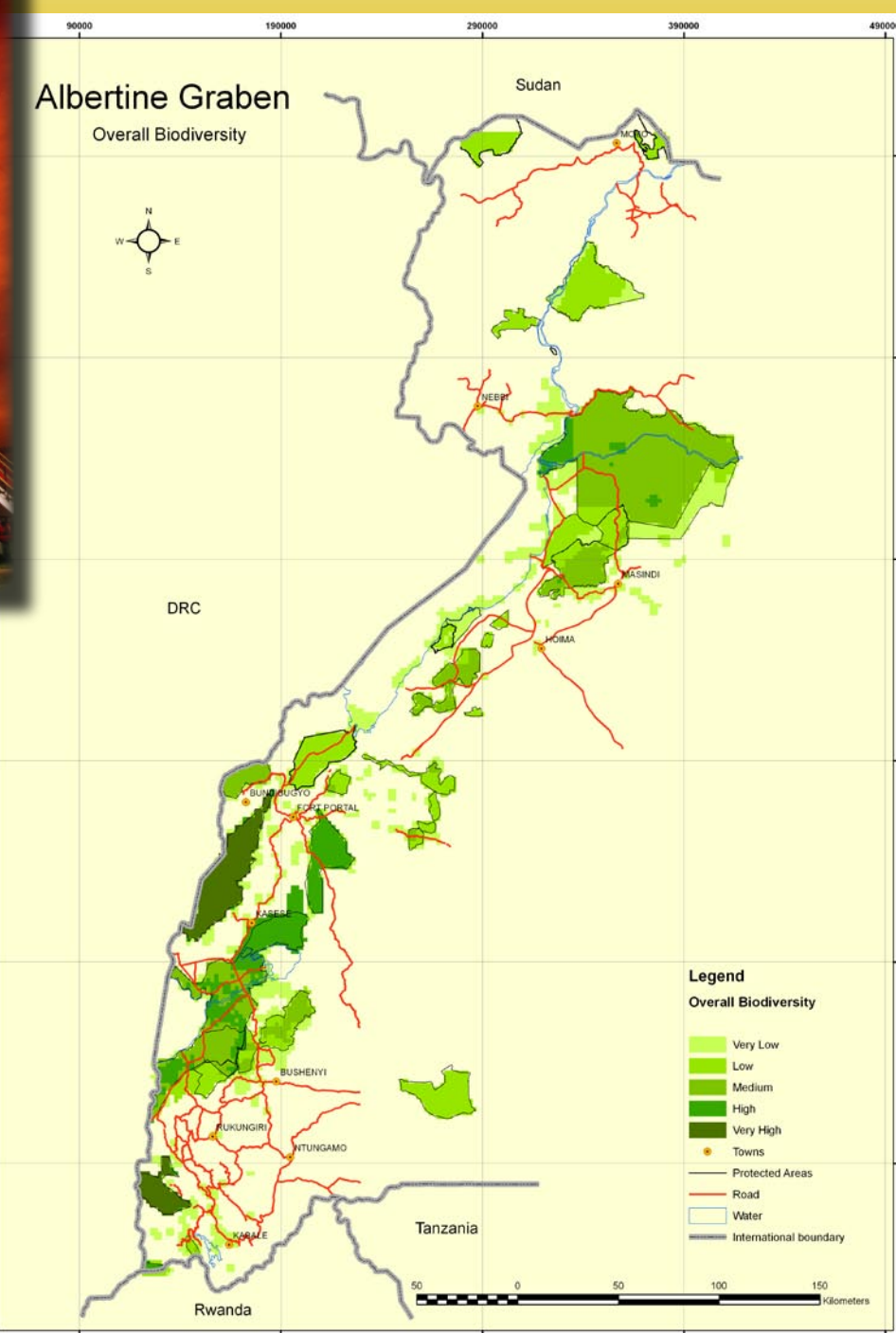
THE REPUBLIC OF UGANDA

ENVIRONMENTAL SENSITIVITY ATLAS FOR THE ALBERTINE GRABEN

SECOND EDITION 2010



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ENVIRONMENTAL SENSITIVITY ATLAS FOR THE ALBERTINE GRABEN

SECOND EDITION 2010

NEMA National Environment Management Authority
ENSURING SUSTAINABLE DEVELOPMENT

UNEP

ROYAL NORWEGIAN EMBASSY

WWF for a living planet*

WILDLIFE CONSERVATION SOCIETY

ENVIRONMENTAL SENSITIVITY ATLAS FOR THE ALBERTINE GRABEN

SECOND EDITION 2010

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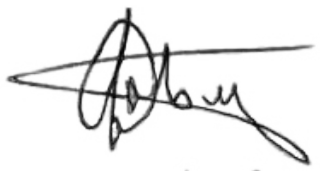
FOREWORD

Oil exploration has been ongoing in the Albertine Graben since the 1920's. Currently there is confirmation of commercially viable oil deposits in this area with early production scheduled to begin 2009. Oil spills can have severe and long term ecological and socio-economic adverse impacts if not properly planned for and addressed. While it is not possible to predict the impacts of an oil spill with certainty it is possible to evaluate the vulnerability of an area to a defined spill scenario based on the environmental resources present in the area.

An environmental oil spill sensitivity atlas has been prepared to provide environmental planners with tools to identify resources at risk, establish protection priorities and identify timely appropriate response and clean-up strategies. The atlas enables oil companies and authorities to incorporate environmental consideration into exploration and contingency plans. It also provides an overview of such aspects as the occurrence of biological resources, human resource use (fishing and hunting) and archaeological sites that are particularly sensitive to oil spill. Furthermore it contains information regarding the physical environment, lake shore and bathymetry of Lake Albert and the climate of the area.

The Albertine Graben is known for its high biodiversity spots at the same time it is now an oil rich region. Oil is a non-renewable resource meaning that at one time it will be exhausted. Therefore, care has to be taken to ensure that exploitation of oil resources is done without compromising the quality and quantity of environmental resources. The oil for development strategy should improve services such as conservation of natural resources, infrastructure, energy, education etc.

I hope the information in this atlas will be used effectively during all decision making processes connected to oil and planning of all activities in oil for development.



Hon. Maria Mutagamba
MINISTER OF WATER AND ENVIRONMENT

Dr. Aryamanya-Mugisha, Executive Director, NEMA, (*second from left)*, Hon. Maria Mutagamba, Minister of Water and Environment (*next to ED, NEMA*), and technical staff inspect an Oil well at Mpuuta village, prior to the Public Hearing on "Hoima Oil Early Production" that was held on 29th July 2008 in Hoima District.

ACKNOWLEDGEMENT

The National Environment Management Authority (NEMA) is honoured to present the Oil Spill Sensitivity Atlas for the Albertine Graben. This atlas provides data on environmentally, economically, and culturally sensitive areas located within the Albertine Graben. Emphasis is placed on those areas that may need special consideration in the event of an oil spill.

I sincerely thank all Government departments and Local Governments under the Environment Information Network who worked tirelessly to produce this atlas. I do immensely appreciate their invaluable contribution. I thank the various organizations and individuals who provided data, photographs, satellite images and information that were used in the analysis and production of maps. All sources of data are acknowledged and referenced where they appear in the atlas.

Special thanks go to the Royal Norwegian Embassy in Uganda who provided the bulk of the funds used in the production of the atlas. I do greatly appreciate the technical and financial contributions of Wildlife Conservation Society (WCS) in the preparation and production of this atlas. Thanks also go to the World Wide Fund(WWF) who provided funds for printing and for development of a database on the NEMA website. I also thank the United Nations Environment Programme (UNEP) for both the technical and financial support in the production of this atlas. Finally, I must thank my staff who contributed immensely and tirelessly in the initiation, preparation and printing of this invaluable resource material.

I hope the information in this atlas is put to good use by all stakeholders in the oil for development strategy to ensure sustainable use and protection of natural resources in the Albertine Graben of Uganda. I do wish all good reading.

Aryamanya-Mugisha, Henry (Ph.D)
EXECUTIVE DIRECTOR
NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

Members of the Policy Committee on Environment (PCE) undertaking a field visit to Amuru District. *Left to Right:* O.O. David Obong, Permanent Secretary, Ministry of Water and Environment, Hon. Jesca Eriyo, State Minister for Environment, Hon. Janat Mukwaya, Minister for General Duties in the Office of the Prime Minister, Hon.Winnie Kabakumba Matsiko, Minister of Information and National Guidance,Vice Chairman Amuru, Simon Ejua, Dr. Aryamanya-Mugisha, Executive Director, NEMA, and an official from Heritage Oil.

LIST OF ACRONYMS

%	-	Percentage
ºC	-	Degrees Celsius
tons	-	Tonnes
m	-	Metres
CAS	-	Catch Assessment Surveys
CFCs	-	Chlorofloralcarbons
DEM	-	Digital Elevation Model
DFR	-	Department of Fisheries Resources
DRC	-	Democratic Republic of Congo
DWRM	-	Directorate of Water Resources Management
EAMD	-	East African Metrological Department
EARS	-	East African Rift System
HFO	-	Heavy Fuel Oils
IBA's	-	Important Bird Areas
ITCZ	-	Inter-tropical Convergence Zone
Km	-	Kilometre
Kv	-	Kilovolts
MFCA	-	Murchison Falls Conservation Areas
MFNP	-	Murchison Falls National Park
MIST	-	Management Information System Technology
MUIENR	-	Makerere University Institute of Environment and Natural Resources
MW	-	Mega Watts
NaFIRRI	-	National Fisheries Resources Research Institute
NEMA	-	National Environment Management Authority
NFA	-	National Forestry Authority
NP	-	National Park
NFRRI	-	National Fisheries Resources Research Institute
PAs	-	Protected Areas
PCE	-	Policy Committee on Environment
PEPD	-	Petroleum Exploration and Production Department
PPD	-	Physical Planning Department (Ministry of Lands, Housing and Urban Development
QECA	-	Queen Elizabeth Conservation Areas
QENP	-	Queen Elizabeth National Park
SRTM	-	Shuttle Radar Topographic Model
SWL	-	Static Water Level
UBOS	-	Uganda Bureau of Statistics
UM	-	Uganda Museums
UNEP	-	United Nations Environment Management Programme
UWA	-	Uganda Wildlife Authority
WCS	-	Wildlife Conservation Society
WMD	-	Wetlands Management Department
WWF	-	World Wide Fund For Nature

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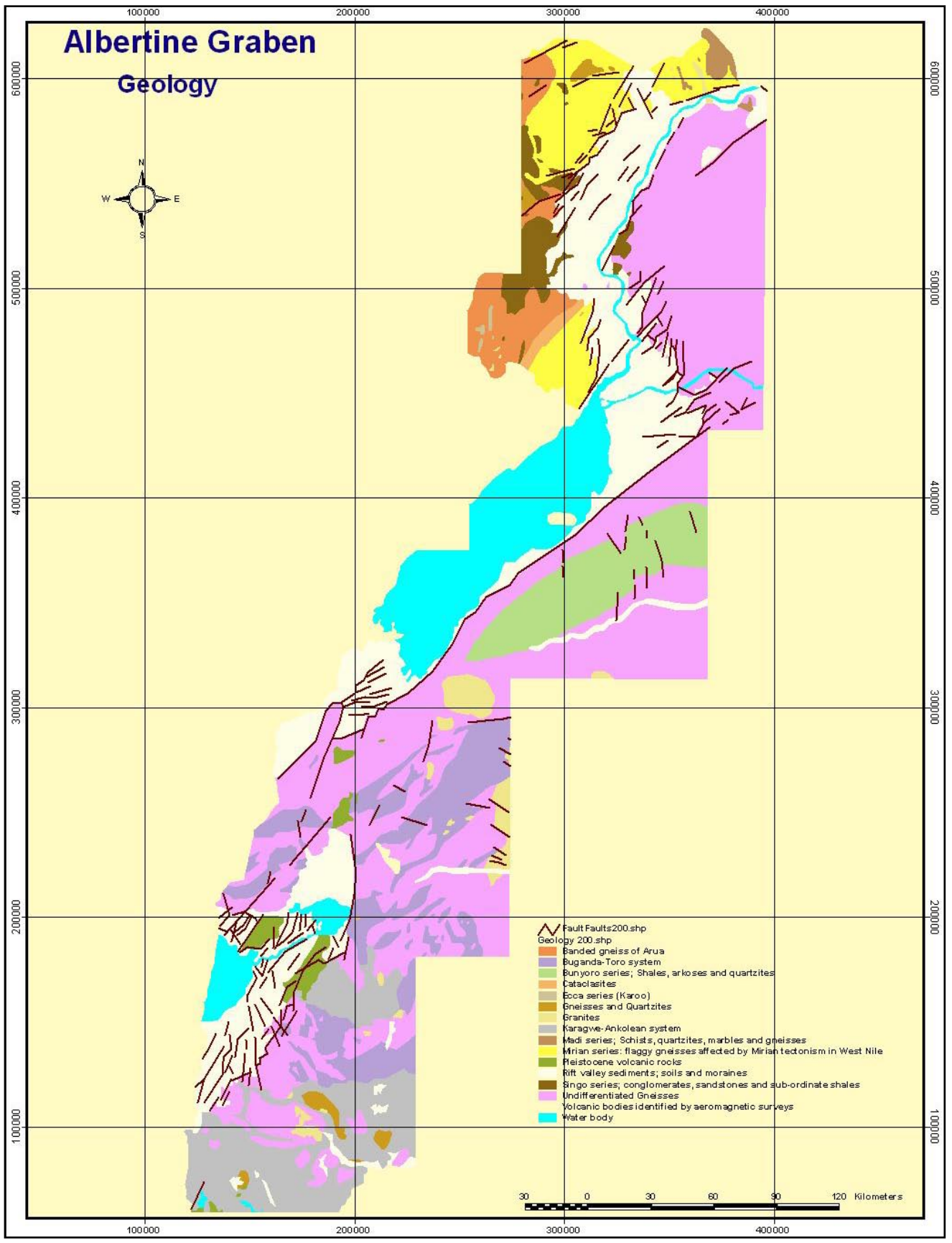
The giant *Lobella* in the Rwenzori mountains

CHAPTER 1

INTRODUCTION



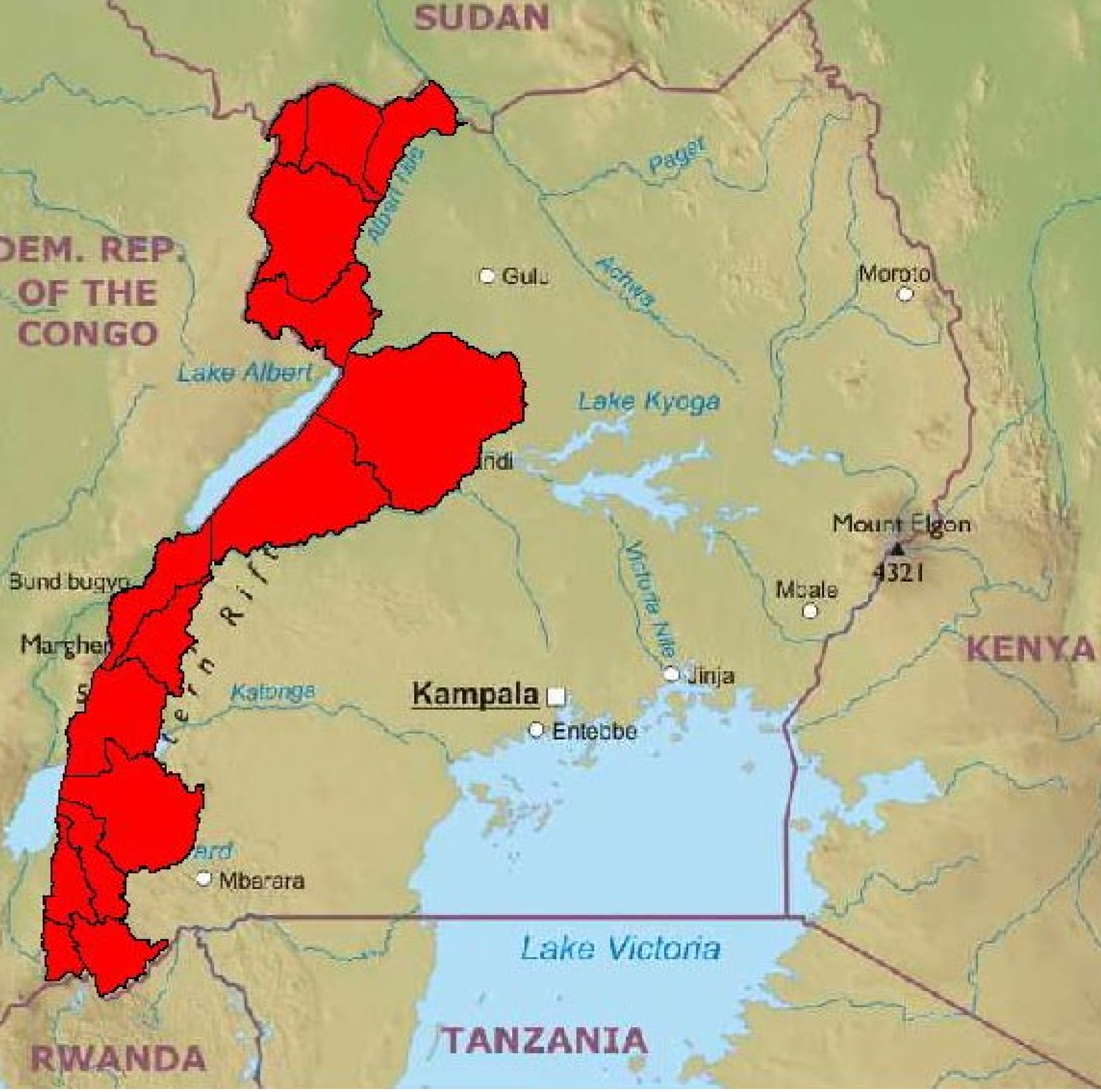
Map 1: Geology of the Albertine graben
Source: Geology Department

1.1 Background to Oil Exploration in the Albertine Graben

1.1.1 Physical Landscape of the Albertine Rift System

The Albertine graben forms part of the western arm of the Great Rift Valley system in East Africa.

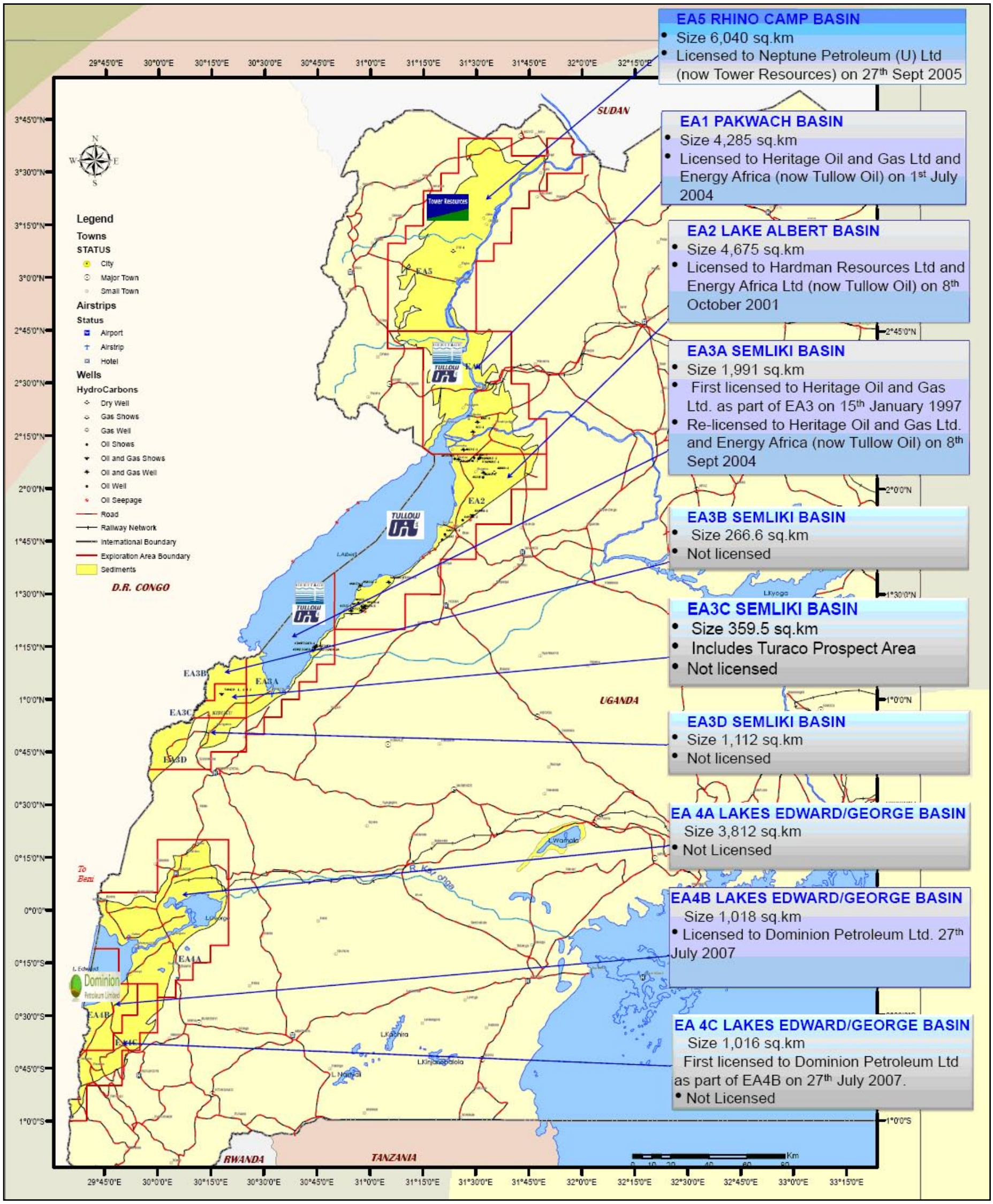
The Rift System is a unique physiographic region, comprising of the rift escarpments, the amorphous block of the Rwenzoris and an extensive Rift Valley or graben that extends in a north-east direction from the districts of Kanungu and Rukungiri at the border with the DRC, to the districts of Moyo and Adjumani at the border with the Sudan. This Sensitivity Atlas covers an area of the Albertine defined by the boundary of oil exploration blocks which was established by Petroleum Exploration and Production Department (PEPD). The area includes the Rift Valley floor and the largest parts of the escarpment except in some parts of the rift stretch in the northern most and southern most parts of Lake Albert. In this latter area, the boundary of the exploration blocks excludes the rift escarpment.



Map 2: Map of Uganda showing location of the Rift Valley.
Source: Petroleum Exploration Production Department (PEPD), August, 2009

The Albertine graben has several lakes including lakes Albert, Edward and George. These lakes were formed by intensive rifting in the geological past, which created depressions that were later filled with water. The valley floor also has a number of crater lakes all of which punctuate the generally variate and spectacular landscape of Rift Valley escarpments, the extensive Rift Valley and the towering block of mountains.

The Albertine area is a landscape of great relief contrast, with both the lowest elevation in the country of about 620m above mean sea level and the highest elevation in the country of about 5110m above mean sea level on the Magherita peak in the Rwenzori Mountains. The Rift Valley extends for a total distance of over 500 km with variable widths of 45-80 km (including part of the Democratic Republic of Congo).



Map 3: Albertine graben Exploration areas
Source: Petroleum Exploration Production Department (PEPD), August, 2009

1.1.2 Trends in Oil Exploration in the Albertine Graben

The petroleum potential of Uganda was first documented by A.J. Wayland in 1925, based on oil seepages he mapped at that time. The first well, Waki-B1, was drilled in the Butiaba area in 1938. The Albertine graben, the area with potential for petroleum accumulation, has since been subdivided into ten Exploration Areas. The Exploration Areas include blocks 1 and 5 located to the north of Lake Albert, blocks 2, 3A, 3B, 3C and 3D on and around Lake Albert, while blocks 4A, 4B and 4C are located around lakes Edward and George in the southern part of the graben. Five out of these ten Exploration Areas are licensed to oil exploration companies for exploration, development and production. Map 3 (above) indicates the exploration areas.

Fig. 1: An Exploration site at Butiaba Runga village, Kapapi Parish, Hoima District.
Source: Petroleum Exploration Production Department (PEPD)

Whereas the first phase of the Sensitivity Atlas focused on areas on and around Lake Albert where oil exploration and production activities were well advanced, this second phase covers other areas to where the activities have now been extended. Specifically, the second phase of the sensitivity mapping exercise will focus on updating the information provided in the first edition of the Sensitivity Atlas that was produced in 2009. It will also assess and map environmental sensitivities in the additional exploration areas including blocks 3B, 3C, 3D, 4A 4B and 4C.

Oil exploration and production activities so far indicate that the oil potential in this area is promising. For example, out of the 34 oil and gas wells that have been drilled, only 2 have been found without oil. Furthermore, the productivity prospects in the area are reasonably high; for instance the buffalo prospect alone can produce 400 million barrels of oil with an estimated revenue 15 times the Uganda's current expenditure. The estimated reserves in the Albertine graben as a whole are about 2 billion barrels. The size of the reserves is enough to sustain production for 20 years.

The significant scale of oil discoveries as well as government policy on energy suggests the need for the construction of a fully fledged oil refinery, preferably within the exploration area. The preferred location of the refinery implies the need for construction of pipelines to transport crude and processed oil between the production wells, the refinery and later to the market outlets. The idea of a fully fledged refinery replaced earlier plans to construct an Early Production Scheme (EPS). The refinery is now deemed appropriate in view of the large size of oil reserves and large regional oil market. A consultant has, therefore, been hired to study the feasibility of the refinery. Some of the key issues in the study include the type, size, location and funding options of the refinery. The feasibility study will also include a preliminary environmental assessment of the potential environmental and social impacts of the proposed refinery. Furthermore, plans to commercialize gas production at Nzizi through use of the gas for power generation project are in final stages.

Fig. 2: A concrete lined waste mud and cuttings pit at Kingfisher in Bugoma, EA 3A.
Source: Petroleum Exploration and Production Department (PEPD) 2006

1.2 Objectives of the Sensitivity Atlas

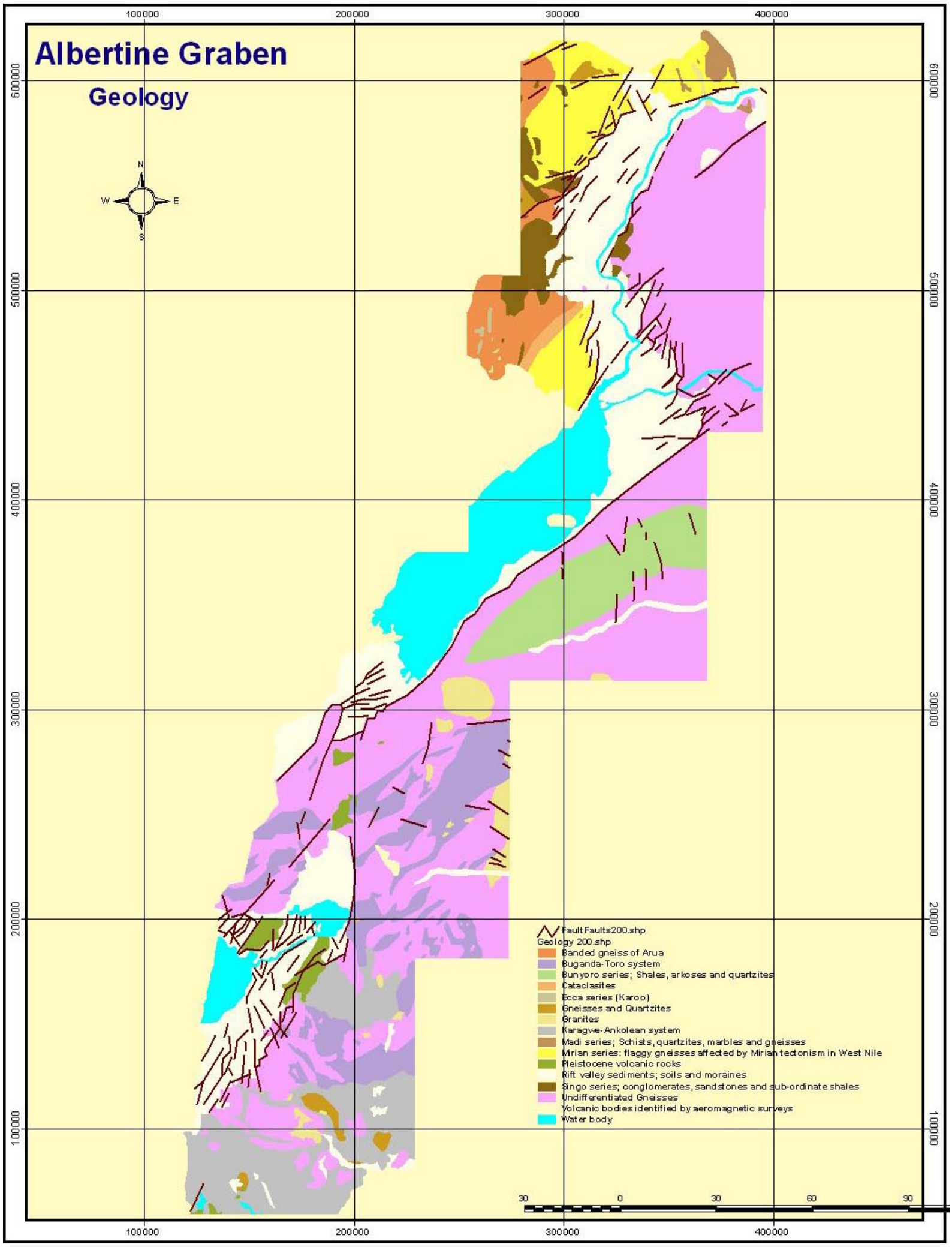
The overall objectiveof the Sensitivity Atlas is to:
"display, identify and provide the ability to analyse the relative environmental sensitivities(physical, biologicaland socio-economic) to oil spill and oil development within the exploration areas in the Albertine Graben region of western Uganda". This objective was agreed upon through a consultative process involving all key stakeholders in the sector.

The following detailed and specific objectives were derived from the overall objective. The specific objectives formed the basis for modelling of the various data layers to determine the environmental sensitivities to oil development activities.
The first objective is to identify and **protect**:

- fragile land cover types;
- designated protected areas;
- endemic and threatened species;
- areas of high biodiversity;
- cultural, religious and historical sites;
- economic activities that could be negatively impacted by oil activities and;
- location and size of water courses.

The second objective is to:

- identify and **preserve** areas currently covered by vegetation but, which areas are susceptible to erosion;
- identify and **locate** permeable soils or areas with high ground water and shallow aquifers that could easily be contaminated by oil development activities, and also;
- identify fault lines and **advise** against major construction of major infrastructure such as, pipelines on fault lines. This objective also covers issues of oil spill risk reduction on lake shorelines.
- provide information to guide decision making.



Map 4: Albertine graben Geology
Source: Petroleum Exploration and Production Department (PEPD) 2008

1.3 Geology of the Albertine Graben

The Albertine graben is a Cenozoic rift basin formed and developed on the Precambrian orogenic belts of the African Craton. Rifting was initiated during the late Oligocene or Early Miocene (25-40 million years ago).
The Albertine graben was initiated by either reactivating pre-Cambrian lineaments or creating new normal faults by an extensional regime during the Cretaceous prior to initiation of the East African Rift System. Available geological and geophysical data suggest that the Albertine graben has undergone substantial tectonic movements and thick sediments (approximately 6 km) have been deposited in fluvial deltaic and lacustrine environments. Surface geological mapping undertaken by the Petroleum Exploration and Production Department and the wells drilled by the Licensees so far indicate these sediments to be predominantly sandstones, siltstones, clay stones and shales. The sandstones and siltstones are mostly of high porosity and permeability.

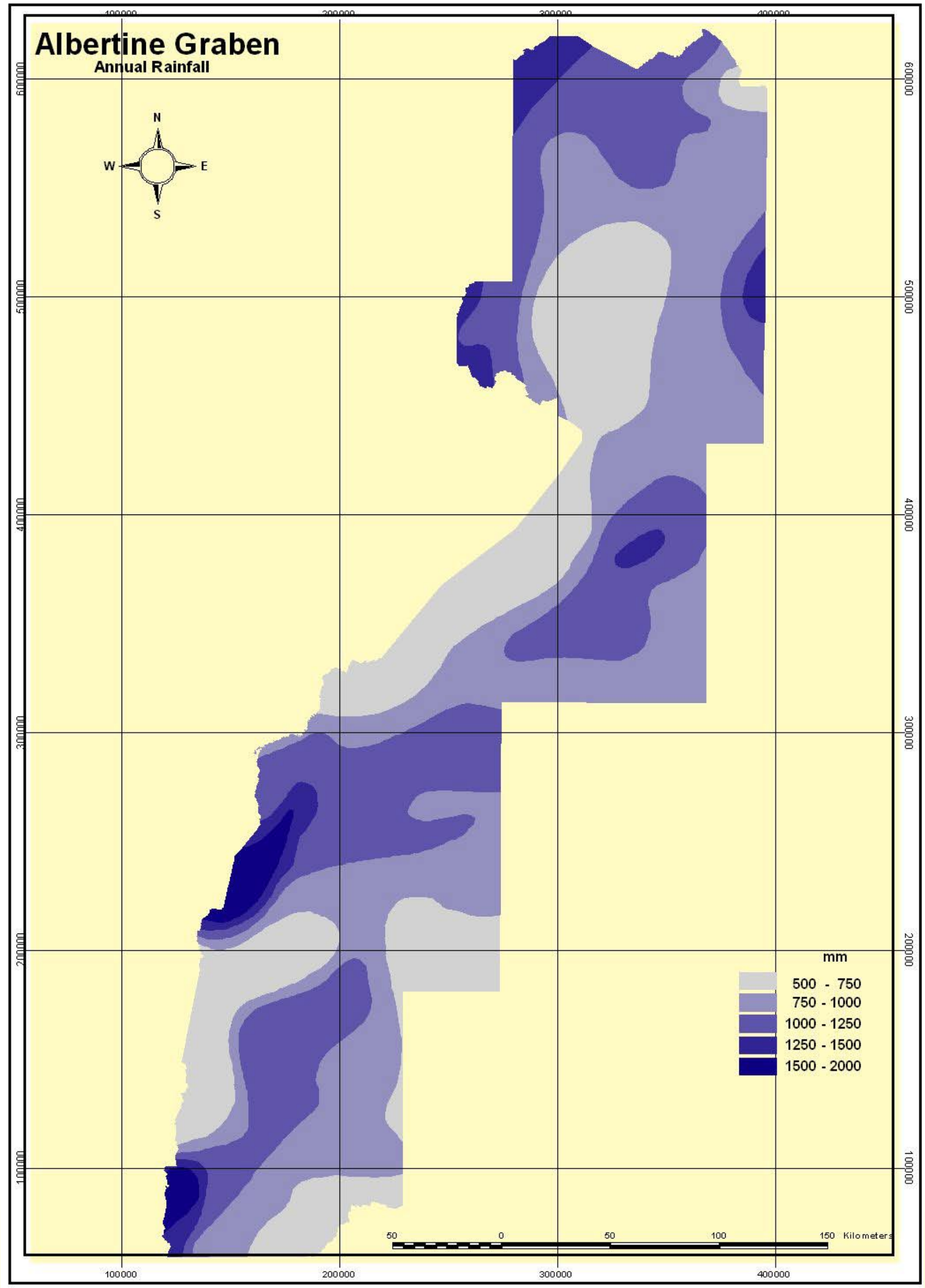
Fig. 3: Butiaba-Wanseko Rift Valley
Source:Petroleum Exploration and Production Department (PEPD) 2008

1.4 Climate

1.4.1 Rainfall

The Albertine graben has a sharp variation in rainfall amounts, mainly due to variations in the landscape. The landscape ranges from the low lying Rift Valley floor to the rift escarpment, and the raised mountain ranges. The highest landscape is the mountain ranges of Rwenzori, the Rwenzori mountains towering at over 5000m above mean sea level (a.m.s.l).

The Rift Valley floor lies in a rain shadow of both the escarpment and mountains, and has the least amount of rainfall average of less than 875mm per annum much lower than that of the highland area. Rainfall records by Directorate of Water Resources Management indicate that Moyo in the extreme north-east received an annual rainfall mean of



Map 5: Albertine graben Rainfall

Source: Department of Meteorology

Fig.5: A herd of cattle grazing and watering at the banks of River Semliki.
The degraded banks are widening at 10m/yr due to the receding snow on the Rwenzori mountains.

1174.8mm over a seven year period between 2003 and 2009. Over the period the highest annual mean rainfall was recorded in 2006 (1593.9mm) while the lowest was recorded in 2004 (623.6mm) indicating a high variation range in the mean annual rainfall received. Butiaba around Lake Albert in the center north-east receives 750mm, while Kasese in the central part of the graben receives a slightly higher mean rainfall of 970mm. No records are available for areas in the extreme south-western parts of the graben in Rukungiri and Kanungu. However, the area similarly receives rainfall amounts lower than that in the highland area flanking the Rift Valley. On the highland areas of the rift escarpment, rainfall averages increase largely due to orographic influence. For example, Masindi receives an annual average rainfall of 1,359mm, while Hoima receives 1435mm.

Rainfall amounts are even higher on the slopes of the Rwenzoris, in most cases increasing to over 1500mm. There is however, a serious lack of coverage of climatic measuring instrumentation, which is a common problem in mountainous regions worldwide. As a result of this, information on the spatial distribution of rainfall in the Rwenzori mountains remains scanty.

There is also scanty rainfall information in the graben but a high variation in the rainfall received both along and across the Rift Valley. Mean Rainfall amounts in the Murchison Falls Conservation Area for instance vary from 1,500mm per year at Chobe in the east to about 1,100mm at Paraa on the western part of the Rift Valley. Likewise, the mean annual rainfall recorded at Pamoti (Moyo District Farm Institute) in Moyo from 2003 to 2009 was 1174.8mm. The long-term mean rainfall amount recorded at Wadelai in Nebbi is 1,029mm, 750mm at Butiaba and 970mm at Kasese; giving a mean range of 425mm between the most northerly and southerly points where rainfall has been measured in the rift system. There is also significant seasonal variation in the rainfall pattern, mainly as a result of variation in factors influencing rainfall and especially the periodic shifting of the Inter-Tropical Convergence Zone (ITCZ) and the wind blows from the Atlantic Ocean through the Congo basin in central Africa. In the northern part of the region, there are two seasons of high rainfall, associated with the passing of the ITCZ over the region. Generally, rain occurs in all months, but with two peaks occurring between April and May, and August through to October, with two relatively drier spells around January and June.

1.4.2 Temperature and humidity

The Albertine graben region lies astride the equator. The region experiences small annual variation in air temperatures; and the climate may be described as generally hot and humid, with average monthly temperatures varying between 27°C and 31°C. The temperature maximas are consistently above 30°C and sometimes reach 38°C. Average minimum temperatures are relatively consistent and vary between 16°C and 18°C. The recorded lowest and highest monthly mean temperatures in the year vary along the Rift Valley: In Pamoti in Moyo, the lowest mean temperatures are recorded in August (22.6ºC) while the highest are recorded in February (27.1ºC). Southwards at Wadelai, the lowest mean temperatures are recorded in January (8.7ºC) and the highest in February (39.0ºC) indicating an extreme change in temperatures within a period of one month. At Butiaba, the lowest mean temperatures were recorded in September (18.0ºC) and the highest in February (35.6ºC). Further south at Kasese, the lowest mean temperatures were recorded in July (10.5ºC) and the highest in February (36.0º). The high air temperatures result in high evaporation rates causing some parts to have a negative hydrological balance.

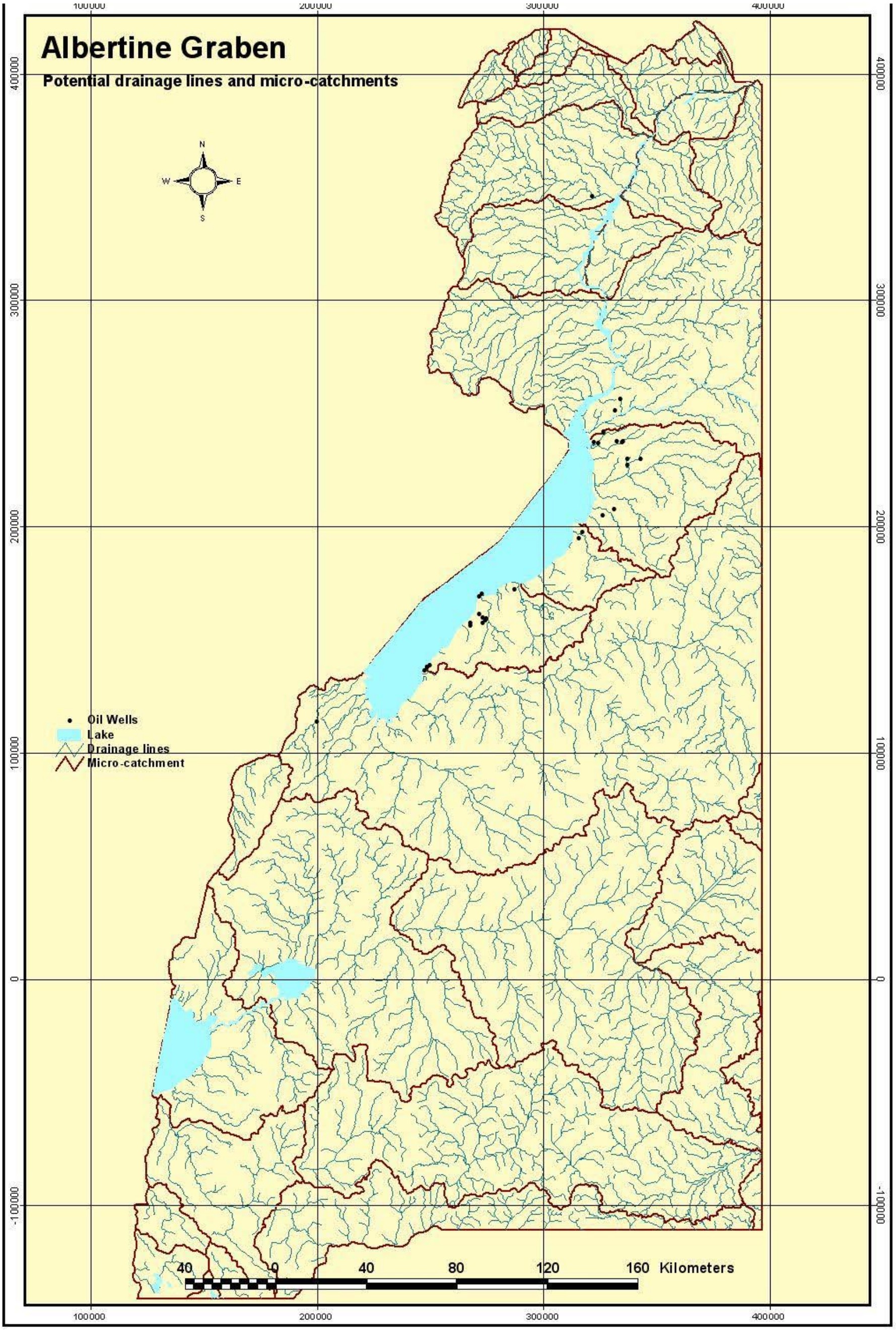
The relative humidity in the Albertine graben is higher during rain seasons with maximum levels prevalent in May. The lowest humidity levels occur in dry seasons with minimum levels occurring in December and January. The average monthly humidity is between 60% and 80%. The relative humidity recorded at Wadelai at 0600 hrs ranges between 70% in February and 88% in August while the record at 1200 hrs ranged between 35% from January to February and 55% from August to September. The average humidity recorded at 0600 hrs for Butiaba ranged between 67% in January and 80% in August while at 1200 hrs, the humidity records ranged between 66% in January and 71% in October. At Kasese, the average humidity recorded at 0600 hrs ranged between 79% in January and February and 85% from April to July, while records at 1200 hrs ranged between 49% in July and 61% in November. Relative humidity records for Moyo and the areas in the extreme south-west of the graben in Rukungiri and Kanungu are not available. It can be concluded therefore , that variation in relative humidity is generally moderate, except for Wadelai where both low and high relative humidity figures have been recorded (35% and 88% respectively).

1.4.3 Wind

Wind speed and direction records indicate a high incidence of strong winds especially in the Rift Valley. The prevailing winds commonly blow along the valley floor in a north-east to south-west direction or vice versa. Winds also blow across the Rift Valley in an east to west direction. On the escarpment and mountain slopes, prevailing wind-blow is largely multi-directional. The long-term wind speed records from the East African Meteorological Department (1975) indicate average annual wind speeds of 4 knots and 6 knots at 0600 hours and 1200 hours, respectively, for Butiaba; 3 knots and 5 knots, respectively, for Hoima and; 2 knots and 6 knots, respectively, for Kasese. The wind speed values indicated, therefore, represent conditions of moderate to strong or turbulent conditions. The average number of calms experienced in the area, are indicated to be experienced for 41days at 0600 hours, and 14 days at 1200 hours, respectively, at Butiaba; 99 days and 27 days, respectively, for Hoima; 181 days and 44 days, respectively, for Kasese; and 99 days and 27 days, respectively, for Masindi. The general conclusion from these climatic figures is that for most of the year, the area experiences moderate to strong and gusty winds, increasing in the afternoon. Both wind speed and direction have important implications on oil exploration and production activities particularly the dispersion potential for oil pollutants.

1.5 The Drainage system

All of Uganda drains into the Nile. Within the Albertine graben, there are three main lakes: Lake Albert, Lake Edward and Lake George. Most of the rivers and streams originating from the highlands surrounding this area drain into the lakes which, in turn, drain into the Nile via Lake Albert. Most significant of these rivers is River Semliki which comes from Lake Edward through the western edge of the great Ituri rain forest in DR Congo, and enters Uganda at a point close to the northern end of the Rwenzori range. The other, is the Victoria Nile which enters Lake Albert at its northern most tip before draining out of the lake as Albert Nile on its way to Nimule and onward to Sudan. Both rivers have built deltas into Lake Albert with that of the Semliki being larger. Ninety percent of the delta is created in Uganda. Although the Victoria Nile carries more water than the Semliki, it has little influence on the ecology of the lake, other than to maintain water levels. The Semliki on the other hand provides the primary supply of water into the lake system. The lake also has a large sedimentation potential from the Victoria Nile. There are other numerous small streams entering the lake from both Uganda and DR Congo, some of which are highly seasonal and of only minor importance to the hydrology of the lake.
Sensitivity of the rivers is in regard to their proximity to the oil wells; The closer the wells are to the river, the more sensitive the river is and vice versa. Several drainage classes are, therefore, formed based on the proximity of the wells to the rivers, as indicated in Map 5.



Map 6: Albertine graben Drainage

Source: DEM - from UNEP

Drainage - from the Directorate of Water Resources Management, Entebbe

1.6 Surface and Groundwater

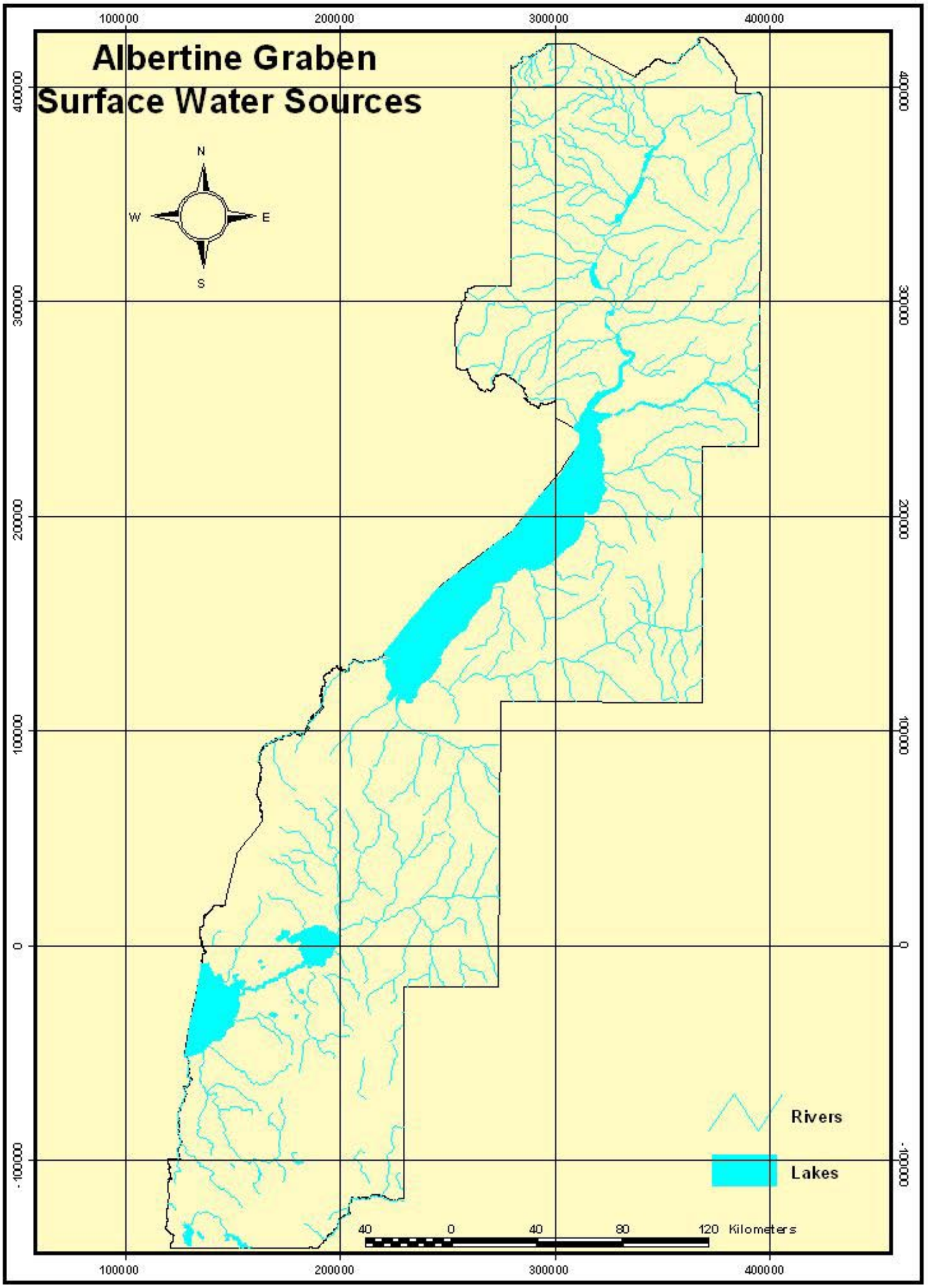
The Albertine graben area has significant amounts of surface water resources including lakes and rivers (Section 1.2). The rivers/streams originate from the elevated grounds on the escarpment and mountain ranges and flow down into the Rift Valley. There are also a number of Rift Valley lakes whose waters are mainly derived from the flowing rivers. The area is drained by numerous perennial rivers including Amua, Nyawa, Kochi, Enyawu, Nyagak, Aswa, and Zoka in the north east of the graben. In the Lake Albert area, rivers like Sambiya, Victoria Nile, Semliki, Hohwa, Wambabya, Waki, Waiga, Sonso, Waisoke and Muzizi are found. The central sections of the graben have rivers Mpanga, Nyamwamba, Mubuku, Kyambura, Oruyubu and Rusangwe, while the south western sections of the graben have rivers Nyamugasani, Ishasha and Mitano- Ntungwa in addition to small seasonal streams.

Furthermore, a series of erosion valleys and gullies cut the escarpment and discharge runoff from the escarpment to the valley. There are also seasonal streams and rivers which are flooded by runoff from the catchment areas after a heavy rainfall event. For example, in the Lake Albert area, water from these rivers drains quickly either into Lake Albert or seeps into the thick sediments of the Rift Valley floor. The seasonal rivers in this area include Sebugoro, Kabyosi, Warwire and Nyamasoga.

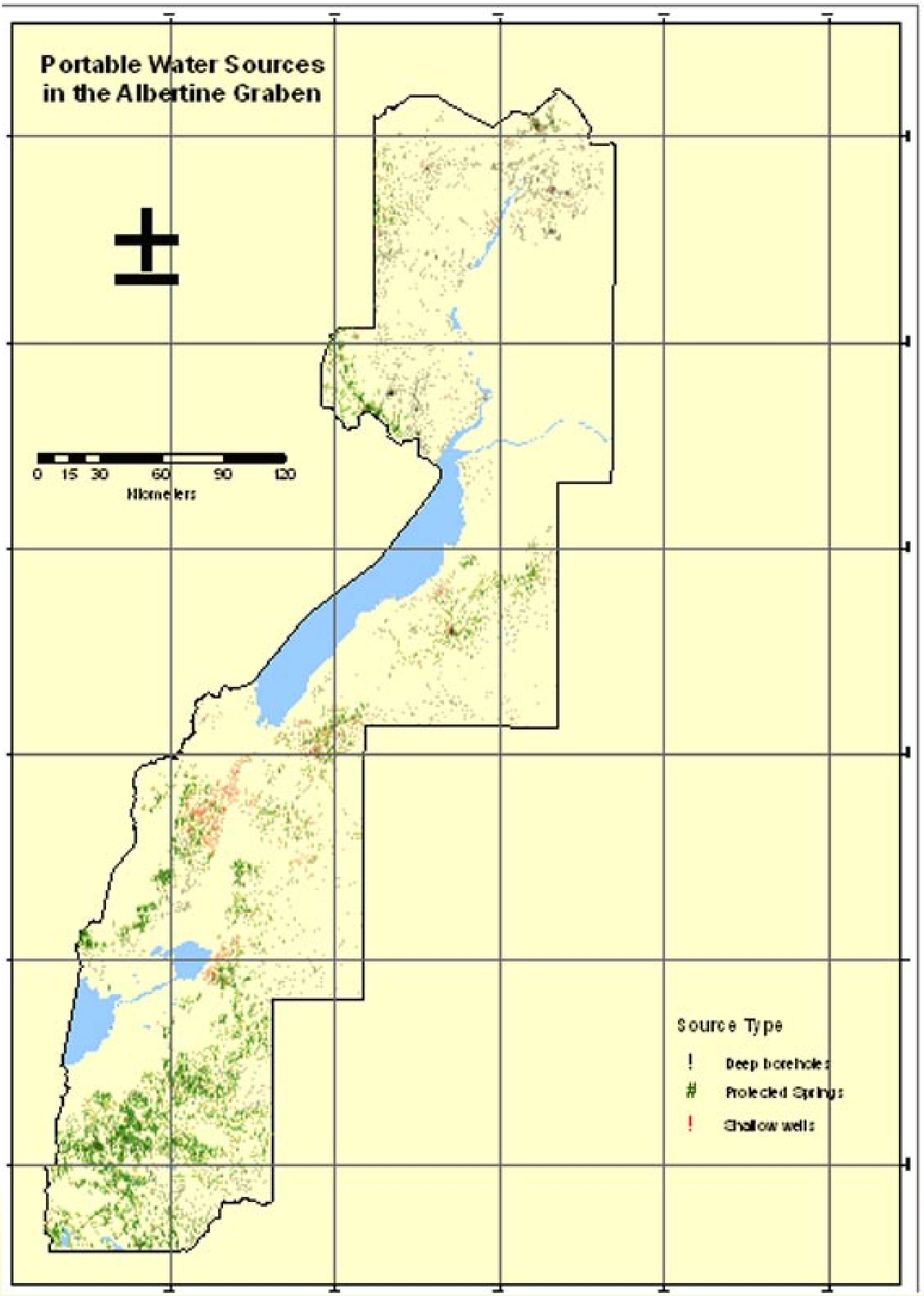
Most of the rivers and streams have incised into the landscapes leading to a topographic pattern of narrow river valleys and sometimes gorge-like features. Due to the nature of rift escarpment landscape, the rivers and streams flowing into the Rift Valley often have a limited catchment size and this implies limited hydrological potential. Consequently, some of the scarps are drained by ephemeral (intermintent) flows to the extent that some of the river valleys are dry most of the time.
The most spectacular landscape of river flow is perhaps the Victoria Nile. The Victoria Nile runs east-west through Murchison Falls National Park for over 80 km. Between Chobe and Paraa, the Nile drops 350 m through stretches of white water rapids and cascades. The most dramatic feature along this reach is Murchison Falls, where the river has cut back through the Rift escarpment plunging 45m below, with huge convulsions through a cleft only 6 m wide. At this point, the falls may be discernable into two separate features. Apart from Murchison falls, a further spill occurs over an adjacent cataract known as 'Uhuru Falls' formed in 1962 (year of Uganda's independence). Below Murchison Falls, the river flows out of the gorge to become calmer and wider, before finally entering Lake Albert as a delta (now a Ramsar Site). While Victoria Nile is responsible for most of the surface drainage in the protected area, smaller watersheds divert drainage into Waiga and Waisoke rivers which discharge into Lake Albert south of Buliisa. The Albert Nile drains in Lake Albert to the north.

Further south-west, the Rwenzori Mountains become the most important water catchment with numerous rivers descending from the high rainfall and snow-capped mountain to the Rift Valley floor and into lakes George and Edward. The key rivers in this area include rivers Mubuku and Nyamwamba. On the other hand numerous rivers and streams drain from the escarpment and highland areas beyond to the rift valley zone, and also often end up in the lakes.

Some ground water resources exist in a number of locations, the hydrology of which is undoubtedly influenced by a number of environmental conditions including geology, rainfall and the existence of Rift Valley lakes and rivers. Overall however, the graben is poor in ground water resources due to absence of true aquifers. Most of the under lying rocks are basement complex which by nature do not contain good aquifers. However, limited ground water reserves occur in rock fissures and localized aquifers. Ground water is harnessed in many areas, largely to provide for water needs of local communities. Evidence from many boreholes and shallow wells indicate relatively high water table conditions in many places. Such conditions imply high sensitivity of the water resources to oil exploration and development activities, including potential for serious problems of pollution of the shallow aquifers.



Map 7: Albertine graben Surface Water Sources



Map 8: Albertine graben Ground Water Sources

1.7 Minerals and Energy Resources

1.7.1 Mineral resources

The Albertine graben has a number of economic mineral resources, although there is not much detailed and accurate information about the location and extent of the mineral deposits. In the northern part of the graben, deposits of lime and dolomite are known to exist. Further south, the Lakes George-Edward area has copper, exploited in the past at Kilembe mines in the Nyamwamba river valley near Kasese town. Although mining at the facility stopped in 1970s, there are still significant mineral reserves which could be exploited in future. Furthermore, the copper ore is richly associated with cobalt mineral that could increase the feasibility of mineral wealth exploitation in the area. Extractions of cobalt from copper tailings is currently going on at Kasese Cobalt Company Ltd located along the Kasese to Katunguru highway.

At Hima, Dura and Muhokya areas in Kasese District, limestone deposits exist and are currently being extracted for the manufacture of cement and lime. Gypsum has been mined for quite some time in the Kibuku area near Sempaya in Semliki, Bundibugyo District.

Gold has also been reported to exist in Maramagambo forest south of Lake Edward in Bushenyi District, while to the extreme south-west, deposits of iron-ore, gold and wolfram are known to exist especially in the escarpment region of Kabale, Kanungu and Rukungiri districts. An assessment of mineral resources in this area is ongoing and possibly more minerals such as tin, might be found when the assessment is completed.

Salt is the other mineral of socio-economic significance found in the graben . Salt mining has been undertaken for over half a century at Lake Katwe north of Lake Edward for many years, both for commercial and local purposes. A second salt deposit at Kibiro near the shores of Lake Albert north of Kaiso-Tonya has also been exploited for a long time, mostly for domestic needs. Potential for export of the mineral also exists and in the past, attempts have been made to establish a complex salt factory at Lake Katwe although this experienced problems related to both industrial structuring and the complexity of the salt mineral constituents.

Existence of minerals has important implications to the dynamics of socio-economic activities in this area and possibly potential for their exploitation could be accelerated by the ongoing petroleum development activities in the region.

1.7.2 Energy resources

1.7.2.1 Energy Potential

Uganda has a rich renewable energy resource base. This includes solar, wind, hydro power, biomass and geothermal energy resources. The Albertine graben similarly has significant energy resource potential. The area has considerable hydropower, geothermal, wind and solar energy resources. At Mubuku River near Kasese, hydropower is being generated by both Kilembe Mines Ltd and Kasese Cobalt Company Ltd. New mini hydropower sites have been initiated on rivers Wambabya in Kaiso-Tonya and on River Muzizi. Hydropower potential also exists on river Waki and at Murchison Falls on the Victoria Nile.

Potential for geothermal energy exists at several known sites in the region, although they have not been adequately explored. Potential sites include the hot springs at Katwe near Lake Edward, at Buranga in the Semliki flats in Bundibugyo District, Kibiro on the shores of Lake Albert and in the Virunga area in the extreme south-west . The total estimated potential from the 4 sites is 450 MW. The Katwe site is considered the most promising due to the presence of sub-surface steam at 230 ºC. The site is also located only 35km from the 132Kv transmission line to Kasese, making it easy to inter-connect to the national grid (NEMA, 2004/2005).

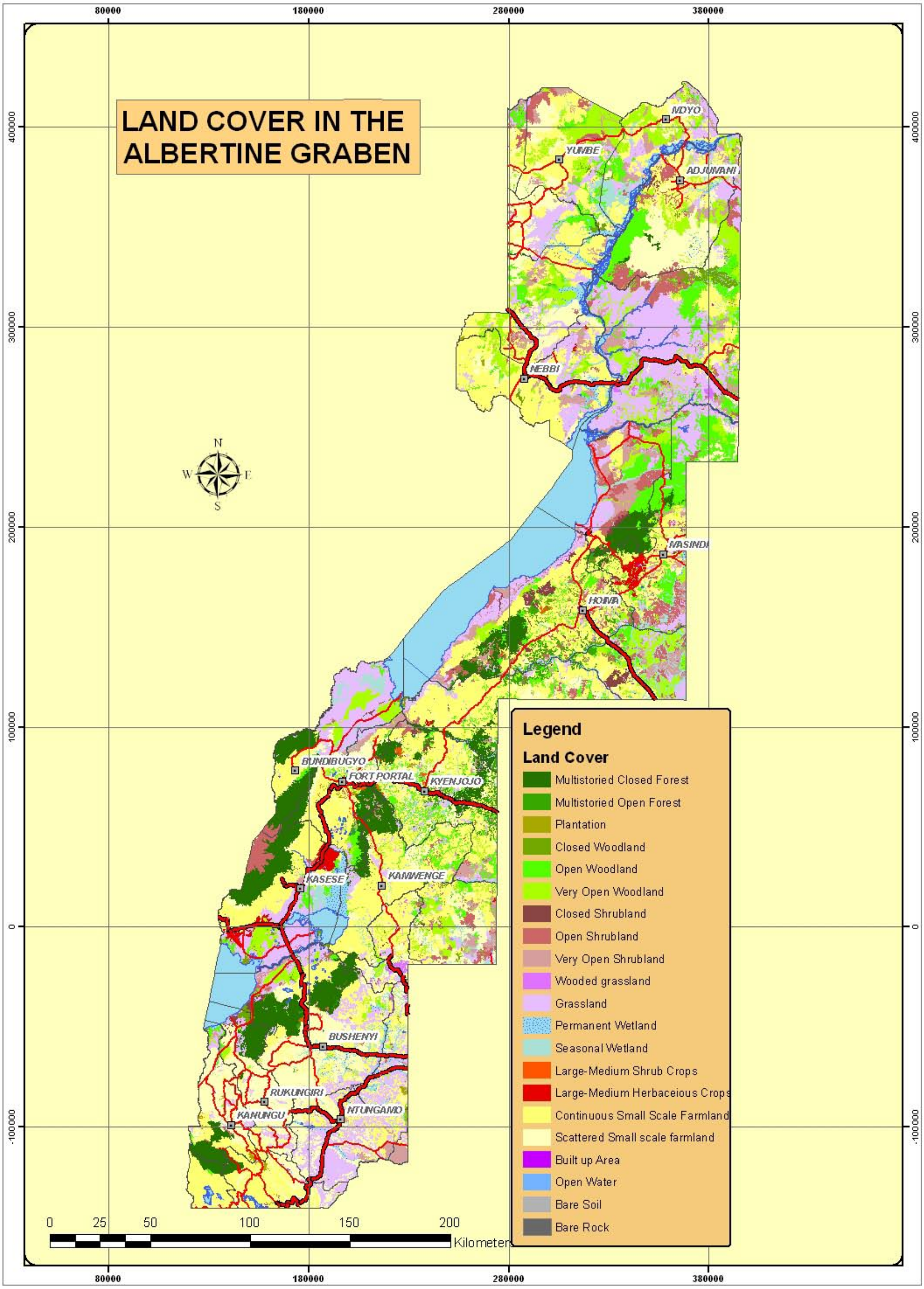
Solar energy use is also becoming more relevant especially given the limited connections to the national grid. Uganda straddles the equator and has a very good average insolation of about 4-5kWh/m²/day. The costs of accessories involved are, however, still relatively high and unaffordable to the majority of the households in the region

1.7.2.2 Energy use

The majority of the population in the Albertine graben use wood fuel as the most dominant source of energy. Kerosene or paraffin is used for lighting and less than 3% of all households have access to electricity supply. However, firewood has become scarce and most people have resorted to using charcoal which is often imported from elsewhere and is very expensive. At the moment, most of the Rift Valley area is not connected to the national grid. Individual companies involved in oil exploration have therefore had to invest in generators.

1.8 Land use and Land Tenure System

The Albertine graben covers a total land area of 6,788,616 ha. Out of this, 5,369,164 ha (79.1%) is under agriculture, settlement and other miscellaneous land uses. The remaining 1,419,452 ha (20%) are under protected areas form of land use. Protected areas include forest reserves (Central Forest Reserves, Jointly Managed Forests by UWA and NFA and Local Forest Reserves) and wild life conservation areas (national parks and wild life reserves). Forest Reserves cover a total area of 462,129 ha (7.01%) while wildlife conservation areas cover a total of 957,194 ha (14.5%).



Map 9: Albertine graben Land cover

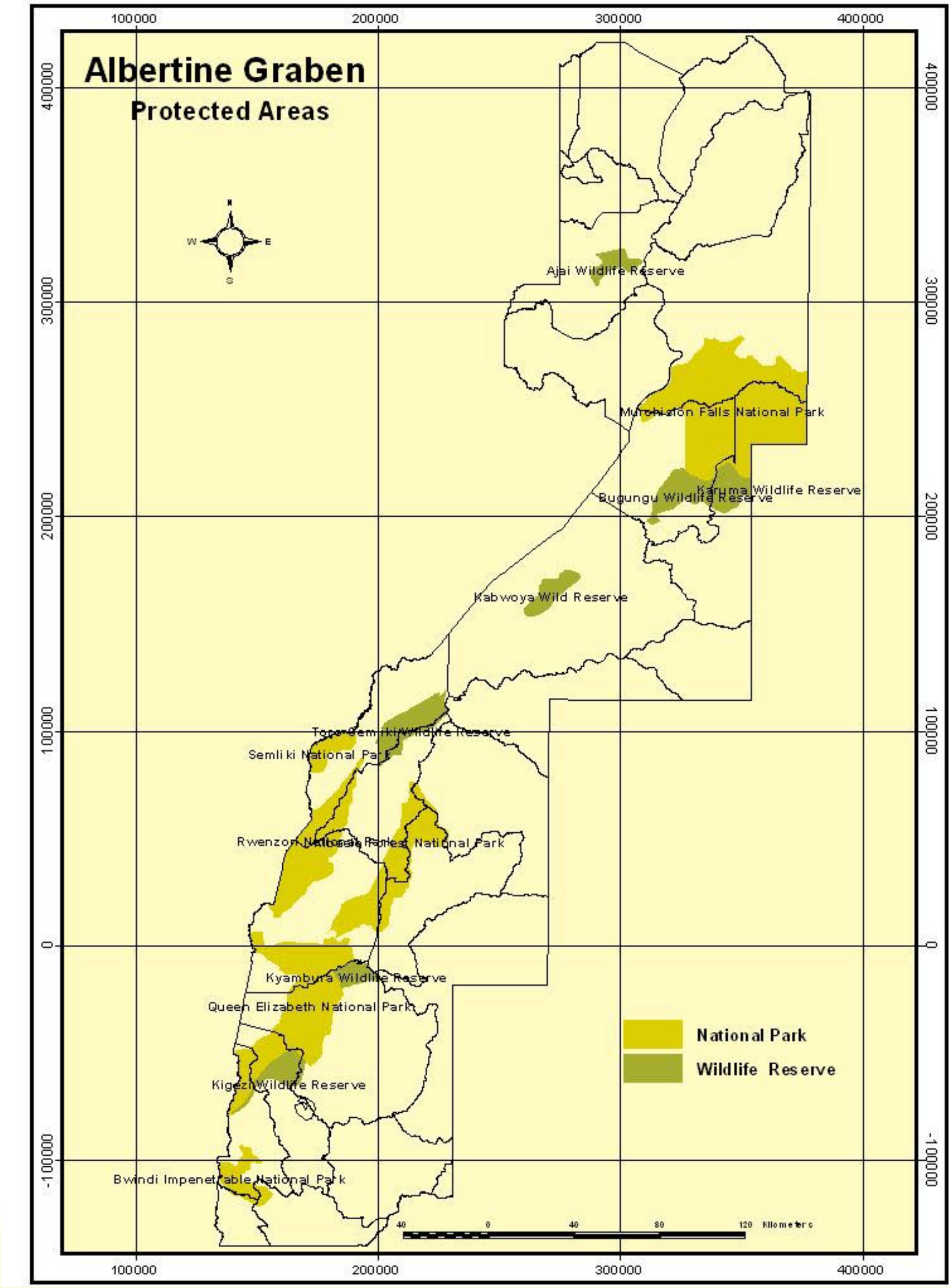
Fig. 5: Land cover in Hoima District.

The area, therefore, has four main types of land use namely; agriculture, settlements, forest conservation and wild life conservation with the protected areas occupying a significant proportion of the total land area, i.e. 20.9%, which has important implications on available land for agriculture and other activities.

Furthermore, the location of 10 out of the total 22 national parks and wildlife reserves in Uganda within the oil rich Albertine graben, presents a land use challenge. Oil development could disrupt conservation efforts if not well planned. Yet, another issue is that these National Parks and Forest Reserves, together with other protected areas inside and outside the Graben, form a relatively continuous protected areas system and are generally linked by wildlife corridors. These corridors facilitate the movement of wildlife between habitats that are increasingly being fragmented by farmed and urban ecosystems. The corridors movement promote exchange of genes, allow animal interactions and act as dispersal routes. The animal corridors also link Uganda's protected area system to the larger protected areas in the Democratic Republic of Congo (DRC).

The major land tenure systems in the graben include customary, freehold, leasehold and public land. All protected forests and wild life conservation areas are under public land form of tenure, in addition to areas accommodating government institutions and infrastructure.

On private land, customary land tenure (both individual and communal) is the most widely practiced system. The majority of households in the areas around Karuma and Bugungu Wildlife Reserves in Masindi District, for instance, acquire land through inheritance, while a few purchase their land. For example, in Buliisa, land tenure remains largely customary, and all members of village communities communally own the land. The lack of a uniform land tenure system, however, presents management challenges particularly with regard to land speculation that has been exacerbated by the discovery of oil in the region. This is threatening to cause land use conflicts and landless households and communities in the area, as land purchases and delineation from the previously communally owned land continue to take place. This challenge is further exacerbated by the lack of a comprehensive land use plan.



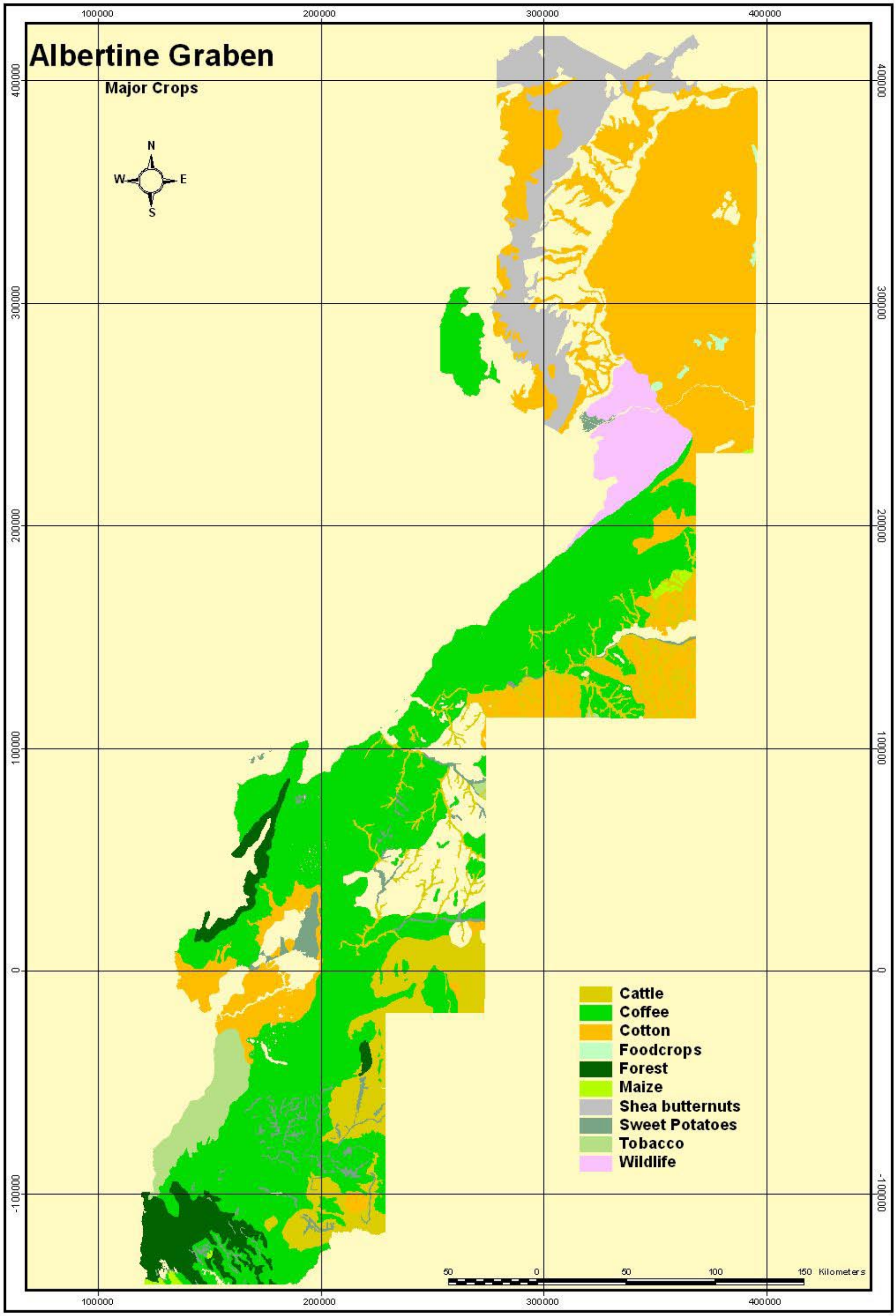
Map 10: Albertine graben Protected Areas

Fig. 6: Grooming time: Gorillas in Bwindi Impenetrable Forest.

1.8.1 Protected areas

Uganda has 39 wildlife protected areas including national parks, wildlife reserves, community wildlife areas and sanctuaries. Twenty two (22) out of the total of 39 protected areas are national parks and wildlife reserves, and 10 out of these are found in the Albertine region. The National Parks include Murchison Falls, Queen Elizabeth, the Rwenzori Mountains, Kibale, Semliki, Bwindi and Mgahinga. The Wildlife Reserves include Ajai and East Madi located in the extreme north-east of the Albertine graben; Bugungu and Karuma Wildlife Reserves in Buliisa and Masindi Districts; Tooro-Semliki, Kabwoya and Kyambura Wildlife Reserves in Bundibugyo, Hoima and Bushenyi respectively, and Kigezi Wildlife Reserve in the extreme south in Rukungiri and Kanungu Districts. The area also has a number of important Forest Reserves including Bugoma and Budongo Forest Reserves.

The Albertine Rift is an important region for global conservation. It harbors more species of vertebrates than any other region on the African continent. This region also shelters more than half of Africa's bird species and nearly forty percent of its mammal species. There are more endemic mammals, birds and amphibians in the Rift Valley than any other site in continental Africa. In terms of biological diversity, the forests and lakes within this area constitute one of the richest parts of the world. The Rwenzori Mountains are reported to have more mammal species than any other site in Africa. The Albertine graben therefore serves as a significant wildlife conservation area, and home to a diversity of wildlife species. The area therefore has a high tourism potential, besides being vitally important for the conservation of the wildlife and their habitats.



Map 11: Albertine graben Major crops

1.8.2 Agriculture

The Albertine graben area comprises of different physical landscapes, climatic conditions and soils which in turn, significantly influence land use systems in the area including agriculture. Because of its location in the rain shadow, the Rift Valley zone is mostly dry and hot and hence the area has serious moisture deficiency problems for agricultural activities especially during critical crop growth periods. Furthermore, except for clay soils in the river Semliki flats, soils on the Rift Valley floor are dominantly sandy with excessive drainage characteristics, making the moisture deficiency problem arising from low rainfall even worse. In addition, the clay soils in the Semliki flats suffer from saline conditions which limits their agricultural potential. The largest proportion of the Rift Valley area therefore is, of low agricultural potential. This partly explains the current major use of the Albertine graben as a conservation area. However, the rift escarpment region and the foothills of Rwenzori Mountains receive moderate to high rainfall, largely due to orographic factors, which increases with altitude. As a result of both moderate to high rainfall and moderately productive soils in these areas, rich agricultural activities take place based on both food and cash crops, for example, on the escarpment part of Masindi, Tooro and Ankole regions as on the foothills of the Rwenzoris in Kasese District. Agriculture in the area is both large scale and small scale. The dominant cash crops grown on small scale farms include tobacco and cotton especially in Buliisa and Kasese, respectively. There is also coffee growing on both the foothills of the Rwenzori mountains and on a wide stretch of the rift escarpment particularly in the Ankole and Kigezi region. Tea plantations are found in Bugaambe sub-county in Hoima, Mwenge Tea estates in the Tooro region, Igara Tea estates in the Ankole region and in Kayonza tea estates in Kanungu district. There is only one sugar cane plantation, Kinyara, in Masindi District. The dominant food crops include beans, maize and bananas although these crops are also often sold for cash income.

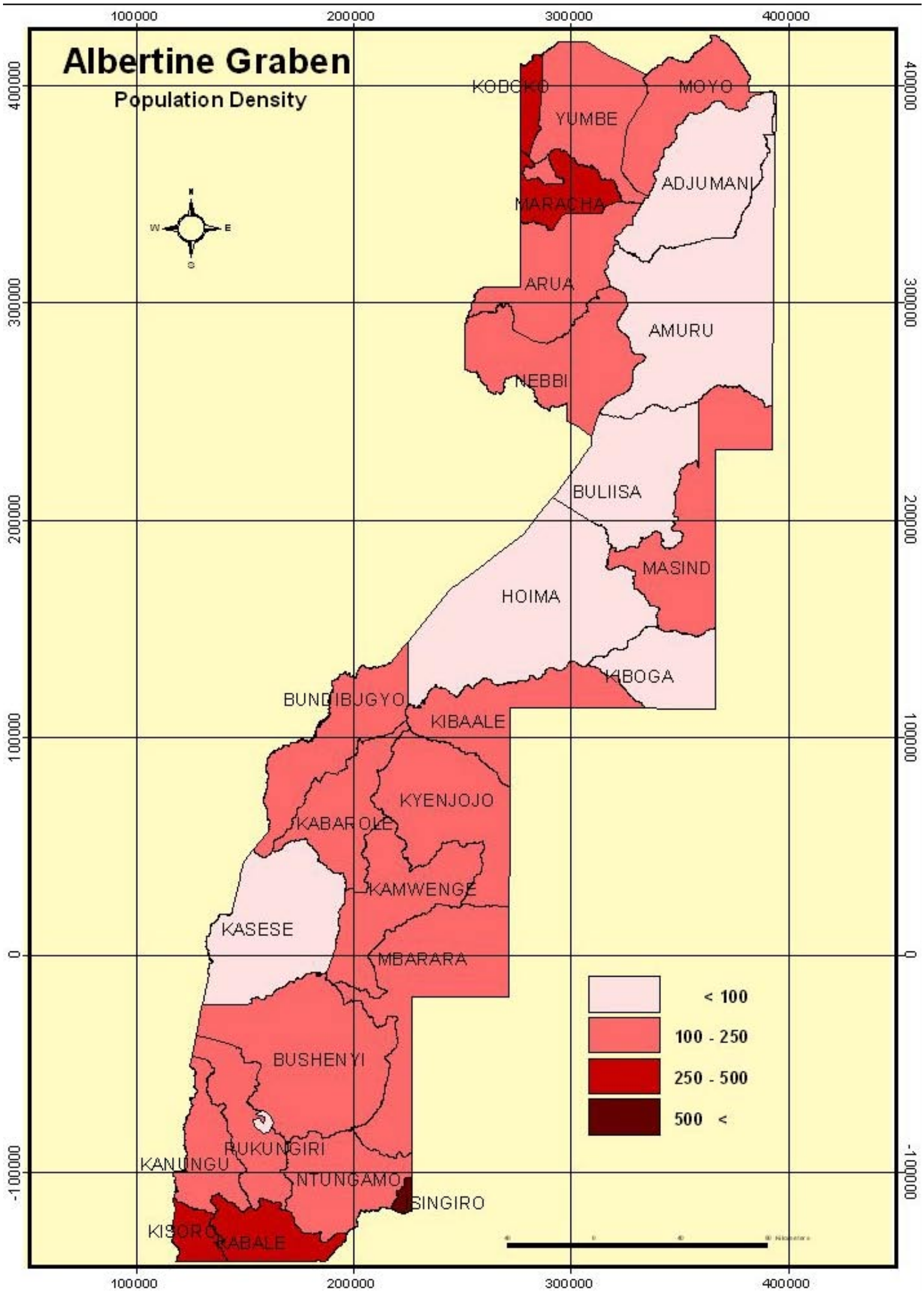
Fig.7: A Tea estate in Kabarole District.

In Kasese District, utilization of water from River Mubuku supports irrigation agriculture in the Mubuku irrigation scheme. Shallow sandy soils dominate on the rift escarpment slopes to the east and the mountain slopes to the west. The shallow sandy soils factor, coupled with the dominantly steep slopes landscape, high rainfall and peasant crop agriculture dominated by annual crops, makes the area very prone to soil erosion and mass wasting (landslides, soil slips and rock falls). Therefore, these areas are of marginal agricultural productivity and high sensitivity to degradation. Consequently, soil erosion and rapid decline in land productivity is a major environmental problem in this area, while soil erosion from these high land areas is the major cause of sedimentation of the rivers and lakes in the Rift Valley.

1.8.3 Human settlements

Because of the dominantly hot and dry conditions, the Rift Valley area is generally considered unattractive for human habitation. For this reason the main settlements in the area are largely sparse and rural. The majority of the inhabitants of the area are indigenous pastoral communities whose livelihoods depend on cattle. They include the Batuku in the Semliki flats and Basongora in Kasese, to the south-west. A number of people also live in fishing villages on the shores of Lakes Albert, Edward and George. The main towns in the area include Masindi, Hoima, Fort Portal, Hima and Kasese-Kilembe. There is also a spiral of urbanization processes taking place along the road system in the region. This process is likely to intensify due to oil production activities in the region. Urbanisation poses new environmental changes if it is not well planned.

Fig. 8: Human settlement in Hoima District.

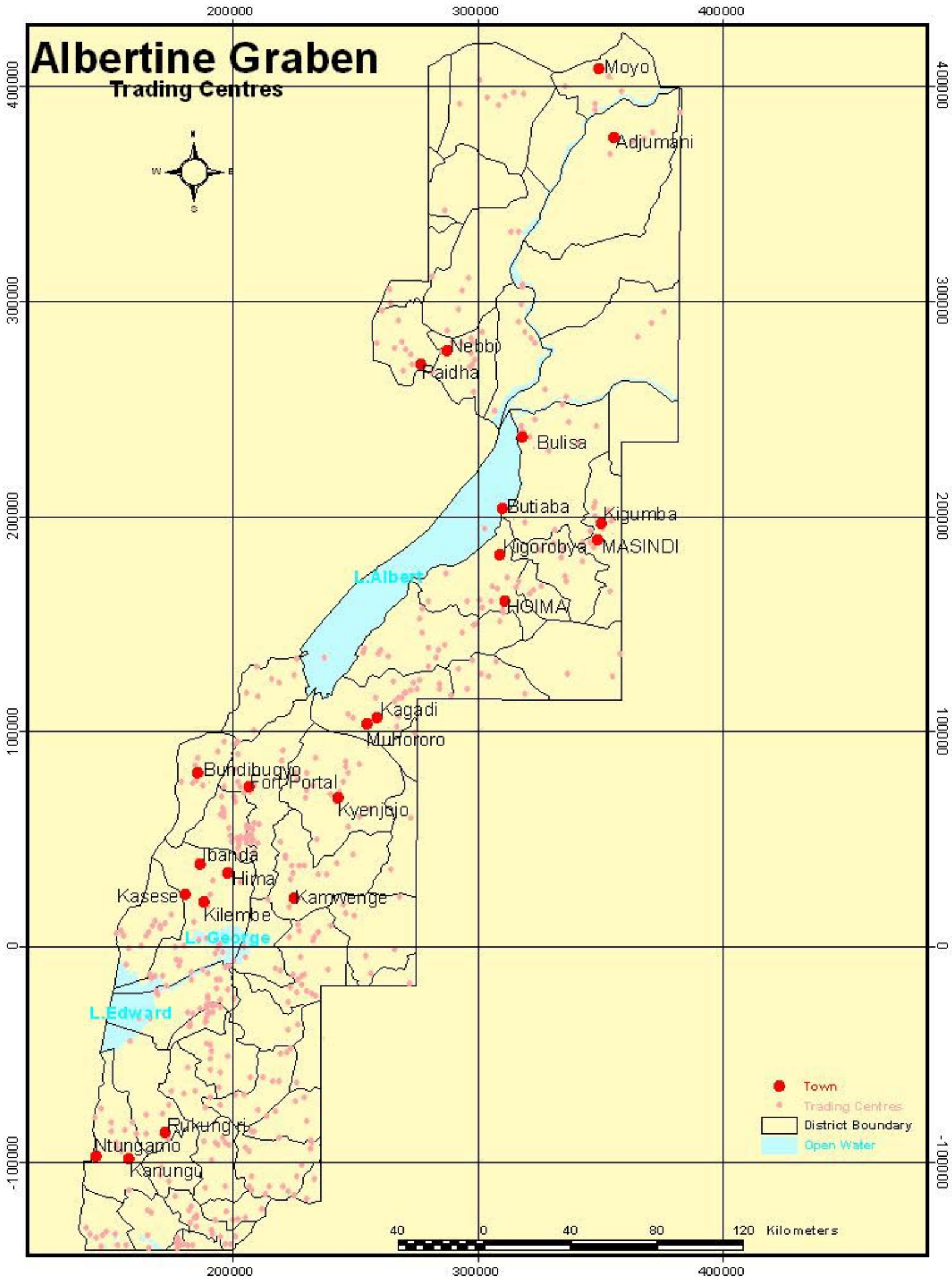


Map 12: Albertine graben Population Density

1.9 Socio Economic status of the Albertine graben

1.9.1 Population Distribution

In the northern part of the graben, the districts of Arua and Nebbi have the highest population densities while Amuru has the lowest. In the central region, the districts with the highest population densities are Kibaale and Masindi while Buliisa and Kiboga have the lowest. Further south, the district with the highest population density is Bushenyi while Kasese and Rukungiri have the lowest.



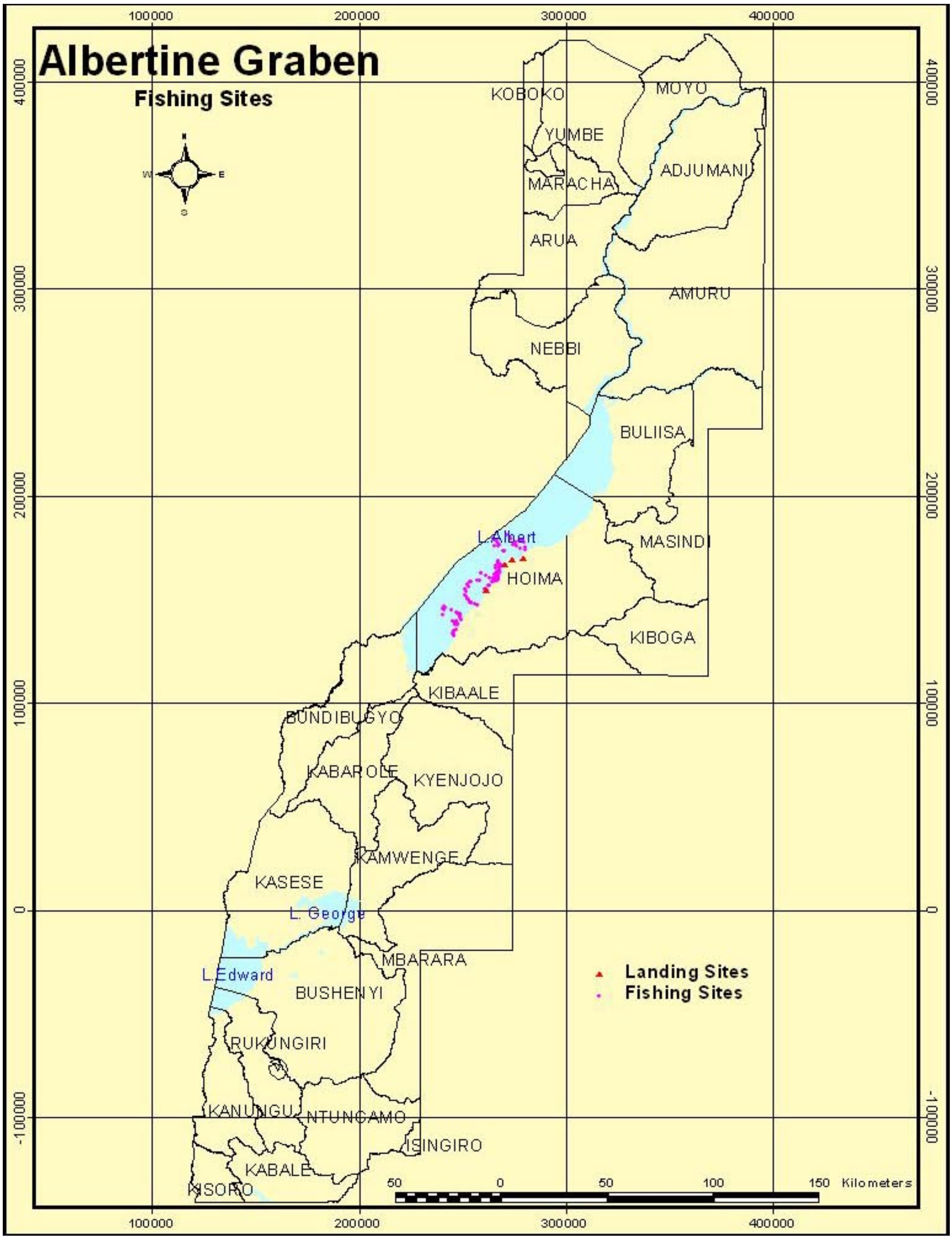
Map 13: Albertine graben Trading Centers and Major Towns

1.9.1.1 Population Structure

The population structure in the Albertine graben reflects similar trends as those in the rest of the country. The population has a pyramid structure reflecting a large dependent age. More than 50 percent of the population lie between 0-20 years of age. There are also slightly more females than males representing 51 percent and 49 percent of the population, respectively.

1.9.1.2 Urban Areas

The Albertine graben is a center of rapid urban growth (see map 12). There are several upcoming urban centers in the Albertine graben including Buliisa, Kasese, Masindi, Kanungu, Rukungiri, Hoima, Kagadi and Ntoroko. There is further growth of the old towns, with a large number of new town councils, town boards and municipalities coming up in the area. Oil exploration and development activities will most likely create further urbanization premises. This prospective growth needs proper planning to forestall unplanned urban sprawl, slum conditions and environmental degradation.



Map 14: Albertine graben Fishing Sites

1.9.1.3 Fish Landing Sites

Fish landing sites are pockets of human settlements located along lake shorelines of the major lakes in the region: Lake Albert, Lake Edward and Lake George. They are inhabited by people who are engaged in fish related activities including fishing, fish processing, boat building and repair. The people are also engaged in other auxiliary services like food vending, retail business, bar and hotel operations. Generally, fish landing sites in the Albertine graben lakes are under serviced in terms of socio-economic infrastructure. The majority of the communities in fish landing sites use lake water for domestic purposes and sanitation facilities are poor. An overlay with the oil prospect areas indicates that a number of fish landing sites are located within the oil exploration areas. Oil drilling and production activities

will exacerbate the existing poor service delivery situation. For example, oil spills on the lake will contaminate the sole source of water to residents of fish landing sites. Similarly oil exploration and drilling activities will necessitate relocation of residents of fishing communities with attendant disruption of economic activities and livelihoods. For instance, a Vice Chairman of Kazinga fish landing site on Lake Edward once remarked that *"I heard rumors that we would be relocated to another place called Ruyinja during Seismic and oil exploration times, which we were not happy with. Generally we do not want to be relocated to another place or if we are shifted it should be to another place where we can continue with our fishing activities".*

1.9.1.4 Hotels and Lodges

There are a number of hotels and lodges within the Albertine graben. These have to date not been physically affected by oil drilling activities. The impact of drilling on tourism may, however, affect the profitability of the hotel sub-sector in particular, and the tourism sector in general, in the future. Efforts to buffer the sector from the impacts of oil exploration and development activities therefore need to be put in place. The key hotel and lodge facilities in the area include Mweya safari, Albert Safari, Paraa safari, Jacana, Kyambura, Wilderness Camp, Bwindi Forest Camp, Kibaale National Park Lodge, Chobe Safari, Red Chilli, Nile Safaris and Semliki Safari Lodge. The hotels and lodges were, however, left out of the sensitivity ranking system.

1.9.2 Infrastructure

Different attributes have been compiled to represent the socio economic data within the Albertine graben. The Key attributes represented in the socio-economic layer include:

- Roads
- Oil reserves and prospects
- Mineral areas
- Major towns and villages
- Fishing villages
- Boat landing sites
- Water reservoirs
- Power utility facilities and stations

1.9.2.1 Roads

The roads have been sub classified into primary all weather and secondary murram roads. The primary roads transect between cities whereas the secondary roads are within the district boundaries. Total coverage of tarmac road infrastructure in the area is limited with only a few hundred kilometers of tarmac. A few more roads are planned for upgrading to bitumen standard in the next ten year road sector plan. These include Kigumba-Masindi-Hoima to Kyenjojo (now at detailed engineering design stage), Hoima-Kaiso-Tonya (detailed engineering design), and Hoima-Biso-Wanseko which is at very preliminary planning stages. In terms of sensitivity to oil spillage, roads only facilitate the process of oil drilling and transportation of heavy machinery but may not be substantially affected by any oil spills. Good road access, however, is important to facilitate quick rescue and response in case of oil spills and accidents. Layout pipes can however be sited within the road reserves of primary roads which are wide enough (30m width).

1.9.2.2 Railway lines

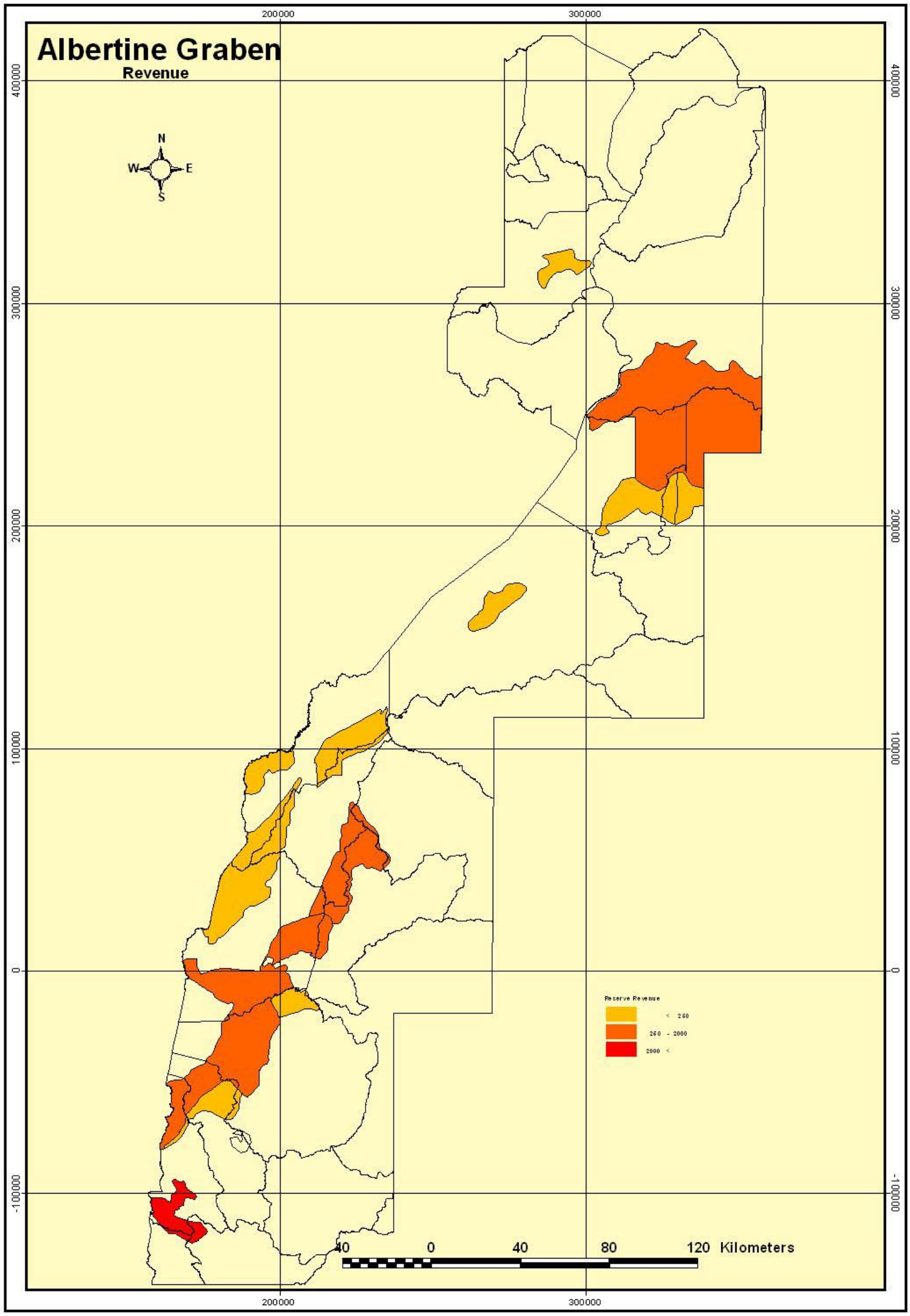
Railway lines have also been identified within the graben region and these include the western line also popularly known as the Kasese line and the light density Pakwach line. Today the railway sector is largely non-functional. More than 30 percent of the tracks on the Kasese line have been removed and the line vandalized. The Tororo to Pakwach section has also been equally vandalized. Feasibility studies to rehabilitate the lines have, however, been initiated by the Ministry of Works and Transport. The functioning section of the railway system is currently limited to the transportation of goods such as imports from abroad and exports via Mombasa. This and the rehabilitated sections of the railway line could be utilized by the drilling and oil processing companies in future. The railway lines, however, have not been ranked in terms of sensitivity ranking

1.9.2.3 Airfields

There are four air fields located within the graben region that can facilitate the movement of goods and personnel. They include Kasese, Arua, Adjumani and Moyo. The air fields are of substantial economic and security importance within the region. They are however also very vulnerable to oil spillage except that drilling activities have to be controlled within their precincts for the threats that such activities may pose to the air fields.

1.9.2.4 Water Transport

There are four major water bodies within the Albertine graben that support water transport. They include Lakes Albert, George and Edward and River Nile. There are, however, only two scheduled ferry services on Lake Albert and River Nile at Wenseko to Panyimur and Paraa respectively. Several private motorised boats operate on the lakes, but have limited cargo capacity. This sector has a large potential to improve movement of goods and services in the graben. Considerable investment, however, will have to be made to improve safety, efficiency and effectiveness of water transport in the Albertine graben.



Map 15: Albertine graben Revenue

1.9.3 Tourism

There are 22 wildlife protected areas (national parks and wildlife reserves) in Uganda. Wildlife protected areas are managed by the Uganda Wildlife Authority (UWA). Some wildlife areas, particularly the forest based ones, are managed by the National Forestry Authority (NFA). Uganda's tourism is nature based with up to 80 percent tourists coming to look at wildlife and scenery. Most of the protected areas in Uganda are located in the Albertine Rift and specifically in the area around Lake Albert. The most popular destinations are the Queen Elizabeth National Park (QENP) and Murchison Falls National Park (MFNP) with 65 – 70 percent of the country's 82,000 to 130,000 visitors who went to the national parks between 2003 and 2006 going to these two parks.

Fig,. 9: Buffaloes in Murchison Falls National Park.

Fig,. 10: The Mountain Gorilla.

Fig,. 11: The Uganda Crested Crane.

Fig. 12: Livestock grazing in a rangeland
Source: National Environment Management Authority (NEMA)

Livestock is another important agricultural activity, especially practised by the Batuku tribe on the Semliki flats in Ntoroko county in Bundibugyo District and the Basongora in Busongora County in Kasese District. The Batuku are psychologically attached to their cows. Rwebisengo market in Ntokoro is one of the largest cattle markets in the country from where the sales are exported to urban areas in the country for supply of meat. Because of the cash earnings from livestock sales, the Batuku families have higher incomes compared to their neighbours on the escarpment and mountain slopes with a crop-based economy. Grazing land is communal and, this coupled with increasing population of both human and livestock, land availability is becoming limited, which has led to overgrazing. Thus, the Basongora communities rely heavily on their livestock for their livelihoods, both as a source food and for sale for cash income.
The development of oil production activities is likely to have a significant effect on the agricultural economy. On one hand, it may lead to increased demand for crop and livestock products, which may trigger increased competition for land use and subsequently, to pressure on the land resources; while on the other hand, emerging economic activities arising from oil production may lead to a transformation in the socio-economic activities of the local communities, that, in turn, will have implications on the environment and natural resources in the area.

1.9.4 Fisheries

Fisheries activities provide an important source of livelihoods for the people in the Albertine graben. The region contributes 18.7% of the total national fish catch, which is quite significant and of this, 15% is contributed by Lake Albert alone. Fish processing has become an important activity on the lake, both at artisanal and industrial levels. At Butiaba landing site, there is a wild catch fish processing factory processing between 40 to 50 tons of Nile Perch per day and employing a labour force of 150 people. The most important sources of fish in the region are Lake Albert, Lake Edward, Lake George and rivers especially the Albert Nile, Waki, Wambabya, Semliki and Kazinga Channel. Lake Albert is the richest of the lakes in the region, in terms of the fish biodiversity, having about 53 fish species and about ten of which are endemic, for example, *Alestes baremose (angara), Hydrocynus forsnkkahlii (ngasia) and Lates macropthalmus. Of the endemic species of Lake Albert, Lates macropthalmus* is threatened. In general most the commercial fish species are under threat of heavy fishing pressure which could lead to over-exploitation. Studies conducted in the Albert area have shown that the Angara lagoon in the delta and lower floodplain zone of the Hohwa River Valley supports many species of fish, indicating possible use of the river by upriver migrant or *andromous fish* (fish that spawn upriver). The shallow inshore habitats of Lake Albert support the biology and ecology of virtually all fish species during their larval and juvenile life, and hence the sprawling fish landing sites owe their existence to the productive multi-species which, in turn, form the backbone of the socio-economic livelihoods of virtually all the lakeside communities and beyond. Thus, invertebrate fauna especially the macro-invertebrates as well as the young of most fish species spend their early life in this shallow inshore zone. Therefore, critical fish habitats especially shallow inshores and river mouths will likely be impacted upon by oil development activities. The key impacts may include severe siltation, bio-accumulation of CFCs in fish tissues, change in water quality resulting from sewage and other oil related development activities. Information available on distribution of aquatic macro-invertebrates show preferential distribution of aquatic invertebrates in the shallow inshore waters less than 7 m deep as compared to deeper off-shore waters. This has significant implications on the sensitivity of aquatic life to oil spills and possibly other pollutants. Recent field surveys recorded 27 fish species, which accounts for about 60 percent of the fish species expected to occur in the zone. This is an indication that the zone is still prime habitat. Small scale fishing also occurs at community level in the numerous streams and wetlands in the area. Unfortunately very little scientific information has been documented on the ecology and dynamics of the fisheries of these key habitats. The currently worrying status of fisheries resources in the region would be greatly exacerbated by oil spills or pollution resulting from oil development activities.

Fig. 13: Kabwoya Game Reserve
Source: Uganda Wildlife Authority (UWA) (2007)

1.10 Ecosystems and Biodiversity

The western arm of the East African Rift System is one of the most important locations for the conservation of mammals, birds, and freshwater fish in Africa. This region extends from the northern end of Lake Albert to the southern end of Lake Tanganyika, and encompassing the land on either side of the western Rift Valley.
The region straddles several countries: Democratic Republic of Congo (DRC), Uganda, Rwanda, Burundi, and Tanzania.

Fig. 14: Elephants in Queen Elizabeth National Park
Source: Uganda Wildlife Authority (UWA) 2008

The Albertine rift comprises unique geographical features which include escarpments, dissected relief and cliffs, undulating hills, Rift Valley flats, rivers and lakes. The area is also a transitional zone for three of Africa's bio-geographical regions (Sudano-Sahelian, Guinea-Congolian and Zambezian).

The variety in geographical and biological features combines to produce a region of complex ecosystems and high biological diversity, as well as magnificent scenery.

For this reason, it is one of the richest biodiversity areas in Uganda; and this is well reflected in the many protected areas congregated in this region. The rift area is one of the biodiversity hotspots in the country and is the most important area for bird endemism in Africa.

The World significance of the Albertine region, therefore, is unquestionable. The region is home to many plant and animal species that are endemic to the region. These include the mountain gorilla, mountain monkey, golden monkey and 42 species of birds as well as many reptiles, amphibians and fish.

In Bwindi Impenetrable and Kibale National Parks, scientists have recorded 173 species of polypore fungi, which is 16% of the total species known from North America, Tropical Africa and Europe.

Additionally, the mountains and forests in this region are important watersheds for the supply of regular and clean water to both surrounding and distant communities.

The lakes in the Albertine Rift are some of the most productive in Africa. The region is also a key attraction for eco-tourists.

The Murchison Falls National Park which borders the northern end of Lake Albert at the Nile delta is the largest National Park in Uganda and is an important tourist destination. This park has a high ecological importance for a number of globally and regionally threatened species of mammals and birds, among others.

Fig. 15: Climbing lions in Ishasha
Source: Uganda Wildlife Authority (UWA) 2008

1.10.1 Flora

A wide variety of vegetation ecosystems and species are known to exist in the region: on the mountain and escarpment slopes and in the valleys and flats. The main vegetation ecosystems include montane forests, tropical forests (including riverine and swamp forests), savannah woodlands and grassland mosaics, papyrus and grassland swamps.

1.10.2 Fauna

The rich and varied flora of the region provides habitats for an equally wide diversity of animal communities and species. The short and medium grassland savannah is preferred by animals like the Uganda Kob, often in association with piaepiacs which feed on ticks on Kobs. The grasslands have great potential to support a high biomass of wild animals. It is common to find distinct ecosystems being a preference to certain animals.

For instance, the *phoenix reclanata* swamp forest ecosystems are frequented by elephants and buffaloes, the *Capparis tomentosa* scrub woodland around the lakes are places frequented by the bushbuck, while tall grasses in depressions are often a favourite refuge for the buffaloes.
The extensive network of *Celtis-Chrysophylum* and riverine forest associated with the numerous rivers that flow from the mountains and highlands on either side of the National Parks and Wildlife Reserves normally draining into the lakes, provide important habitats for chimpanzees, monkeys such as black and white colobus monkeys, and red tailed and blue tailed monkeys, while vervet monkeys and herds of baboons range throughout these conservation areas.

Fig. 16: Pelikans in Queen Elizabeth National Park
Source: Uganda Wildlife Authority (UWA) 2008

The wildlife areas are also a habitat to lions, leopards, bohor reedbuck, the giant forest hog and warthog, hippopotamus, waterbuck, the African jackal and several other animal species. Open waters provide a unique ecosystem for animal life. Mammals such as hippopotamus, crocodiles and sitatunga commonly occur in the estuarine and delta swamps, and other wetlands flanking open waters. In particular, crocodiles inhabit the shores of Lake Albert and River Wasa (Wango area).

1.10.2.1 Avifauna

The Albertine region is very rich in bird species whose habitats range from forest and grassland to wetlands and deltas.

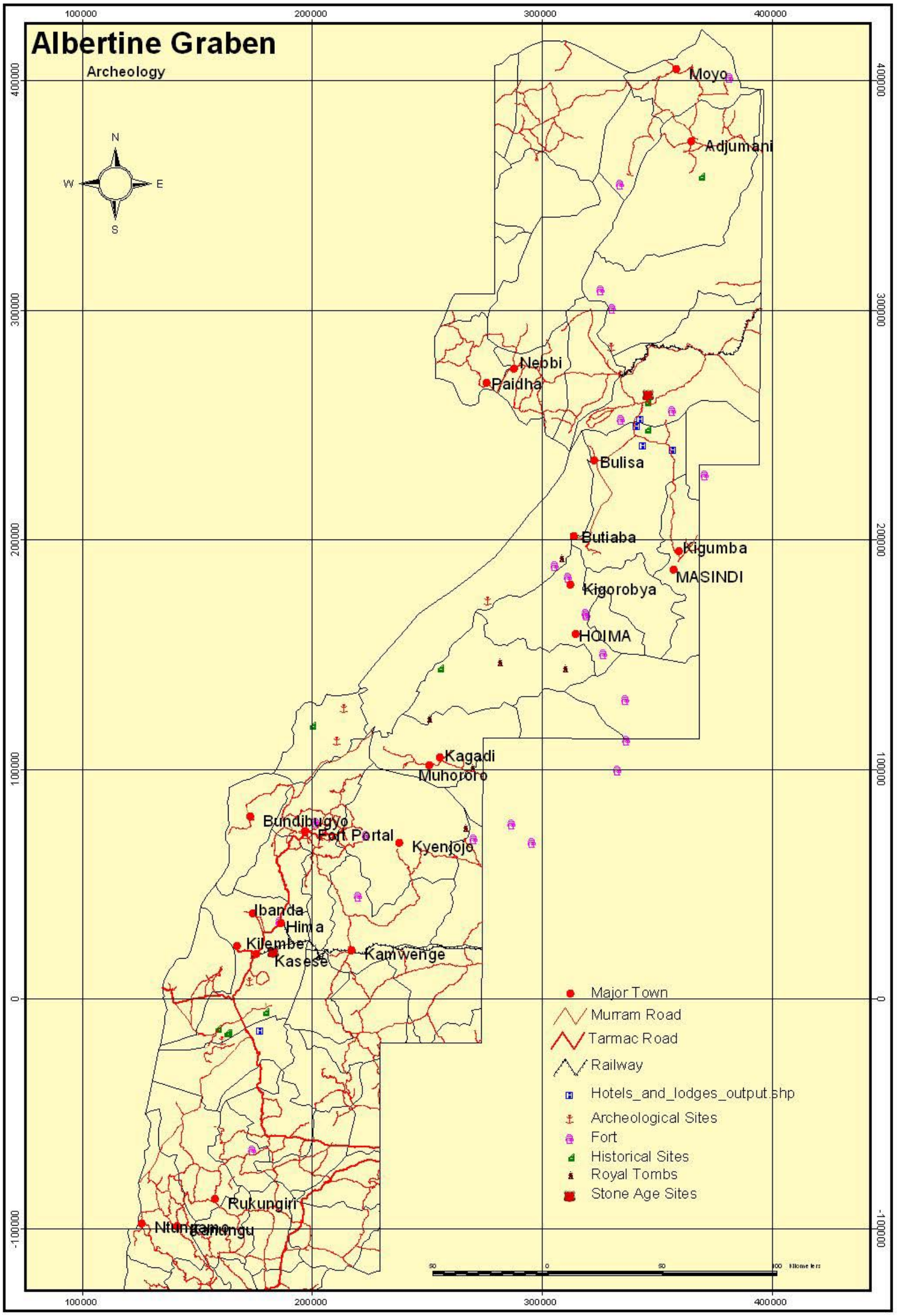
The delta area on Lake Albert shores, for example, is a convergence zone between the River Nile that flows through the lake, and fifty other tributaries, which flow through shallow papyrus swamps. The swamps are well known for wide variety of water birds, including the Shoebill. The delta species are part of 400 already known in the whole of Albert and Murchison Falls National Park area.

1.10.3 Biodiversity outside protected areas

There is also a wealth of biodiversity outside protected areas. Unfortunately, the bulk of this is either already disturbed or threatened while some of it is already extinct. Conservation of this biodiversity requires land-use based incentives to land owners and users. Oil exploration and development will certainly escalate the threats to this biodiversity.

Fig. 17: Aerial view of River Nile at Moyo, West Nile Region (2008)

Fig. 18: The Delta in Murchison Falls National Park
Source: Uganda Wildlife Authority (UWA) 2008



Map 16: Albertine graben Archeological Sites, Infrastructure, Hotels and Lodges

1.11 Archeological, Historical and Cultural sites

Uganda does not possess examples of human archaeological remains of enormous antiquity value. There is, nevertheless, a rich assemblage of artifacts from Stone Age, pottery, earthworks, rock-paintings, royal tombs and shrines and forts (Langlands 1975, Uganda Museum 2008). Therefore the Albertine graben has a number of archaeological and historic sites of national heritage importance, besides the unique physical resources of the Rift Valley, Rwenzori Mountains, National parks and lakes, all of which are of great tourist attraction.

Archaeological Sites

Clip1.shp
Arch sites.shp
Early Iron Age sites
Earth Works
Earlier Stoe Age Sites
Forts Prior to 1890
Forts 1890-1905
Historical Sites
MLS
PPF
RT

N
W
E
S

30 0 30 60 90 Kilometers

Map 17: Albertine Graben Archeological Sites. *Source*: Uganda Museum and NEMA (2009)

1.11.1 Archaeological sites

The oldest human bones found in this area are only 8000 to 10,000 years BP (before present), from Kikorongo crater near Lake George. Early Stone Age sites with Acheulian hand axes occur at Mweya Peninsula and at Paraa and are dated from 50,000 years BP, while Middle Stone Age sites occur at Chobe.

The Nkondo and Kaiso palaeontological sites on the eastern shores of Lake Albert form another category of heritage sites, particularly due to their 5.4 to 2.5 million years old mammalian fossils which are important for palaeontological research. Others occur near Kibiro salt processing areas. Most of the Stone Age localities are lacustrine, and are particularly associated with strand flats, terraces and caves from formerly more extensive lakes.

1.11.2 Historic and cultural sites

The caves in Nyakasura near Fort Portal are a result of weathering of a limestone (calcium carbonate) rock to form stalactites and stalagmites within the cave that are like drooping human breasts and locally named *Amabere ga Nyinamwiru (Nyinamwiru's breasts*). These features in the caves together with local waterfalls have become a tourist attraction site. The site is also of cultural importance, that is, the local tribe of Batooro still believe that the place has the powers of the Bachwezi, the rulers of the past Empire of Kitara.

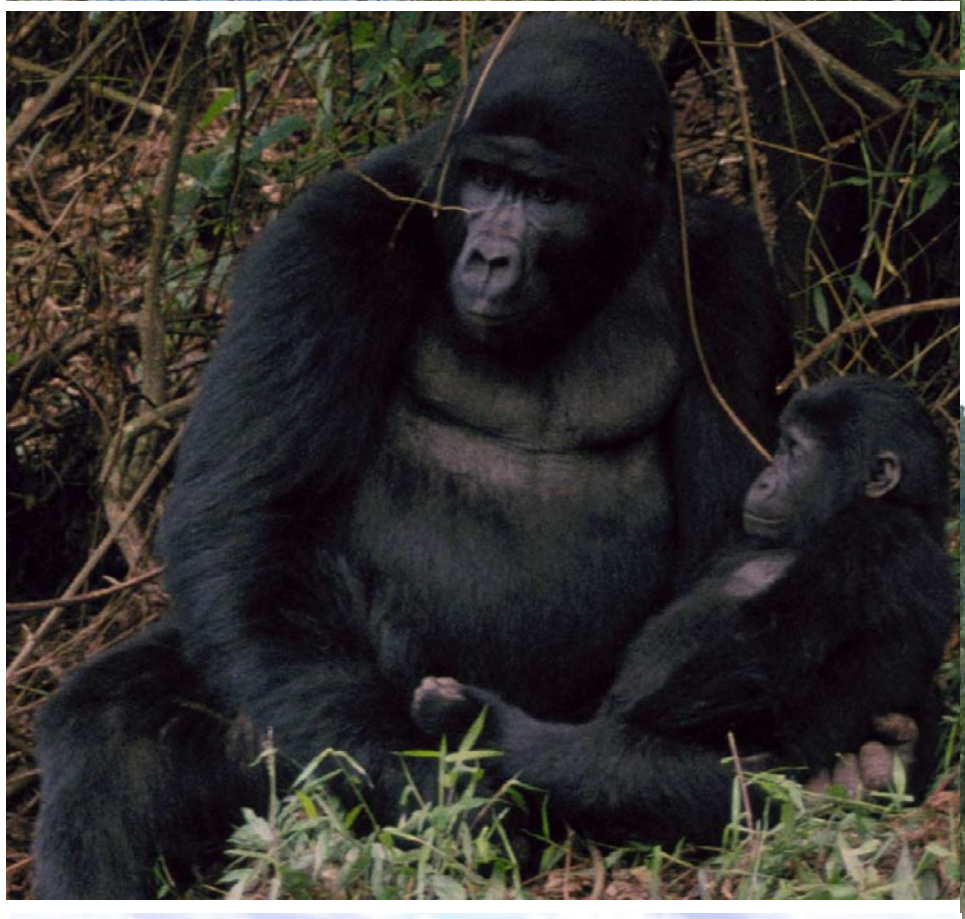
The Katasiha Fort and Cave located 3 km from Hoima on the Hoima-Butiaba Road are surrounded by a defensive trench established in 1894 by a British Colonel Colvile, when he led an expedition against Kabalega, the then Omukama of Bunyoro; while the cave was used by Kabalega to fight off the colonial invasion of the kingdom. The site is of tourism importance and is currently used for recreation.

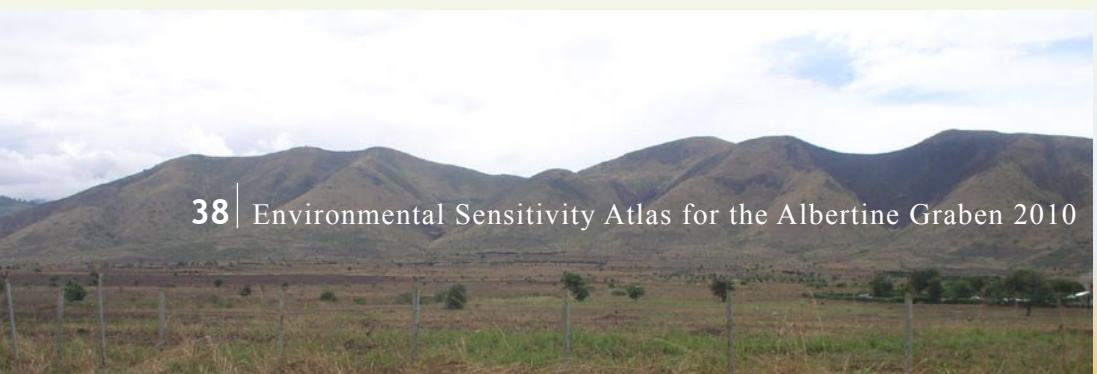
Fort Kitana a former British Fort situated on the Kigorobya-Kibiro track, is a potential tourist site.
The Kibiro traditional sites, including a salt processing village are located approximately 1 kilometer down the escarpment, or 9 kilometers from Kigorobya town council, or 22 kilometers from Hoima Municipal town. This is a stone-age site, situated along the Eastern shore of Lake Albert.

Other sites of national heritage are the burial grounds for the former kings of Bunyoro and Tooro kingdoms. The Mparo tombs located 2km from Hoima town on Hoima-Masindi road contain the remains of the great Omukama Kabalega of Bunyoro Kitara. On the other hand, Karambi tombs located 6km on the Fort Portal – Kasese road contain the remains of the deceased kings of Tooro. These sites are of high cultural and heritage importance for tourism and historical research. The same kingdoms had palaces – the Kabarole Palace located on Kabarole hill within Fort Portal Municipal Council for the King of Tooro and, the Hoima Palace known as Karuzika for the King of Bunyoro Kitara located within Hoima Municipal Council are all of historical, cultural and tourism values.

The relatively rich archaeological and historic sites mentioned, are likely to be significantly affected by petroleum exploration and development activities, both positively and negatively. Positively, by increasing tourism activities by the growing population associated with the petroleum development activities and, negatively by likely risk of interference with and demise of the various sites. A sustainable development strategy is necessary that will safeguard the integrity and continued existence of these sites.

Fig. 19: Mparo Cultural Tomb (*above)* and antiques inside the tomb (*below)* in Hoima District.
Source: National State of Environmental Report for Uganda (NSOER) 2006





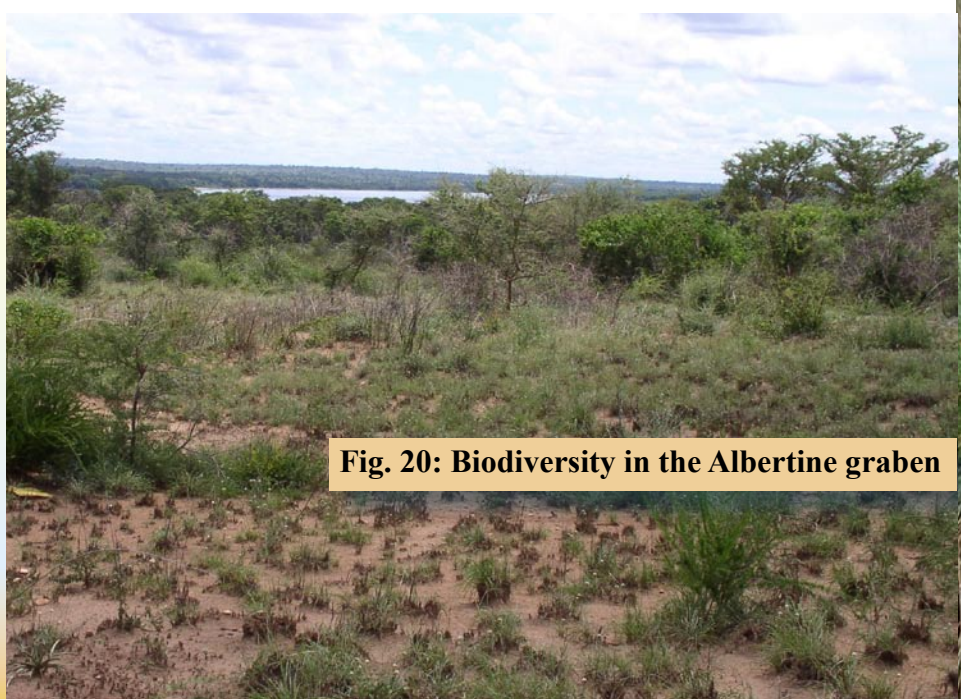
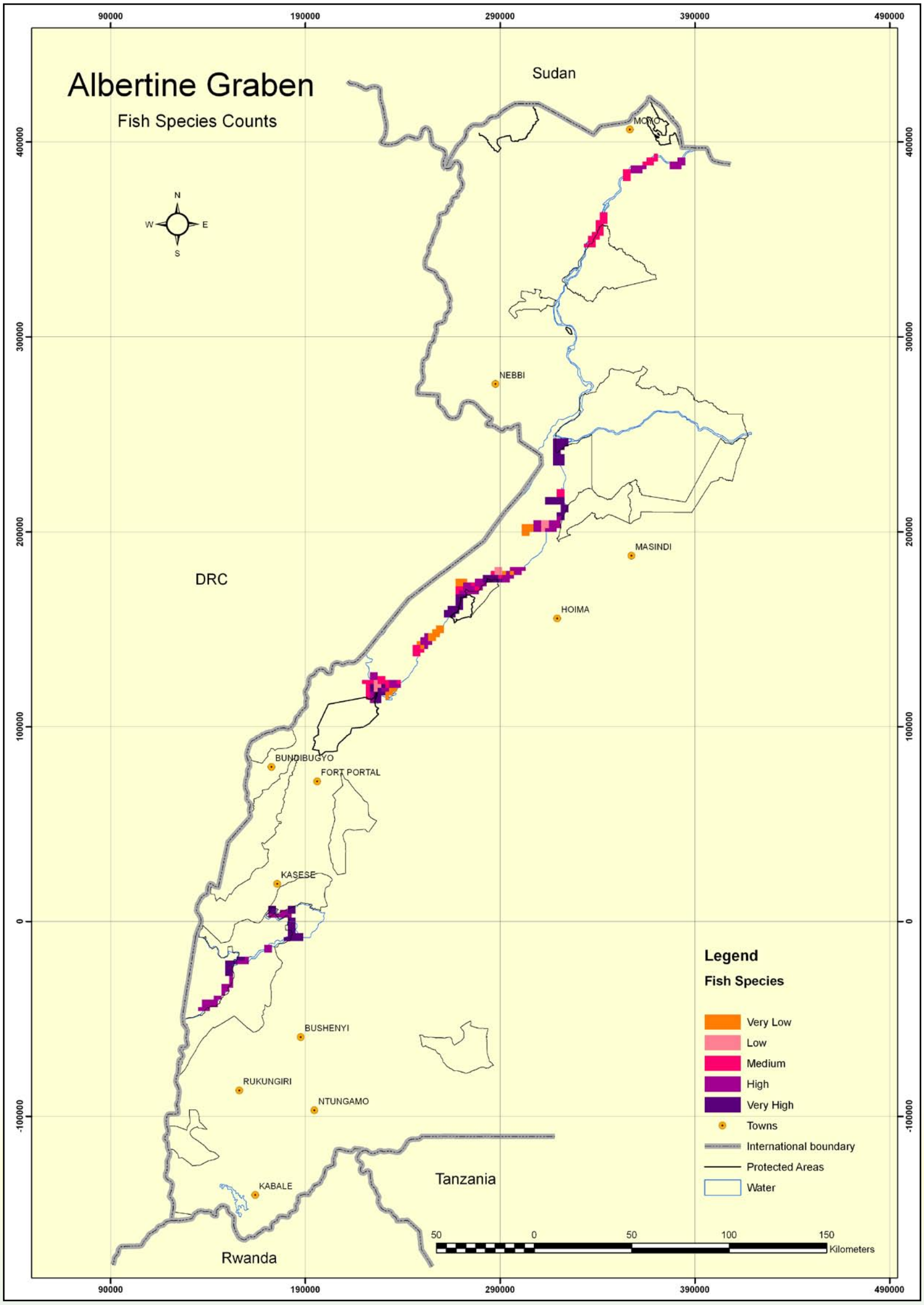


Fig. 20: Biodiversity in the Albertine graben

CHAPTER 2

SENSITIVITY OF BIOLOGICAL RESOURCES

This chapter provides information about the sensitivity of the biological resources found in the Albertine graben. The biological resources mapped include plants, large mammals, crocodiles, birds and fish.



Map 18: Albertine graben Fish species distribution.

2.1 Biodiversity of Uganda's Albertine rift

The species biodiversity of the Albertine rift is unparalleled on the African continent (Eilu et al, 2004). It is also the most vertebrate species rich on the African continent (Plumptre 2003). The area has 14% of all African reptiles (175 species), 19% of Africa's amphibians (119 species), 35% of Africa's butterflies (1300 species), 52% of all African birds (1061 species), 39% of all African mammals (402 species of mammals), and about 128 species of fish (Greenwood, 1965). Plumptre et al., (2003) also noted that the Albertine Rift is the most important eco-region on continental Africa in terms of vertebrate species and species endemism. This species richness is important in the food chain and it contributes to tourism. A sample of this species richness is displayed in this biological resources layer.
All data that could be accessed and was collected in a scientifically acceptable manner has been used in this atlas. The variables used include large mammals, crocodiles, birds, plants and fish. Data on endemic and threatened species was incorporated. Data collected on the variables indicated above were combined to generate the biodiversity richness, species of special importance and overall biodiversity maps. It was desired that data from both protected areas and outside protected areas be used. However, to date, there is still limited scientific data on biological resources outside protected areas. Most of the data so far obtained is from protected areas. Data acquisition, therefore, needs to be carried out in the data-deficient areas so as to provide a complete picture of the species distribution in the Albertine graben. The protection status value of every protected area has been calculated. Whereas some protected areas may have one protection status e.g. Forest Reserves, others have several protection statuses. Details of the protection status ranking are described below.
Data collected on the variables indicated above were combined to generate the biodiversity richness, species of special importance and overall biodiversity maps.

2.2 Data presentation and combining of variables

In the biodiversity layer, data on species counts has been used. All data received was in point form i.e. point locations within the landscape. In order to present it as a polygon output in which all data could be represented using a few colors, a grid system was used. With the grid, all data for a specific variable e.g. plants was combined and then grouped into five classes; 1 to 5 with 1 designated for the lowest number (value range) of species and 5 the highest number (value range) of species. A sixth class (class 0) was added to designate all the areas where no data was obtained and areas where the species under consideration did not occur. In the final map, the class 0 areas have been made transparent so that they are not visible on the output map. They all the same exist in the map grid and can be updated once the data becomes available. The conservation status of the different protected areas was also mapped. The species data, and conservation designation data, were then combined to generate the species richness, species of special importance, conservation status and overall biodiversity maps presented in this atlas. Details of the individual data layers and how the data was summarized are outlined in the subsequent sections.

2.2.1 Fisheries resources

All the lakes in the graben are rich in fish biodiversity. The large water bodies are Lake George, Lake Edward, Kazinga Channel, Lake Albert and River Semliki. Some of these lakes are the most productive on the African continent (Snoeks, 2000). For example, fifty six fish species are endemic to lakes George and Edward (Plumptre et al, 2007). Fish is an important source of food, livelihood and income to residents within and in the immediate vicinity of the graben. The most widely distributed fish species in the graben are; *Oreochromis niloticus* (the Nile tilapia/ 'Ngege'), *Bagrus docmak* (Catfish/'Semutundu'), *Protopterus aethiopicus* (Lung fish/'Mamba') and *Clarias gariepinus* (Mud fish/'Male') and over 50 species of *Haplochromine species* ('Nkejje') dominating the fish biomass in all the lakes. Other fish species of less commercial importance but of high nutritional value, occurring in small numbers in all lakes of the graben include *Barbus* spp, *Mormyrus* spp and *Labeo* spp. In terms of fish species richness, Lake Albert ranks highest among the Albertine Graben lakes. Some species e.g. *Alestes baremose* ('Angara') *Malapterurus electricus* (Electric Cat fish), *Hydrocynus forskahlii* (Tiger fish/'Ngassa), *Distichodus niloticus* and *Brycynus nurse* ('Muzri') are endemic to Lake Albert.

Catch Assessment Survey (CAS) data collected from Lake Albert and Lake Edward by National Fisheries Resources Institute (NaFIRRI,) in 2006 and 2008 respectively indicates that there is predominance of fish juveniles and brood stock (female egg bearing fishes) in shallow inshore waters, sheltered areas (lagoons and bays), river mouths and rocky areas. Other fish species e.g. *Barbus altianalis* and *Clarias gariepinus* are anadromous i.e. they migrate upstream into rivers and streams to breed and spawn in riverine wetlands. There are also fish species that breed and spawn in the open deep waters. Their juveniles swim to shallow, sheltered, food-rich and less predation prone areas.

The Sensitivity of fisheries resources to petroleum development is associated with high frequency noise from petroleum development activities e.g. offshore seismic shots, exploration drilling in fish habitats and fishing grounds.The sensitivity is also associated with oil spills, and pollution from hydrocarbon compounds and chemicals from mud cuttings. These can cause drastic change in aquatic environment leading to migration or death of fish. This would lead to changes in fish species distribution, composition and diversity.
Data obtained covers Lake Albert, parts of Lake Edward, Kazinga Channel and Lake George, and parts of River Nile. Generally, the areas of Lake Edward, Kazinga Channel and Lake George showed the highest biodiversity (Figure 1) followed by Lake Albert. For Lake Albert, the delta area of River Nile, occurring in Murchison Falls National Park, areas around Kabwoya and the south-most tip of the lake registered the highest fish species counts.

Fig.21: The Mountain gorilla (Gorilla beringei beringei) in Bwindi Impenetrable National Park. This gorilla is endemic to the Albertine Rift. Picture by WCS

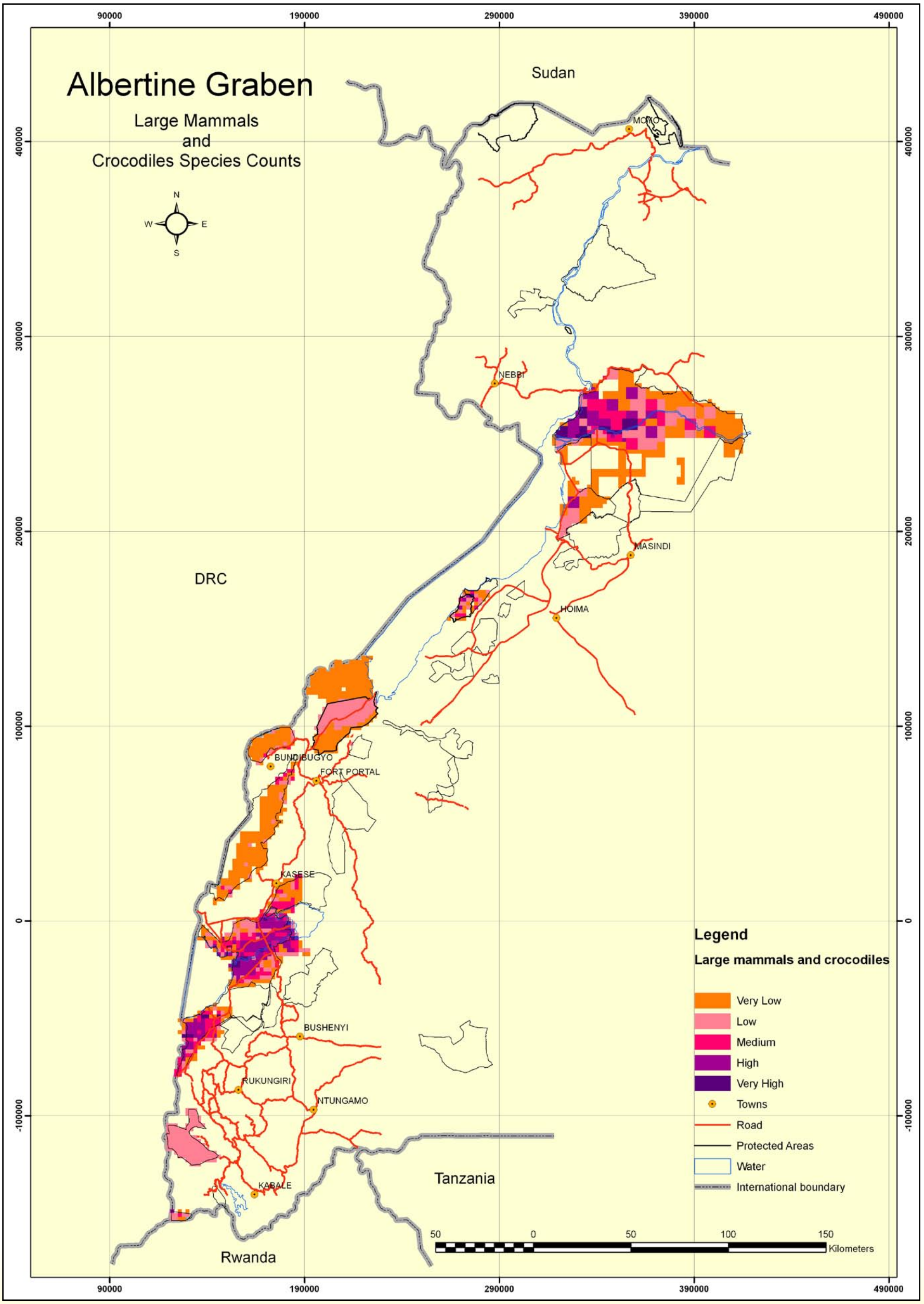
2.2.2 Large mammals and crocodiles distribution in the Albertine Rift

Although most large mammals (elephants, lions, buffalos etc) occur in protected areas, a few are found outside the protected areas. The status of biological resources within protected areas has, therefore, been better researched than outside protected areas. So most of the data used in this sensitivity atlas was collected from within protected areas. For QENP, Toro-Semliki WR and MFCA, aerial survey data was used. For Kabwoya WR, Kaiso-tonya Wildlife Area and Bwindi NP, systematic ground survey data was used. The data collected by rangers and entered into Management Information System (MIST) for analysis was used for the rest of the protected areas.

Although mammals occur throughout protected areas, none were observed in some areas at the time of the survey. This does not imply that there are no animals in such areas. The populations may be very low, seasonal or the animals could have moved to parts of the protected area at the time of data collection. On the other hand, there are areas which have higher animal concentrations than others on a permanent and seasonal basis. Such areas, if explored, should be handled with maximum care to ensure sustainable conservation of the biodiversity therein. For example the delta region of MFNP, which is also a Ramsar site has permanently higher large and small mammals concentrations compared to other parts of the park. Other areas e.g. Bwindi Impenetrable NP and the Ishasha sector of QENP may have fewer mammals but these mammals are either of unique character or are highly restricted in habitat range. For example, in Uganda the Mountain Gorilla only occurs in Bwindi Impenetrable NP and Mgahinga NP (Figure 2.2). Such areas attract the highest number of tourists to the region.

Fig. 22: The L'Hoest's Monkey (Cercopithecus l'hoesti). This monkey is endemic to the Albertine Rift.
Picture by WCS

At the time of preparation of this atlas, information on breeding areas, watering points and feeding areas was not yet available. These data gaps require further basic research to enrich upcoming editions of the sensitivity atlas.



Map 19: Albertine graben Large mammal and crocodiles species counts.

The delta area of Murchison NP showed the highest mammal counts (Figure 2.4). The central part of Queen Elizabeth NP and its southern part also showed high mammal counts.

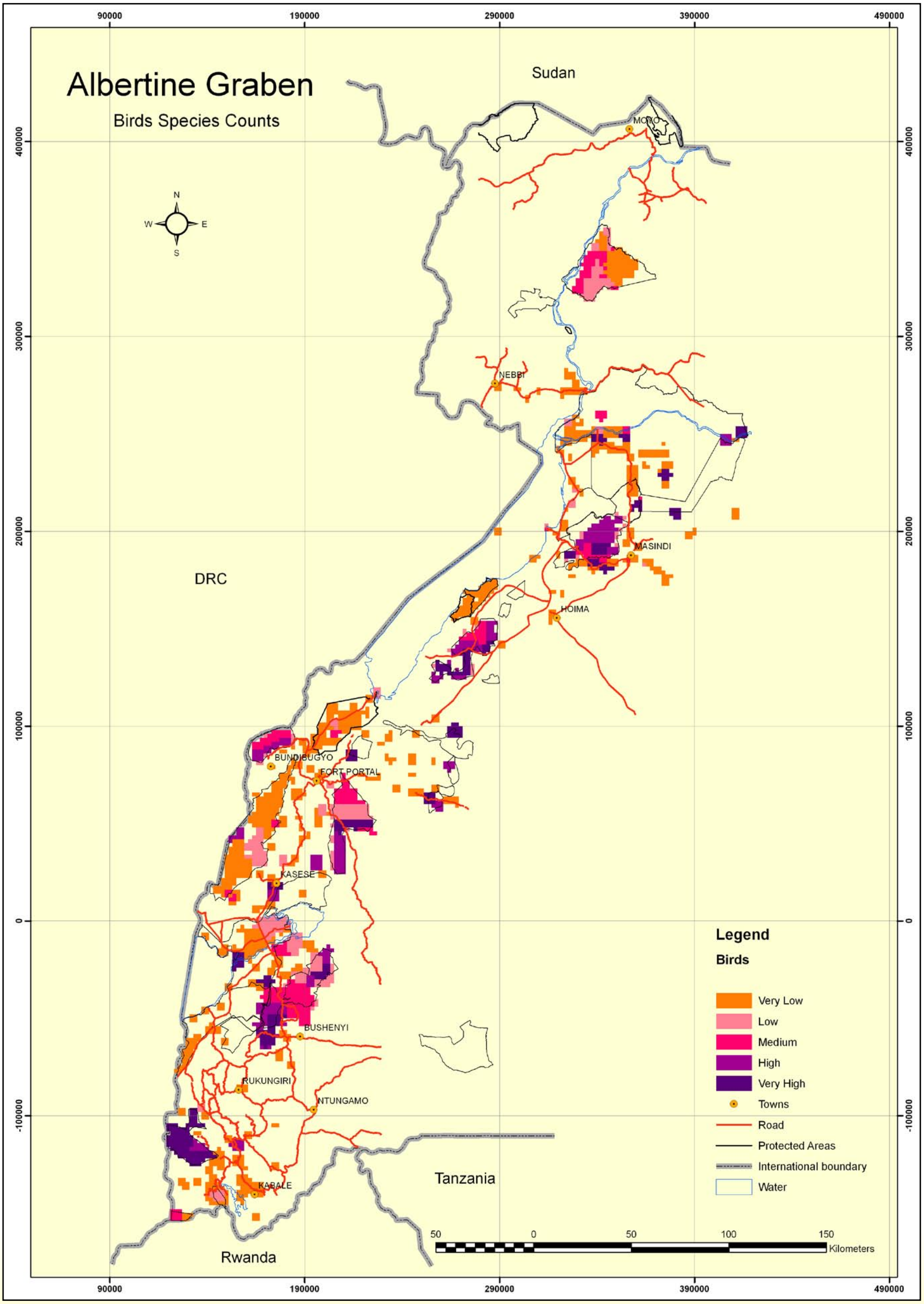
Fig. 23: A school of White-winged terns (white birds in the background) on the northern shores of Kazinga Channel in Queen Elizabeth NP. These are migratory birds from northern Africa. Inset: the Dusky Crimsonwing (top) and the Regal Sunbird (bottom).

2.2.3 Woody plants and bird species

The Albertine Graben has a high biodiversity of bird species. Over fifty percent of the total African birds are found in the Albertine graben. There are also a number of important Bird Areas (IBAs) in the graben. The 30 Important Bird Areas (IBAs) in Uganda occupy some 8% of the land surface of the country and include a wide variety of forest, savanna and wetland habitats (Byaruhanga et al. 2001). The IBA network captures 73% of the total birds species found in Uganda and 82% of those of highest conservation priority species i.e. endemic to the Albertine graben. Queen Elizabeth National Park has important migratory birds stopping points for birds coming from Europe along the African-Eurasian flyway.

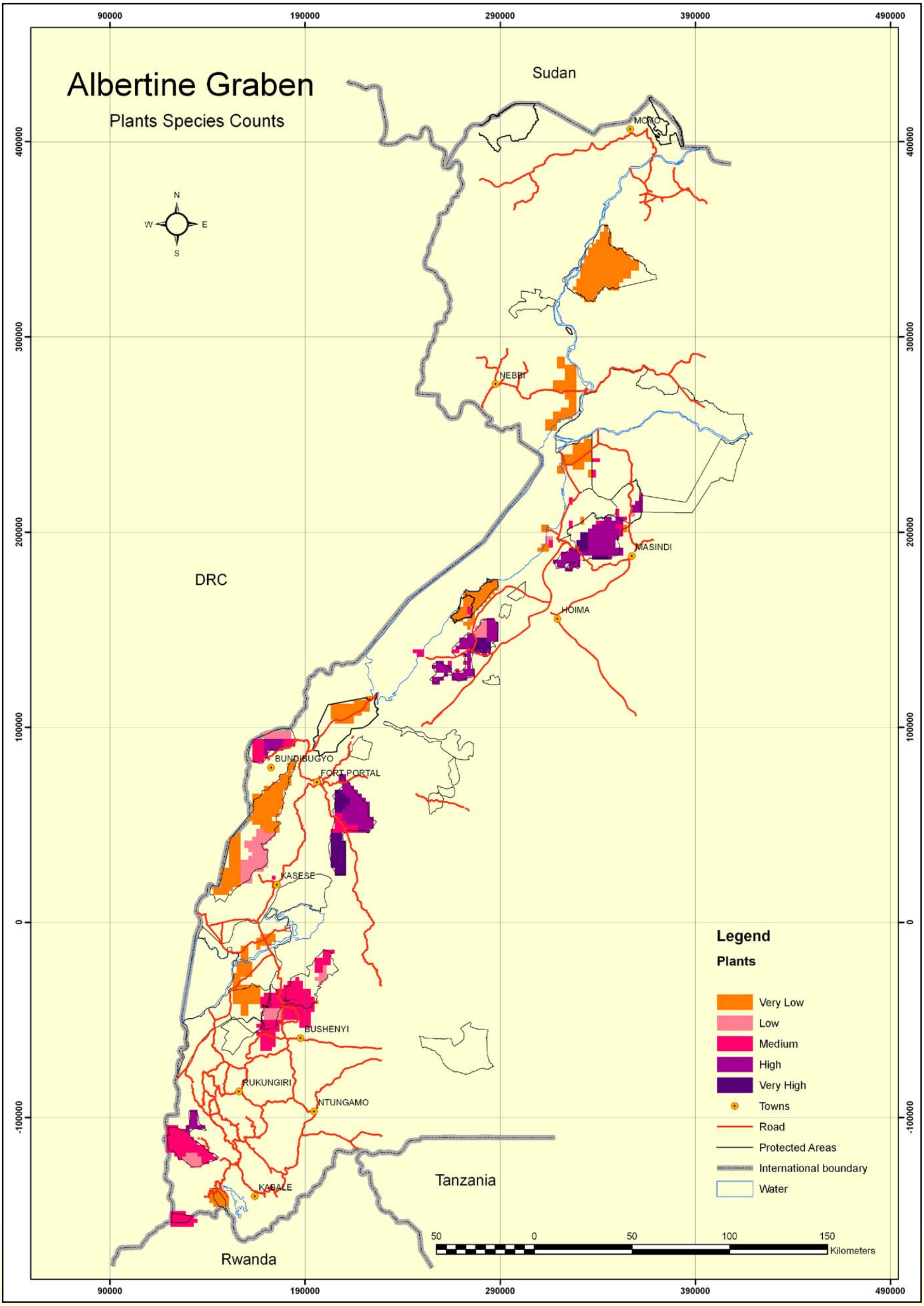
By 2007, 5793 plant species had been recorded within the Albertine Rift. This forms 14% of all mainland Africa's plant species. So far 551 endemic plant species have been identified in the Albertine Rift (Plumptre et al. 2007).

The birds and woody plants species data was collected at the same time. Each landscape, where data was collected, was divided into blocks. Data was then collected along transects in each block. The total species in each block was computed. These total numbers are presented in this Atlas. Whereas data for Queen Elizabeth NP was still being processed at the time of preparation of this report and so it is not presented in this map, there is no complete birds and plants data set available for Murchison Falls NP.



Map 20: Albertine graben Birds species distributions.

Bwindi Impenetrable NP registered the highest birds species numbers (Figure 2.6). Bugoma FR, Maramagambo FR and a large part of Budongo FR also registered high birds species counts. The small areas scattered over the whole graben that registered high numbers are the permanent data collection areas monitored by Makerere University Institute of Environment and Natural Resources (MUIENR).



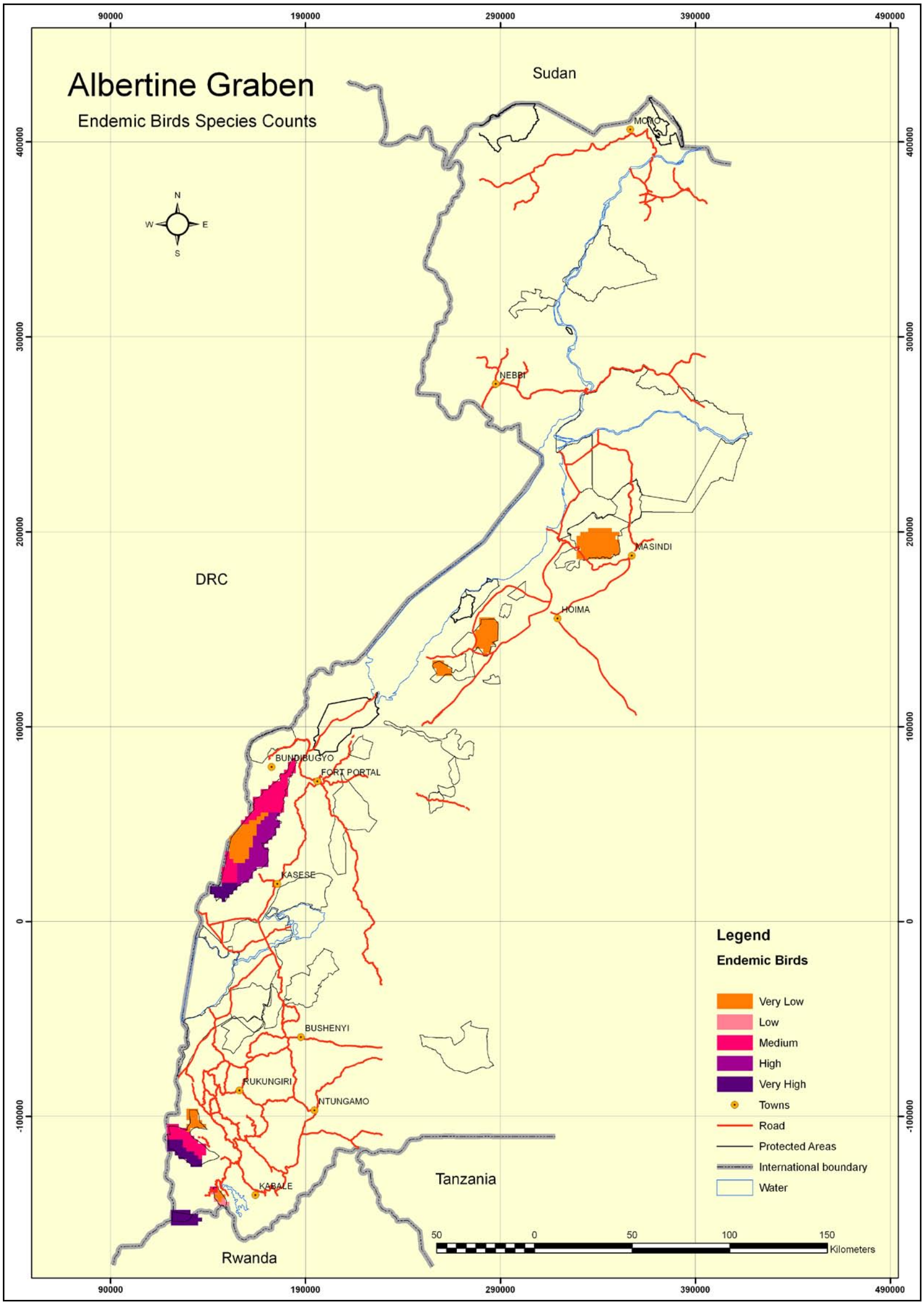
Map 21: Albertine graben Plants species counts.

Kibale NP registered the highest species counts followed by Budongo FR and Bugoma FR (Figure 2.7). Data for Queen Elizabeth NP and for Murchison Falls NP was incomplete.

Fig. 24: The giant Lobelia that is part of the afro-alpine vegetation occurring on Rwenzori mountains (4,000 m above see level). Photo by Uganda Wildlife Authority (UWA)

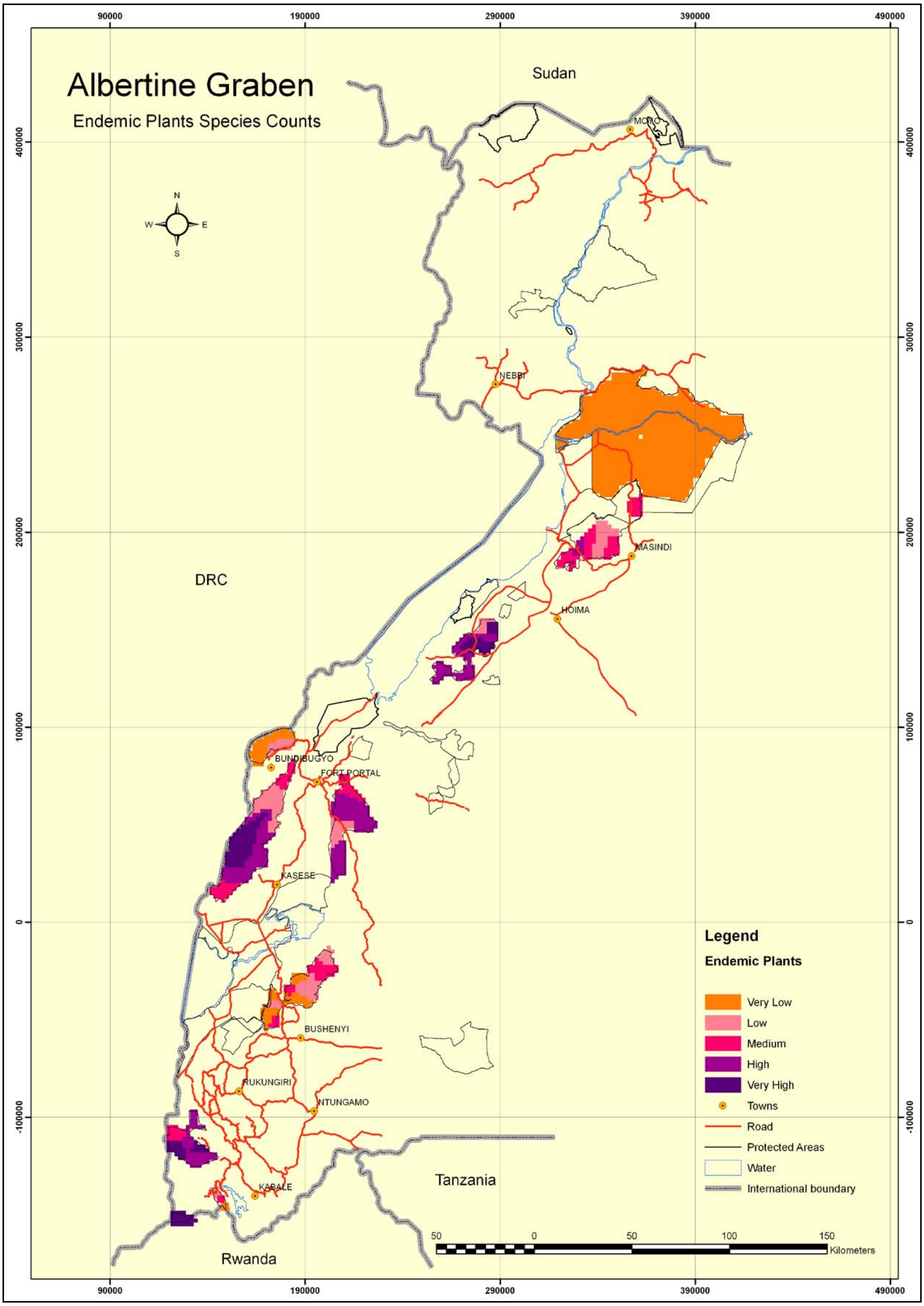
2.2.4 Sensitivity based on endemic and threatened species

Uganda's Albertine graben is a global centre of species endemism (biological resources that can't be found anywhere else in the world). The Albertine Rift harbours more endemic mammals, birds and amphibians than any other region on the African continent (Conservation international). Birdlife International also recognizes the Albertine graben as an Endemic Bird Area (Stattersfield et al, 1998). Among the protected areas in the Albertine Rift, Bwindi Impenetrable and Mt. Rwenzori National parks rank second and third respectively in number of endemic mammal species (Plumptre et al, 2007). There are seven (7) phytochoria or regional centers of endemism including; Guinea-Congolian; Sudanian; Afromontane/Archipelago and L. Victoria Regional Mosaic among others (White, 1979). White (1983, 1993) classified the Albertine Rift as part of the Guinea-Congolian center of endemism. There are, unfortunately, a number of species that are threatened. By 2007, twenty five (25) species occurring in the Albertine Rift were threatened. Of these, thirteen (13) are endemic. Figure 2.8 shows the giant Lobelia, a plant endemic to the high altitude areas of the Albertine rift.



Map 22: Albertine graben Endemic birds species distribution.

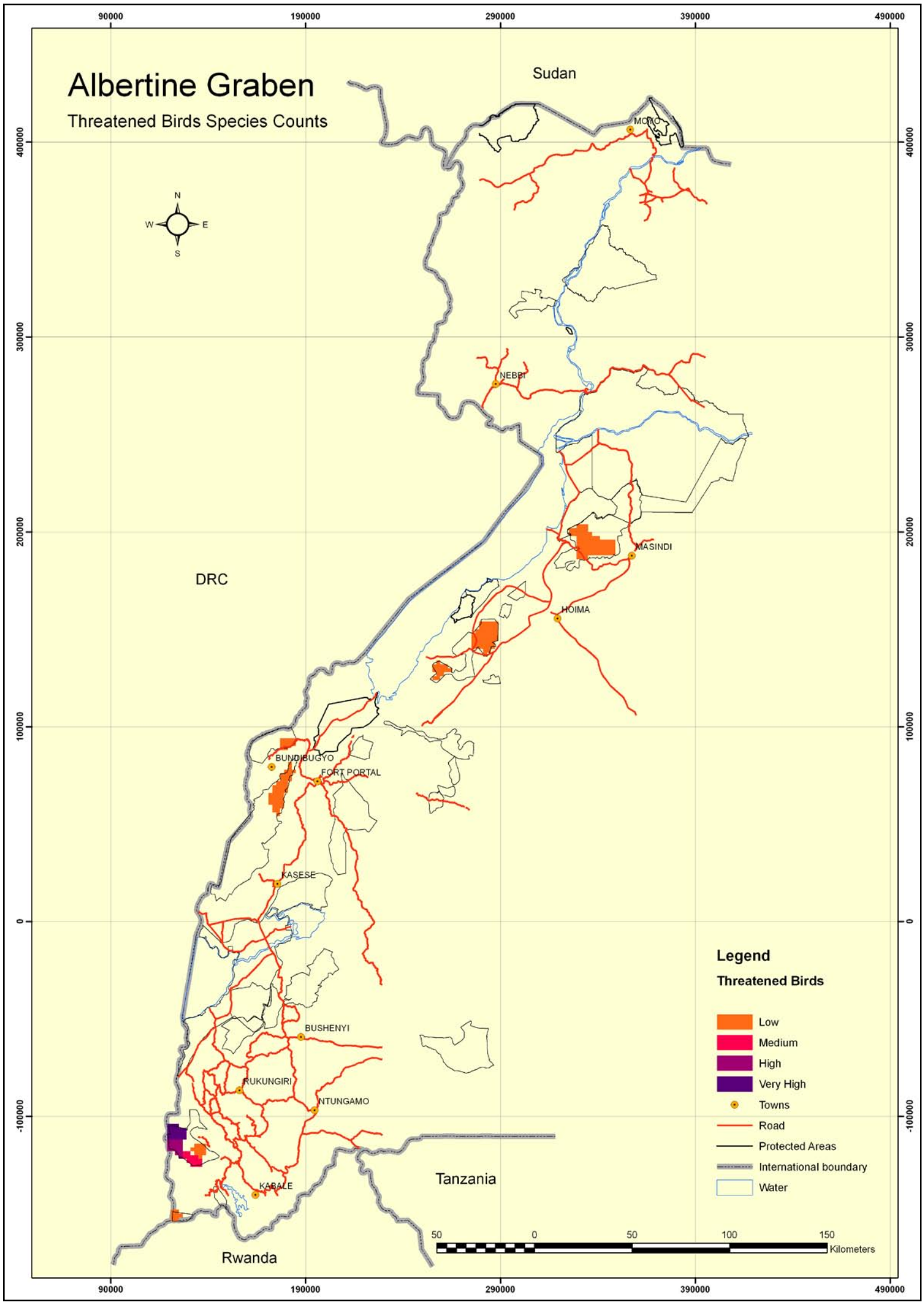
Data on endemic and threatened birds and plants was obtained for forested areas (National parks and Forest reserves). Although the compilation of data is not complete for all areas, there are some areas in which no endemic species have been encountered. No endemic birds were found in Kashoha-kitomi FR, Kibaale NP, Semliki NP, Bugoma FR, and Budongo FR. There were also no threatened bird species encountered in Echuya FR, Kashoha-Kitomi FR, Kibale NP, most parts of Semliki NP, the southern part of Rwenzori NP, the northern part of Budongo FR. Although no endemism was recorded for the large mammals, there exists endemic mammals in the Albertine rift, especially among the smaller mammals e.g. Red duiker found in Mt. Rwenzori and Bwindi Impenetrable National Parks. It should be noted that smaller mammals were not considered in this atlas due to the limited coverage of the available data.



Map 23: Albertine graben Endemic plants species distribution

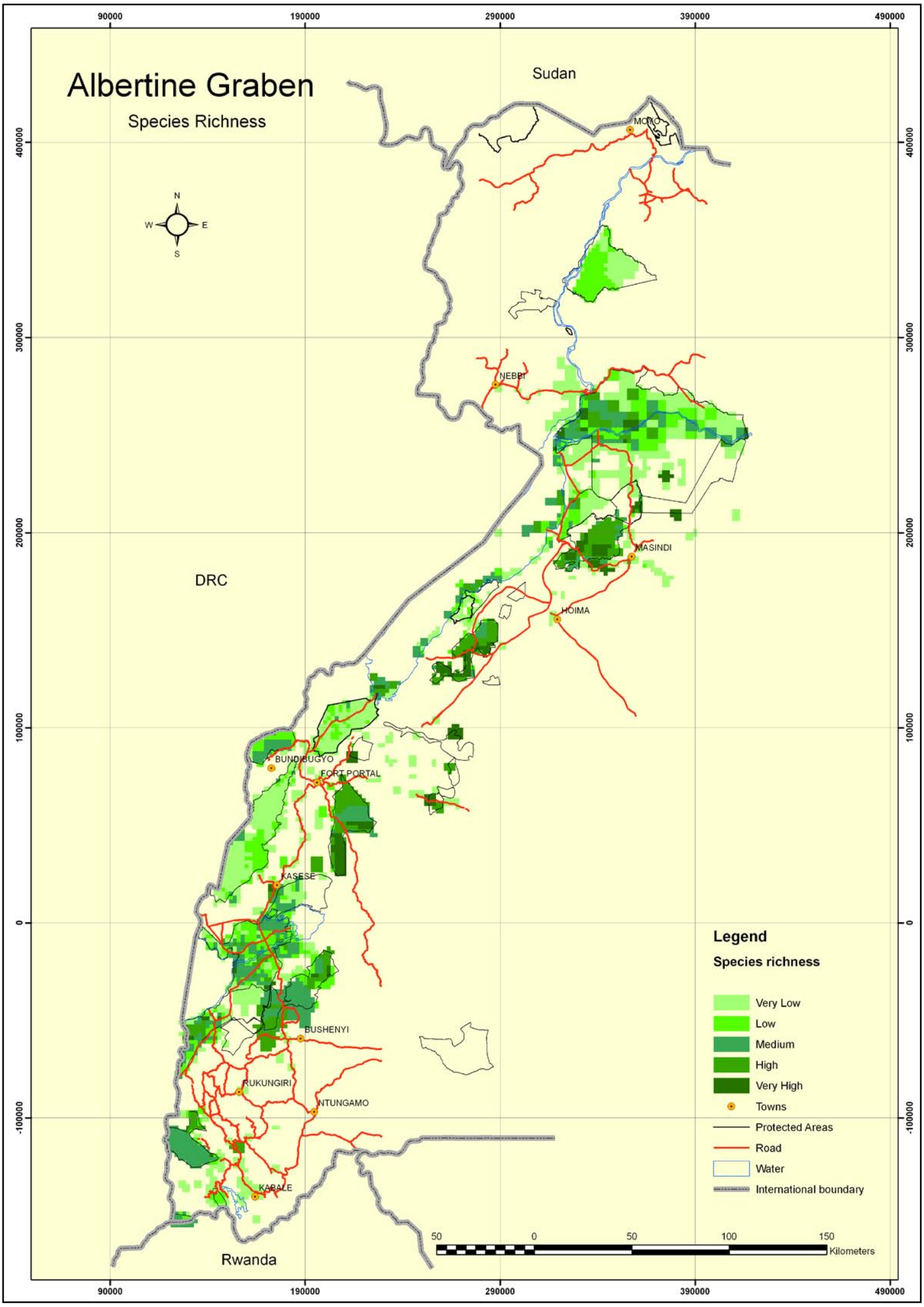
Whereas Mgahinga NP registered very high birds species endemism all over the area, Mt. Rwenzori and Bwindi Impenetrable National Parks registered varying levels of birds' endemism (Figure 16). Some of the areas had very high values. Of the forested areas, Budongo and Bugoma forest reserves registered endemic birds' presence.

The whole of Mgahinga NP registered high plants species endemism (Map. 23). Parts of Bwindi Impenetrable and Mount Rwenzori national parks also registered high plants species endemism. Of the forest reserves, Bugoma FR registered the highest plants species endemism.



Map 24: Albertine graben Threatened birds species distribution.

Bwindi Impenetrable NP registered the highest numbers of threatened birds species distribution (Map.24). Other parks that registered endemic birds presence were Mgahinga, Mount Rwenzori and Semliki NP. Budongo and Bugoma forest reserves also registered presence of threatened plant species.



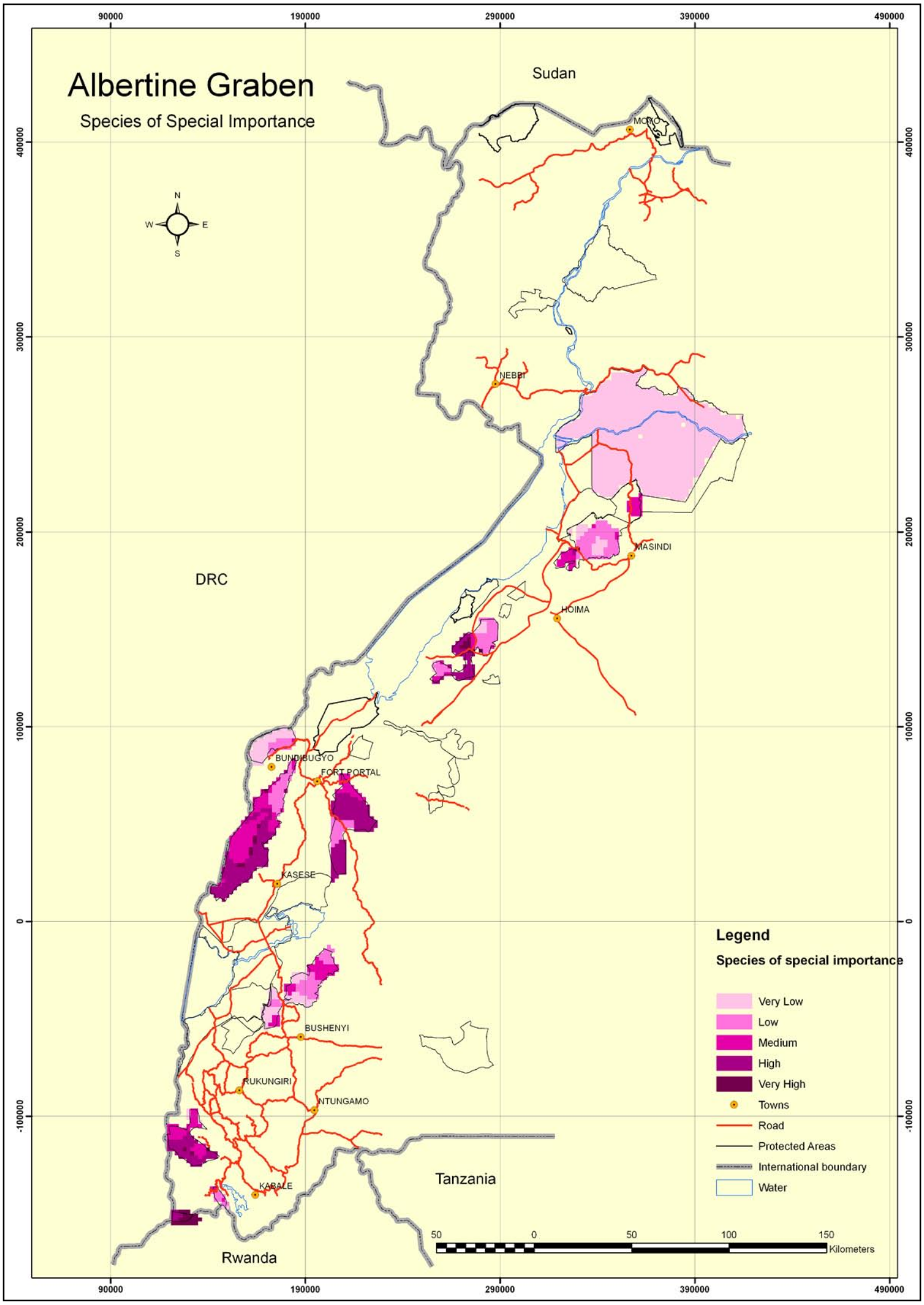
Map 25: Albertine graben Species richness.

2.3 Sensitivity based on species richness

The sensitivity ranking system for species richness incorporates data on large mammals and crocodiles, birds, plants and fish species. The species richness value of a specific site was calculated by dividing the sum of species ranking values in a specific area by the frequency of occurrence of the species. Whereas areas where all variables were represented were divided by four (4), areas with only data on two variables (e.g. fish and birds) were divided by two. The results of this analysis are presented in the species richness Map 25.

Highlights of the species richness map

Forests, both national parks and forest reserves, generally show higher species richness than the grassland/woodland areas (Figure 2.12). Parts of Budongo and Bugoma Forest Reserves, and Kibale National Park showed the highest species richness. The delta area of Murchison Falls National Park also showed high biodiversity.



Map 26: Albertine grabenSpecies of special importance.

2.4 Sensitivity based on species of special importance

Data on endemic birds, and plants, and threatened birds were combined to prepare the map of species of special importance. It should be noted that data for Queen Elizabeth National park was not yet available at the time of preparation of this sensitivity atlas. The data for Murchison Falls National park was also not comprehensive.

Highlights of the species of special importance map

The map shows that the highest number of endemics occur in the southern part of the Albertine graben. Mgahinga, Bwindi, Mt. Rwenzori and Kibale National Parks and the southern part of Bugoma forest had the highest number of species of special importance (Map. 26). Although literature cites species of special importance in Queen Elizabeth National park, data on such species was not yet available at the time of completion of this edition of the atlas. This is why this part of the map appears blank.

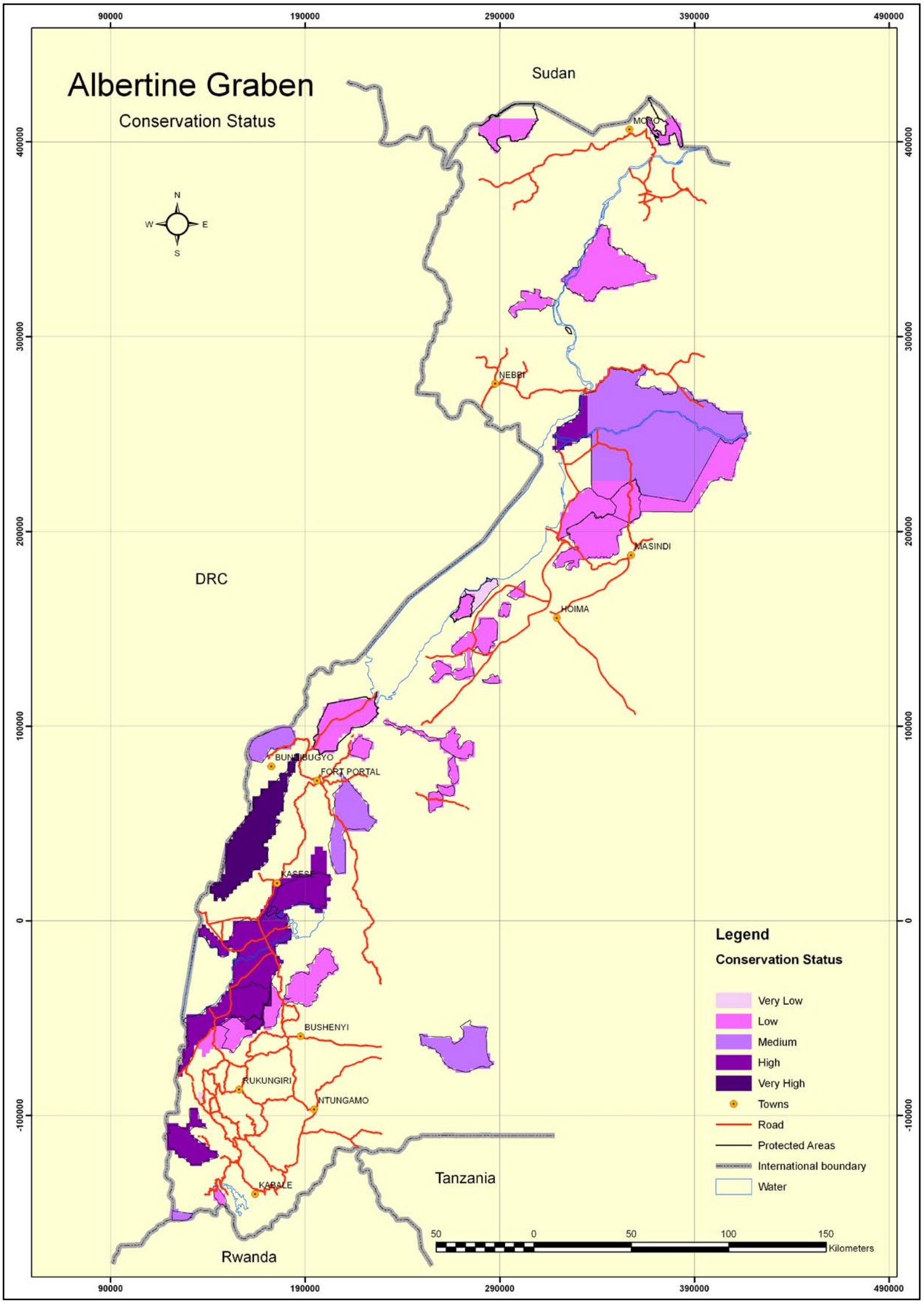
2.5 Conservation Status

The Albertine graben's unique habitats support a high diversity of species and ecological processes. Of the ten (10) National Parks, seven (7) occur within the Albertine graben. There are also twelve (12) Wildlife Reserves, thirteen (13) wildlife sanctuaries and five (5) Community Wildlife Areas. The protected areas system of the Albertine Graben is about 70 percent of all national parks and wildlife reserves in Uganda (Buhanga, 2009).

The conservation areas found in the Albertine Graben were divided into conservation designations determined by the Government of Uganda and designations determined through Global conservation agreements. All conservation areas along the Albertine graben were recoded and scored against these conservation categories. An initial value was awarded to each conservation area based on its national conservation designation i.e. National Park - 9, Forest Reserve – 6, Wildlife Reserve – 5 and Community Wildlife Area – 3. A value was added to the initial value for every additional global conservation designation. For World Heritage site – 5, Biosphere Reserve – 3, Ramsar Site – 3 and Important Bird Area – 1 was added. A final conservation status value for each protected area was generated by adding up the values scored for the specific conservation area (See Table 1 below). A map of conservation status for each protected area was then generated using the final value (Total). It needs to be noted that for conservation areas that had Ramsar sites, the Ramsar site value was only reflected for the actual extent of the conservation area that is designated as a Ramsar site and not the whole conservation area. There are several small forest reserves that have not been indicated in the table. These have, however, been scored and registered in the conservation status map.

Conservation designation									
Conservation Area	NP	FR	WR	CWA	WHS	BR	RS	IBA	Total
Mt. Otze		6							6
Mt. Kei		6							6
Ajai WR			5					1	6
MFNP	9						3	1	13
Bugungu WR			5						5
Karuma WR			5						5
Kabwoya WR			5						5
Kaiso-Tonya WCA				3					3
Semliki NP	9							1	10
Semliki WR			5					1	6
Mt. Rwenzori NP	9				5		3	1	18
Kibale NP	9							1	10
QENP	9					3	3	1	16
Bwindi NP	9				5			1	15
Lake Mburo NP	9								9
Mgahinga NP	9							1	10
Budongo FR		6						1	7
Bugoma FR		6							6
Kashoha-Kitomi FR		6							6
Kalinzu FR		6							6
Maramagambo FR		6							6
Katonga WR			5						5
Kigezi WR			5						5

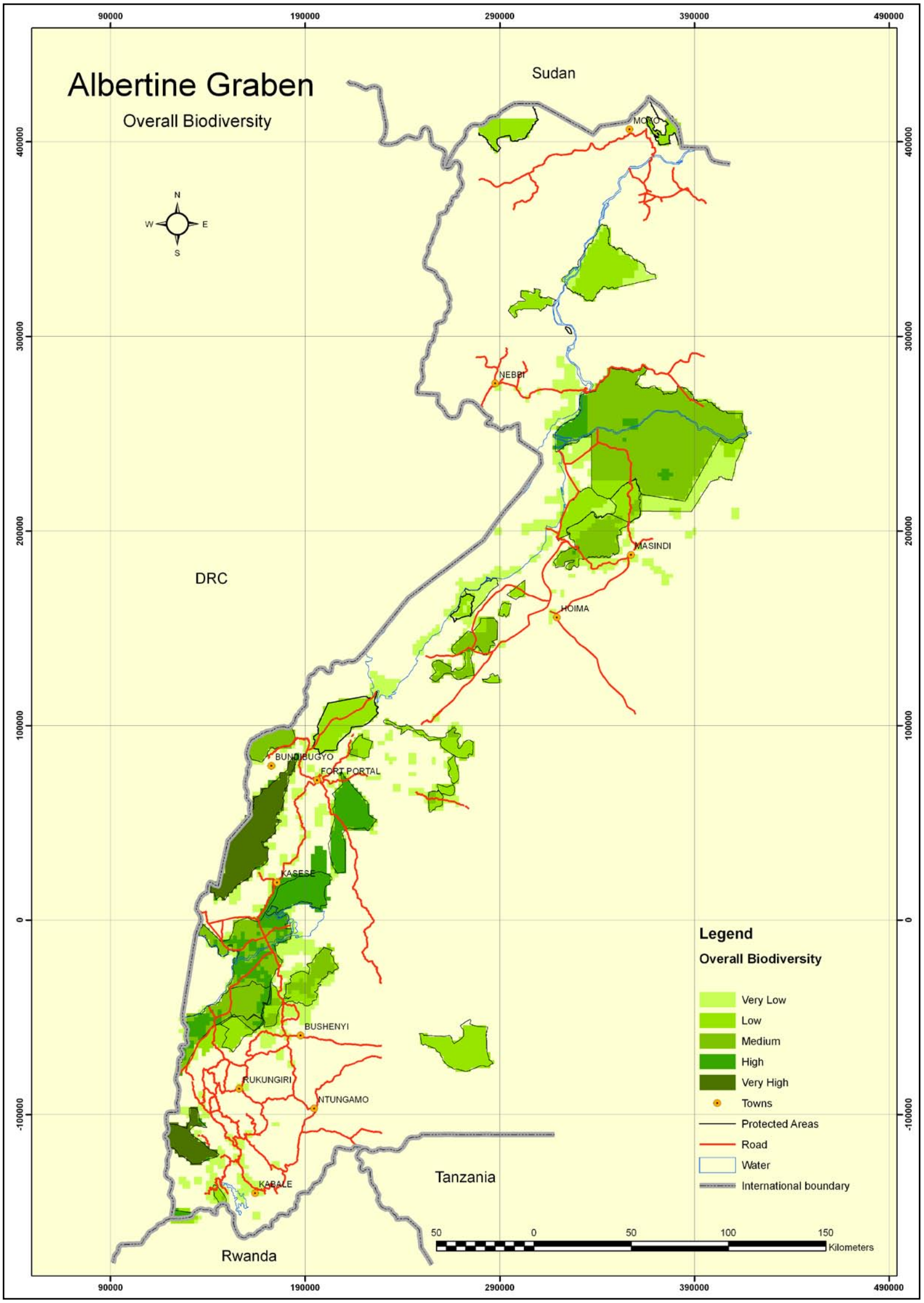
Table 1: Conservation areas along the Albertine graben scored against conservation categories



Map 27: Albertine graben Conservation status ranking of all protected areas.

Highlights of the conservation status map

Mt. Rwenzori National park shows the highest conservation status value (Map. 27). This is followed by Bwindi NP, Queen Elizabeth NP and the delta area of Murchison Falls NP.



Map 28: Albertine graben Overall biodiversity sensitivity.

2.6 Overall biodiversity sensitivity to petroleum development

The species richness value, species of special importance (endemic and threatened) and the conservation status value were combined to generate the overall biodiversity value. The obtained values were categorized into five class ranges presented in the map above.

Highlights of the Overall biodiversity map

The northern part of Queen Elizabeth NP shows the highest overall biodiversity (Map. 28). Bwindi and Mt. Rwenzori National parks also show high biodiversity. The high overall biodiversity showed by Lake Mburo NP is an artifact. There was very little data (few variables) available for Lake Mburo NP and so the division factor (frequency) was also low making it stand out as having high biodiversity.

2.7 Sensitivity of biodiversity to petroleum development

The sensitivity of biodiversity to petroleum developments depend on the species type and the ability of the species to adopt to changes.

Mammals are sensitive to vibrations from seismic survey, movement of heavy equipments and the drilling activity. The noise resulting from petroleum activities interfere with breeding patterns of wildlife. The clearing of vegetation during various infrastructure developments reduce the habitats for wildlife, destroys the homes of some animals and blocks the corridors for animals. The oil spills and pollution from other chemicals used during petroleum developments contaminate water sources for wildlife and affects the water dwelling animals including birds and fish species. As already mentioned, this atlas considered only the large animals. There are many small sized wildlife species that have not been surveyed, which are very sensitive to these developments.

Plants are affected through clearing of the development site, oil spills and pollution. For plant species, the issues to consider are how fast an area would recover from disturbance if cleared and which vegetation types are likely to be most affected if an oil spill occurred. Recovery of an area involves two phases. The first phase is the development of re-growth so as to control erosion and water runoff. The second phase is the regeneration of the originally existing species. There are areas where it may take a much longer period for such species to come up and later on to grow to the initially existing sizes and species richness levels. There are also species which have a limited distribution range. For species that take very long to recover and those that have a limited distribution range, the areas where they occur will need to be avoided or used with extreme care.

Whereas maps in this chapter indicate sights that have high species diversity, they do not show the specific species that occur in such areas. These maps are pointers to where caution needs to be exercised when carrying out petroleum development activities. Acquisition of detailed species information and the conditions in which the species occur will, therefore, be required for the specific area selected for a petroleum development activity.

2.8 Review of data availability, quality and reliability

The main sources of data and information in this section have been Wildlife Conservation Society, Uganda Wildlife Authority (UWA), National Forestry Authority (NFA), National Fisheries Resources Research Institute (NaFIRRI,) and Makerere University, in particular MUIENR biodiversity bank. Most of the available data were for within protected areas. There is therefore need to collect data for the areas not covered in this study and for the areas where not all the variables were covered. Data is also still required for the following;

i. Proposed wildlife corridors
ii. Major breeding and feeding sites
iii. Watering points

Sempaya Hot spring in Semliki National Park. Photo by UWA (2009)

Flock of birds. Photo by Nature Uganda (2009)

Giraffe crossing an access road to Buffalo East-2 in Amuru District.

Iyamuliro wetland in Kabale District.

Habitat of wetlands.

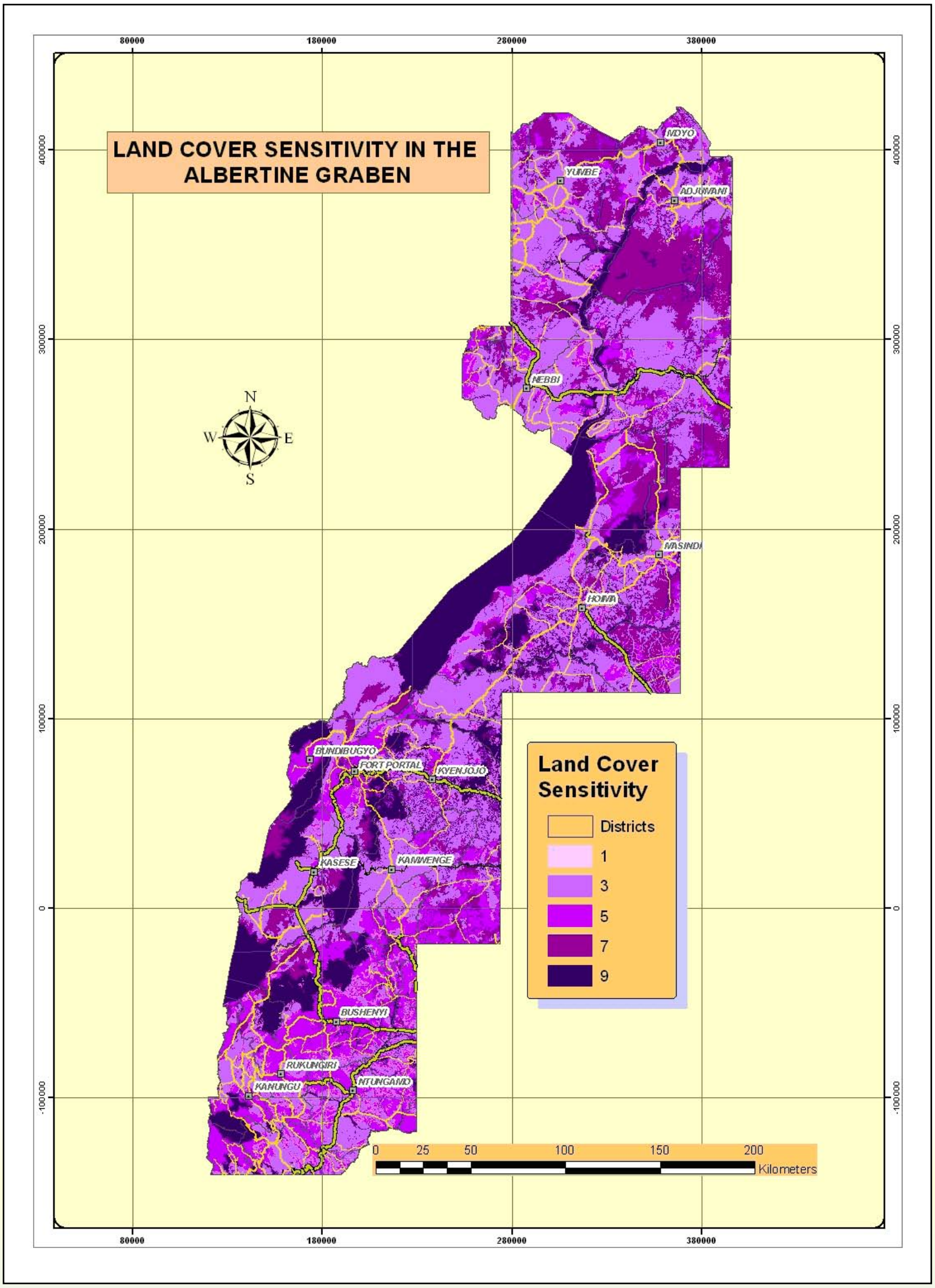
Biodiversity in the grasslands.

Fig. 25: Threatened species in the Albertine graben

Fig. 26: Murchison Falls

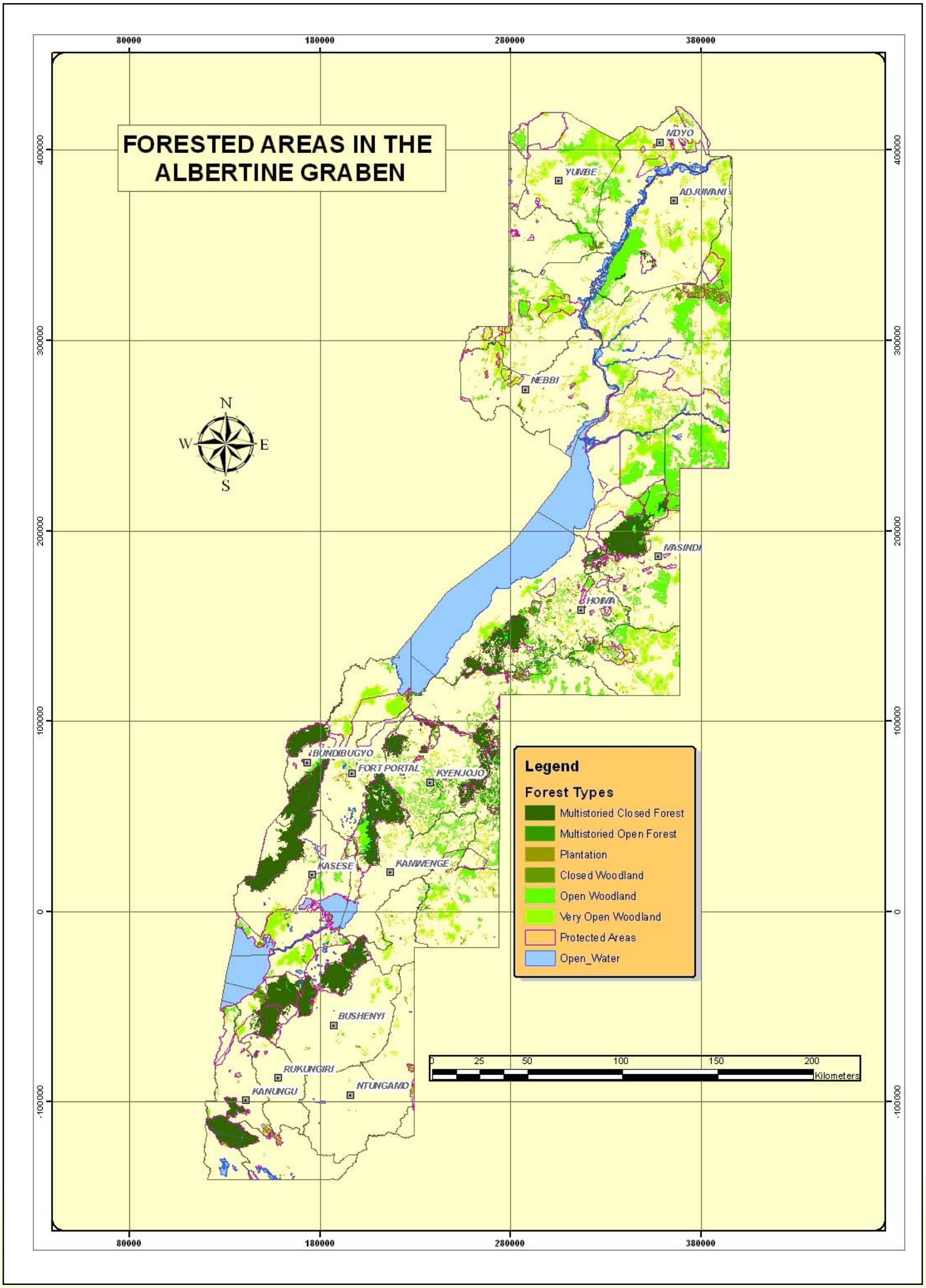
CHAPTER 3

SENSITIVITY OF OTHER NATURAL RESOURCES IN THE ALBERTINE GRABEN



Map 29: Albertine graben Land cover sensitivity.

3.1 Land cover sensitivity



Map 30: Albertine graben Forested areas sensitivity.

3.2 Sensitivity of forests

Central Albertine Forest Reserves in the Albertine Graben

Functions
Eco = Ecological and Environmental
Ind = Industrial and Commercial Forest Plantations
Loc = Local Fuel, Charcoal and Forestry Investments

District	CFR	Area_ha	Function	Notes
Nebbi	Abiba	2,007	Eco	Protects the steep slopes of the Agem, Akuru, Ayugi and Afoda range of hills and the catchment area for some important rivers like Moro and Aumbali which are sources of water for animals and domestic use for the communities in Kaliwangi Parish. It was also intended to provide forest products for the local people. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of industrial timber and bio-energy to generate economic returns
Arua	Ajupane	472	Ind	The reserve protects the hill tops of Ajupane from soil degradation and also acts as water catchment for the streams that flow from it. Today, the FR is still managed for the same environmental purposes
Nebbi	Alui	575	Eco	A riverine forest gazzetted to protect the wetlands that are part of the drainage system which empties into the Albert Nile. It was also intended to provide forest products for the local people. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of industrial timber and bio-energy to generate economic returns
Moyo	Atiya	194	Eco	This forest, together with the Otzi East CFR, constitute a biodiversity connectivity between the critical biodiversity sites of Era and Otzi CFRs. NFA has established a timber plantation demonstration site in the CFR
Nebbi	Awang	163	Ind	An industrial plantation reserve. It was harvested and is now being re-planted by NFA
Masindi	Budongo	82,530	Eco	The forest is part of the network of critical sites for biodiversity conservation in Uganda. It constitutes part of the catchment area for Rivers Bubwa, Sonso and Waisoke which flow gently over the escarpment to Lake Albert. Other rivers in this catchment include Siiba & Waki which join together and feed into Lake Albert. River Waki has a high potential for electricity generation at the falls as it rolls over the Western rift valley escarpments near Lake Albert. The rivers and other water points located in the reserve are used for domestic use by the local populations in the subcounties of Budongo, Kigorobya, Biiso, Karujubu, Pakanyi and Bulisa. The forest also has high valued trees like Cynometra alexandri which can be used for industrial timber (for making railway slippers, plat form for bridges) and high calorific industrial charcoal. It is a source of high valuable mahogany trees which are known for high quality furniture. The forest is home of some globally threatened wildlife like chimpanzee and others
Mbarara	Bugamba	1,210	Ind	Protects the steep slopes of hills in the “bare-hills” zone in Mbarara. It is planted with industrial timber plantations by NFA
Hoima	Bugoma	41,144	Eco	It protects the banks of Rivers Nguse, Ngemwa, Lyalo, Rwemiseke and Rutowa which eventually drain into Lake Albert. It acts as a biodiversity corridor by connecting Kabwoya Game Reserve to MFNP, Budongo, Rwengeye, Matiri, Itwara CFR and Semiliki NP. It is a watershed for River Nguse and Rutowa which eventually feed Lake Albert. Rivers Nguse and Rutowa serve as a water source to the communities of Kabwoya, Kyangwali, Buseruka, Lugasari and Kyalyanga Sub-counties. It is a natural forest with high potential for producing high value timber like Khaya anthotheca, Milicia excelsa, Aningeria alitisma etc. It has immense potential for ecotourism. It is one of the CFRs that constitute the network of critical biodiversity sites in Uganda. Prized species include chimpanzees, elephants, antelopes, and a variety of birds and butterflies. It is a centre for professional research and education with numerous studies being carried out
Kyenjojo	Buhungiro	1,020	Eco	Local communities of Kazizi, Nyanga, Iringa, Igunda, Katamba, in Mpara and Kakabara sub counties draw water from Buhungiro CFR. The streams include Kataira,Rwangarwe, Rwangomi,Kahombo. The hills include Duyungu, Nyanga, Ngangi, Katamba, Kasunga, Kabasasa, Kyaiserunboha. Private tree farmers have been licensed to plant trees
Hoima	Bujawe	4,869	Eco	It protects Rivers Hoimo and Rwamutunga which are a source of water to the people and animals in Buseruka and Bugambe sub-counties. The rivers eventually feed into Lake Albert. It is part of the biodiversity corridor connecting MFNP, Budongo, Bugoma and Kabwoya Wildlife Reserve. The reserve has a high potential for the production of industrial timber through private tree investment (so far 700ha have already been planted by private tree investors such as BAT, Corewoods and others. It is a source of employment to the local people
Nebbi	East Uru	477	Eco	Protects the steep slopes of Uru Hill and is also a catchment for streams which eventually feed into River Nyagak. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of forest products like honey and services like scenic drives and mountain hiking to generate economic returns
Moyo	Era	7,389	Eco	The CFR is part of the network of critical sites for biodiversity conservation in Uganda. It is home to the primitive cycad spp, and some rare species of butterfly. It is also a catchment area for Odraji, Lama, and Lukuji streams which feed into River Nile
Moyo	Eria	575	Ind	A number of streams like Leya, and others originate from this CFR. NFA has established a demonstration teak plantation in areas that were formerly encroached

Table 2: Albertine graben Central Forest Reserves

Central Albertine Forest Reserves in the Albertine Graben

Functions
Eco = Ecological and Environmental
Ind = Industrial and Commercial Forest Plantations
Loc = Local Fuel, Charcoal and Forestry Investments

District	CFR	Area_ha	Function	Notes
Kabarole	Fort Portal	65	Eco	Protects the wetlands associated with river Mpanga that meander through the town. An urban CFR important for cleaning the environment and is being developed into a recreation green
Amuru	Got-Gweno	2,310	Eco	It is a water catchment forest for Achwa, Kwii and Amuka rivers supplying 8 villages in the sub county. It is intended for industrial timber production
Hoima	Ibamba	313	Ind	Protects of Ibamba Hill. It is potential for industrial timber production through private tree investment. It provides employment to the Local community. Encroachment in the area is a big threat to the ecological functions of the forest
Kyenjojo	Ibambaro	3,724	Eco	Rivers include Kahombo and Burunga all serve the communities of Kanyangalama; hills include Nyabatoro and Babaija
Rukungiri	Ihimbo	566	Eco	It is the only CFR with hot springs in South-West Range which has medicinal properties and has potential for ecotourism. It is a water catchment for rivers Ntungwa and Kachindo that drain into Lake Edward. Plantation in Ihimbo supply poles and fuel wood to the tobacco industry and surrounding communities. CFR is the only source of water for the parishes of Kikongi, Murama. The wetland forest in Ihimbo traps sediments in rivers and thus helps purify the water
Kyenjojo	Itwara	8,638	Eco	A natural forest protecting a number of rivers and streams that supply water to the surrounding population. One of the prominent rivers is Muzizi. It is a source of industrial furniture grade timber
Arua	Kafu	2,600	Eco	The reserve protects the steep slopes of Kafu Hill from soil degradation. It also protects the water catchment for Rivers Agoi, Nyara, Ewivio and Anjea which are the only permanent water sources for animals and domestic uses for communities adjacent to the reserve i.e. Madua, Olaka, Lazebu villages. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of industrial timber and bio-energy to generate economic returns for the local people
Kibaale	Kagadi	8	Eco	An urban CFR important for cleaning the environment and can be developed into a recreation green
Kiboga	Kagogo	689	Ind	Protects Kagogo-Kyomya Hills
Kibaale	Kagombe	17,751	Eco	Protects the watershed for Rivers Kagombe & Muzizi which eventually drain into Lake Albert. It connects to Semliki National Park via Muhangi, Kitechura, Ibambaro, Matiri and Itwara CFRs. The CFR is seriously encroached, which is a threat to the ecological functions of the reserve. It is a young forest with a high a potential for producing high value timber from natural forest e.g. mahogany
Kyenjojo	Kagorra	4,314	Ind	The reserve is boarded permanent water sources of R. Aswa and Muzizi which flows to L. Albert and is a catchment area for these rivers. It has so many streams e.g. Nyabudogo, Wambuzi, Wabijoka and Kyamusigire, Bimugora. The reserve has small hills like Kembubi and Kasonge. The reserve has natural belts with valuable trees for timber e.g. Cordia melliniie, Albizzia spp. R. Aswa which boarders this reserve is a source of water for domestic use and agriculture to the local communities of Rukukuru, Nyabwenga, Kyanika. The cattle grazers also use the same water for their animals. The reserve has been encroached by local communities bordering the forest
Hoima	Kahurukobwire	1,088	Ind	It is a catchment area for Rivers Kafu and Kiribangwa which are water sources to the people and domestic animals in Buhanika and Buhimba sub-counties. River Kafu and River Kiribangwa which originate from the CFR eventually feed into Lake Kyoga. The reserve has been earmarked for industrial timber production through private tree investment. Encroachment and illegal harvesting in the area are serious threats to the ecological functions of the forest
Bushenyi	Kalinzu	14,126	Eco	Protects the steep hills, a catchment for several rivers and rich in biodiversity. Ecotourism is ongoing and there is potential for expansion given the high number of chimps and other tourist attractions. It also provides market for local handicrafts and food items. Conservation education for the adjacent local communities and school children is provided by Kalinzu CFR. The forest is a seed source of various indigenous species
Kibaale	Kanaga	650	Ind	It's a young forest that protects the fragile soils around Kyanaisoke Sub county. The CFR is highly encroached
Hoima	Kandanda-Ngobya	2,556	Ind	It is a source of Rivers Ikuma and Kidibidi which are watersheds of River Rafuma which eventually feeds Lake Kyoga. Rivers Ikuma and Kidibidi are sources of water to the people and domestic animals in Kyabigambire Sub-county. It is a potential for industrial timber production through private tree investment, thus providing employment to the Kyabigambire communities. Encroachment in the area is a big threat to the ecological functions of the Forest
Kibaale	Kasato	2,691	Eco	The forest acts as a water catchment area for Ruzaire River which eventually drains into Nkuse and Muzizi Rivers
Masindi	Kasokwa	73	Eco	The CFR protects the banks of River Kasokwa which is the main water source for Kinyala Sugar Works LTD and the surrounding local communities of Kabango & Kibwona Parishes. The forest is a habitat to chimpanzees and other animals which are now completely cut off from Budongo CFR as a result of destruction of the riverine forest along Kasokwa River that used to connect Kasokwa and Budongo CFRs. The reserve is currently under pressure by cultivators, illegal grazing and removal of wood products for timber, fuelwood and poles
Hoima	Kasongoire	3,089	Ind	It is a catchment area for Rivers Kasowa, Waitebe and Pabidi which serve as water sources for the people & domestic animals and wildlife in Budongo and Kyabigambire Sub counties. It is a potential for industrial timber production through private tree investment, hence providing employment to the communities of Budongo and Kyabigambire. Encroachment is a serious threat to the CFR

Central Albertine Forest Reserves in the Albertine Graben

Functions
Eco = Ecological and Environmental
Ind = Industrial and Commercial Forest Plantations
Loc = Local Fuel, Charcoal and Forestry Investments

District	CFR	Area_ha	Function	Notes
Bushenyi	Kasyoha-Kitomi	39,464	Eco	A watershed and catchment for rivers such as Kyambura, Buhindagi, Ngoro, Katerera, Kitomi, among others. These rivers drain into Lake George ecosystem. The steep hills of Munyonyi, Muragara, Kategule, Kampuma, Rubare, Nyakakoma acts as the major watershed areas for the areas of Bunyaruguru, Irimba, Burere, and Runengo in Buhwezu. These rivers also provide domestic water to communities around the reserve in the parishes of Nwongera, Katanda, Kazumbura, Kitake, Mujera, Katala, Kyambura. Besides R. Kyambura had been identified a potential for hydroelectric power. A sanctuary to wildlife during dry seasons. Exceptionally diverse in its flora and fauna and therefore of high conservation value in the country and the region as a whole. It is also a core Conservation Master Plan 2002. Some grassland areas have been lincenced to private tree farmers to support their livelihoods. Has potenial for ecotourism due to the scenic beauty of Kamunzuku lake
Kyenjojo	Kibego	1,269	Eco	A natural forest that protects the banks of tributaries that feed into River Muzizi. It is also an important forest in biodiversity corridor along River Muzizi
Masindi	Kibeka	9,570	Ind	This is one of the reserves dedicated to industrial timber production through private sector investment. It is heavily encroached by settlers who were evacuated at the time of establishment of Bunyoro Ranching Scheme
Kiboga	Kikonda	12,186	Ind	Hilly and undulating FR with some rivers that are seasonal and supply R. Kitumbi and R. Kafu thus the FR acts as catchment area. The whole FR was allocated to private tree farmers with 1000 ha planted
Kyenjojo	Kikumiro	730	Ind	Hills: Muzilanturu, Kitembe, Byakweri, Ndondogorozi ,Nyambubi, Kanyara, Akonza and Kikumiro. Slopes towards River Aswa and Nyakwisi. Kihemu, Lugaya, Kibongoro joins Aswa River then Muzizi.R. to L. Albert. Balahija joins Nyakwisi River to Muzizi then L. Albert. All rivers pass through Kyegwere, Nsinde, Balihija parishes. Industrial bio-energy-tea estates of Mukwano
Amuru	Kilak	10,205	Eco	Catchment for most water supply sources especially streams and rivers in Amuru and parts of Gulu. It protects soil from erosive effects downstream and areas at the bottom of the hill. The Ecosystem is undisturbed thus supporting biological resources especially animals since it neighbours Murchison Falls National Park
Kasese	Kisangi	5,340	Eco	FR acts as wildlife corridor joining Queen Elizabeth National Park and Kibale National Park. These also serve as a wildlife sanctuary which is evergreen during the dry season around L. Kabaleka. The lake is also used by local communities for fishing and water. FR has 4 wetlands which help in filtering wastes from Hima cement and lime factories around the region. The communities of Biganda and Ibuga prison get domestic water and fuelwood from the reserve. FR also helps in modifying the climate around Hima & Rwimi. These therefore support agriculture.
Kyenjojo	Kitechura	5,317	Eco	Rivers include Kagenga, Mirinchi and Muzizi. Communities drwa water from Muzizi river. Hills include Mwakia, Igongwe and Ibanda
Hoima	Kyahaiguru	422	Eco	It is a catchment area for River Wambabya which is a source of water for domestic, animal and wildlife use in the areas of Bugambe, Kiziramfumbi and Buseruka Sub county. It is a potential for industrial timber production through private tree investment and thus employment to the local communities
Hoima	Kyamugongo	117	Ind	It is a source of River Hoimo which in return supplies water to the people of Kiboba and Buseruka sub counties. The River eventually pours into Lake Albert. The reserve has high potential for industrial timber production through NFA established plantations and private tree investors. As a result job creation is being realised, employing about 100 people annually
Kibaale	Kyamurangi	417	Eco	It is a natural forest rich with indigenous species (Blighia, Nkalati) that produces quality timber. It is part of the biodiversity corridaor connecting Murchison Falls, Bugoma, Matiri CFRs and eventually to Semliki NP
Kyenjojo	Kyehara	482	Ind	It has 3 streams: Kiziku in cpt 1, Nyanyogera/Kiembe which boarders cpt 15 and Kikumiro FR and lastly Kaburamaiso in cpt 14. Kyehara has 10 hills according to cpts; Waitara, Isungu, Kyehara, Nyitira enfundo, Kigoma, Mwana ayangire ise, Kyanyina mwana, Ntuntu, Mbata hills
Amuru	Labala	1,673	Eco	It is a hill reserve that is a catchment area for Okoli, Omee, Wenyere, Ajok, and Achwa streams, natural woodland and savannah woodland with scattered valuable tree species like Milicia excelsa, Khaya grandifolia and Albizzia spp. It will continue to be managed for the same ecological purposes, and production of high grade timber for furniture
Arua	Laura	2,764	Eco	A hill reserve that protects the Laura range of hills from soil degradation and also acts as water catchment for River Nyara which is the only source of reliable water for animals and for domestic use by communities adjacent to the reserve. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of industrial timber and bio-energy to generate economic returns for the local people
Oyam	Lela Olok	215	Loc	Located in the flat and dry Acaba Sub county, but it has potential for establishing commercial forest plantations

Central Albertine Forest Reserves in the Albertine Graben

Functions
Eco = Ecological and Environmental
Ind = Industrial and Commercial Forest Plantations
Loc = Local Fuel, Charcoal and Forestry Investments

District	CFR	Area_ha	Function	Notes
Nebbi	Lendu	2,378	Ind	An industrial timber plantation reserve. It is being harvested and re-planted by the NFA. It is also a source of of several streams (e.g along the Uganda-Congo Border) on which the local people depend for their water
Koboko	Liru	497	Eco	The CFR is the source of River Oya which serves the people of Lobule Sub county. River Oya is now drying up as a result of over cultivation of hill bases and over-grazing on the hill tops
Moyo	Lobajo	111	Ind	The CFR was established to provide forest products to the surrounding communities. NFA has established a demonstration plantation for pine and teak
Yumbe	Lodonga	106	Loc	The NFA has established a demonstration plantation for industrial timber and the rest of the CFR has been licensed to a private tree grower
Nyadri	Lokiragodo	117	Ind	2 streams, Kichi, and Azii, originate from the forest to supply water for 5 villages in Kijomo Sub county in Maracha County. It is one of several CFRs in the West Nile Region which is earmarked for production of industrial timber and bio-energy through private sector investment
Arua	Luku	4,043	Eco	Protects the range of hills including Gimbara, Odruva, Oguruku, Ojioze, Nokiri, Oyi & Luku hills. A number of streams like Odukudu, Linya, Okangalika, Agoyiva, Olemika, and Ozukuva originate from these hills, supplying water to Ajia, Ogoko, Ulepi & Arivu subcounties. The FR was also intended to be a sanctuary for birds and a source of forest products to the surrounding communities. Today, the FR is still managed for the same environmental purposes but it is also targeted as a core reserve for production of industrial timber and bio-energy into which the smaller reserves in the area and out-growers can feed for industrial processing
Nebbi	Lulu Kayonga	114	Eco	Constitutes part of the network of protected areas (Murchison Falls, Wadelai and Lul Kayonga) that protect the northern shores of Lake Albert and Albert Nile. The reserve also acts as water catchment for some streams which empty their water into Lake Albert. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of forest products like timber by small-holder outgrowers
Nebbi	Lulu Oming	373	Eco	Together with other CFRs it protects the drainage system which empties into the Albert Nile. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of forest products like honey and services like scenic drives and mountain hiking to generate economic returns
Nebbi	Lulu Opio	249	Eco	A riverine CFR gazzetted to protect the drainage system which empties water into the Albert Nile. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of forest products
Kiboga	Luwunga	9,718	Ind	Hilly and undulating FR. protects drainage system of R. Kitumbi that joins R. Kafu. The New Forest Company was given 700 ha for commercial tree planting with 106 ha planted
Arua	Lyi	2,437	Eco	A hill reserve that protects the watershed for Rivers Ora and Anikuru which pour into River Nile. These rivers are very important sources of water for livestock and domestic use by the local communities in Offaka and Logiri Sub counties. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of industrial timber plantations and transmission poles by private investors
Kabale	Mafuga (Part)	3,699	Ind	An industrial timber plantation reserve. It protects the steep slopes in the area. It is also a source of several streams on which the local people depend for their water. It is being harvested and re-planted by the NFA
Bulisa	Masege	951	Ind	It is the only CFR in the rift valley near Lake Albert and as such, it is important for the protection of Lake Albert. It also contributes to the protection of River Waiga that drains into Lake Albert. This is Reserve also stands as a potential area for the production of industrial timber plantations and mitigation of negative environmental impacts of oil extraction in the rift valley area and Bulisa District in particular. It is a corridor for wild life between Lake Albert Area and Murchison Falls National Park
Masindi	Masindi	39	Eco	This is a water catchment for Rivers Nyangaya and its tributary River Rwabinoli. This river flows to Lake Kiyanja which supplies Masindi Town with water. The outlet from the Lake Kiyanja joins River Kafu that pours into Lake Kyoga. Bunyoro Kitara Kingdom claimed ownership of the reserve which triggered off settlements in the reserve. The settlers have degraded the river banks through brick making, clearing of vegetation for building and cultivation causing siltation of the river hence a threat to the Masindi Town water supply
Bundibugyo	Mataa	109	Eco	A reserve in the foothills of Mt. Rwenzoori. Important for soil stabilisation and protection against landslides
Kyenjojo	Matiri	5,431	Eco	Local communities of Rwibale, Mukonomura, Mahasa, Kyankaramata in Kihuura Sub county draw water from Matiri CFR. Rivers include Kahombo, Rusesenge, Kazizi, Kaikasaisha. The hills protected by the CFR include Ntutu, Bwesese, Rusongora, Kasunga, Rweboha, Nyakahama, and Itehe. Proposals to establish a seed orchard in Matiri under way especially for Araucarias. CFM is being initiated in Matiri, establishment of an ecotourism site in Matiri CFR is underway and plan for construction of building has been done
Mbarara	Mbarara Plantations	194	Eco	An urban CFR important for cleaning the environment and can be developed into a recreation green. Some of the blocks protect wetlands and water sources for the town

Central Albertine Forest Reserves in the Albertine Graben

Functions
Eco = Ecological and Environmental
Ind = Industrial and Commercial Forest Plantations
Loc = Local Fuel, Charcoal and Forestry Investments

District	CFR	Area_ha	Function	Notes
Kanungu	Mburamaizi	497	Ind	Only CFR with Garcinia plant whose berries are commercially sold and used as domestic food. Tree farming by the Private sector for commercial supply of construction timber and poles plus fuelwood to the tobacco industry. Settlement (encroachment) is on 1 sq. mile of the reserve
Hoima	Mpanga	544	Ind	It protects Rivers Nyakabale, Kabaganda and Rwemiyaga which are important for the people and domestic animals of Kabwoya and Kiziranfumbi Sub counties. It is a potential for industrial timber through private tree investment, thus providing employment to the people of Kabwoya and Kiziranfumbi
Yumbe	Mt Kei	40,689	Eco	The CFR is part of the greater cross-boarder ecosystem with Southern Sudan and one of critical sites in the network of protected areas for biodiversity conservation in Uganda It protects the banks Kaya River which forms part of it's (Mt. Kei) boundary. It is the origin of the three rivers -Araga, Kechi, and Komi which serve Midigo and Kei Sub counties. It is a hill reserve with a high abundance of Combretum and Terminalia tree spp. which are not common on private land in the surrounding areas
Kasese	Mubuku	1,662	Ind	FR absorbs exhaustive gases and other wastes from Hima, Cobalt, Lime factories around Kasese Town. The reserve is also vital for modifying peri urban micro-climate in the neighbouring Kasese Town. The FR supports agriculture in the area. Mubuku reserve supplies fuelwood and other forest products to people around Kasese Town and factories. Part of the FR has been given to private tree farmers to support their livelihoods by planting trees. NFA and private tree farmers employ many local communities in the establishment /management of the plantation/reserve
Kyenjojo	Muhangi	2,044	Eco	A closed tropical moist forest that protects the banks of River Muzizi
Kibaale	Muhunga	399	Eco	A catchment area for River Muhunga which serves as a water source for both Kibaale and Karuguuza piped water before draining into Muzizi River. Encroachment and illegal pitsawying are threatening to reduce its ecological functions
Hoima	Mukihani	3,619	Ind	It is a water catchment for Rivers Nyakabale, Burara and Waki which are a source of water to the people and animals in the areas of Kitoba, Businsi and Kigorobya Sub counties. It has tremendous potential for industrial timber production through private tree investment, thus generating opportunities for employment for the local people
Kabale	Muko	168	Eco	Planted with pine, the CFR protects some of the steep hills bordering Lake Bunyonyi
Masindi	Musoma	278	Ind	The CFR is a water catchment for River Musoma and its tributaries: River Walugogo, Nyabisojo and Kayora. The River supplies water for domestic use and for livestock to the communities of Bujenje and Bulindi Sub-counties. Part of the reserve was sold to Kinyara Sugar Works by Bunyoro Kitara Kingdom. This has led to cutting down of the natural vegetation along the river banks leading to siltation of the river, hence posing a long term threat to manage it for its functions
Kibaale	Nakuyazo	342	Eco	It is a water catchment for Nakiriba River and wetland which drain into Nkuse River at Kikwaya. It is still a young forest with potentially good valuable timber species and therefore a future source of timber for industrial use
Kiboga	Nakwaya	477	Eco	It has steep slopes and seasonal rivers which draw into River Kabirondo/Lukuge which flows to Bukomero and therefore its purpose of gazettement was protection of protection of steep slopes, and the associated watershed. It is currently planted by NFA
Kyenjojo	Nkera	790	Eco	Mukubuli river a source for water for the community. Hills include Kanyamaizi
Bushenyi	North 2 Maramagambo	9,127	Eco	The CFR is a water catchment for Rivers Nchwera, Sherere, Rwampunu, Keizi that drain into Lake Edward. The CFR is an important water catchment for the blue lakes and Lake Nyamusingiri and Kibona wetland. The forest is a habitat for a variety of wildlife from butterflies to elephants. The forest cover in N. Maramagambo protects the fragile soils against erosion. The CFR contributes significantly to climate amelioration. Ecotourism is on-going in the Northern parts of the CFR
Bundibugyo	North Rwenzori	3,665	Eco	Located in the foot hills of Mt. Rwenzoori, the CFR serves a soil stabilisation function, protecting the area from landslides
Masindi	Nsekuro	132	Ind	A hill reserve dedicated for industrial timber production through private sector investment
Ntungamo	Ntungamo	13	Eco	Water catchment area for river Kyamate. Only FR in Ntungamo district. The forest supplies fuel wood and construction poles to Ntungamo town council. Creates employment and alleviates poverty through awarding of management activity contracts to local communities
Kibaale	Nyabigoye	495	Eco	The forest is a water catchment area for Nkuse River which drains into Muzizi River
Kibaale	Nyabiku	355	Eco	This is still a young forest with high value tree species along River Nyabiku which drains into Ruzaire at Imara. The Forest is highly and the encroached part is intended to be restored while conserving the existing forest patches
Bundibugyo	Nyaburongo	174	Eco	Located in the foot hills of Mt. Rwenzori, the CFR serves a soil stabilisation function, protecting the area from landslides
Masindi	Nyabyeya	347	Eco	This reserve is a training forest for the only forestry college in Uganda that offers both theoretical and practical skills in forestry and other forestry related courses like agroforestry, bee keeping, biomass and energy conservation, carpentry both at certificate and diploma levels. It protects the water points for domestic use in Nyabyeya Parish. The plantation provides raw materials (logs) used by the sawmill located in the forestry college for the production of commercial timber

Central Albertine Forest Reserves in the Albertine Graben

Functions
Eco = Ecological and Environmental
Ind = Industrial and Commercial Forest Plantations
Loc = Local Fuel, Charcoal and Forestry Investments

District	CFR	Area_ha	Function	Notes
Kibaale	Nyakarongo	3,535	Eco	It protects the banks of Mbaya River which feeds into River Nguse draining into Muzizi River and eventually into Lake Albert. The CFR is important for biodiversity connectivity as it connects Semliki NP to MFNP via Bugoma, Kagombe and Itwara as explained above. It is under threats of encroachment and illegal timber cutting which reduces its chances of providing high value timber for future use since it's still a young forest
Masindi	Nyakunyu	466	Ind	A hill reserve dedicated for industrial timber production through NFA planting and private sector investment
Masindi	Nyamakere	3,898	Ind	This is one of the reserves dedicated to industrial timber production through private sector investment It is heavily encroached by settlers who were evacuated at the time of establishment of Bunyoro ranging scheme. It was earlier alone
Oyam	Ojwiting	269	Loc	A catchment to Otara and Aleka Stream and the surrounding wetlands that supply water to people in Abela Parish
Arua	Okavu-Reru	420	Ind	An industrial timber plantation which has mature crop. The harvested areas are being re-planted by NFA. It has a quality tree seed stand
Amuru	Olwal	1,386	Ind	Catchment for Fabudi, Olwal, Paminaba, Cokke, Punudyang, Agung and Atotembele Streams that serve the forest adjacent communities of Oboo and Pagoro villages. The plan is to put it under industrial and/or bio-energy plantations
Nebbi	Omier	2,380	Eco	A hill reserve that protects Abiba, Ayogo and Awu hill tops from soil erosion and it's also a very important catchment area for river Nyagak where a hydro power plant is being constructed for the West Nile region. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of industrial timber plantations and transmission poles by private investors
Kyenjojo	Oruha	347	Ind	Oruha is characterised by the following hills; Rugombe, Kasozi, Mahangwe, Rubona, Oruha and Nyabubaale. It's also having two water sources; Katoobire and Kyentale. The two sources of water help the community to get water and staff of Oruha station get from Kyentale which is one of the two sources
Nyadri	Otrevu	549	Ind	Protects Turuna and Iyioyi Streams that originate from the forest, providing water to 5 villages in Omugo & Uriama subcounties. The FR was also reserved to protect the slopes of Osundua Hill, and to provide forest products to the surrounding population. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of industrial timber and bio-energy to generate economic returns
Moyo	Otzi East	18,757	Eco	The CFR is part of the network of critical sites for biodiversity conservation in Uganda. it protects the source of water for Moyo Town Council & Metu S. County; key streams include Chala, Apipi, Amua, Ayiro, Ubi, Ayido, and Awodo
Moyo	Otzi West	425	Eco	The CFR is part of the network of critical sites for biodiversity conservation in Uganda. It is a water catchment for streams feeding into River Nile
Koboko	Ozubu	681	Loc	It protects the banks of Kochi River that flows through the forest reserve. Providing water for domestic and livestock survival in Midia and Ludara Subcounties. It is the only land left with valuable indigenous trees and other vegetation types
Mbarara	Rugongi	5	Loc	The only reserve in the vast Kiruhura District. It will be licensed to a local person to grow a forest plantation to provide forest products for this district
Kibaale	Rukara	456	Eco	The forest protects the banks of River Rukara for which the reserve constitutes a catchment area; this river / stream drain into River Ruzaire. The local communities along this Rukara River use it for domestic and small-scale industrial processing. It's also a young forest with a high potential of future valuable timber tree species for industrial use
Rukungiri	Rukungiri	26	Eco	CFR is a water catchment area which supplies Rukungiri Town. absorbs toxic gases emitted by urban activities in Rukungiri towns -Forest reduces speed of surface run-off of rain water and filters the percolating water. Provides construction materials and fuel wood
Rukungiri	Rushaya	31	Loc	FR supplies fuel wood for tobacco industry and domestic use plus poles for the construction industry
Kibaale	Ruzaire	1,160	Eco	The forest acts as a water catchment area for Ruzaire River which eventually drains into Nkuse and Muzizi Rivers
Kibaale	Rwengeye	329	Eco	It protects the banks of River Pachwa which drains into Nkuse River which in turn eventually drains into Muzizi River and finally to Lake Albert. It is part of the biodiversity corridor connecting Murchison Falls Park, Budongo, Bugoma to Matiri - Itwara CFRs and Semliki NP. It is also a watershed for Nkuse River, which eventually feeds into Lake Albert. It is a young high forest with a potential for producing high value timber from natural forest. Encroachment is a serious threat to the ecological and economic functions of the reserve
Rukungiri	Rwengiri	155	Loc	Forest protects the banks of River Kachindo. Wetlands within CFR help reduce flooding. Provision of fuel wood for tobacco industry, timber and poles for construction by the private farmers
Masindi	Rwensama	127	Eco	The forest protects Sonso river and other water points used by the local community for domestic use in Nyabyeya Parish, Budongo Sub county. It is used by Nyabyeya Forestry College for training and research. It has a high potential for Eco-tourism as it has a variety of wildlife including chimpanzees and unique natural high forest plants. The forest contains a high population of young mahogany and being near the Masindi-Butiaba highway, its prone to illegal timber activities

Central Albertine Forest Reserves in the Albertine Graben

Functions

Eco = Ecological and Environmental
Ind = Industrial and Commercial Forest Plantations
Loc = Local Fuel, Charcoal and Forestry Investments

District	CFR	Area_ha	Function	Notes
Kyenjojo	Rwensambya	671	Ind	The local communities of Kabwenza, Kyakatwanga, and Muhangi use Gaiboleka stream for drinking water. other streams include galiboreka which is used by the community of Kibuye. Hills include Kyamukumbya all in Kyegegwa Sub county. Private tree planting is taking place this reserve
Ntungamo	Rwoho	9,073	Ind	Together with Bugamba, it protects the hills in this part of Mbarara -Isingiro - Ntungamo Districts. It is an industrial timber plantation which is being harvested and re-planted by NFA. The World Bank has funded a prototype carbon project for NFA in this reserve
Masindi	Sirisiri	492	Ind	A hill reserve dedicated for industrial timber production through NFA planting and private sector investment
Rukungiri	South Maramagambo	15,175	Eco	CFR is a water catchment for rivers Rushaya, Nchwera, Rugaizi that drain into Lake Edward. Rivers Rushaya and Rugazi are important sources of domestic water for the parishes of Kikarara Bwambara, Nyabubare and Kanyabwanga in Rukungiri and Bushenyi districts. The forest provides sanctuary to a variety of wildlife since it is adjacent to Kigezi wildlife Reserve which is part of Queen Elizabeth protected areas. The forest cover protects soils against erosion and land slides. The forest supplies local communities with NTFP such as herbal medicine, dead wood. The forest contributes for local community significantly to climate amelioration. It is a source of timber products for local communities adjacent to the FR. 30 hectares of the reserve are under pine plantations by the private sector
Arua	Suru	368	Ind	It was gazzetted mainly to provide forest products to the surrounding communities. To day the reserve is targeted at producing industrial timber and bio-energy to feed into a processing industry for wood products in West Nile sub-region
Kiboga	Taala	9,150	Eco	Purpose of gazettement is to protect the drainage system of R. Kitumbi and river Lugulima that join and flow north into River Kafu. Taala is good for biodiversity with its unique butterflies and it is said to have habited some hippos and buffalos that have all migrated due to human pressure. 50% of the FR is licensed to commercial tree planting for private tree planters
Nebbi	Usi	433	Ind	An industrial timber plantation which has been harvested. The harvested areas are being re-planted by NFA.
Nebbi	Wadelai	552	Loc	The harvested areas are being re-planted by NFA. Protects part of the drainage system which empties into River Nile. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of forest products like timber by small-holder outgrowers
Hoima	Wambabya	3,429	Eco	Protects River Wambabya which is a source of water for people and domestic animals in the sub-counties of Busereka, Bugambe and Kiziranfumbi. It forms part of a net work of protected areas that constitute the watershed on the Eastern Rim of Lake Albert. It is one of the natural forests that form the biodiversity corridor connecting Budongo CFR, Murchison National Park, Bugoma CFR and Kabwoya Wildlife Reserve. Encroachment in the area is a big threat to the ecological functions of the forest
Nyadri	Wati	764	Eco	Protects the steep hills of the Mt. Wati System and the streams that originate from there. A gravity water flow scheme which served the local communities has dried up due to deforestation as a result of cultivation and over-harvesting of woodfuel, leaving the hill slopes bare. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of forest products like honey and services like scenic drives and mountain hiking to generate economic returns
Nebbi	West Uru	293	Loc	A hill reserve that protects Uru hill top from soil degradation and also act as head water catchment for small streams which eventually find their way into River Nyagak. Today, the FR is still managed for the same environmental purposes but it is also targeted for production of forest products like honey and services like scenic drives and mountain hiking to generate economic returns
Amuru	Wiceri	6,470	Eco	It is the source and watershed for streams and rivers for serving the people of Amuru with water and joining River Nile for example, Omee stream serving Omee community. It supports animal population from the Murchison Falls National Park
Kiboga	Zimwa	834	Eco	Forms part of the Singo Hills, Singo County of Northern Buganda. Consists of steep hills that require protection from soil erosion. The CFR is the source of River Karaga flowing from Bukomero area through the reserve. Part of it has been licensed to private tree farmers who have already planted about 10% of the reserve
Adjumani	Zoka	6,089	Eco	The CFR is part of the network of critical sites for biodiversity conservation in Uganda, with a unique flying squirrel. It is a water catchment area for Zoka, Itiriwa, Esia, Lidwi and Dangani streams

3.3 Sensitivity of wetlands

This dataset below shows the distribution and sensitivity of wetlands in the whole Albertine graben. ASTER, SPOT XS and a few Landsat 7 ETM+ satellite images of the period between 2006 and 2008 were used to map the wetlands. The images covered 70%, 21% and 9% of the land area of Uganda respectively. Of these 60% were for 2008. For all the images the spatial resolutions was restricted to between 15 and 20 m.

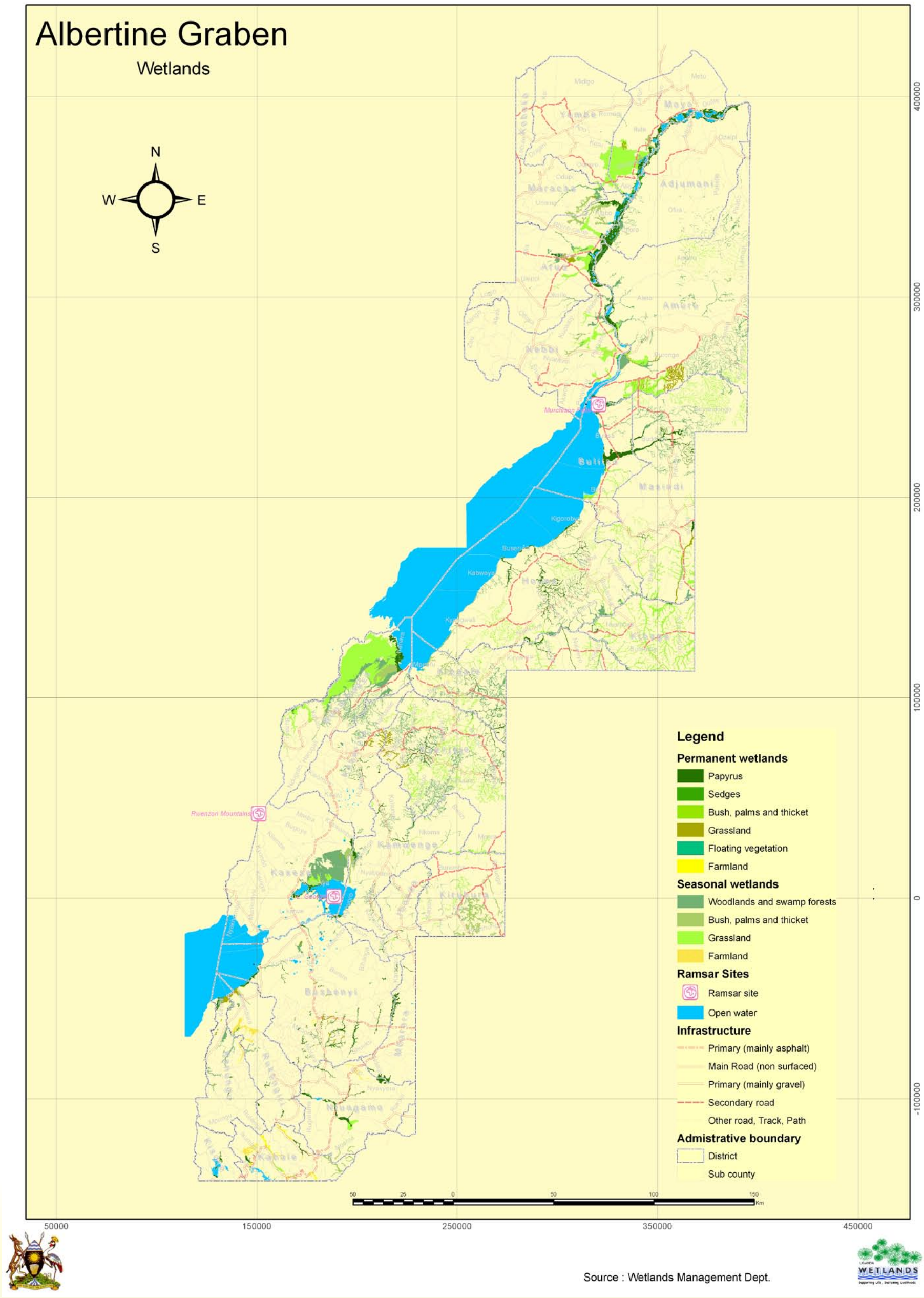
Wetlands in the Albertine graben fall into five of the eight major catchments. They are mainly in the Lake Albert but also in some parts of the Albert Nile, Lake Edward, Lake Victoria and Victoria Nile catchments. The wetlands are stratified into five land cover types namely papyrus, sedges, grassland, swamp forests and farmland. These are also categorized by water regime as seasonal (s) and permanent (p) wetlands. Seasonal wetlands are defined as those with water regime of between two to four months. While the permanent are those which retain water for at least four months.

The sensitivities of the wetlands were derived from the general sensitivities of the land cover classes (1 - 9). The calculations were based on the importance and difficulty of wetland restoration if affected by oil spills. The final sensitivity of each wetland was computed based on its hydrological function and ecological response. The specific variables used are ecological characteristics of a wetland; water regime and vegetation cover density. These resulted in sensitivity values ranging from 6 to 9. These were then standardized to the sensitivity range of 1-9 (See table 1).

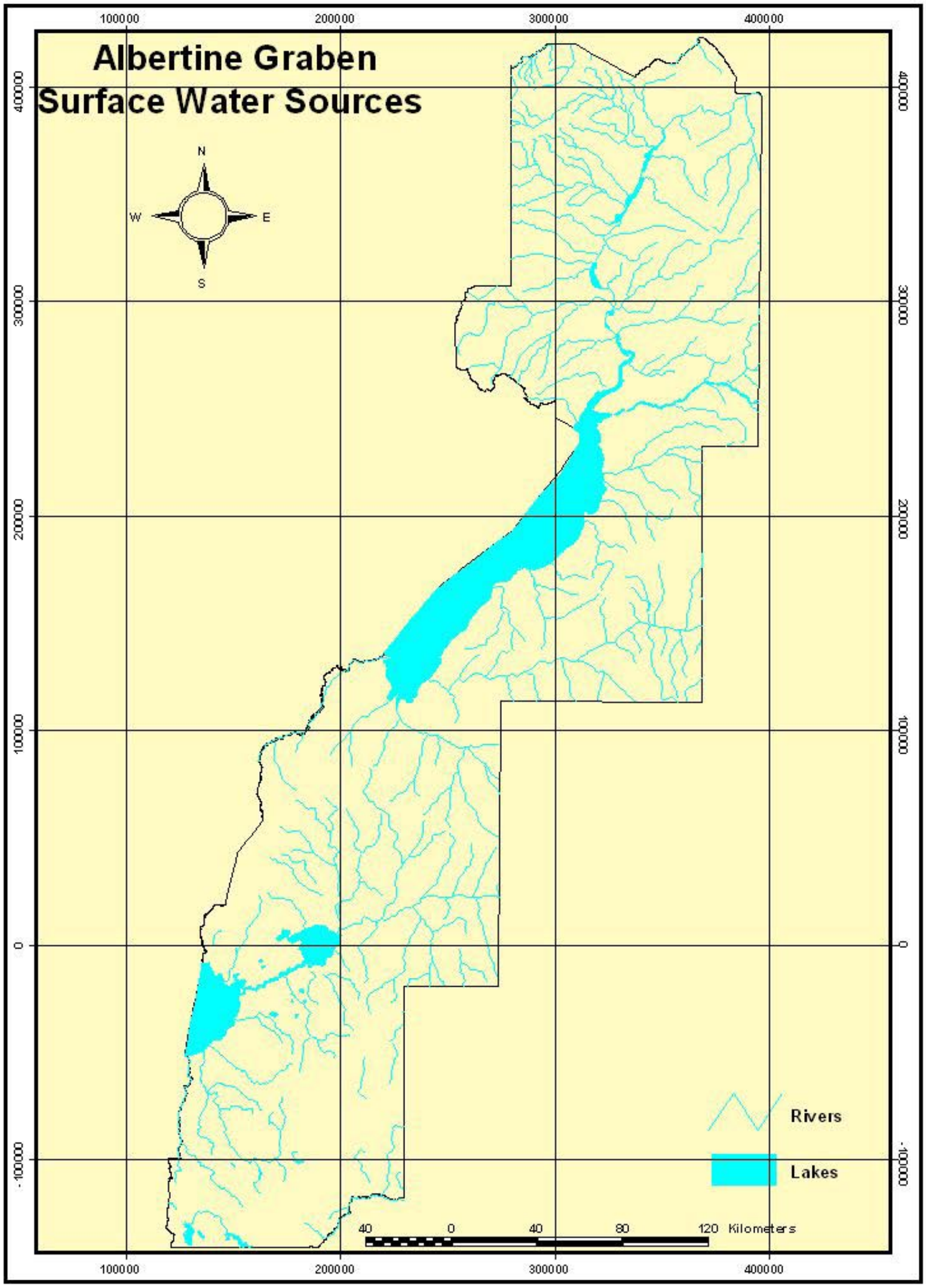
Class Name	Ecological	Water Regime	Density	Sensitivity	Description
				Land cover	Wetlands
Grassland (s)	3	2	1	6 1	Rangelands, pasture, open savannah may include scattered trees shrubs and thickets
Subsistence farmland (s)	3	2	1	6 1	Mixed farmland small holdings in use or recently used with or without trees
Palms and thickets (s)	3	2	2	7 4	Thick or sparse palm trees and or scattered trees and shrubs
Grassland (p)	3	4	1	8 6	Rangelands, pasture, open savannah may include scattered trees shrubs and thickets
Sedges (p)	3	4	1	8 6	Rangelands, pasture, open savannah may include scattered trees shrubs and thickets
Subsistence farmland (p)	3	4	1	8 6	Mixed farmland small holdings in use or recently used with or without trees
Papyrus (p)	3	4	2	9 9	Swamps with Papyrus as dominant species
Swamp forest(p)	3	4	2	9 9	Thick closed canopy forests and woodlands

Table 3: Sensitivity of wetlands

Fig. 27: A typical wetland.



Map 31: Albertine graben wetlands.



Map 32:Albertine graben Surface water sources.

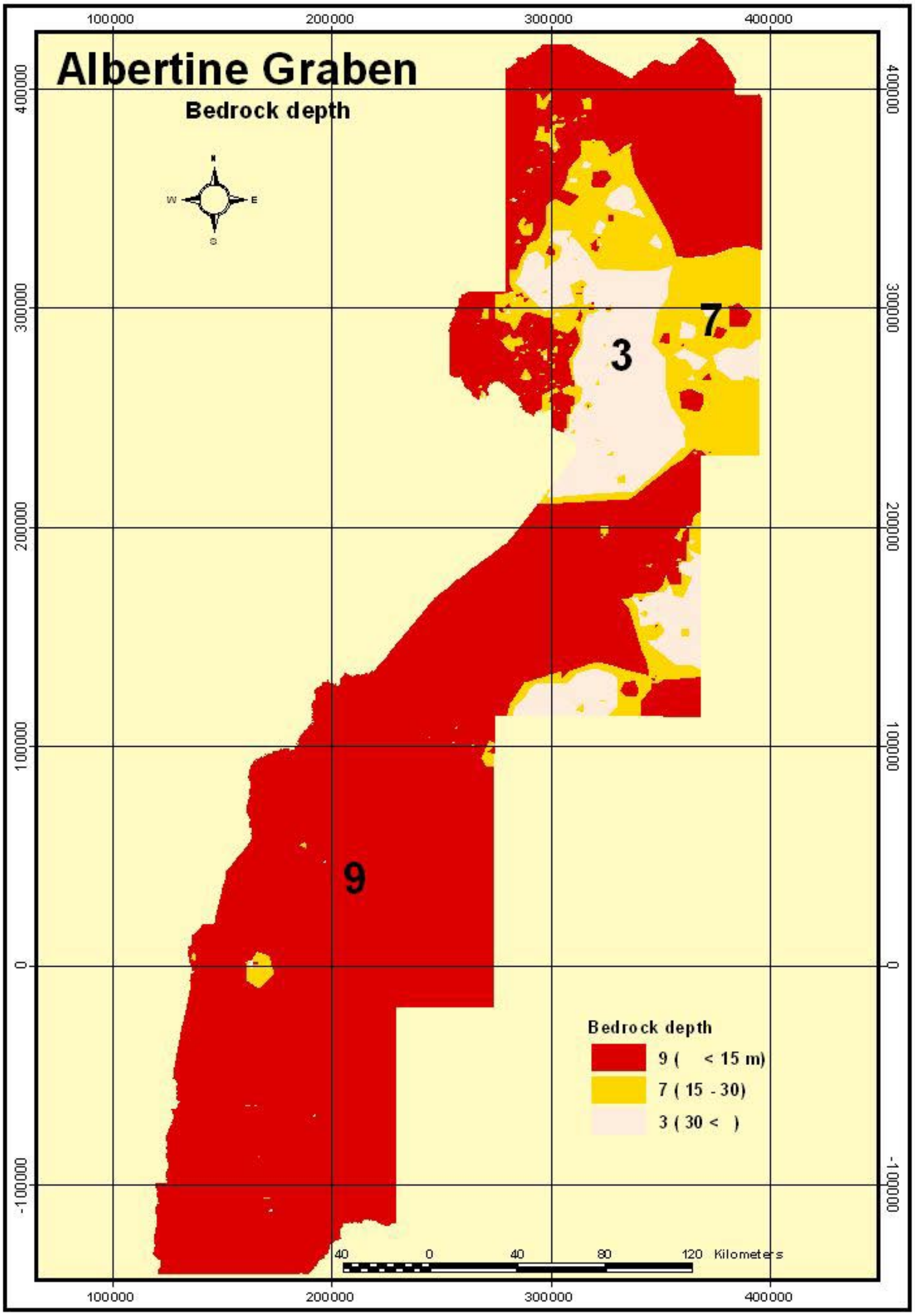
3.4 Sensitivity of Water and Lakes

Water resources have been classified into surface and groundwater. In terms of sensitivity, water resources will be affected in terms of quantity and quality by the oil development and its related developments.

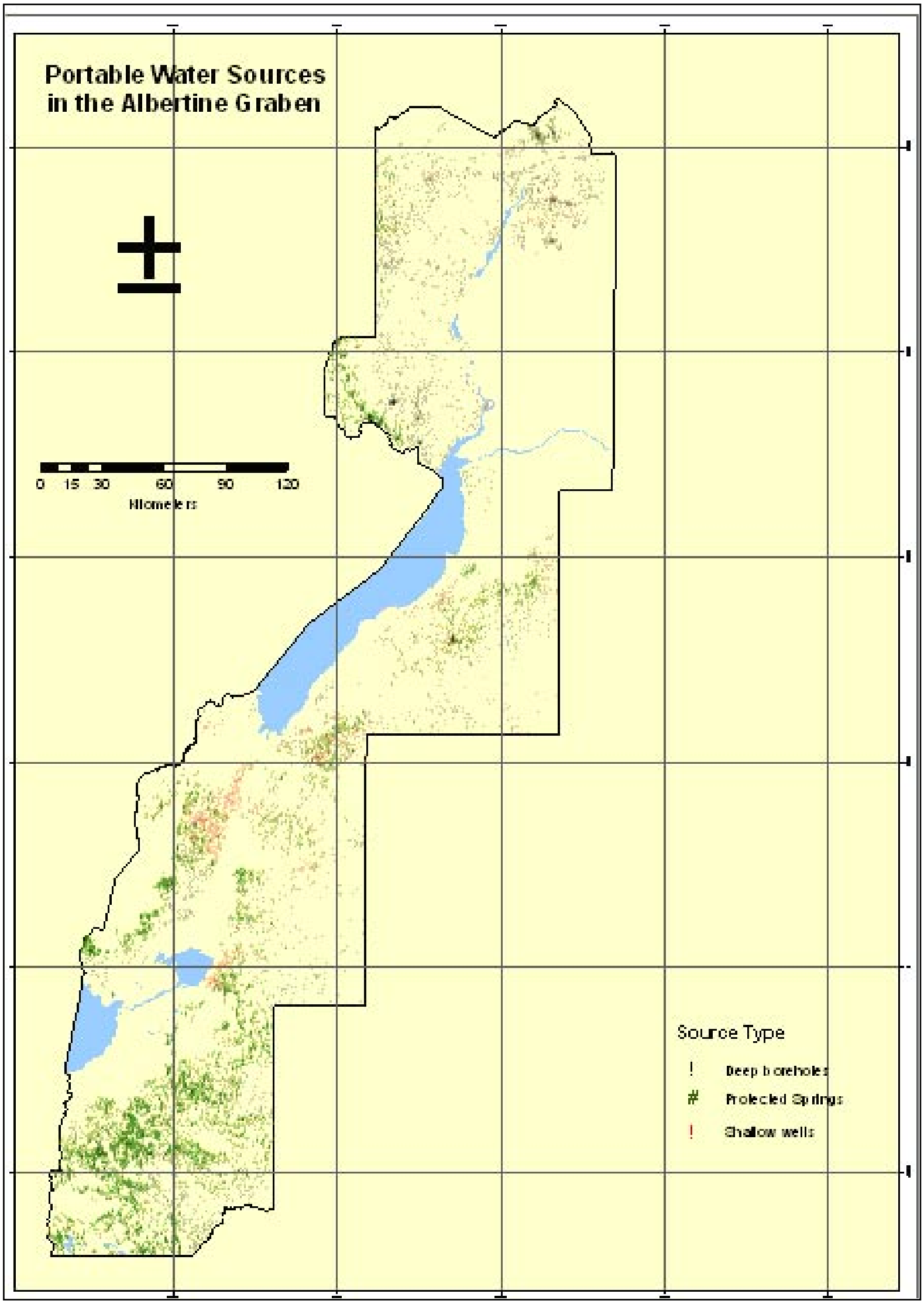
3.4.1 Surface water sources

There are three major lakes within the graben; Lake George, Lake Edward and Lake Albert. While bathymetric studies have been undertaken on Lake Albert, the levels of Lake George and Lake Edward are unknown. Also within the graben, there are many rivers and streams as presented in the map above.

Surface water sources within the graben are very vulnerable to contamination and are therefore categorized as highly sensitive. Sensitivity reduces with distance from the respective sources.



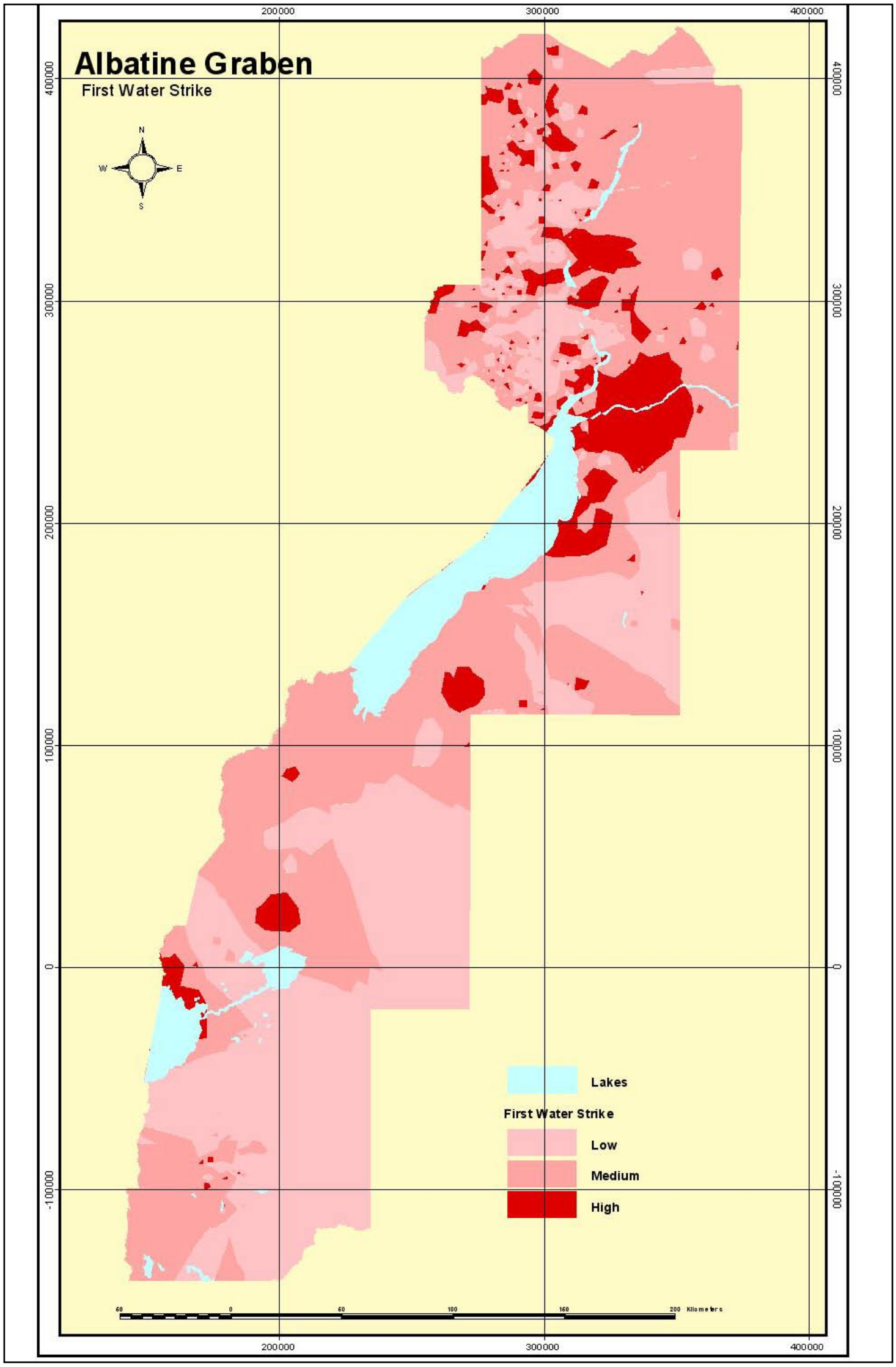
Map 33: Albertine graben Bedrock depth.



Map 34: Albertine graben Portable water Sources.

3.4.2 Groundwater

The Ugandan rural population depends on groundwater for domestic purposes as a result extensive groundwater development has taken place in the Albertine graben. The map in figure 3 shows the extent of groundwater development in this area. Just like sensitivity of surface water sources, the sensitivity of each of these sources is highest at the source and reduces away from the source.

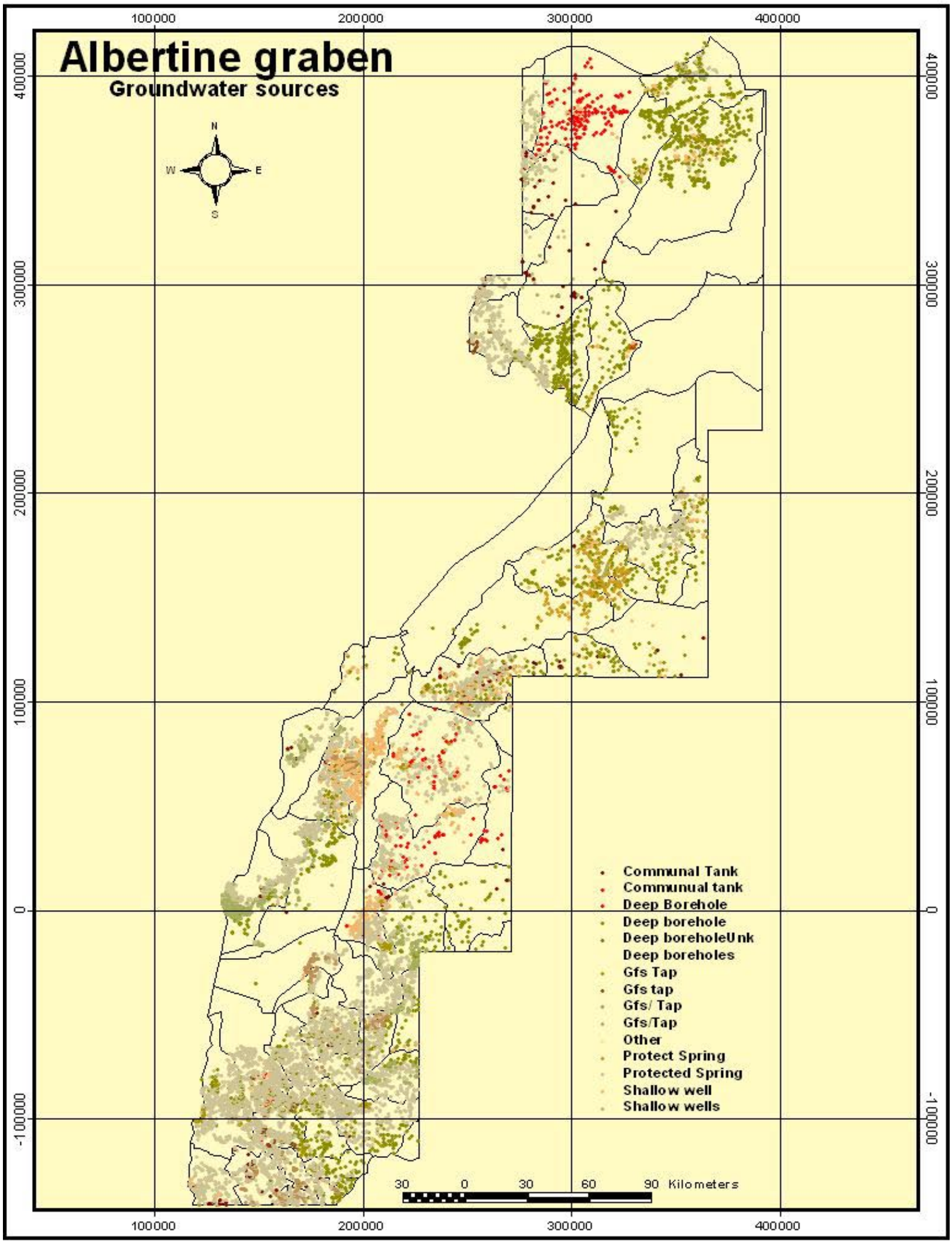


Map 35: Albertine graben First Water Source.

3.4.3 Groundwater resources sensitivity

This map was prepared on the basis of the level at which water is first intercepted if one is to drill in that area (first water strike). It is a general indication of the level of the first aquifer underlying the graben.
The first water strike map gives an indication of how easily groundwater can be contaminated. The shallower the groundwater the more susceptible it is to contamination. Therefore a shallower water strike is more sensitive than deeper water strike.

The map was prepared using data from borehole logs and springs in the Albertine graben.
The description of sensitivity of first water strike is divided into three ranks as shown in Table 4.

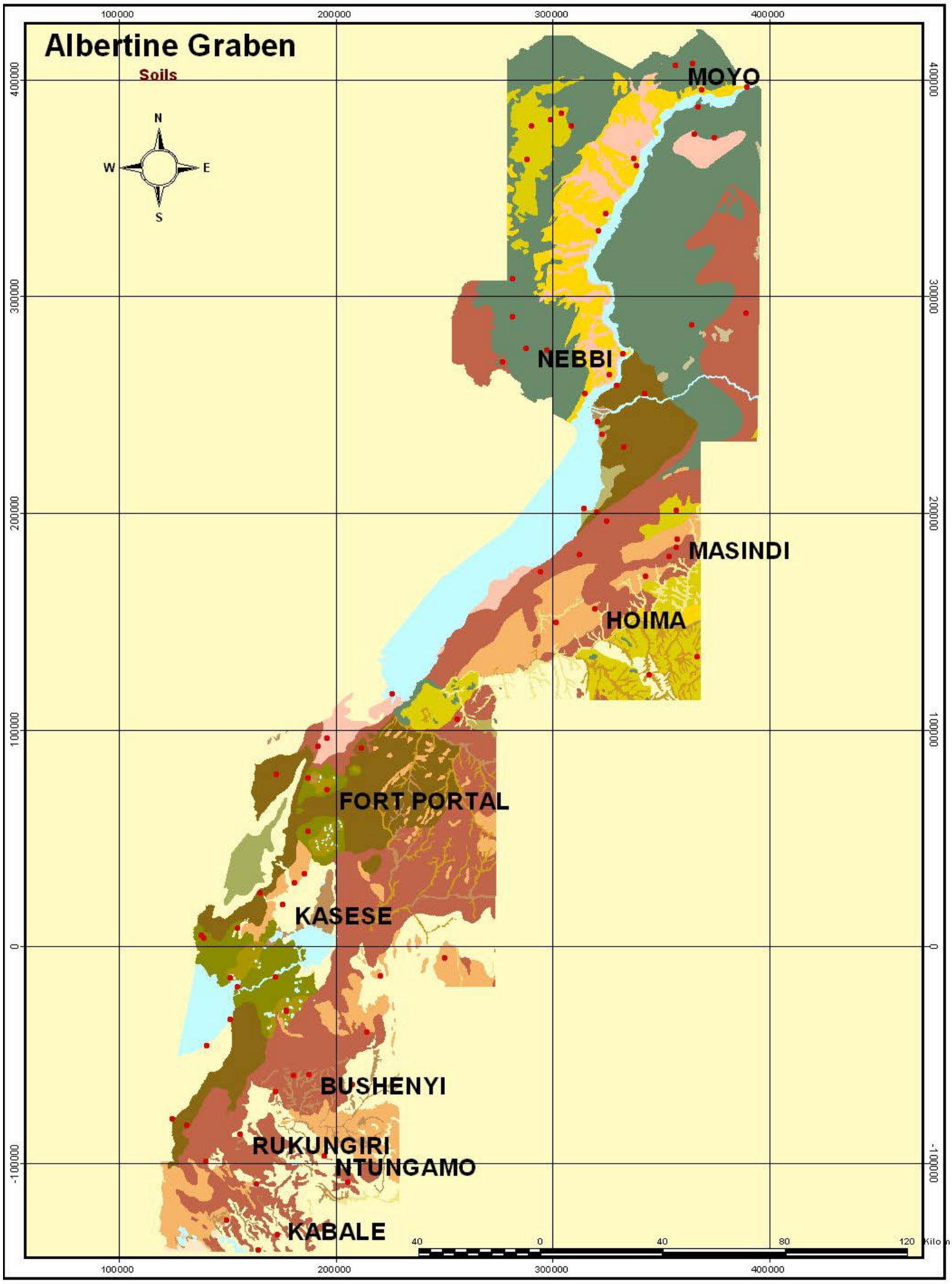


Map 36: Albertine graben Groundwater Sources

Table 4: Sensitivity of Groundwater resources

Depth to Water Strike in meters below ground level	Description of sensitivity	Rank
1 – 15	High	9
15 – 30	Medium	7
> 30	Low	3

From analysis, 80% of the area has high sensitivity, 8% has medium sensitivity and 12% has low sensitivity. The ranks are given to the respective classes in terms of sensitivity, the higher the sensitivity, the more vulnerable the resource to contamination therefore the higher the rank.



Map 37: Albertine graben Soils durability

3.5 Sensitivity of soils

3.5.1 Soil erosion hazard assessment

Emphasis was put on the role of water erosion which is governed by the following land characteristics: climate, land surface, soil, land cover and management. The erosion risk is assessed by:
erodibility + erosivity + slope steepness

3.5.1.1 Soil erodibility

The resistance of the soil to disintegration of soil aggregates and the dispersion and detachment of the soil particles was assessed using clay and silt percentage, organic matter content. Organic matter and silt/clay ratio ratings were derived from the soil survey data (topsoil 0 – 30 cm) at the National Agricultural Research Laboratories, Kawanda (See soil map above). The ratings (Siderius, 1992) are indicated in the tables below:

Table 5: Soil organic matter and carbon rating

Table 6: Rating of the silt/clay ratio

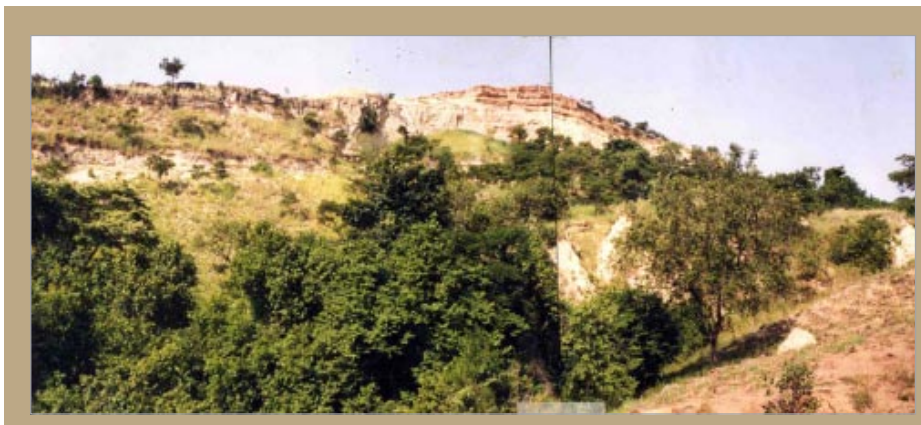


Fig. 28: Sandstones of the Kisegi formation exposed in Kibuku, Semliki Ba-

Fig. 29: Sandystone of the Segugoro formation in Kaiso-Tonya area

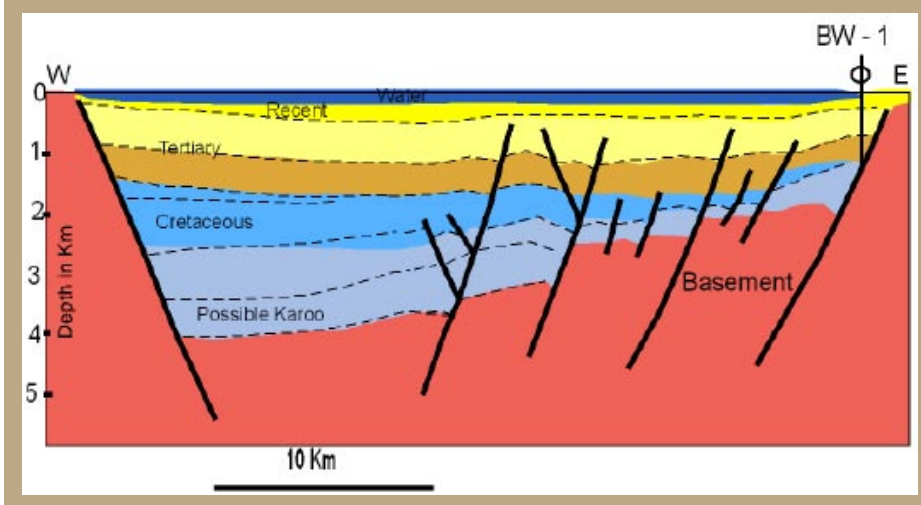


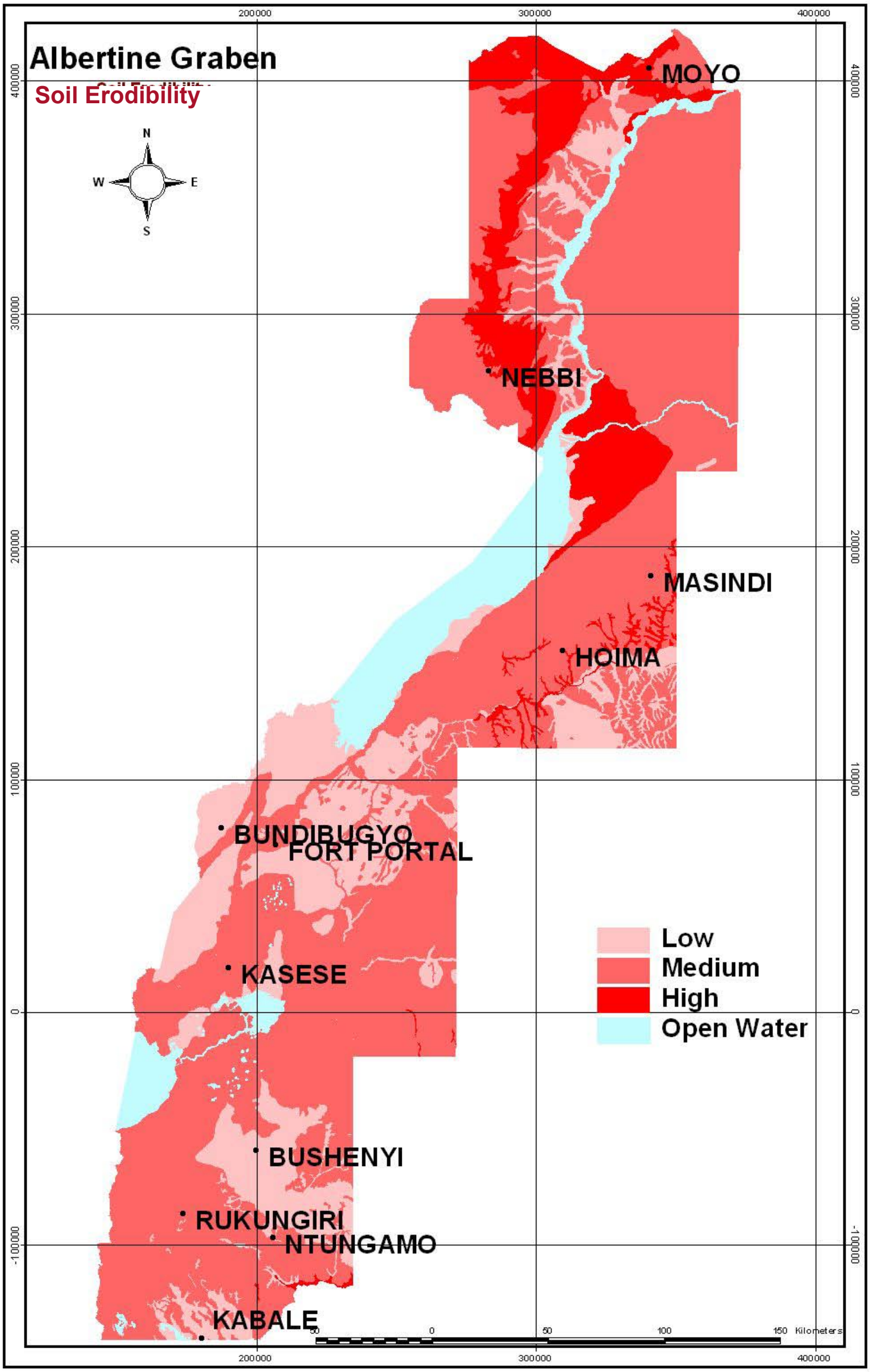
Fig. 30: East-West structural cross-section across the Albertine graben

Soil erodibility factor rating

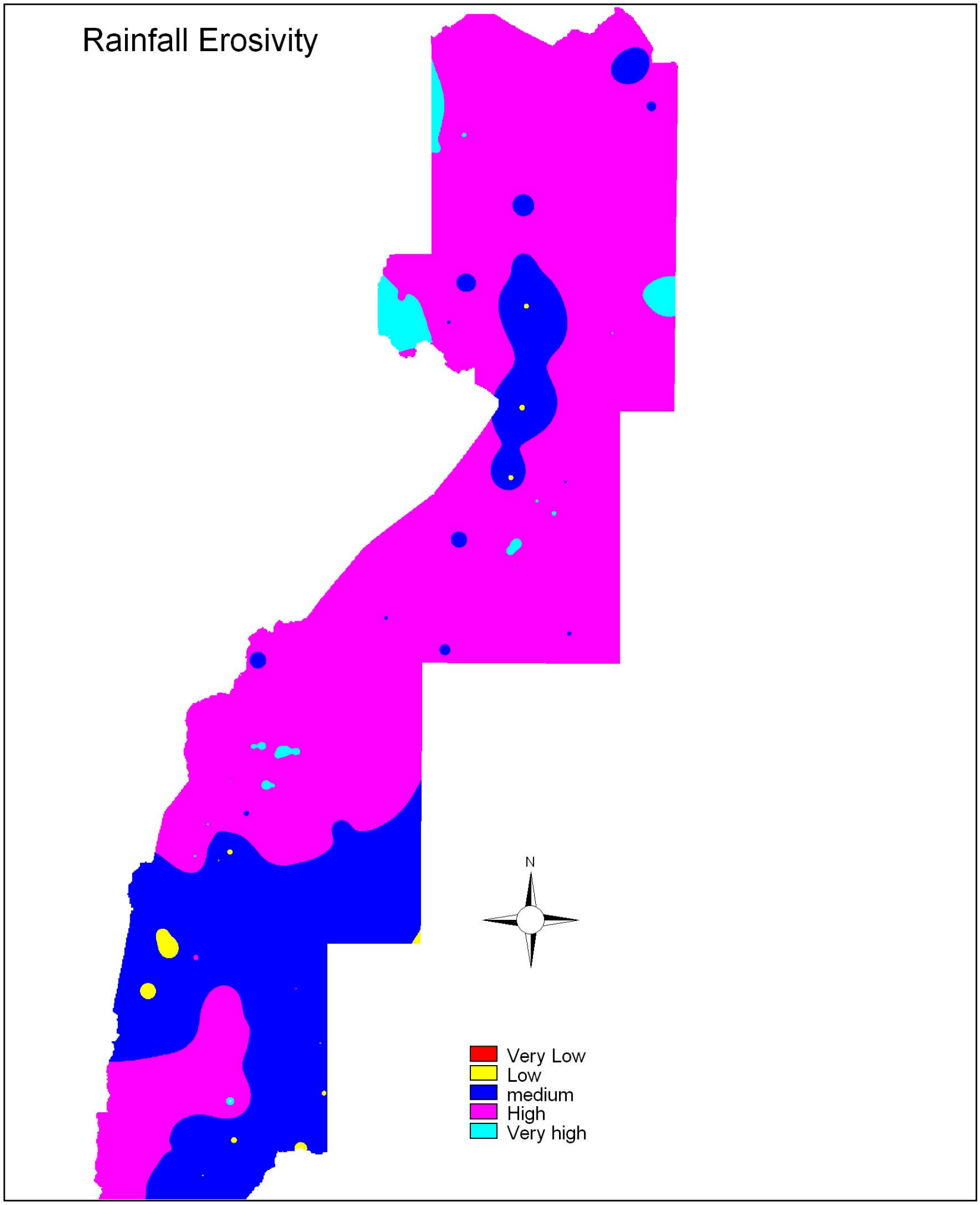
The final soil erodibility rating was obtained by adding the soil organic matter and silt/clay ratio sub ratings. The final soil erodibility rating is shown in table

Table 7: Final soil erosion erodility factor rating

Fig. 31: Sandy soils in the Albertine graben



Map 38: Albertine graben Soil erodability



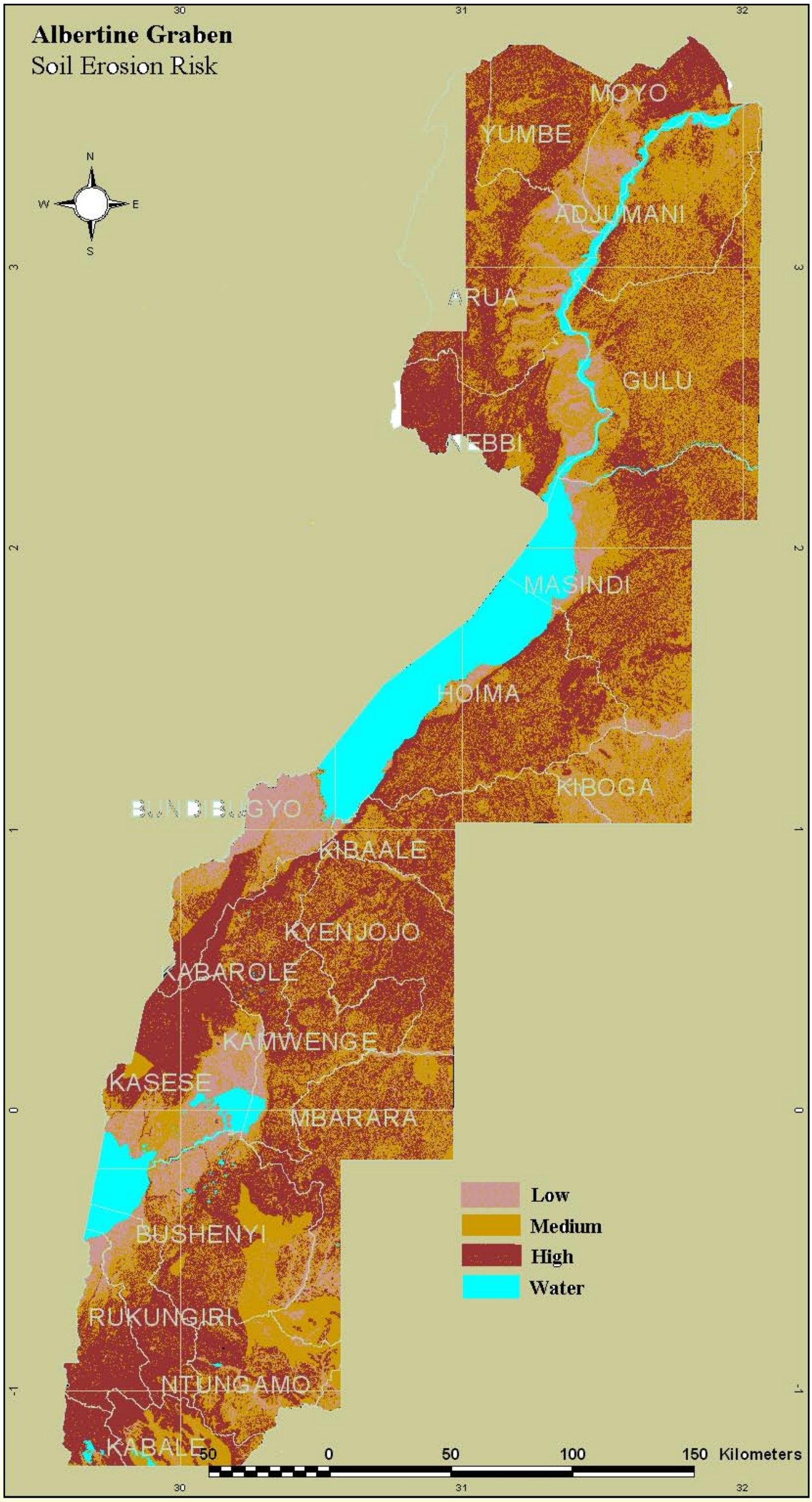
Map 39: Albertine graben Rainfall erosivity

The slope factor

Slope gradient was derived from the SRTM digital elevation model using the Integrated Land and Water Information System (ILWIS). The slope was categorized into 5 classes namely:

Table 8: Erosional slope rating and categories

Rating	Erosional slope (%)	Categories
-2	0 – 3	Nearly level
-1 to 0	3 – 8	Undulating to gently sloping
+1 to + 2	8 – 16	Rolling to steep
+3	16 – 30	Hilly to moderately steep
+4	> 30	Steep to very steep



Map 40: Albertine graben Soil Erosion Risk

The rainfall factor (Erosivity)

The energy generated by the falling raindrops that disintegrates soil aggregates and dispersion was derived from mean annual rainfall values using the following equation
developed by Moore (1979) for East African conditions:

R = 0.029 × (3.96× P + 3122)− 26 (Moore, 1979) (7.4)

where:
R= Rain erosivity (J mm /m2/h)
P= Annual rainfall (mm/year)

The final ratings depicting soil erosion risk was obtained by crossing of the soil erodibility, erosivity and slope steepness maps (See erosion risk map). The erosion risk map shows areas that require soil conservation measures to minimize surface water runoff.

Table 9: The rainfall erosivity factor rating and categories

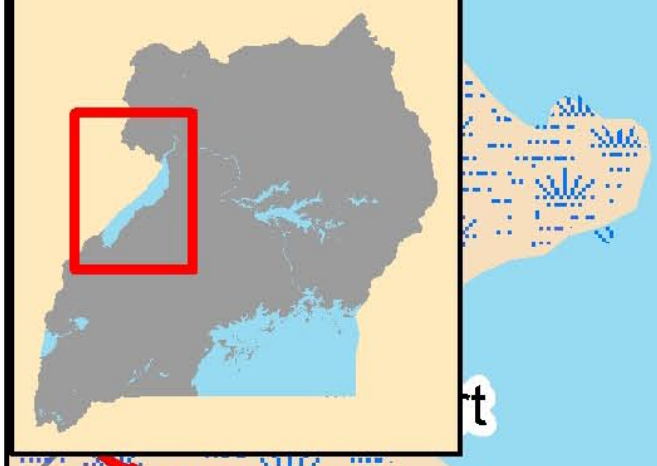
Rating	Erosivity (J mm /m2/h)	Categories
1	0 – 144	Very low
2	144 – 172	Low
3	172 – 199	Medium
4	199 – 227	High
5	227 – 254	Very high

Fig. 32: Oil exploration along Lake Albert

CHAPTER 4

SENSITIVITY SHORELINES

Fig. 33: Oil testing in the Albertine graben; (*Inset*) Looking North up the escarpment along Lake Albert faultline.
Source: **Petroleum Exploration and Production Department (PEPD) 2008**



Lake

Albert

RWANGARA

Katoma

Ntoroko

Nyakasenyi

NTOROKO

SEMULIKI NP

NDAIGA

Kitebera

Kalondo

RWABARANGA

Buyaga

Ndaiga

NYANTONZI

Lulangala

KARUGUTU

KYATEREKERA

NYAKARONGO

KABENDE

Kyabweme

Map 41: Senstivity of Lake Albert shoreline

KYANGWALI
Kyangwali
Kasonga
Kasungwa
BUHUKA
KYANGWALI GR
KASONGA
BURORA
RUBIRIZI
Kyambogo
Kyabaniamu
MUGYENZA
NYAMUKARA
Bulaza
ojo
GAL
KISUURA
Kitumba
Kisuura
MAIRIWE
ongo
Bwikara
NYAMITI

Sensitivity Atlas Map 1

Legend

- Market/Trading center
- Settlement
- Hotel
- Achaelogical site
- airstrip
- Fishing sites
- Fish landing site
- Boat landing site

Average fish catch assessment per year (Kg)

- 0-156
- 157-313
- 314-469

- Bore wells
- Prop water abstr' point-EPS
- Wildlife animals
- Bird & Plant area
- Exploration Site

Sensitivity Ranking Index

- Low
- Medium
- High

- International boundary
- Parish boundary
- Fish sensitive areas
- New access road
- Production pipeline
- Proposed EPSarea
- Road
- River
- Expl boundary 1,2,3A
- Fault line
- Oil Prospective site
- Kaiso Lagoon
- Thicket
- Wildlife reserve
- National park
- Wetland/Shrub
- Water body

N

0 1.5 3 6 9 12

Kilometers

Lake

Albert

Buhuka

Buhuka

Rwemisanga

Ngogole

KYANGWALI

Kyangwali

Kasonga

Kabaale

Kaseeta

K

Sensitivity Atlas Map 2

Legend

- Market/Trading center
- Settlement
- Hotel
- Achaelogical site
- airstrip
- Fishing sites
- Fish landing site
- Boat landing site

Average fish catch assessment per year (Kg)

- 0-156
- 157-313
- 314-469
- Bore wells
- Prop water abstr' point-EPS
- Wildlife animals
- Bird & Plant area
- Exploration Site

Sensitivity Ranking Index

- Low
- Medium
- High

- International boundary
- Parish boundary
- Fish sensitive areas
- New access road
- Production pipeline
- Proposed EPSarea
- Road
- River
- Expl boundary 1,2,3A
- Fault line
- Oil Prospective site
- Kaiso Lagoon
- Thicket
- Wildlife reserve
- National park
- Wetland/Shrub
- Water body

N

0 1.5 3 6 9 12

Kilometers

Lake

Albert

Sensitivity Atlas Map 2A

Legend

- Market/Trading center
- Settlement
- Hotel
- Achaelogical site
- airstrip
- Fishing sites
- Fish landing site
- Boat landing site

Average fish catch assessment per year (Kg)

- 0-156
- 157-313
- 314-469

- Bore wells
- Prop water abstr' point-EPS
- Wildlife animals
- Bird & Plant area
- Exploration Site

Sensitivity Ranking Index

- Low
- Medium
- High

- International boundary
- Parish boundary
- Fish sensitive areas
- New access road
- Production pipeline
- Proposed EPSarea
- Road
- River
- Expl boundary 1,2,3A
- Fault line
- Oil Prospective site
- Kaiso Lagoon
- Thicket
- Wildlife reserve
- National park
- Wetland/Shrub
- Water body

N

0 1.5 3 6 9 12

Kilometers

Lake

Albert

Sensitivity Atlas Map 2B

Legend

- Market/Trading center
- Settlement
- Hotel
- Achaelogical site
- airstrip
- Fishing sites
- Fish landing site
- Boat landing site

Average fish catch assessment per year (Kg)

- 0-156
- 157-313
- 314-469

- Bore wells
- Prop water abstr' point-EPS
- Wildlife animals
- Bird & Plant area
- Exploration Site

Sensitivity Ranking Index

- Low
- Medium
- High

- International boundary
- Parish boundary
- Fish sensitive areas
- New access road
- Production pipeline
- Proposed EPSarea
- Road
- River
- Expl boundary 1,2,3A
- Fault line
- Oil Prospective site
- Kaiso Lagoon
- Thicket
- Wildlife reserve
- National park
- Wetland/Shrub
- Water body

N

0 1.5 3 6 9 12

Kilometers

NKONDO

KASEETA

KYANGWALI GR

KABALE

Kabaale


Lake Albert
KAPAAPI
KIGANJA
KISUKUMA
NORTHERN WARD
Kigorobya
BWIKYA
SOUTH W. WARD
SOUTH E. WARD
NORTH E.
KIIONGO
NYAKABINGO
KATANGA
Bugambe Plantation L
Sensitivity Atlas Map 3
Legend
Market/Trading center
Settlement
Hotel
Achaelogical site
airstrip
Fishing sites
Fish landing site
Boat landing site
Average fish catch assessment per year (Kg)
0-156
157-313
314-469
Bore wells
Prop water abstr' point-EPS
Wildlife animals
Bird & Plant area
Exploration Site
Sensitivity Ranking Index
Low
Medium
High
International boundary
Parish boundary
Fish sensitive areas
New access road
Production pipeline
Proposed EPSarea
Road
River
Expl boundary 1,2,3A
Fault line
Oil Prospective site
Kaiso Lagoon
Thicket
Wildlife reserve
National park
Wetland/Shrub
Water body
N
0 1.5 3 6 9 12
Kilometers
UNEP

Lake

Albert

Butiaba

Lake Albert

KAPAAPI

KIGANJA

Sensitivity Atlas Map 4

Legend

- Market/Trading center
- Settlement
- Hotel
- Achaelogical site
- airstrip
- Fishing sites
- Fish landing site
- Boat landing site

Average fish catch assessment per year (Kg)

- 0-156
- 157-313
- 314-469

- Bore wells
- Prop water abstr' point-EPS
- Wildlife animals
- Bird & Plant area
- Exploration Site

Sensitivity Ranking Index

- Low
- Medium
- High

- International boundary
- Parish boundary
- Fish sensitive areas
- New access road
- Production pipeline
- Proposed EPSarea
- Road
- River
- Expl boundary 1,2,3A
- Fault line
- Oil Prospective site
- Kaiso Lagoon
- Thicket
- Wildlife reserve
- National park
- Wetland/Shrub
- Water body

N

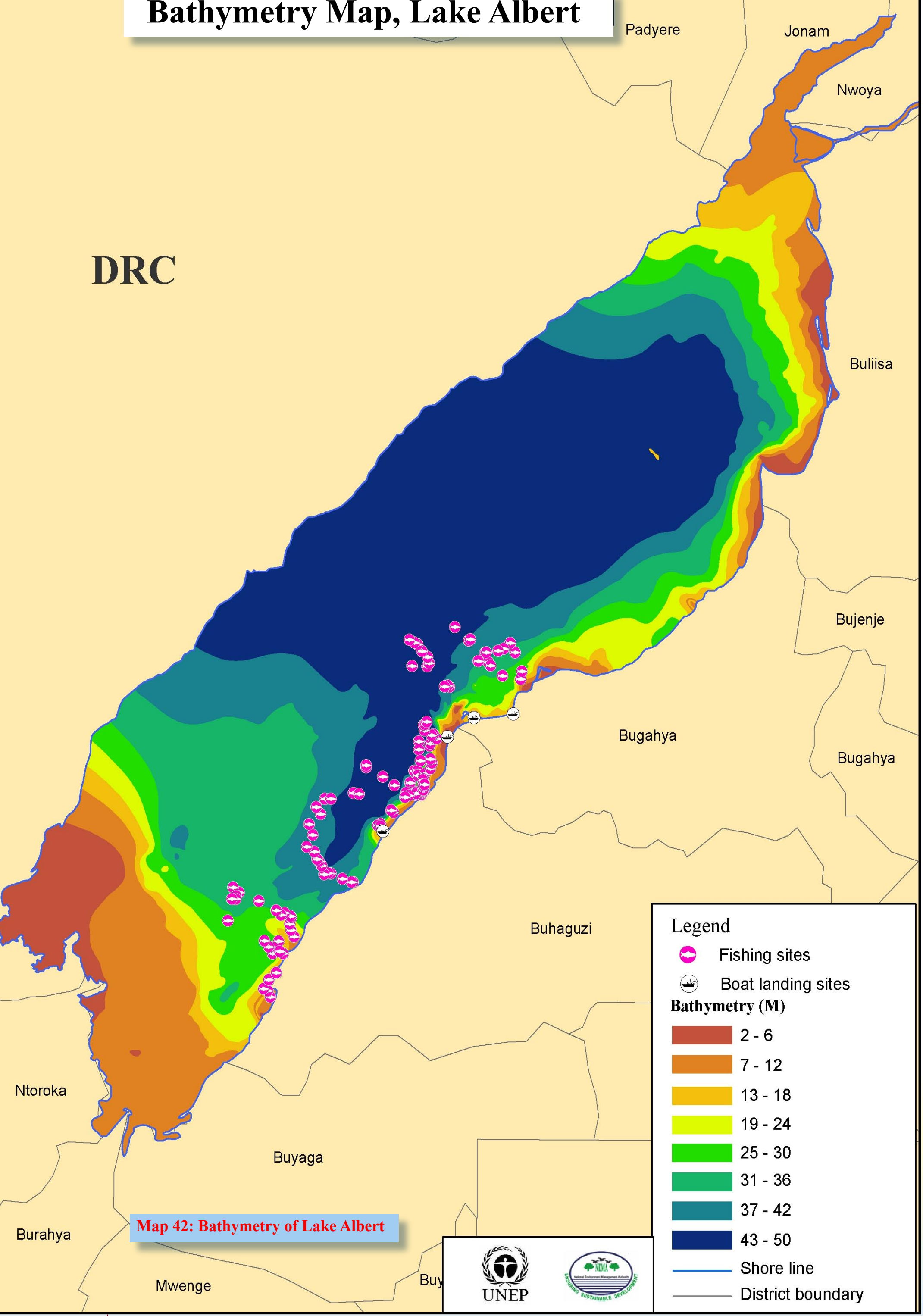
0 1.5 3 6 9 12

Kilometers

Bukumi

Forestr

Bathymetry Map, Lake Albert



Map 42: Bathymetry of Lake Albert

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