are already under pressure from over-use. It is also hoped that the information in this report will make a helpful contribution to the important work taking place under the Albertine Monitoring Plan for the Albertine Graben 2012 – 2017, by providing a basis to understand implications of landscape-scale change in ecosystems for people's wellbeing.

The approach used to generate the results in this report is outlined in an accompanying report: *A Method for Ecosystem Services Review at the Landscape Level* (TEC, 2015) and a detailed technical account is available on request from TUOP ltd.

1 There are references to ecosystem services in Performance Standards (PS) 1, 4, 5, 6, 7 and 8 (IFC 2012).

Overview

The Albertine Rift of Uganda supports biodiversity of national and global significance and many people who depend on ecosystem services to meet their basic requirements for life. Their ability to obtain a standard of living adequate for health and wellbeing, adequate food and access to clean water and sanitation depend critically on ecosystem services that could be affected by oil development.

Oil development can affect the benefits that people are able to derive from ecosystem services, by changing:

- Ecosystem service supply (the state, health and productive capacity of ecosystems).
- Ecosystem service use (the ability of people to access them or the extent to which patterns of use are altered).
- Ecosystem service benefit (the extent to which essential needs are met, given predicted levels of supply and use).

Potential effects have many drivers, some direct (occupation of land for infrastructure) and some less obvious. In common with much of Uganda, over-use of natural resources is threatening the capacity of ecosystem to supply services in future. Primary causes are land clearance and enclosure for subsistence farming, logging, collection of domestic firewood; production of charcoal; wetland drainage, encroaching human settlements, poaching, use of inappropriate fishing gear and increasing use of agro-chemicals[2]. These pressures have been growing for decades and many reports have stressed the urgency of action to halt ecosystem decline before it becomes irreversible and essential services are lost. Population growth brings increased competition for scarce resources and increases pressures such as these. Population has been growing in the oil production areas at 4%, compared with a national average of 3%. Infrastructure investments linked to oil and gas exploration have already opened access to new markets, increasing demand for natural resources from the area and potentially catalyzing further in-migration. Changes in land tenure, urbanization and land enclosure have also occurred, benefitting some, but depriving others of their customary access to ecosystem services such as livestock grazing.

As well as potentially increasing pressure on ecosystem services, oil production could provide opportunities to improve management of others. To assess the likely significance of ecosystem change and identify associated risks and opportunities, it is important to know how ecosystem services are supplied and used and to establish whether the relationships between supply and use are sustainable. In such a rapidly changing landscape, dynamic baselines are needed to show how ecosystems have changed over time and to predict how they can be expected to change in future, with or without oil production. This provides a basis for estimating how much people's access to essential benefits will be affected.

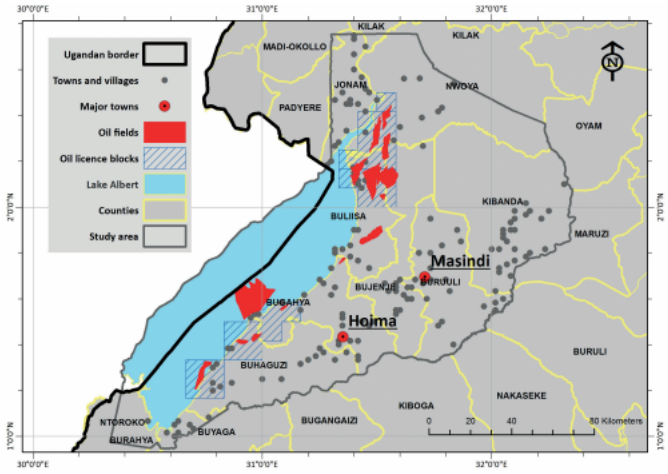
2 CRA (2006); NEMA (2009, 2010)

Stakeholder Engagement

Stakeholder engagement was an essential part of this exercise. An expert panel of representatives from key stakeholder organisations met in Kampala in December 2014 to discuss the approach and identify ecosystem services requiring in depth assessment. As well as the companies, organisations represented included NEMA, PEPD, UWA, NFA, WCS, Makerere University, DEA/MNE, MAAIF (DPR). A further meeting in December 2015 discussed the results presented in this report and identified next steps that could be taken to ensure that sustainable supplies of ecosystem services are maintained. On the basis of this meeting, further consideration was given to subsistence farming.

In addition to engagement with organisations involved in national level planning of land use and natural resource management, meetings were held with communities in proposed oil production areas at District and sub-district levels to gain better understanding of ecosystem service uses and dependencies across the landscape. The results were used to finalise the prioritisation process, to select ecosystem services for detailed consideration, as presented in this report. A series of focus group discussions, together with key informant interviews were then held to discuss selected priority services in detail, focusing on levels of use and benefit and the ability of different beneficiary groups to access alternatives to priority services. These were facilitated in local languages with the assistance of CDI and ALTREC and were held in Hoima, Bulisa, Butiaba, Wanseko, Kaiso-Tonya and villages such as Bugoigo and Piida-B.

Study Area



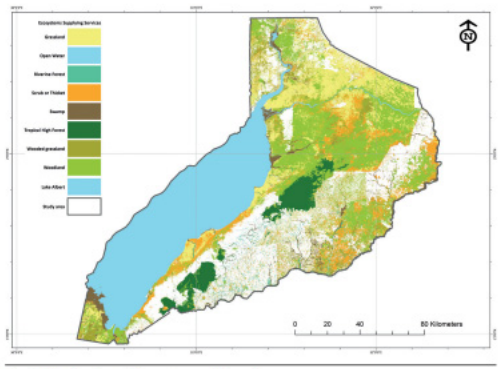
Map 1 Study Area

The Study Area includes the Albertine Rift oil fields and licence blocks, the main water catchments for Lake Albert and the constituent protected areas of the Murchison Falls Conservation Area. Some oil-related infrastructure will extend beyond the limits of this area (primarily the export pipeline) and some wider demographic shifts may occur that are linked with oil development, but it is within this area that the most significant changes are thought likely to occur and for which a reliable baseline is required.

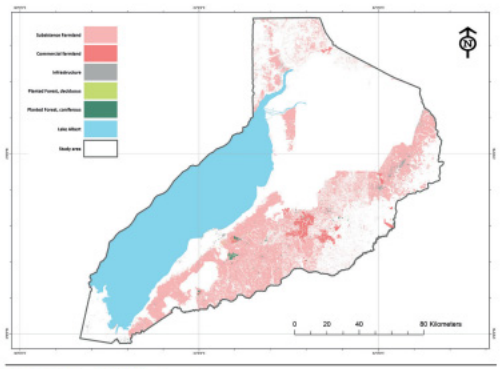
The Land Use/Land Cover maps generated by the Wildlife Conservation Society (WCS) for TUOP were the most up to date source on ecosystem distributions and the Study Area was adjusted to match available coverage. Past satellite imagery and maps were reviewed to establish a time-series that could be used at a comparable scale.

The extent of the Study Area is 2,219,834 ha.

Ecosystems supplying services



Map 2 Distribution of "natural" ecosystems supplying services



Map 3 Distribution of "artificial" land cover types

Sustainable flow of ecosystem services requires ecosystems to be in a healthy state and able to yield surplus production. The amount that people can take from an ecosystem without damaging its productive capacity is "sustainable supply", for example the number or weight of fish that can be taken from a fishery without reducing its productive capacity.

To identify services supplied in the Albertine Graben, the ecosystems that potentially supply them were mapped. This was done using results of a Land use/ Land cover-mapping exercise carried out by the WCS on behalf of TUOP, based on satellite imagery from 2007 (SPOT 4) and 2013 (SPOT 6). The Study Area is dominated by forest-woodland-savannah terrestrial vegetation types and has a major Rift Valley Lake (Lake Albert), rivers and associated wetlands. The East Sudanian Savanna (AT0705) and Rift Valley Lakes Freshwater Global 200 Ecoregions extend into the Study Area.[3] These are a global priority for conservation because of a combination of biodiversity-importance and exposure to threat. Their presence indicates the ecological importance and sensitivity of the Study Area, which is also part of a global biodiversity hotspot.

Human-modification of ecosystems typically reduces the range and level of supply of services they provide. Relatively "natural"/ unmodified ecosystems remain as important sources of ecosystem services in this landscape but have been declining rapidly. Although largely confined to Protected Areas, 31% of land outside them in 2013 could still be considered relatively unmodified, despite the rapid changes that have taken place. Relatively natural ecosystems are shown in **Map 2** and the more modified land cover types in **Map 3**.

3 Olson and Dinerstein (2002)

Ecosystems supplying services

ECOSYSTEM TYPES	CURRENT EXTENT (HA)
Tropical high forest	92,025
Riverine Forest	21,029
Woodland	388,311
Scrub/ thicket	181,309
Wooded grassland	130,275
Grassland	254,569
Wetland / swamp	81,825
Open water (Lake Albert, Rivers)	552,636
Total extent of "natural" ecosystems	1,701,979

Table 1 Ecosystems potentially supplying services

23% of the total Study Area of 2219834 ha now has "modified" land cover types (commercial farming, infrastructure), but this does not account for degraded condition of remaining "natural" ecosystems (assessed by WCS for TUOP's biodiversity baseline assessment) and is therefore likely to under-estimate of the degree of landscape modification. It is recognised that subsistence farming provides provisioning services to a high proportion of people in the Study Area. At the same time, conversion of land for subsistence and commercial farming is one of the main drivers of decline in "natural ecosystems" and the services they supply. To understand the trade-offs involved in conversion from natural ecosystems to a farmed landscape, it is first necessary to be able to quantify the services that natural ecosystems supply, hence this was the main focus of this review, but trends in conversion of land to subsistence or commercial farming were also mapped.

Ecosystem Service Benefits

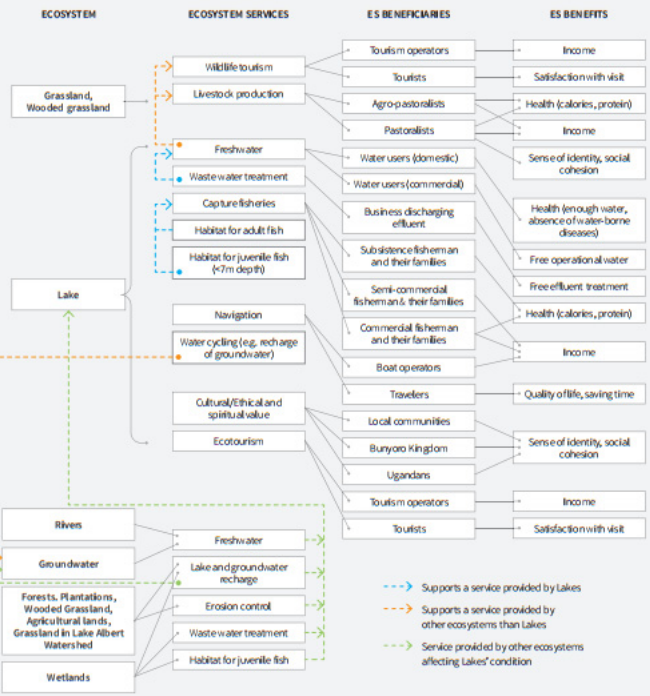
Benefits from ecosystem services typically fall into the following categories (MA 2005[4]):

- Basic material for a good life (e.g., secure and adequate livelihoods, enough food at all times, shelter, clothing, access to goods);
- Health (e.g., clean air and access to clean water);
- Security (e.g., secure access to natural and other resources, personal safety, security from natural and human-made disasters); and
- Good social relations (e.g., social cohesion, mutual respect, ability to help others).

They may be financial or take other forms, for example benefits enjoyed in the Study Area include visitor satisfaction from wildlife-viewing and strong cultural attachments to sacred sites.

The extent to which people rely on ecosystem services depends on the particular benefits they get from using them, and whether they can find other ways to secure these benefits if supply of a particular service declines. Levels of benefit are highly contextual and specific to different beneficiaries. Detailed information about benefits derived from specific ecosystems and services was not available for the Study Area and a series of focus group discussions and key informant interviews were therefore held to improve understanding of typical types and levels of benefit derived from ecosystem services in the Study Area.

4 www.millenniumassessment.org



Framework diagram for Lake Albert

Ecosystem services do not exist without beneficiaries or users. Based on review of literature, stakeholder consultations and local focus group discussions, ecosystem services supplied by natural ecosystems in the Albertine Rift were identified (on this page and **Table 2**). Most ecosystems provide several services to people and most people use several different services to meet their needs, resulting in complex interactions.

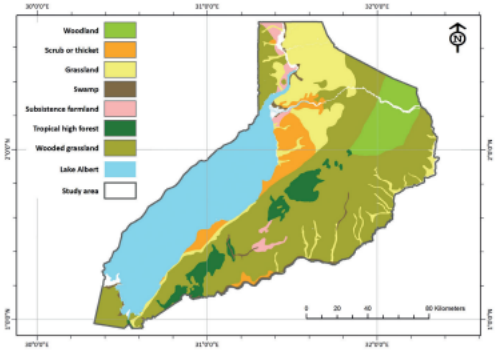
Ecosystem Services supplied and used

Table 2 Ecosystem services for which beneficiaries were identified in the Study Area

Key: Importance of ecosystem service: ● *High* ○ *Medium/low* – *Not relevant/negligible*

Ecosystem Services	Natural forest	Plantation forest	Riverine forest	Woodland	Scrub / thicket	Wooded grassland	Grassland	Wetland / swamp	Open water (Lake Albert, Rivers)
PROVISIONING									
Crops	–	–	–	–	–	–	–	○	○
Livestock products (meat and milk from cattle, sheep, goats)	–	–	○	○	●	●	●	●	●
Capture Fisheries	–	–	○	–	–	–	–	●	●
Aquaculture (near Bugoigo)	–	–	–	–	–	–	–	●	●
Wild food (mushrooms, nuts, fruit)	●	–	○	○	○	●	○	●	○
Biological raw materials (grass for thatching, cattle horn for utensils and ornaments for sale, skins)	–	–	–	●	●	●	●	●	–
Timber	●	○	○	●	○	○	○	●	○
Woody Biomass for firewood, charcoal	●	●	●	●	○	●	–	–	–
Freshwater	●	●	●	●	○	○	○	●	●
Biochemicals, natural medicines	●	–	○	●	–	●	●	○	–
REGULATING									
Air quality regulation	●	○	○	○	○	○	○	○	○
Global climate regulation	●	●	●	●	○	●	○	○	○
Regional/local climate regulation	●	○	●	●	○	○	○	●	●
Water regulation	●	○	○	○	○	○	○	●	●
Erosion regulation	●	●	●	●	●	●	●	●	●
Water purification	●	●	●	●	●	●	●	●	●
Waste assimilation	●	–	○	○	○	○	○	●	●
Disease regulation	○	○	○	○	○	○	○	○	○
Soil quality regulation	●	○	●	●	○	○	○	○	–
Pest/invasive species regulation	●	–	○	○	○	○	–	–	○
Pollination	●	–	●	●	●	●	●	●	–
Natural hazard regulation	●	○	●	●	○	○	○	●	●
CULTURAL									
Recreation and eco-tourism	●	–	○	○	○	●	●	●	●
Spiritual values	●	–	●	●	○	–	○	●	●
Ethical/non-use values, e.g. existence value of wildlife	●	–	●	●	–	●	●	●	●
Pastoral way of life from customary open access to grazing land	●	–	●	●	–	●	●	●	●

Changes in ecosystem extent over time



Map 4 Approximate distribution of ecosystems according to Langdale-Brown et al, (1964)

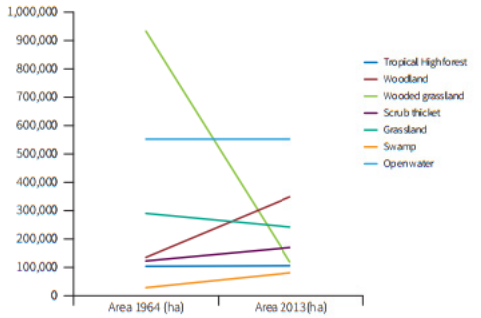


Figure 1 Trends in natural ecosystems between 1964 and 2013 (x axis shows extent in hectares)

Declining extent of ecosystems indicates declining capacity to supply services. To establish a baseline, distributions of the 21 vegetation communities described by Langdale-Brown *et al.*, (1964) were translated into an updated habitat classification to allow comparisons with the present day.

Extent of natural ecosystems declined by 4% between 2007 and 2013, which can be expected to translate into reduced levels of supply of associated ecosystem services across the Study Area. Ecosystems declined at different rates **(Table 3)**.

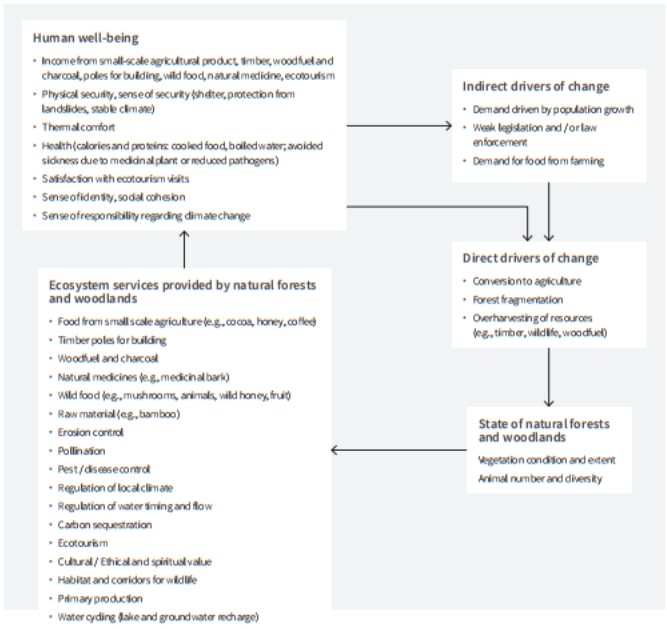
Significant losses of wooded grassland and grassland habitats of 36% and 29% respectively occurred and back-casting to 1964 shows that woodland extent has declined dramatically since the 1960s **(Map 4, Figure 1)**. As well as being relevant to supply of woody biomass, this significant loss of wooded grassland from the Study Area has implications for sustainability of wildlife populations as well as access to open grazing for livestock production, both priority services. As mentioned previously, services also decline as a result of degradation of remaining ecosystems, so this is a likely under-estimate in decline of associated ecosystem services. Note, the apparent increase in swamp is unlikely to represent an actual increase in extent; it is more likely that removal of other natural vegetation has made swamp more visible, or that imagery was used from the wet season to obtain data in 2013. However scrub and thicket is thought to have increased in this period and there have been increases in woodland cover, primarily in the Protected Areas.

Changes in ecosystem extent over time

ECOSYSTEM	AREA 2007 (HA)	AREA 2013 (HA)	CHANGE (HA)	CHANGE %
Tropical High forest	127,299	103,788	-23,511	-18
Woodland	348,466	348,269	-197	0
Wooded grassland	184,680	118,944	-65,736	-36
Scrub/ Thicket	69,948	167,616	97,668	140
Grassland	341,393	243,175	-98,217	-29
Swamp	60,357	78,915	18,558	31
Open water	552,637	552,637	-2,261	0
Total	**1,684,779**	**1,613,343**	**-73,697**	**-4**

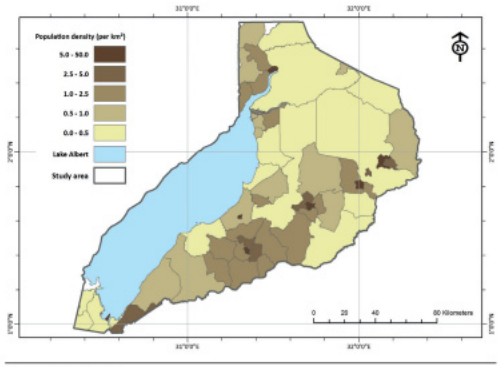
Table 3 Change in extent of natural ecosystems

Figure 2 Change in extent of natural ecosystems

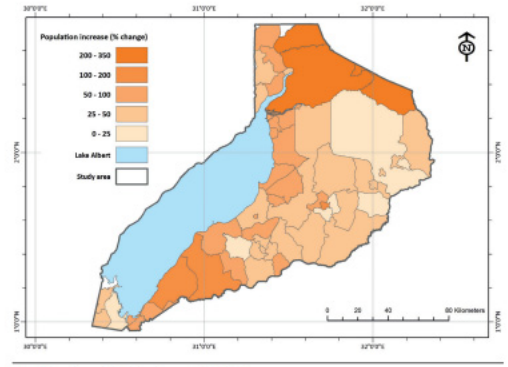


There are many pressures operating in the Study Area that could affect future supply of ecosystem services. These include:

- Population change (e.g. in-migration affecting rate of land use change and levels of resource harvesting);
- Markets and economic changes (e.g. increased market access through improved road networks);
- Changes in technology (e.g. rural electrification or shift from shallow wells to piped drinking water supplies, which improves access and benefit but may increase per capita water demand);
- Development of infrastructure (e.g. road networks or improvements to existing roads)
- Governance, land tenure systems and regulation (e.g., extent to which access to protected areas is controlled, enclosure of communal grazing lands).



Map 5 Population distribution



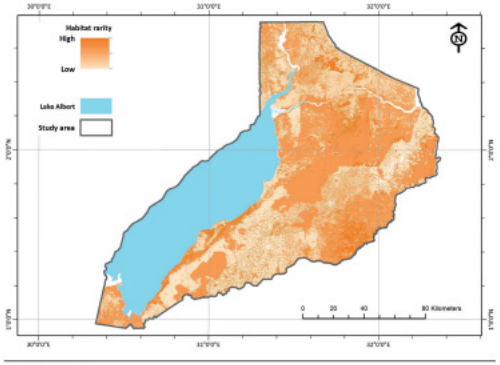
Map 6 Change in population by sub-county 2002 – 2014

Population as a driver

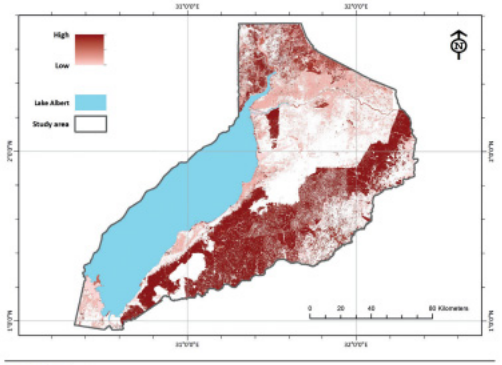
Natural-resource based livelihoods are prevalent, so population growth drives demand and is a reasonable proxy for estimating levels of use, particularly for provisioning services. Census data from 2002[5] and provisional results from 2014 show a 61% increase to approximately 1.56 million people in the Study Area. The growth rate of 4% per annum is slightly higher than the national average of 3% and gives a doubling rate of 18 years. **Map 5** shows the population distribution in the Study Area and **Map 6** shows change. Some areas have experienced dramatic increases in population, as high as 350% bordering parts of Murchison Falls National Park, Purongo and Koch-Goma in Nwoya District. Concomitant increases in demand for ecosystem services can be expected and for some services this will result in levels of use that exceed sustainable supply, as explored in more detail for selected, individual priority services.

5 UBOS (2006; 2014)

Drivers of change



Map 7 Habitat Rarity



Map 8 Habitat threat

Population growth and associated increases in demand for ecosystem services have increased the rarity of some ecosystems and levels of threat throughout the landscape.

- **Relative rarity** of ecosystems is important because if ecosystems disappear, so do the species, ecological processes and ecosystem services associated with them. Ecosystem rarity in the current landscape was modelled using InVEST[6] **(Map 7)**. Rarity is weighted to account for disproportionate decline over time, with ecosystems that have become progressively rare, such as wooded grassland, given more weight than those that have always been rare. "Rare habitats" are widely distributed, outside of Protected Areas as well as within.

- **Habitat threat** was modelled based on relative sensitivity of different ecosystems to different threats, their proximity to sources of threats and degree of legal protection. **Map 8** shows relative threat across the study area from settlements, encroachment from farming, woodfuel collection and roads. The margins of protected areas are under intense threat from outside. Within the core of protected areas, locations with few roads or tracks, such as the south part of Murchison Falls NP, Budongo and Bugoma CFRs, have lower relative threat than parts of Murchison Falls NP north of the Nile.

6 Sharp et al., (2014)

Priority Ecosystem Services

Some services are a particular "Priority" because people depend on them to obtain essential benefits for a healthy life and are not easily able to access alternatives to maintain these benefits. If supply of these services goes down, or access to them is blocked, people's livelihoods and wellbeing will suffer.

Dependence on ecosystem services is generally high throughout the Study Area. The majority of people rely on direct access to ecosystem services to obtain their basic requirements for life, or they need income derived from ecosystem services to purchase them. Much of the population relies on locally harvested natural resources for essential benefits (food, water, cooking fuel, building-material or medicine[7]). Alternatives are limited due to poverty and lack of finance to invest in different livelihood strategies or purchase replacements when supplies of ecosystem services run down. Evidence for this came from focal group discussions and key informant interviews in which respondents reported difficulties in maintaining levels of benefit at present, compared with the past, and referred to competition for limited land and resources. In some cases, their ability to compensate for declining supply, for example by walking further to collect firewood, has already reached a maximum limit. There is widespread concern about ability to maintain benefits in future and some people are already missing meals because they can't catch enough fish, purchase alternative food or harvest enough firewood to cook a hot meal every day.

Based on the full range of services provided in the Study Area, a prioritisation exercise was conducted with stakeholders in Kampala and locally. Six "Top Priority" Ecosystem services were selected to pilot the Landscape-ESR approach:

1. **Lake Albert Capture Fishery**
2. **Woody biomass for fuel**
3. **Wildlife populations for nature-based tourism**
4. **Wildlife populations for bushmeat hunting**
5. **Livestock production and pastoral way of life from customary access to open grazing land**
6. **Freshwater**
7. **Food from Subsistence Farming**

These are not the only priority ecosystem services supplied in this landscape: they were selected for detailed assessment due to their particular importance in this landscape and for vulnerable groups. Other priority services identified through consultation were: crop products from subsistence farming, biological raw materials, wild food, natural medicines and important ethical and spiritual values associated with sacred sites and local cultural traditions. The balance between these services and the ability of people to access the full range of services they need is obviously important, as well as the supply of each one. There are important cultural differences in this Study Area that need to be considered in more detail when EIAs are done for proposed developments, as do the particular needs of vulnerable groups such as cultural minorities, gender or age-related groups or people living in poverty.

7 Ogwal, 2011; UBOS, 2002

Lake Albert supports the main capture fishery in the Study Area, but some fish are also taken from rivers and wetlands.

Source Ecosystems

Lake Albert is a major feature of the Study Area (**Map 9**). Associated wetlands, swamps and river-mouths are important fish nursery areas. Supply of fish in the Lake is also influenced by land use onshore and intermediate services provided by wetlands and forests associated with feeder-rivers. Forests and woodlands perform an important supporting function, protecting soils from erosion and maintaining good water quality, as well as regulating water supply to the Lake from the upper catchment. Removal of these habitats may affect flows into the Lake as well as sediment levels. Progressive removal of woody biomass from riverine forests and swamps has potentially serious consequences for fish spawning in river-mouths and in shallower waters along the lake-shore.

Benefits

Lake Albert supports a nationally important capture fishery, targeted by the Ugandan government as a source of fish processing for export to the EU and other international markets[8]. It is shared by Uganda and DRC and any impacts would have a potential trans-boundary implication.

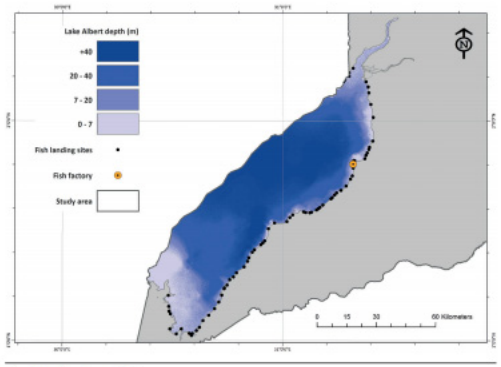
Fish are an essential source of protein and income. Most communities eat fish regularly when supplies are available and entire lakeshore communities depend on fishing and associated livelihoods. When fish supplies are low, local economies grind to a halt and people go hungry. Many beneficiaries are living below the poverty line, have large numbers of dependents and limited or no alternatives to fishing for food and income.

Decline in fish stocks are already affecting benefits from the fishery. Fish used to be eaten 5 – 7 days a week, with income from surplus fish being used to vary the diet with meat or beans on the other two days. Now people report being able to eat fish on only 2 or 3 days per week. Average expenditure on food increased by a factor of at least 5 between 2000 – 2015 (from an average of UGX3000 per day to UGX15,000), partly due to the need to replace dwindling fish with alternative foods and partly due to rising food prices. People who used to sell 3000kgs of Nile Perch a year are now are lucky to sell 20kg. Assuming current price of Nile Perch at UGX8000 compared with UGX1500 in 2000, this means their income is of 4% of what it was[9]. Women's incomes have dropped the most. Their income in 2000 was only slightly less than the men's, but is now about ¼. Women seem to get a lower share of fishing proceeds, which are either sold directly, or processed on the lake and sold, by the men.

People unable to make a living from fishing have very limited alternatives. In the past it was easier to move into farming as an alternative; now competition for remaining farmland is strong and most people have limited access to capital or the funds needed to move into other businesses. Where alternatives do exist (for example women and youth report working for others or running a retail business or shop) these depend on clients having available income from fishing to spend and thus are also no longer considered viable.[10]

Fish frame studies emphasise the need to improve landing site facilities as a means of improving the situation for fishers, but improved commercialization and road access to landing sites in the past[11] could have some perverse consequences and disbenefit smaller scale fishermen who are less able to capitalize on opportunities to sell fish to urban centres. Furthermore, fish prices may be driven up to the point where they are too high for local communities to afford.

8 Uganda Nile Discourse Forum, 2013
9 From Focus Group Discussions, documented in TUOP ESR Main Technical Report
10 From Focus Group Discussions, Pida B, Butiaba, August 2015
11 Nomogaia, 2012



Map 9 Lake Albert Capture Fishery

Baseline trends in supply and use

Supply of the service depends on the health and productivity of the Lake Albert ecosystem and the diversity and biomass of the fish it supports. Lake Albert has a very diverse fish assemblage, with several endemic species and some listed as Endangered on global or regional IUCN Red Lists. Information on species composition is largely from monitoring of commercial and artisanal catches, but a small number of more systematic fish population surveys have been carried out[12], most recently by Mbabazi (2015)[13] on behalf of TUOP, focusing on shallow water habitat and the Nile Delta.

Lake Albert's fish species decreased from at least 53 in the 1960s to 33 in the 1990s[14]. In 2007/8, Wandera and Balera (2014) found 40 species, (33 largely in river mouths, 18 largely in open water in the Lake). Mbabazi (2015) focused mainly on the lake-shore and river mouths and found 31 species. 80% of species regularly recorded in catches at landing sites were also found in river mouths and the shore-line, emphasising the importance of these breeding and nursery areas to the fishery. Diversity was highest at the mouths of the Hohwa and Wambabye Rivers and lowest at the mouth of the Waiga River and the flood plans of the Waisoke. Rapid deforestation and land use change around the River Waiga and throughout its catchment may be damaging juvenile fish habitat there, as it has previously been identified as an important fish nursery.

12 E.g. Holden, (1964) Wandera and Balera (2014) for surveys done in 2007 – 8; Mbabazi (2015) as part of WCS biodiversity baseline surveys for TUOP
13 WCS/Mbabazi (2015)
14 Ssentongo, 1992.

Sustainable production of fish from the Lake was estimated at 18,000 tonnes per year for Angara Alestes baremose in the 1960s. This species is caught less often now and at reduced weights. In the 1990s potential yields or sustainable production of 13,500 to 18,240 tonnes per year were estimated[15]. These are the best figures currently available for "sustainable supply" and are probably an over-estimate, as over-fishing decreases rates of reproduction and recruitment into adult populations, diminishing the productivity of the system.

Use of the fishery is reported from "Fisheries Frame Surveys" by the National Fisheries Resources Research Institute (NaFIRRI). These inventory numbers and types of boats, numbers of fishers, fish landing sites, fishing gear and the fish species they target to generate information needed to guide development and management of the lake fisheries. They also include fish catch assessment surveys used to estimate total annual fish production from the Lake. Boat numbers and catch data do not quantify fishing effort precisely (this also depends on time spent fishing, for example and not all outlets for fish can be surveyed as the proportion sold through market outlets in DRC is not known), but give a good indication.

There were 764 boats in Ugandan waters of the Lake in 1965, 1479 in 1988 and 5700 in 2007[16]. Numbers increased approximately 3 times between 1991 and 2012 and in 2012, 2681 fishing canoes were recorded using the Albert Nile, reflecting a dramatic increase in overall fishing effort in the last 10 years. The number of multifilament gillnets in use increased by 31% from 96,655 in 2007 to 126,575 on the main lake in 2012. There is increasing night fishing with lights. In parallel, offtake of fish increased from 10,000 tonnes per year or less in the 1950s to as much as 180,000 tonnes per year in 2014[17]. This is at least 1000 times the sustainable supply or maximum potential yield as determined in 1989 (**Figure 3**).

Biological over-fishing is now indicated by changes in species composition, reduced numbers of species in the Lake, reduced size of fish caught and increases in the effort needed to catch the same amount of fish. Moonfish (Citharinus citharus) and a butterfish (Eutropius niloticus) are no longer recorded in catches[9] and Hydrocynus vittatus is near extinct[18]. Large Nile perch or Tilapia are caught increasingly rarely. Fishers acknowledge that the Lake is over-fished, to the extent that new fish names have been coined for the immature fish that comprise most of the catch. Catch per Unit Effort (CPUE) has declined considerably: in the 1980s, one fleet of nets would catch 500 – 600 fish overnight, now 15 fleets may come back with only 3 – 4 fish. In FGDs[19], some participants said that some fish maws from Nile Perch were "like gold" and that finding mature fish of some fish species is now "like a dream".

Fishers respond to declining supply by attempting to increase their level of effort, (more nets, fishing for longer), by switching to different fish species and by changing their fishing methods (fishing with lights, Sallacio, smaller net mesh-size) to maintain income. As a result, the pressure on the fish stocks increases further and the situation deteriorates leading to a further decline in CPUE and income as part of a vicious circle. The "Sallacio" fishing method is now common, with fishers staying out on the Lake for 2 to 3 weeks without landing, leaving their nets in the water and removing fish periodically without lifting the nets. There is increasing use of nets with small holes, including mosquito nets, to catch very small fish. Fish species not previously exploited such as Ragoge Brycinus nurse, Ngassa (H. forskahlii) and Neobola bredoi now make up the largest proportion of the commercial catch. Expansion of the mukene fishery and recent development of a new fishery for the freshwater shrimp C. niloticus (for animal feed and increasingly also for people to eat) are a further concern because these are "prey" fish on which species such as Nile perch depend.

15 Vanden Bossche and Bernacsek (1990) based on all species in the Lake.
16 NAFIRRI Reports 2007; 2012
17 Wandera and Balera (2014)
18 Mbabazi (2015)
19 Plida B, Butiaba, August 2015

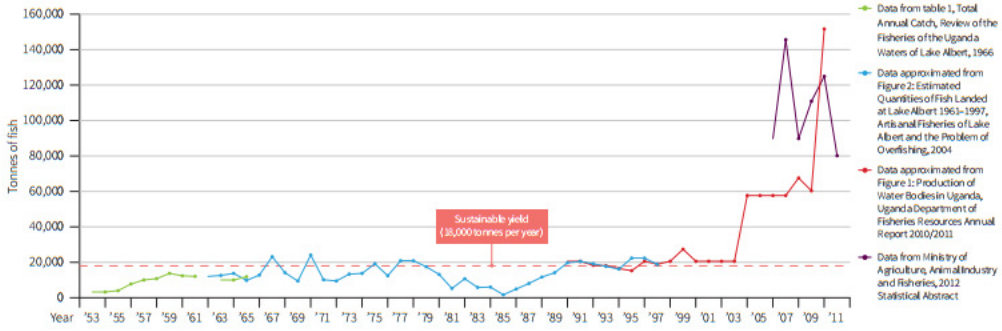


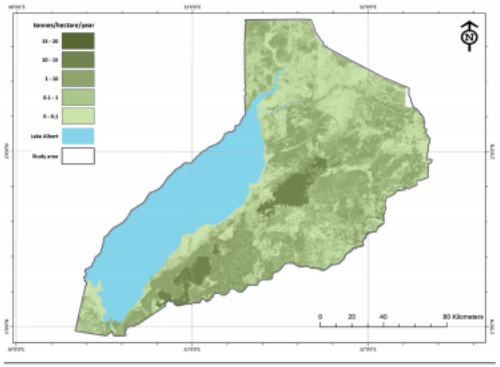
Figure 3 Evolution of Lake Albert Fish Catch Tonnage, 1953 – 2011

Baseline Summary

Significantly more fish are extracted from the lake than can be reproduced from remaining stocks and the relationship between supply and use is not sustainable in the baseline situation. Catches are at least a thousand times greater than the 1989 maximum potential yield from the Lake and may be greater now, as potential yield will have declined with declining stocks. Removal of juvenile fish compromises recruitment and the ability of populations to recover. Degradation of breeding habitats at river mouths is also a significant threat to regeneration. Not only is there an unsustainable relationship between supply and use, but this is already translating into significant loss of benefit for people who have extremely limited alternatives.

The fishing communities were all very clear about the measures that need to be taken to control the overexploitation of the fisheries[20], including better controls on illegal gears and enforced closed fishing periods, but are powerless to implement these unilaterally, when others (the Congolese fishermen were particularly cited) will not comply. Hence government intervention was seen as essential for better regulation.

20 From Focus Group Discussions and Key Informant Interviews at landing sites in June and August 2015



Map 10 Woody Biomass Increment

ECOSYSTEM	STANDING STOCK (TONNES)	ANNUAL YIELD (TONNES / ANNUM)
Tropical High Forest	29,944,544	1,356,153
Woodland	17,980,917	2,194,656
Riverine Forest	2,584,624	191,763
Scrub / Thicket	1,808,260	67,404
Wooded grassland	1,455,314	160,203
Subsistence Farmland	1,220,913	523,044
Planted Forest	108,044	14,820
Total	**55,102,616**	**4,508,043**

Table 4 Ecosystems supplying woody biomass and annual yield in tonnes from Study Area

Woody biomass for fuel (firewood and charcoal) was prioritised due to its prevalent use throughout the Study Area. Firewood is the dominant source of energy for cooking and firewood and charcoal generate income for many.[21]

21 Timber for poles and construction are also important, but are not considered in detail here.

Source Ecosystem(s)

Woody biomass **(Map 10)** is provided by forests, woodlands, wooded grassland and scrub/thickets. Relative contributions to the Study Area's standing stock are in **Table 4** and **Figure 4**. "Natural" woodlands, wooded grasslands and thickets are the main ecosystems supplying woody biomass for fuel with small areas of woodlot. Most Tropical High Forest and a proportion of other wooded ecosystems are in Protected Areas: access depends on levels of enforcement.

Regulation of water flows (intermediate service) supplied by forests, rangelands and wetlands upstream plays an important part in maintaining woody biomass in the Study Area. Land conversion for farming in the upper catchments reduces flows of rivers. There is reduced infiltration and water availability to forest or woodland vegetation downstream and reduced wetness also means wetland and riverine forests there are more vulnerable to fire, reducing standing stocks of trees. This is evident in riverine forest along the Waiga River for example.

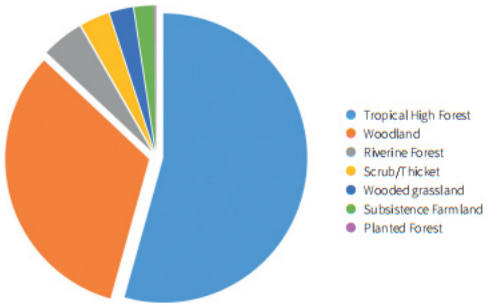


Figure 4 Stocks of ecosystems producing woody biomass in the Study Area

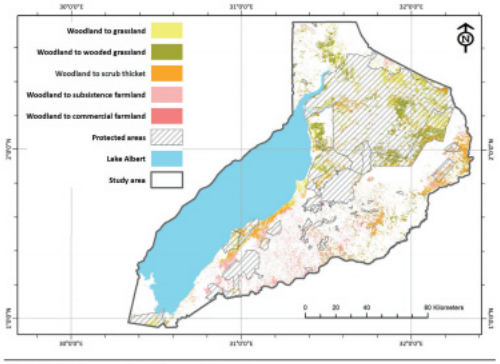
Benefits

93% of the energy consumption in Uganda is woodfuel (firewood and charcoal) and agricultural wastes and 95% of the wood supply is for energy consumption. Only 1% of the rural population had access to electricity in the year 2000[22] and where there is an electricity supply its cost is generally unaffordable[23]. For most settlements in the Study Area, wood is the only source of fuel for cooking and water heating. Use of improved wood stoves, LPG, solar energy, biogas and kerosene is extremely limited.

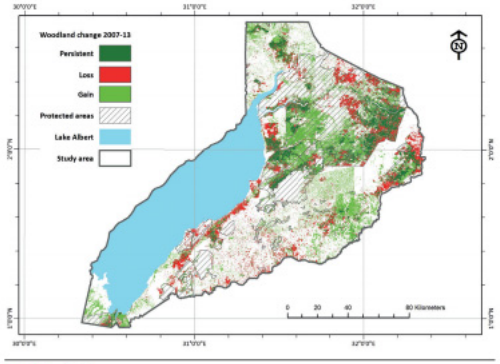
In the Study Area[24] women collecting firewood depend on it for cooking and boiling water and some sell surplus firewood for income. Households need 3 – 5 bundles firewood a week depending on size and often fail to collect enough, women having to adjust the family's diet to include foodstuffs that require less cooking. There is little surplus for sale. Some families miss meals regularly in the current situation and there is serious concern about the future, as people recognize that supply is running short. Women already have to walk for up to 20km and spend up to 9 hours collecting wood at least twice per week, whereas in the past, it was generally possible to collect sufficient firewood to cook and boil water 3 times a day within a mile from home and to spend only 2 to 3 hours collecting it.

Men collecting wood to make charcoal depend heavily on it for income to purchase sauce, fish, meat, beans, school fees, clothes, soap and medical care, as well as saving for the future (it is hard work to make charcoal) and helping others in the community who are disadvantaged. They are concerned about their ability to continue earning due to shortage of trees and said that alternatives were foremost in their minds. Cultivation of crops and livestock is an option, but soils are infertile and the area is over-grazed. People do not feel any cultural attachment to making charcoal; it is something they do because of lack of alternatives. Shortage of woody biomass has increased the effort needed to earn sufficient income and reduced time and money for socialising. It takes up to 7 hours a day collecting wood for firewood or charcoal to earn between 15,000 to 200,000 per month (the upper limit being now very hard to achieve). 3 large trees produce 6 – 10 bags, which takes one month, or more, smaller trees are needed. An average of 4 bundles of firewood per person are collected for sale per week, with alternate collection and sale days. A bundle costs UGX5 – 10,000 now compared to UGX1500 – 2500 in 2000, giving a maximum potential income from firewood of UGX 40,000 per week.

22 MEMD (2001, 2013); Rural Electrification Agency (2012).
23 FGD Bugoigo Village August 2015
24 Focus Group Discussions with women collecting wood for domestic use in Bugoigo Village, Buliaba Sub-County, August 2015; Men making charcoal for sale, Bugana Village



Map 11 Wooded ecosystem losses to less wooded ecosystems



Map 12 Woodland change

Baseline Trends in Supply and Use

Supply of woody biomass is determined by the extent of source-ecosystems and their condition.

The national context is one of ongoing decline in supply. The National Forestry Authority (NFA) surveys and reports on woody biomass yield (sustainable supply) and trends in standing stocks over time[25]. Their reports show Uganda's natural forests and woodlands to have declined from 4.9 million hectares in 1990 (24% of the land area)[26] to just over 3.6 million ha (18% of the land area) by 2005, a decline of 1.3 million ha in 15 years (or a loss of 27%). Total stock of woody biomass in Uganda declined from 477.2 million tons in 1995 to 275.9 million tons only 6 years later. Annual mean increment declined from approx. 20 to 14.5 million tons a year, by which time there was a negative balance of 4.9 million tons a year at a national level. The relationship between supply and use for all wood products nationally has been reported as unsustainable for many years: the 2002 – 3 National Biomass Study (2003) estimated that 73% of Districts had a woody biomass deficit.

Supply of woody biomass in the Study Area is declining because of over-harvesting, "stock" being removed at rates above the regenerative capacity of ecosystems. This is reflected in decreasing extent of ecosystems supplying woody biomass and degradation of those remaining. Woodlands have generally changed to less wooded ecosystems (**Map 11**). **Map 12** shows where woodland ecosystems have remained relatively stable in the landscape. Between 2007 and 2013, 89,444ha of forest, woodland and wooded grassland were lost from the Study Area and there were significant losses along the shores of Lake Albert and around Bulisa (**Table 4**).

25 National Biomass Surveys (MWLE/NFA, 2003; NFA, 2009).
26 National Forest Policy, 2002

Harvesting rates exceeding annual yield are unsustainable. Annual yield was calculated for source ecosystems outside Protected Areas (**Figure 5**) and for the Study Area as a whole (**Table 4**). Trends in use of woodfuel were established from population census data and amounts used per household were based on results of focus group discussions, which gave an average of 1 tonne per capita per year (150 kg per household per month or 2 – 3 m³)[27]. In the Study Area as a whole, demand exceeded the theoretical total annual yield from ecosystems supplying woody biomass (outside protected areas) for the first time in about 2014 (**Figure 6**). This priority ecosystem service is therefore not sustainable in the baseline situation. If 2007 – 13 trends in the ecosystems supplying woody biomass continue linearly, and population in the study area continues to rise at 4% p.a., supply of woody biomass outside protected areas will decline to zero by 2028[28]. At various dates between the present and 2028 more and more settlements will completely lose access to supply of woody biomass and will not be able to compensate for this by expanding the "use-shed". This means pressure will grow to use protected areas for access to woodfuel. If restrictions on woodfuel extraction in protected areas are lifted, land conversion from woodland (and Tropical High Forest) to less wooded habitats will quickly follow in all physically accessible areas, as use is not sufficiently well regulated to ensure that ecosystems are used sustainably. Increased road access will accelerate this trend, by increasing access to markets to sell firewood and charcoal. Road access together with land privatisation and enclosure for cattle ranching will accelerate stripping of woody vegetation for charcoal and fencing.

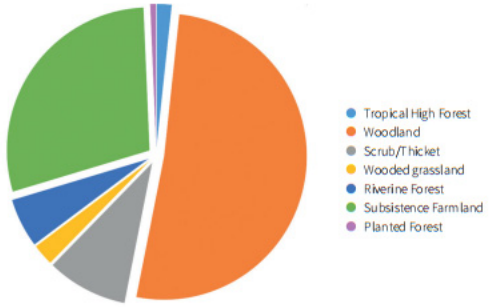


Figure 5 Annual yield of woody biomass (ecosystems outside of protected areas in 2013)

27 FSSD 2007 and focus group discussions in Bugoigo Village, August 2015
28 based on the assumption that there is no switching of fuel use to alternatives such as solar

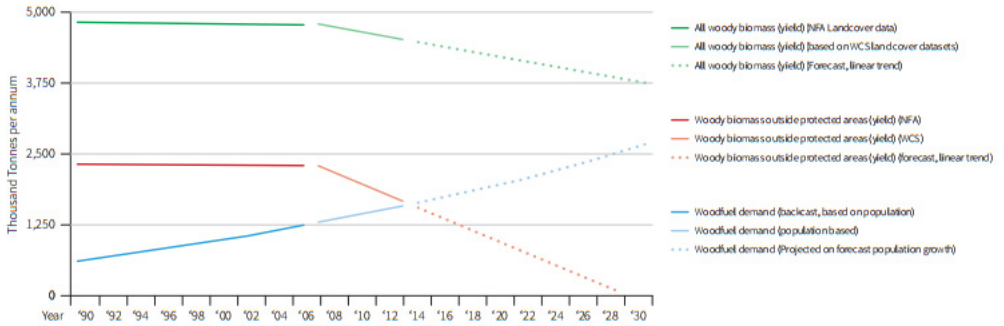


Figure 6 Baseline trends in supply and use of woody biomass

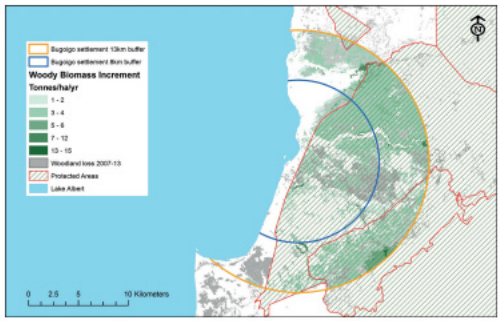
A local case:

As a local case study of relationships between supply and use, we calculated the availability of woody biomass within the "use-shed" of Bugoigo Village based on:

1. i) a 13km buffer representing the maximum distance women said they walk along the road from Bugoigo now, before turning off and walking a further 4km into "Waiga".

2. ii) an 8km buffer to quantify availability of woody biomass closer to the village, within a more reasonable walking distance.

Woodfuel demand was estimated from the approximate number of households (3000) and assuming 5 people per household (from the 2014 census). Increment colour codes on **Map 13** show annual yield in the 13km buffer. Bugungu Wildlife Reserve is also shown. Wood fuel use was estimated at 1 tonne per person per year, giving a total demand of 15,000 tonnes per annum. Sustainable ecosystem service supply requires this to be sourced from annual increment of woody biomass without affecting stock. Within a walking distance of 13km[29], 14,500 tonnes/year are available unless woody biomass in the protected area is included, in which case there are 43,100 tonnes/yr. Current demand is therefore above the sustainability threshold unless wood is taken from the protected area. Outside it, supply became unsustainable in 2013.



Map 13
Woody biomass round Bugoigo

Within the 8km buffer the situation was stark, with only 2000 tonnes per year increment available outside of protected areas. There is almost no woody ecosystem remaining apart from fragments of scrub/ thicket and the biomass yield is less than 20% of estimated demand.

Grey shows areas show where woodland in 2007 converted to an ecosystem with less woody cover by 2013 (grassland, scrub/thicket, wooded grassland, subsistence farming). Some land conversion caused by woodfuel harvesting has taken place in Bugungu Wildlife Reserve, land south of Bugoigo is completely cleared of woodland outside of the PA, and the Waiga woodland partly cleared in the north, the area reported as the only area now available for exploitation. People from Kigpya to the north also harvest woody biomass from this area, so there is competition.

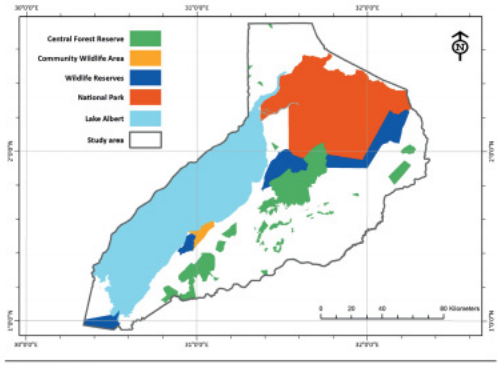
Sustainable harvest of woody biomass from Bugungu Wildlife Reserve is an option to improve accessible supply, but there is little evidence that regulation would be effective. A free-for-all would result in over-harvesting of accessible areas, causing conversion to less wooded ecosystems and a rapidly declining yield. This is not a good long-term solution, though it is seen as the only immediate solution in local communities. All other solutions, such as growing woody biomass in woodlots, require access to land, support with equipment and seed, and sufficient time for trees to mature. Interim alternatives would be needed to maintain benefit.

29 Based on 2013 WCS land cover map and increments for land cover classes reported in the National Biomass Study

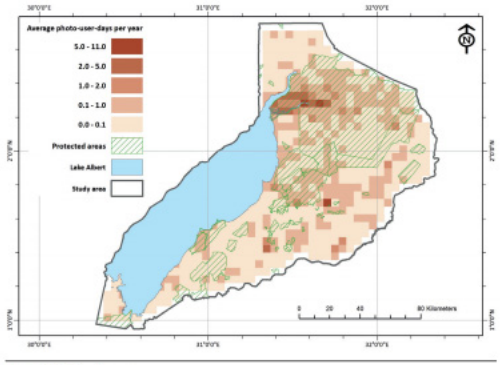
Baseline Summary

Based on this analysis, the baseline for woody biomass is characterised by:

- Declining supply, indicated by reducing extent and condition of source ecosystems across the Study Area, unless protected.
- Increasing use, indicated by population growth and almost complete dependence on woodfuel for cooking and boiling water.
- Loss of benefit below levels needed for basic requirements, with people already having to miss meals or use foodstuffs requiring less cooking, due to lack of firewood.
- An unsustainable supply/use relationship with risk of ecosystem service collapse. The sustainability threshold was crossed in around 2014 for ecosystems outside Protected Areas and supply of woody biomass outside Protected Areas is predicted to decline almost to zero by 2028 if current trends continue. Stocks of trees are not able to regenerate.
- Limited affordable alternatives. Capacity of people to adapt by further expansion of the "use-shed" is now limited without access to more effective means of transport, or to stocks of woody biomass in protected Areas. Neither are sustainable solutions. Even if supplies in protected areas are used, their predicted lifetime is around 20 years before the same point would be reached, and this is assuming population increases remain at current rates.
- Alternative fuel sources for cooking throughout the Study Area are essential to prevent collapse of ecosystems supplying woody biomass and urgent intervention is needed to restore stocks of trees in the landscape.



Map 14 Protected Areas



Map 15 Variation in visitor rates

Source ecosystems

Wildlife populations are provided by all the "natural" ecosystems in the Study Area, particularly those in protected areas (**Map 14**). Murchison Falls Conservation Area (MFCA) has tropical forests, woodlands, wooded grasslands, grasslands and wetlands as well as Rivers and Lakes. Tropical high forests and remnants of riverine forest and woodlands on the escarpment support Chimpanzee populations that are popular with tourists as well as being highly vulnerable to habitat fragmentation and potentially affected by linear infrastructure for oil production (roads and pipelines). The wildlife value and functionality of the protected areas depends on wildlife corridors[30] facilitating the "movement of wildlife between habitats that are increasingly being fragmented by farming and urbanization. They promote the exchange of genes, allow animal interactions, act as dispersal routes and increase species diversity".[31] Wildlife corridors include rivers such as the Hohwa and Waiga, remnant forests on the escarpment and, historically, the savannah strip along Lake Albert. Due to lower levels of human disturbance, the escarpment retains a corridor function now. Corridors such as these provide a supporting service to that of wildlife populations for nature-based tourism.[32] **Map 15** shows areas most visited by tourists as indicated by photos logged on Flickr and the ecosystems supporting wildlife in these locations are on **Figure 7.**

30 Akwetaireho et al., (2010)
31 NEMA, (2009)
32 Ayebare et al., (2013)

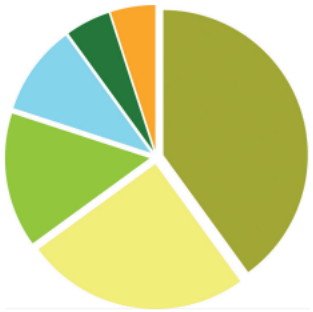


Figure 7 Relative importance of natural ecosystems supporting nature-based tourism, based on Land Cover types at hotspots for visits to the study area as modelled through INVEST (tourism and recreation tool)

Benefits

Stakeholder workshops confirmed strong national pride in Ugandan wildlife and concern that populations should be conserved. Ugandan national parks and conservation areas lie at the heart of the country's tourism industry and nature-based tourism is the primary reason for leisure tourists to visit Uganda[33]. Ten of Uganda's 22 national parks and wildlife reserves are in the Albertine Rift, so it is essential to conserve Uganda's biodiversity and to support tourism. Murchison Falls National Park (MFNP) is one of the top wildlife destinations in the country with 30 – 40% of Uganda's leisure visitors (60,000 a year or more), bringing significant revenue and with visitor numbers showing a rising trend since 1995[34]. Wildlife populations are seen as underpinning *"Ecofriendly and socially sustainable tourism/business development with the potential to spur economic growth and reduce poverty, while simultaneously acting as a tool for financing and protecting the Ugandan flora and fauna for future generations"*[35]. Formal tourism businesses (e.g. lodges, tour operators and boat cruises), informal tourism providers (e.g. local guides), neighbouring communities (especially those bordering the Park) and government agencies such as the Ministry of Tourism, Wildlife and Heritage (MTWH) and the Uganda Wildlife Authority (UWA) are all stakeholders who currently benefit from tourism based on wildlife populations in the Park. The presence of oil activity and changes in access and other conditions within and around the MFNP as a result of the Buliisa Project could have significant impacts on tourism activities, potentially deterring visitors from coming altogether. Access to some of these areas will become restricted, notably the Buligi Circuit. Tourists coming to see particular species such as the shoebill may decide to pursue alternative opportunities. Obviously international tourists have many alternative destinations, so their dependence on MFCA as a destination to watch wildlife is relatively low and they may choose to visit other locations instead. Other beneficiaries are much less able to source the same benefits from elsewhere. This applies in particular to local communities, who theoretically receive 20% of monthly revenue through a benefit-sharing agreement.

Visitor numbers to MFNP have been rising since 2006[36] (**Figure 8**) but it can't necessarily be assumed that this would continue indefinitely in the baseline situation, as there is likely to be a ceiling to how many people the Park can accommodate without visitor experiences being negatively affected and this threshold is not known. This has a bearing on the "counterfactual" scenario of future revenue in the absence of oil. Even if current visitor numbers continued however, and assuming a daily expenditure of 150 US$ per day and 5-day stays in the Park (which may be slightly more than average) there could be future earnings of 45 million US$ per year from the Park and perhaps higher, depending on access and facilities. Certainly sustained benefit over time is likely in the absence of oil development, and this can be expected to decline at least to some extent with it. Estimates of the extent to which benefits would decline are based on many assumptions about future visitor numbers, expenditure and willingness to accept presence of oil development. Depending on the extent to which numbers of visitors increased in the baseline situation and then declined due to oil activity, lost tourism revenue from MFNP could range from US$15 – US$45 million per annum in 2016 to US$22 million – US$67 million per annum in 2030 (the lower numbers assume a 25% reduction in visitor numbers and the higher a 75% reduction). Hitherto, MFNP has been the number one motivator for visits to Uganda. A detailed study of the implications of oil development for nature-based tourism will be needed to understand how visitor numbers and their preferences are likely to respond to the changes that oil development will bring.

33 WORLD BANK (2013). Economic and Statistical Analysis of Tourism in Uganda
34 Artelia, 2015
35 Murchison Falls Conservation Area Business Plan 2010 – 2015
36 Ministry of Tourism, Wildlife and Heritage (2012)

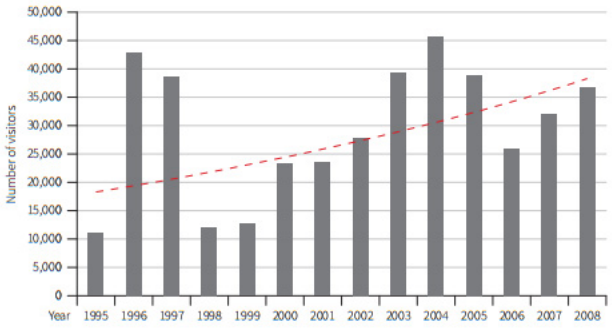


Figure 8 Visitor numbers to MFCA per year 1995 to 2008

Baseline trends in supply and use

Nature-based tourism depends on "supply" of wildlife to see and on viewing opportunities. Use is indicated by visitor numbers, the locations they visit, their expenditure and the reasons they give in visitor surveys. The main tourism area coincides with higher quality habitat for a number of wildlife species. Some wildlife has highly specific requirements: shoebill in the Study Area is confined to wetlands associated with the Nile Delta and is a flagship species on the Buligi Circuit, though bird watching takes place throughout the Study Area. A number of species have their distributions concentrated within the proposed oil production areas of MFNP.

Supply of wildlife populations varies throughout the Study Area, with wildlife species populations largely confined to the MFCA[37]. In 2014, UWA commissioned WCS to do a baseline survey MFCA and provide a comprehensive assessment of the area potentially affected by oil development. This confirmed the importance of MFCA for wildlife populations of global conservation importance. MFNP itself contains the largest (and only truly "wild") population of Rothschild's giraffe in the World[38] as well as other globally threatened species. Bugungu Wildlife Reserve is very important for threatened and endemic amphibians and plants and reserves such as this perform a critical supporting function to the tourist destinations,

37 Plumptree et al., (2015)
38 WCS/Wanyama et al., 2015

helping to maintain viable populations of the wild animals that tourists come to see. Species prioritised for viewing by tourists are a small proportion of overall species but there are some "flagship" species that can be used to indicate level of supply, such as lion, leopard, elephant and giraffe, as well as birds such as shoebill. Elephant numbers have been recovering to over a thousand in 2014, but still have a long way to go to recover to 1960 – 1970s levels, which peaked at about 10,000. The number required to give visitors a satisfying elephant-viewing "experience" has not been established, however, so it is not currently possible to estimate what constitutes sustainable supply from a wildlife-viewing perspective. This is an important gap in the baseline and another reason to carry out a detailed baseline study for nature-based tourism.

As well as amount and suitability of habitat "supply" of wildlife is affected by level of legal and illegal resource-use, notably cultivation, grazing of livestock, collection of woodfuel and hunting for bushmeat. Evidence for the impacts of unregulated hunting for bushmeat is provided by the 90% wildlife population declines that took place when law and order broke down in the 1970s – 1980s[39] and the significant decline in tourism that occurred as a result. Un-regulated hunting can therefore have drastic effects on viability of wild animal populations for tourism. The MFCA in its entirety is essential to maintain viable populations of wildlife species in this part of Uganda as populations outside it have declined almost to zero. Even with full protection, there are some "landscape" species expected to decline throughout the landscape due to loss of continuity of habitat.

To assess use of wildlife for nature-based tourism, "photo-user-days" estimated from geo-tagged photographs posted to the website flickr were used. The number of people who visit a location annually has been shown to correlate quite well with the number of photographs taken in the same area and uploaded to the Flickr database at 836 visitor attractions worldwide[40] (Wood et al. 2013). Data were modelled in InVEST to derive **Map 16** which confirms that visits are strongly concentrated around the Victoria Nile in the Murchison Falls National Park and the area within the Park between Paraa Lodge and the delta, the area most affected by oil production. Oil development can therefore be expected to affect access to wildlife viewing, as well as potentially reducing wildlife populations themselves.

The InVEST recreation tool can also be used to predict how future changes to natural features might alter visitation rates and to map future patterns of use under different scenarios. This was outside the scope of this study but could be done with better understanding of likely development changes in key tourism locations. Possible mitigation solutions such as opening new tourism areas address use/access of this ecosystem services, but not its supply, which could potentially decline. It is important to ensure that supplies of wildlife are maintained, that sufficient suitable habitat is available and that significant threats and pressures are managed effectively.

Baseline Summary

In terms of tourism based on wildlife populations, this is a thriving industry that has been showing growth over the last 10 years and generates considerable revenue. In the absence of oil development this could be expected to continue, provided that hunting, encroachment and uncontrolled burning do not depress populations to the point where viewing opportunities suffer. On the basis of available information it is not possible to predict the thresholds for this to occur. This is an important gap, given the potential for direct and cumulative impacts associated with oil development. Proposed actions to relocate tourism activities to other parts of the Park may improve access for tourists (assuming they are prepared to tolerate presence of oil activity) but will not do anything to ensure that there are sustainable wildlife populations for people to see. Further in-depth analysis is needed to predict and manage impacts on livelihoods, revenue and the future sustainability of this service.

38 Lamprey et al., (2003)
40 Wood et al., 2013

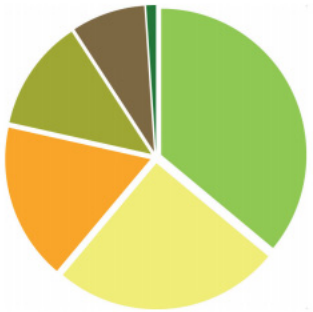


Figure 9 Ecosystem types estimated from reports of locations where bushmeat was taken (Olupot et al 2009) and literature on mammal productivity in different ecosystems

Source Ecosystems

Ecosystems outside of protected areas are significantly depleted of wildlife, so bushmeat hunting is more prevalent around protected areas and increasingly within them. In terms of bushmeat, savanna and woodland ecosystems are more productive than forests and xeric landscapes and moderately disturbed habitat more than undisturbed (**Figure 9**).

Benefits

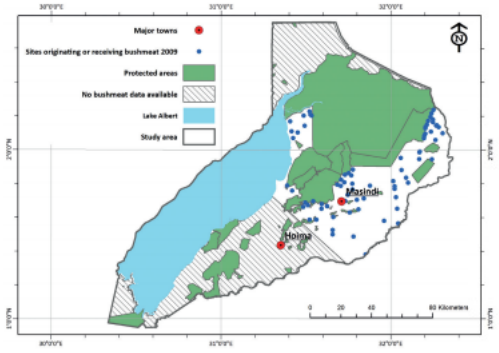
It is difficult to discuss "benefits" from an illegal activity such as bushmeat hunting within a Protected Area. The fact that this service is obtained illegally from within Protected Areas makes it very important to assess and manage: controlling illegal hunting is only possible if alternative sources of income and protein can be found and if current beneficiaries will accept them, due to their current cultural attachment. Most of the information on benefits from bushmeat in this review was derived from Olupot et al., (2009) who interviewed ex-poachers, hunters and consumers of bushmeat around MFCA and Critchlow et al., (in press), who reviewed available data for MFNP between 2001 and 2012. Overharvesting of wildlife through illegal hunting threatens wildlife populations and reduces potential benefits from nature-based tourism, but obviously benefits hunters who derive income from it and many people who purchase it as a preferred meat.[41] Available reports suggest that killing animals to stop them from crop raiding, hunting to obtain animal parts, leisure and employment are less important as reasons to hunt than obtaining income or food. Hunters generally keep 30% of their catch for home consumption and sell the rest. Hunters around MFCA have incomes far above the village average. Approximately one third of meat was sold to neighbouring households and the remainder to distant villages (usually within the same sub-county) or distant urban centres. Some meat from MFCA and Kafu Basin was taken to Masindi, Kampala, Gulu, Apac and other townships (see Map 17). On average, bushmeat prices were found to be 40% higher at distant markets than in villages near hunting sites, creating opportunities for middle-men (additional beneficiaries).

"Ex-poachers said that their households ate meat every day and a lot of it at each meal while they were still active as opposed to once in two weeks or fewer times now; and much less meat at each meal".[34] Therefore, although bushmeat is not frequently eaten by households living in and around hunting sites, it makes an important contribution to

41 Olupot et al., (2009)

the diet in the households of active hunters. Around MFCA, bushmeat contributed on average 48% (range = 11 – 71%) of annual income averaging Ugandan shs 2,109,590 for MFCA. Average per capita income for poachers around MFCA was far higher than that of average households.

Up to 32% of respondents admitted to eating bushmeat, considering it to be tastier than domestic meat. Both hunters and consumers of bushmeat indicated that it was preferred over all types of livestock meat and fish. There were strong preferences for some kinds of bushmeat over others, hippopotamus being particularly favoured. On the few occasions domestic meats were ranked at the same levels with bushmeat types, they did not rank top, but at the level of moderately preferred animals such as bush pigs, cane rat, porcupine, bushbuck, hartebeest and waterbuck. This preference for bushmeat over livestock meat constrains promotion of protein substitutes as a solution to illegal hunting. Despite the preference for bushmeat, most families using it get more of their protein from livestock meat and only eat bushmeat occasionally, e.g. 1 – 12 out of every 100 days. Bushmeat is generally eaten in addition to livestock meat because people like it, rather than substituting for it. On average, bushmeat cost Uganda shs 2,000 (1.17 US$) per kg or its approximation near hunting sites and just under shs 3,000 (1.75 US$) per kg in distant areas. Bushmeat tended to be cheaper than livestock meat[34], making it relatively affordable. Prices of livestock meat increased gradually throughout the study



Map 16
Wildlife benefits – bushmeat trading (after Olupot et al., 2009)

whereas bushmeat prices remained fairly constant. Prices of both bushmeat and livestock meat peaked in December (the "hungry gap").

Baseline trends in supply and use

All hunting in Uganda is currently illegal except for sport hunting around Lake Mburo National Park and supervised control of three species declared vermin. It is therefore difficult to establish levels of use of wildlife populations for hunting. Landscape-scale changes in land conversion for farming and road access are considered highly likely to accelerate hunting and could increase levels of commercial hunting, which are currently relatively low.

Bushmeat use is generally positively correlated with availability, the most commonly hunted species being those that are abundant and have habitat near to human habitation. Hence, levels of bushmeat hunting are highest around the protected areas, as supplies of animals to hunt are more or less exhausted elsewhere. The probability of non-commercial hunting for smaller animals such as bush pigs, cane rats, guinea fowl and kob in MFCA is quite high throughout the area, particularly in parts of the protected

area bordering high population areas, but hunting (based on evidence of snares) takes place almost everywhere (**Figure 10**).[42] Critchlow et al., (2015) found that commercial animal poaching in MFNP involves high value products from large herbivores that are transported regionally, whereas non-commercial poaching is focussed on lower value bushmeat for subsistence or local markets only, typically caught using snares. Landscape-scale changes in land conversion for farming and road access are considered highly likely to accelerate hunting and could increase levels of commercial hunting. Importantly, Critchlow et al., (2015) concluded that non-commercial animal poaching has increased significantly. Between 2001 and 2007, the probability of occurrence was stable, but since 2008 it has more than doubled (on average) and does not appear to be decreasing.

42 WCS/Wanyama et al., (2015)

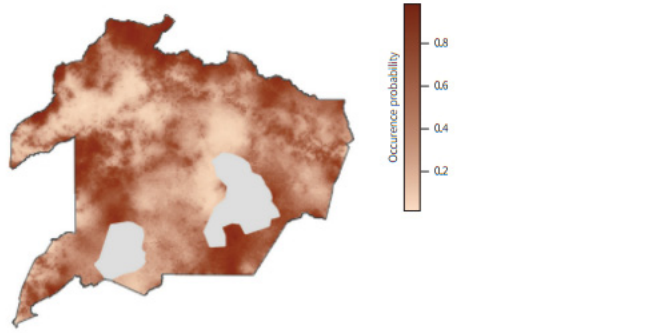


Figure 10 Occurrence probability of non-commercial hunting for small animals in MFCA (Critchlow et al., 2015)

Baseline Summary

In the case of bushmeat hunting and consumption, it may be that beneficiaries find alternatives unacceptable because of their preference for bushmeat, even though they don't depend on it strongly for protein intake. It is likely that current levels of hunting are depressing wildlife populations, particularly for preferred species. Experience suggests that uncontrolled hunting has catastrophic effects on target animal populations because the are now largely absent outside of protected areas, but the thresholds for population viability are not known. The risks are likely to be highest to larger mammals with slow reproductive rates, even though they are hunted less than smaller animals. The fact that wildlife populations have almost disappeared outside protected areas suggests that they will be at risk within them if hunting isn't regulated and controlled. However the precise levels of hunting that can be tolerated by wildlife populations in this area are unclear. This is a significant gap in the baseline.

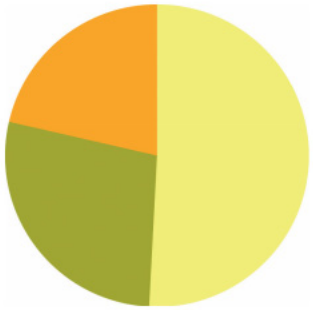
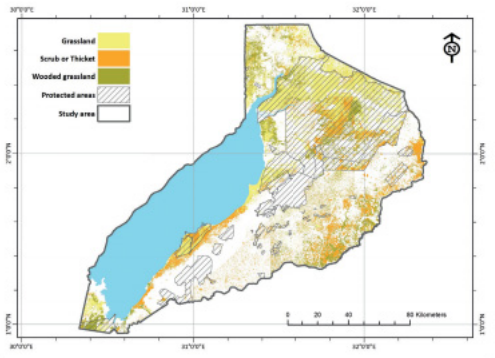


Figure 11 Source ecosystems for grazing



Map 17 Distribution of grazing ecosystems

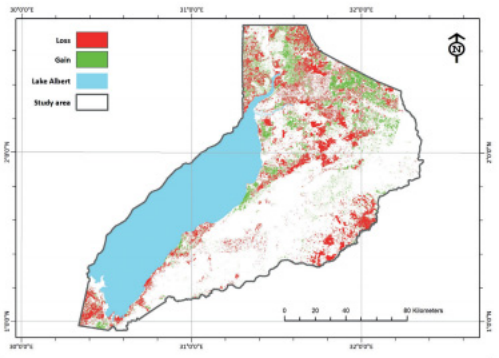
Source Ecosystems

Ecosystems providing open grazing for livestock are primarily grassland, wooded grassland and scrub or thicket (**Map 17** and **Figure 11**), though herders are now also taking cattle into woodlands and riverine forests due to over-grazing, including within protected areas.

Benefits, dependence and alternatives

Some very vulnerable people rely on livestock production from open access grazing land for their livelihoods and wellbeing: displaced pastoralists such as the Balaalo, and people employed as cattle herders, who are paid very low wages and have little access to alternatives. Others have a strong cultural attachment to owning cattle and see them as an important form of capital and savings. Grazing lands are dispersed across the landscape and could be further fragmented by oil-related development, especially linear infrastructure.

Beneficiaries are resident cattle owners and their herders and some nomadic herders, who moved into the district after about 2004, having been excluded from grazing lands elsewhere due to competition for land associated with population growth and drought. These pastoralists, or Balaalo, are not all native to Uganda (though some are) and have no tribal, historical lands. With roots in Rwanda and Congo, they are considered to be outsiders by local populations and there is history of tension over access to land. Many were relocated to less populated sub-counties by the Government of Uganda in 2012. Otherwise the resident cattle keepers in the Buliisa area are generally settled, but use



Map 18 Grassland Change

customary grazing areas. Rangelands are jointly utilized and all have freedom to graze anywhere and water their animals at the available water sources without restriction "provided they are the indigenous people".

Most people rely on their cattle to pay "bride price", to pay school fees, to provide meat and milk and for income to purchase other food. Cattle are also seen as "insurance" against famine, to save for the future and to obtain income for buying clothes or building materials, or accessing medical care. They have not been used for meat to any significant degree until relatively recently, being regarded more as a form of capital. Milk was traditionally given to the herders as part of their pay. This has changed since development of a milk refrigeration unit in Buliisa, that has provided facilities for a local dairy cooperative to purchase milk from cattle owners and export it to a large dairy company based in Kampala. Some herders now struggle to purchase alternative sources of protein, as their pay has not increased to compensate for removal of their payment in kind of milk. One respondent stated: "In the past, (around 2004), herders would get 30,000 Ugsh per month, but they would also get the milk to sell. Now the milk generally goes to the cattle owners, so herding pay is not enough to live on any more". Some cattle herders must be considered a vulnerable group due to their extremely low levels of pay and the fact that they are unable to purchase adequate food for a healthy life or save anything for their dependents or for their old age. One respondent reported that he is only able to eat meat once a year, subsists on beans and black tea and is generally hungry.

Baseline trends in supply and use

Habitats used for grazing (primarily grassland, open scrub, wooded grassland) have been declining inside and outside of Protected Areas since at least 1990 (**Map 18**). There are

currently 160,595 ha of grassland in the Study area, 87,738 ha of wooded grassland and 67,623 ha of scrub or thicket. Analysis of historic data suggests progressive decline in grassland and wooded grassland since the 1960s, faster inside Protected Areas till about 2005 and then outside them. If current rates of decline outside Protected Areas continue, open grassland ecosystems could have almost disappeared from the Study Area by c.2028 and wooded grasslands could disappear inside and outside of Protected Areas by the mid 2020s.

Decline in grassland ecosystems inside Protected Areas is thought to be due to a transition to more wooded habitats, possibly due to historic decline in large game or ungulate populations. Decline outside Protected Areas is largely due to spread of subsistence farming, land enclosure and development of infrastructure. Clearance of woodland for woodfuel-harvesting may slightly compensate for losses of grassland and wooded grassland to other land uses, but threatens longer-term supply. Removal of trees from wooded grassland increases risk of soil erosion and is also believed to accelerate drying of the landscape. Removal of woody vegetation cover is believed to have increased levels of soil damage in Buliisa District.

Case Study: grazing in Buliisa area

Focus Group Discussions were held in the Buliisa area with cattle owners, cattle herders/ keepers and people selling livestock in the market. Key informant interviews were also held with the District Veterinary Officer and other District Officials. As a result of these meetings and discussions, it can be concluded that supply of grazing has decreased and the number of grazing animals has increased, contributing to over-stocking, pasture-degradation and decline of animal productivity.

Although half of the respondents considered grazing to be "good" at present, all agreed that it was better in the past. People now have to take their cattle further to access sufficient supply and this includes going into protected areas to find additional grazing. Reasons cited for declining supply included declining rainfall, urbanization, fencing of land for farming and exclusion of cattle from Buliisa Town area. Oil-related development has also reduced the area of grazing to some extent due to new infrastructure and compaction of soil where vehicles go. It has had a particular impact on wooded grassland areas (e.g. "Oil development brought in cutting trees"). Overall, the area and quality of grazing has declined. The main drivers are seen to be in-migration and the induced effects of oil-related development on urbanization and land enclosure.

In the past, respondents reported that was possible to find sufficient grazing around the homesteads without travelling very far. They mentioned that they now go to Sambye, Kayeke, Kabolwa, Waiga, Bugana, Ntweka (Wakitu), Kijangi, Katala: "Animals are now moving long distances for pastures, and for water. We go about 6 to 8 miles e.g. from Ntweka or Bugana to Songalendu looking for water". In other words, use patterns have had to change to adapt, partly to decline in supply of grazing and partly because of difficulties of access to water for livestock. In discussion the respondents agreed that it is getting harder to find grazing round the homestead. Their limit to walk for grazing each day was 6 – 8 miles (16 miles return journey), with a maximum of 20. Further distances were considered possible with overnight camping. This is increasingly common, but difficult for older people or people who don't have anyone to herd the animals for them. It is normal to take animals "into the Park" to graze, especially in the dry season. To compensate for decline in supply of grazing and access to grazing, people have increased the distances they take the cattle to graze, i.e. they have expanded the use-shed, but most felt that it would not be able to increase it any further.

Reduced grazing area, combined with increased levels of use is resulting in over-grazing. The Buliisa District Veterinary Officer reports that carrying capacity has been exceeded throughout the District: it should be about one acre per head, but is now about 0.3 acres per head. He reported that rates of over-grazing are particularly high in Butiaba Sub-County,

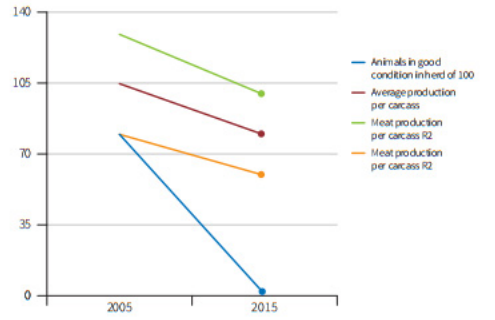


Figure 12 Condition and production from livestock in 2005 and 2015

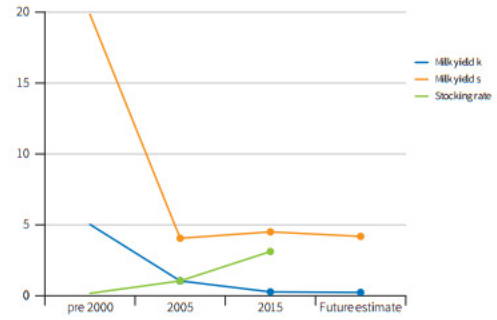


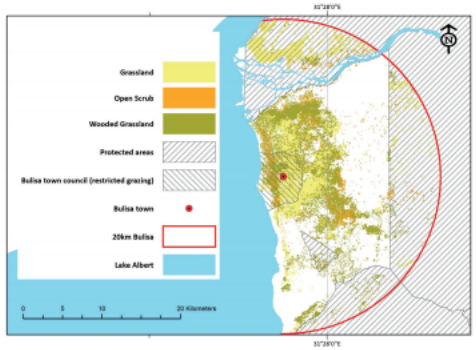
Figure 13 examples of change in milk yield over time compared with stocking rate (head of cattle per acre)

Bugana Parish in Buliisa and Kigwere Sub-County. Note that Bugana Parish depends heavily on producing charcoal, so there has been extensive removal of trees. Bush fires are set to chase away snakes and also by illegal hunters and these are causing further pasture degradation. Extensive clearance of trees and woody vegetation means cattle have no shade and this reduces their productivity. Pastoralists excluded from Buliisa Town Council (following introduction of the bye law to exclude livestock activity from within the town council boundary) migrated to Bugana Parish, leading to reduction in forest there, as well as in Maseege Forest Reserve. This is an example of an ecosystem service use being displaced from one area, causing unsustainable use of the same service in another.

Participants in Focus Group Discussions reported declining condition of cattle over the last 10 years. Examples are shown in **Figure 12 & 13**, as reported by two cattle keepers who said that cattle condition, weight and production had declined dramatically since 10 years ago. This also shows how stocking rates have increased in this area.

As shown in **Map 19**, Bulisa town is in an area of land bounded by MFNP to the north and east and Bugungu to the south. Livestock grazing is not permitted in the protected areas and has recently been excluded from the Bulisa Town Council administrative area.

The area to the east of Bulisa near the NP boundary is used for subsistence farming and not available to grazing livestock. Therefore, within a 20km "use-shed", the reported maximum range of cattle herders within a day (without staying away overnight), ecosystems available for grazing represent only about 30% of land, assuming that grazing in the Protected Area is also prohibited. In practice, it is known that a significant amount of grazing does take place within protected areas, keepers taking cattle in at night. As can be seen from **Table 5**, available grazing area declined by 13% between 2007 and 2013, and quality of grazing has also declined.



Map 19 Ecosystems supporting grazing within 20km Bulisa

	GRAZING HABITATS (HA)	
	2007	2013
20km buffer representing maximum daily "use-shed"	18,334	19,420
Area excluded due to Bulisa Town Council grazing restriction	0	-1,390
Area excluded due to fencing (Bugana/Kijangi)	0	-162
Available grazing land	**18,319**	**15,856**
Terrestrial land area (all ecosystem types)		62,761
% decline in available grazing 2007 – 13		13

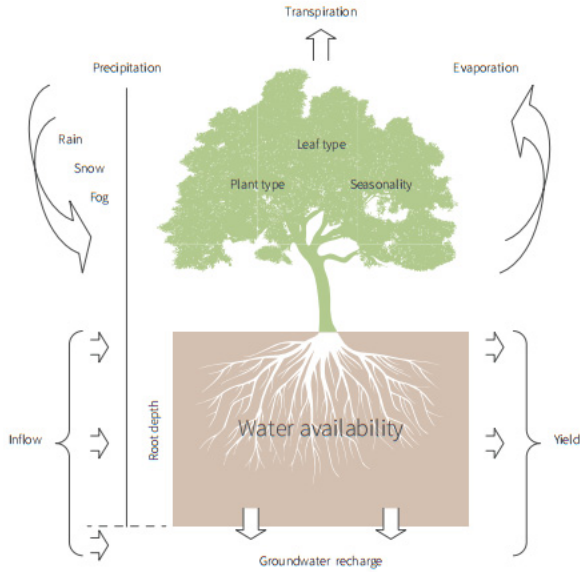
Table 5 Available extent of grazing to cattle owners/keepers living in Bulisa

Baseline Summary

Available grazing area has declined due to infrastructure footprint, conversion of land for farming and progressive urbanisation. Quality of grazing has declined due to over-stocking, with carrying capacity exceeded. Access to grazing has declined due to exclusion of grazing from certain areas (change in access) and land privatisation. Based on indicators such as condition of cattle or production of milk, the relationship between supply and use became unsustainable in about 2004. People are unable to take their cattle for longer distances than they are now, to obtain sufficient grazing and they are already using forage within protected areas. Benefits for some people, particularly Balalo/some cattle herders are inadequate and increased market value for milk has exacerbated poverty and malnutrition in this group as owners are retaining milk for sale. Many cattle owners are relatively wealthy and are able to purchase food and other necessities, as well as saving for school fees and old age. Any increase in livestock numbers, without concomitant improvements in production methods and pasture productivity cannot be considered sustainable.

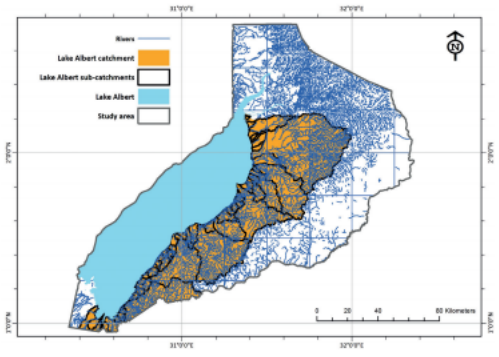
Source Ecosystems

Water is obtained from rivers and Lake Albert (**Map 20**) and groundwater, the latter being the major source for communities, through hand dug wells or boreholes. Groundwater is not conventionally considered to be an ecosystem and does not appear in the ecosystem classification, though groundwater recharge depends on water balance from precipitation, evapotranspiration and surface water "yield" (**Figure 14**), several ecosystems providing this intermediate service (See Annex D). Lake Albert provides water for lakeside communities. Water for bathing, laundry, cooking and drinking is drawn directly from Lake Albert, from some rivers and streams and primarily from community wells. Rivers and streams and the Lake are also used to provide water for livestock. Runoff from surrounding seasonal and perennial streams flows into Lake Albert. Intermediate services provided by ecosystems in the upper catchments of these rivers and streams (notably woodlands, forests and wetlands) are important for maintaining flow and also water quality in these watercourses and in the Lake. **Map 21** gives the distribution of public water sources in the central part of the study area; district based water atlases[43] show more detailed distributions.

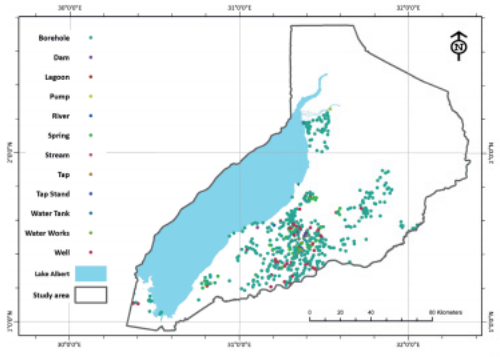


43 Hoima District Water Atlas

Figure 14 Water Yield



Map 20 River catchments



Map 21 Water sources

Benefits, dependence and alternatives

Freshwater for drinking is an essential ecosystem service. On 28 July 2010, through Resolution 64/292, the United Nations General Assembly explicitly recognized the human right to water and sanitation and calls upon States to take the action needed to provide safe, clean, accessible and affordable drinking water and sanitation for all. The Ugandan Government is committed to achieving the Millennium Development Goal (MDG) Number 7, which underscores the need for environmental sustainability, through "integrating the principles of sustainable development into country policies and programmes, reversing degradation of environmental resources, reducing biodiversity loss and reducing the proportion of people without access to safe drinking water and basic sanitation". Access to clean water and sanitation is clearly a priority concern in the Study Area. Oil development requires significant amounts of water to support production and the implications of this have been a long-standing concern in the Study Area. Due to the critical dependence of people on freshwater and the fact that there are some gaps in information about production requirements in relation to flows (see Dependence Assessment Report), the possibility of landscape-scale effects on access to freshwater was identified in the prioritization process.

Access to safe water supplies in Uganda as a whole is 69%. More than half of all residents in Uganda do not have access to improved sanitation, sharing overcrowded pit latrines or practicing open defecation.[44] The number of people with access to safe water and sanitation in Uganda has improved over the last 10 years, but a high proportion of people in the Study Area rely on contaminated water sources such as

44 www.water.org/country/Uganda

streams, springs and open wells. These surface sources are often highly contaminated due to poor drainage and waste disposal practices are very poor, with negligible regulation.

Residents of Buliisa and Kabaale say they experience extreme water stress.[45] Water supply in Kabaale is currently nearly insufficient, with boreholes running dry by midday in the dry season. Water supply in Buliisa becomes increasingly saline during the dry season, both quantity and quality declining in tandem. Average water use of around 13 litres per day is well below the amount of 50 to 100 litres per day considered necessary by the World Health Organisation (WHO) to ensure that most basic needs are met and few health concerns arise.

In February 2014, a team of Uganda Bureau of Statistics (UBOS) officials, in collaboration with district staff, collected data at village level on the various water sources in the Study Area, namely: public stand taps, springs/wells, boreholes, public water tanks, valley dams, rivers, lakes and gravity flow schemes. The results reveal that people in Bugoigo Parish generally use borehole and lake water for domestic uses like washing and cooking. However, for drinking most people buy water from Biiso from protected springs or shallow wells which is approximately 20km away. A jerrycan of drinking water from Biiso costs 1,500/=. According to 2014 census, household size of Buliisa district was 5.3 persons per household. This means that on average a family needs a jerrycan of drinking water per day, costing

approximately 200 US dollars per year. In Buliisa water can also be bought from outdoor taps for 100 shillings per jerry can[46].

Alternatives are limited. The alternative of boiling contaminated water is not viable due to shortage or cost of fuel. Those unable to afford to buy clean drinking water often suffer outbreaks of waterborne disease and children, especially, get sick from drinking contaminated water. The percentage of the population able to access an improved water source has a national target of 77%. Access in Buliisa District is 62% on average, but in Buliisa, Butiaba and Kigwera Sub Counties it is less than 50%. People from here are using unsafe supplies or travelling long distances to buy clean water from elsewhere at quite high cost.

Baseline trends in supply and use

The total renewable water resources of the country are estimated to be 66 km³/yr. The potential yield from deep aquifers is above 3 m³/hr in the southwest, southeast, northwest and along the eastern border of the country.[46]

Flow rates of rivers in the Study Area are unclear, but are reputed to be declining. Surface water flow has decreased significantly in recent years, and formerly perennial streams are now dry for part of the year at the base of the escarpment, where pastoralists and farmers rely on streams, stream flow rates have declined but no depletion rates have been estimated.[38]

High population growth and migration to informal settlements places stress on water and sanitation infrastructure and resources. There are serious water quality issues in places: in 2008-2009, UBOS concluded: "most of the water along the lake is polluted by disposal of human waste. On certain sites the settlements are very close with houses built just two metres from the lake waters".[47]

45 Nomogaia (2012)
46 Aquastat/ www.fao.org
47 http://www.ubos.org/onlinefiles/uploads/ubos/2009_HLG_%20Abstract_printed,Buliisa.pdf

To the extent possible with available data, InVEST models were used to estimate supply of the ecosystem service ("water yield") and the effects of use ("water scarcity") in the Study Area. The model is spatial, based on mapped inputs and outputs. The Water Yield part of the model uses Rainfall, Soil, Potential Evapotranspiration, Land Cover and Catchment data inputs. Globally available data sources were used to generate suitable datasets for rainfall, soils and potential evapotranspiration for the Lake Albert catchment together with WCS land cover data. The outputs include potential water yield by catchment; analysis at the sub-catchment level is also possible but was not pursued in this study. Domestic water consumption was estimated through use of population distribution datasets from census data, combined with data extracted from Ugandan water use reports[39]. The InVEST model provides an estimate of water yield for the Lake Albert catchment of 204 million cubic metres per annum. Domestic water consumption is estimated at 4.9 million cubic metres per annum, representing 2.5% of water yield.

Groundwater recharge is excluded from the InVEST model for reasons of model simplification. Due to the importance of groundwater sources in the Study Area, more information is needed on groundwater levels, seasonality and the headroom for increased groundwater abstraction from hand-dug wells and boreholes without significantly increasing the risk of depressing levels locally to the point where the sources run dry. More detailed hydrological models than those available in InVEST are needed to research these aspects in more detail, which are beyond the scope of this project.[48]

	TOTAL UGANDA (MILLION M^3 P.A.)	PER INHABITANT (M^3 P.A.)	% OF RENEWABLE WATER RESOURCES
Renewable Water Resources	**66,000**	**2472**	
Water Withdrawal			
Irrigation and Livestock Use	120		0.2
Domestic Use	134		0.2
Industrial Use	46		0.1
Total Water Withdrawal	**300**	**12**	**0.5**

Table 6 Water sources and uses, Uganda (Aquastat, figures for 2000 to 2004)

However groundwater, rivers and lakes can be treated as a single inter-related hydrological system with a recharge, base flow and discharge relationship as shown in **Figure 15**). Overlap between surface water and groundwater is 100% of groundwater recharge. This is because most of the groundwater is drained by rivers (equivalent to their low flow), as Uganda is a humid, landlocked country. The water yield output of the InVEST model is therefore considered to be a reasonable estimate of the sustainable water yield for the Lake Albert catchment.

The characteristics of groundwater differ in a number of ways from surface water. Since groundwater responds slowly to changes in rainfall, the impacts of droughts are often buffered.[49] In areas with a long dry season, such as the Study Area, groundwater is still available when sources such as rivers and streams have run dry. Groundwater is generally microbiologically uncontaminated and to a certain extent naturally protected from pollution. The resource is relatively cheap to develop[50] (McDonald and Davies 2000). Although detailed hydrological modelling at the sub-catchment level,

48 E.g. WETSPA (Water and Energy Transfer between Soil, Plants and Atmosphere) A GIS-based Hydrological Model for Flood Prediction and Watershed Management, Yongbo Liu and Florimond De Smedt, Department of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel.

49 Calow et al., (1997)

50 McDonald and Davies (2000)

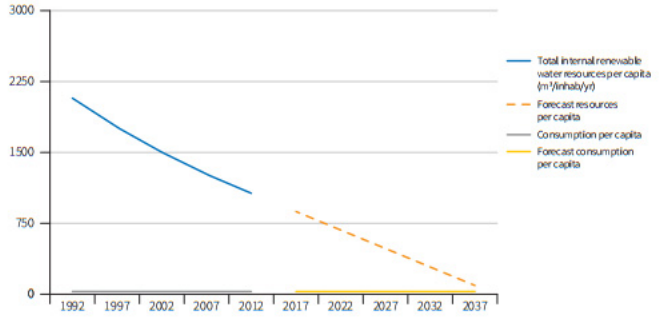


Figure 15 Relationship between total renewable water resources and forecast consumption in Uganda as a whole

including groundwater, is required to ensure sustainability in all areas it appears that there is opportunity for public water supply from groundwater to be increased in the study area. Practical knowledge is available through NGOs working on water in the area.[51] Direct river/ lake extraction is under consideration for part of the projected oil-related industry use.

Rural water consumption is reported to be even lower than the 12m^3 p.a. suggested in **Table 13**, at 13 litres per day per capita (equivalent to 5m^3 per annum). As a result of population growth, available resources per capita are decreasing but are projected to remain above consumption levels for a few decades (see **Figure 15**). This is projected for Uganda as a whole: timing of crossing the sustainability threshold will vary spatially according to local demand and groundwater availability and couldn't be modelled in this study. Based on the preliminary analysis of supply and use across the Study Area using InVEST and UBOS data, it seems that benefit is currently constrained by lack of access to reliable supplies of clean water, rather than by level of supply per se.

51 The Busoga Trust, The Water Trust

Baseline Summary

In the current situation, water consumption is thought to represent a small proportion of the water yield in the Lake Albert catchment at 2.5%. Rainfall remains relatively high though local communities report changing rainfall patterns and increasing incidence of drought conditions. Climate change scenarios indicate relatively modest changes to total rainfall in this catchment through to 2080, although variability is forecast to increase. River flows are reported to be declining and may decline further due to vegetation removal in upper catchments of rivers flowing through the Study Area. This could affect water quality in Lake Albert and associated wetlands.

Benefits from the service are largely constrained by lack of access to improved water sources and there is considerable scope for improving this without compromising overall supply. At present a high proportion of people in the Study Area do not have access to safe, clean drinking water. Levels of use (litres available per household daily) are extremely low by global standards and a significant number of people have to travel (sometimes up to 20km) to "improved water sources" or to fetch clean drinking water. The cost of purchasing clean drinking water is quite high.

It would be possible to model future consumption, factoring in oil-development requirements for water, but insufficient information is available about planned levels of use and proposed sources at present.

Source Ecosystems

Land suitable for farming has relatively deep soils and is located in areas with sufficient rainfall and/or access to surface or groundwater for crop irrigation.

Benefits, dependence and alternatives

A very high proportion of the population in Buliisa District (about 45%) relies on farming (crop cultivation or production of smaller livestock from enclosed land) for food and/or income (e.g. UBOS, 2009[52]), though there is still a significant level of dependence on fishing (despite declining stocks) and pastoralism (in this study, livestock production from open access grazing). In Hoima District 91% of people are engaged in agriculture and there is more sale of produce for income than in Buliisa District. Throughout the Study Area there are some groups largely relying on subsistence cropping and others more engaged in keeping small livestock such as goats, sheep and chickens or diversifying to ensure that they have access to varied food, sources of income and fuelwood from woodlots. The traditional food crops grown in Buliisa District are cassava, maize, sweet potatoes, bananas, Irish potatoes, beans, and groundnuts. Traditionally the main cash crops were cotton and tobacco, but now food crops are more often sold for income. Cassava and maize are the main staple food eaten in Buliisa. In Hoima District, cassava, beans, sweet potatoes, and maize are key food crops, and chickens, pigs, dairy cows, and goats are important for food and incomes. A wider variety of food crops and cash crops are grown as well as fruit, fish, fodder, honey, timber, charcoal, large livestock and manure/compost.

In the past, people losing access to benefits from other ecosystem services (such as fish from Lake Albert) would often relocate to Hoima District to enter into farming, but this is more challenging now as there is little land available. A baseline survey, supported by the Climate Change, Agriculture and Food Security Project (CCAFS) was undertaken in late 2010[53] aimed at describing farming systems and how they have changed over time. This also gathered information on the socio-demographic characteristics of farming communities and basic livelihood and welfare indicators. This study reported increasing levels of food insecurity in the last 10 years. For the surveyed households in Hoima, 31% were 'food secure' all year, 35% suffered food deficits for 1 – 2 months/year, 16% for 3 – 4 months, 9% for 5 – 6 months, and 10% for more than six months per year. The report by Arkesteijn and Mugisa (2012) found that as many as 45% of farming households in Buliisa and Hoima Districts had insufficient food at least some of the time. Diets are "one-sided" and are usually "based on what is available on the farm" (WFP, 2009).[54] There is poor knowledge of food-nutrition, food-preparation, appropriate food-storage or preservation (including processing).

In conclusion, many people depend heavily on subsistence farming for good and income in Districts affected by oil, and some of these people are already experiencing food insecurity or loss of income because of declining yields (see below).

52 http://www.ubos.org/onlinefiles/uploads/ubos/2009_HLG_%20Abstract_printed/Buliisa.pdf

53 Mubiru, D.N., Kristjanson, P. 2012. Summary of Baseline Household Survey Results: Hoima District, West Central Uganda. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: http://ccafs.cgiar.org/resources/baseline-surveys

54 WFP 2009. 'Comprehensive Food Security & Vulnerability Analysis on Uganda'.

Baseline trends in supply and use

In Uganda as a whole, the area of agricultural land increased from 45% of the country's land area to 65% between 1965 and 2005 (FAO, 2009). The overwhelming majority in Uganda are subsistence and smallholder farmers mainly using labour and land as the most significant inputs. There is growing evidence of declining yields and also declining levels of production per capita (FAO, 2009). This may be related to climate change and to impoverishment of soil (for example from erosion or nutrient-stripping) or from localised over-grazing. Some estimates for proportion of land degraded in the country are as high as 65% (FAO/TERRASTAT 2009). The 'Comprehensive Food Security & Vulnerability Analysis on Uganda' concluded that levels of food production are growing at a slower rate than population. FAO (2009) also showed decline of food availability per capita despite increasing agricultural area.

Unsustainable agricultural practices comprise among other things constant nutrient mining by crops without any measures to replenish those nutrients, inadequate erosion control, poor soil tillage, abandonment of soil and water conservation practices such as terraces, embankments, strip cropping or in general a lack of soil fertility management to restore organic matter content in topsoil layers. For those without access to artificial inputs such as fertilisers, it is difficult to increase yields, but some practices could be improved with assistance and advice. TUOP and others have initiated projects to help improve resilience of farming communities in the Districts where they propose to operate but the challenge is growing as population grows.

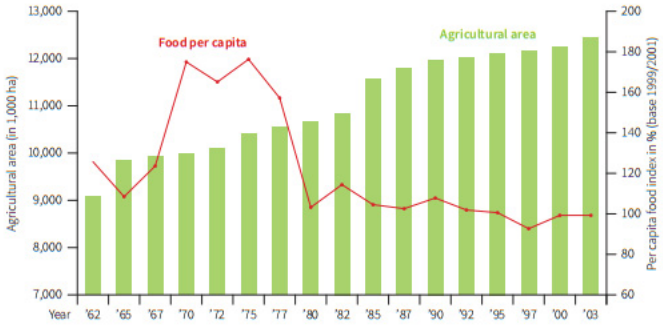


Figure 16 Agricultural area and per capita food index in Uganda (after FAO, 2009)

There is growing pressure to commercialise farming to boost food production and profitability of the farming sector, which can disadvantage subsistence farmers as well as reducing availability of land for them to use. **Map 22** illustrates this trend, with large areas of land between Hoima and Masindi going into commercial farming between 2007 and 2013. During the same period, new areas came into subsistence farming as a means to maintain supplies of food and income from this ecosystem service. However there is a limit to future ability to do this, and most of the land with suitable soils is now already in agricultural use.

Land with good soils in the areas affected by planned oil development is already farmed. Additional areas are generally relatively drought-prone with thin, poor soils. **Figure 17** (page 49) shows increasing trends of land conversion to subsistence and commercial farming. The ceiling on this trend is not known. It is important to establish whether there are any areas remaining in the landscape that are suitable for subsistence farming and

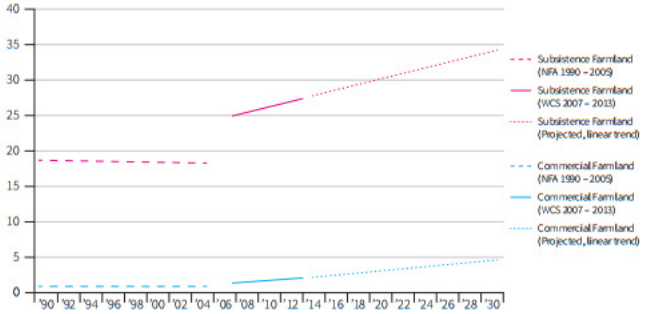
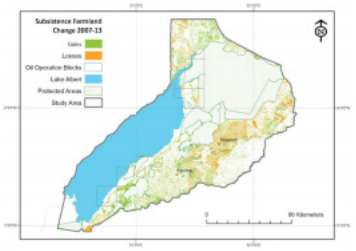


Figure 17 Historic and projected trends in land conversion for commercial and subsistence farming in the Study Area

Map 22 Gains in commercial farming between 2007 and 2013

that can be brought into production without causing other priority ecosystem services to decline further. If there is little additional land that can be brought into production to increase supplies of food crops, the only other way to enhance production is to intensify. During the same period, new areas came into subsistence farming as a means to maintain supplies of food and income from this ecosystem service (**Map 23**).



Map 23
Change in land area used for subsistence farming between 2007 and 2013

Already by 2009, UBOS concluded: "the state of environment in [Buliisa] district is very worrying; there is a lot of overgrazing by both the domestic and wild animals. There is too much pollution along the lakeshores where people have built up to a distance of five meters from the lake. At the moment there are no serious efforts being put in place to avoid pollution in the district". The same report concluded: "There were no established nursery beds" for trees, though it is very clear to all users of woody biomass in the District that supplies of trees are being used unsustainably.

Of the priority ecosystem services reviewed in this report, three have unsustainable supply-use relationships (the fishery, woody biomass for fuel and livestock production from open-access grazing). Two services are likely to have unsustainable supply-use relationships unless action is taken to safeguard wildlife populations (wildlife-based tourism and bushmeat). Access to wildlife-based tourism and the benefits derived from it could be threatened by oil-related activity. One has a sustainable relationship between supply and use, but poor access to resources of adequate quality (freshwater for domestic use) and finally it is likely that subsistence farming is also failing to keep up with increasing demand from a growing population. Throughout this Study Area, people will find it increasingly challenging to access the services that they need and depend on. Because many services have unsustainable supply now, options to switch to alternative services are becoming more limited. The fact that there are growing signs of food and income insecurity makes it important to take action to restore supplies of priority services, to diversify livelihood strategies and to safeguard access to priority services for vulnerable groups.

Of the priority ecosystem services reviewed in this report:

Priority Service	Summary of baseline
(1) Lake Albert Fishery	• Use exceeds sustainable supply/ maximum potential production. • Ecosystem service is not sustainable in the baseline state and benefits are already compromised for the majority of users/beneficiaries. • Urgent intervention is needed to improve the state of the ecosystem and its productive capacity, combined with measures to ensure that people have access to alternative sources of benefit while recovery takes place, e.g. through closed fishing periods.
(2) Woody biomass for fuel	• Use exceeds sustainable supply/ annual yield. • Ecosystem service use currently depends on unsustainable use of stocks of woody biomass. The source ecosystems are not regenerating. • Benefits are compromised for some users now and an increasing number of users/beneficiaries will be affected, with serious deficits developing in the next 10 years. • Urgent intervention is needed to grow stocks of woody biomass (including native species) and to ensure people have access to alternative means of cooking and boiling water while recovery takes place.
(3) Wildlife populations for tourism	• This is a thriving industry that has been showing growth over the last 10 years and generates considerable revenue. • In the absence of oil development this could be expected to continue, provided that hunting, encroachment and uncontrolled burning do not depress populations to the point where viewing opportunities suffer and that increasing visitor numbers do not disturb wildlife populations significantly (threshold not known). • There are information gaps that make it impossible to establish the relationship between supply, use and benefit in the baseline situation and to determine whether wildlife populations are being used to the extent possible. • Revenue to different beneficiaries and their level of dependence on this is not known in sufficient detail and the baseline is not sufficiently well established for implications of oil production to be quantified. Further investigation is needed to ensure that any management solutions address supply (wildlife requirement), and benefits for the full range of beneficiaries and don't just target levels of access for National Park visitors.

Priority Service	Summary of baseline
(4) Wildlife populations for hunting	• Illegal hunting is taking place within Protected Areas with snares and traps found throughout MFNP. • There are information gaps that make it impossible to predict future impacts of current or increased levels of hunting, but unregulated hunting is known to drive significant or terminal decline of wildlife populations and this has occurred outside protected areas in the baseline situation. • Any increase in levels of illegal hunting would therefore have to be regarded as a significant risk to future supply of wildlife whether for tourism or hunting. • Increased access to equipment for hunting and cash income is likely to exacerbate levels of hunting due to opportunistic nature of hunting and the fact that people eat bushmeat in addition to their normal diet. • Management interventions need to address implications for income (hunters and sellers of bushmeat) and cultural preference for bushmeat, requiring community-based, participatory action.
(5) Livestock production from open access grazing	• This ecosystem service is unsustainable in the baseline situation due to declining supply, declining access and levels of use that mean carrying capacity is exceeded. This is affecting production from cattle and benefits, including for some vulnerable groups. • Agronomic improvements may boost production to maintain levels of benefit, but this will require inputs from outside the grazing system, or production of cattle from enclosed land where their diet is supplemented. • Improved access to markets (for example through refrigerated dairy facilities and road transport) could drive further unsustainable use and disadvantage vulnerable groups. • An integrated approach to planning, pasture management and livestock production is needed.
(6) Freshwater	• Supply of freshwater in the baseline situation is sustainable. • Levels of access to freshwater supply are inadequate due to poor infrastructure and sanitary facilities. • Lack of access to water drives low level of benefit. Improved facilities to deliver clean water and improved sanitary facilities can be provided to a significant degree without compromising supply. • However land use changes in the Study Area are thought to be reducing water regulation capacity and flows in rivers and this could have adverse consequences for some users of surface water as well as for the health of the Lake Albert Ecosystem.
(7) Food from subsistence farming	• Supply of land suitable for subsistence farming is reducing. Soil quality is poor in much of the Study Area and there is increased incidence of drought. • Supply of food from subsistence farming will decline without significant investment in agronomic capacity • Availability of new land is reducing. Conversion of land for subsistence farming reduces availability of land for pastoral farming • Supply of this service per ha and per capita is declining and there is insufficient suitable land to bring into production to compensate for this Other means of enhancing supply will be needed to maintain benefits.

Potential indicators for assessment and monitoring

Based on the baseline situation established for the priority services described in this report, Box 1 suggests indicators that could be used to assess and monitor impacts, whether through further landscape-scale review or at Project ESIA-level to ensure consistency in approach.

Priority Ecosystem Service	Indicator		
	Supply	Use	Benefit
Lake Albert Fishery	Fish diversity and biomass	Number of landing sites; numbers of craft registered; catch per unit effort; numbers of basins of fish/ kg fish caught or transported by road each week	Numbers of meals with fish; meals missed per person per week; monthly income from fish, fishing or related activities (stakeholder consultation)
Woody biomass for firewood	Standing stock of woody ecosystems, annual yield	Distance walked to collect firewood; amount of firewood collected per week; woody biomass within use-shed	Number of cooked meals; litres of clean water (stakeholder consultation)
Woody biomass for charcoal	Standing stock of trees/ annual biomass production/ potential yield/ tree species/ age and condition of trees/ regeneration capacity (e.g. proportion of fruiting-age trees)	Numbers, type and size of trees felled for producing charcoal/ number and weight of bags produced a month	Income (price and amount sold); stakeholder consultation required
Wildlife populations for nature-based tourism	Numbers and distributions of target species	Visitor numbers to tourist locations e.g. MFNP	Level of satisfaction from viewing wildlife (visitor surveys)
Wildlife populations for hunting	Numbers and distributions of target species	Numbers of snares, signs of hunting, numbers of animals caught, number of people hunting, number of households using bushmeat.	Satisfaction from eating tasty meat; additional protein; income (bushmeat surveys).
Open access grazing	Extent (ha) and quality of rangeland; carrying capacity; presence/proportion of palatable or invasive species, bare or eroded ground.	Numbers of cattle/ stocking rate; condition of livestock; average meat and milk yields per animal	Income (amount sold and price), number of meals with meat per week, amount of milk drunk per week. (stakeholder survey, market survey (cattle market in Buliisa, milk collection centres).
Fresh Water	Water yield from catchment	-% population with accessible supply (within 1km of household) -Per capita water-use % cattle herders experiencing shortage of water for their herds or having to walk further to find water/ No. watering points/ head of livestock	Incidence of water-borne disease Healthy cattle (supporting service to livestock production from open grazing
Food from subsistence farming	Land used for subsistence farming (ha)	Per capita production or yield of crops and small livestock products	• Balanced diet • Number of meals from home-grown produce, • Income from sale of surplus products

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