Background Information on Natural Resources in the Kagera River Basin

Location and Extent of Kagera Basin

The Kagera River basin is the upper part of, and makes up 75% of the Lake Victoria basin and forms the western border between Rwanda and Tanzania. It encloses a total area of 59,700km^2 spread over four countries: Burundi (23%), Rwanda (34%), Tanzania (35%, 20,765km^2) and Uganda (8%).

The Kagera River is the most important incoming river of Lake Victoria. The inflow into Lake Victoria from the Kagera River is estimated at 7.5 km^3 per year, of which 0.5 km^3 is generated within Tanzania (FAO, xxxx). The land and open water surface in each district draining into the Kagera River is illustrated in Table 1.

Climate

The climate in the basin is moderated by altitude relief and many water bodies. It ranges from sub-humid to semi-arid with a bimodal rainfall with two dry and two rainy seasons per year, with the wettest months in April and November.

Definitions of drylands and semi-arid zones vary according to the purpose of the classification, for example by FAO, UNCCD and UNCBD:

- Under FAOs agro-ecological zones classification, which takes into account the growing period: Drylands include arid and semi-arid lands, as well as hyper-arid "desert" areas, . Typically, arid areas receive less than 200mm of winter rainfall annually or less than 400mm of summer rainfall, while semi-arid areas receive 200-500mm of winter rainfall or 400-600mm of summer rainfall. Drylands are defined as areas where mean annual precipitation is less than half the potential evapotranspiration. This in turn is reflected in the number of growing days that constitute the *length of the growing period (LGP)* for crops. Using this criterion, FAO defines drylands as lands with a LGP of less than 120 days. Within this range, arid lands have less than 75 growing days while semi-arid lands have 75 days or more.

There are two main agro-ecological zones (i) the central area lying east of the Rwandan border where annual rainfall averages 800mm and pastoralism and annual cropping predominates and (ii) the higher altitude areas and the fringes of Lake Victoria, where higher rainfall, generally above 1000mm, and up to 2100 mm in the extreme north west of Bukoba district, Tanzania, which allows perennial cropping. The majority of the area ranges between 800mm and 1000mm. It is also higher in the west of the Akagera National Park rising to 850mm with increasing altitude and falls to 750mm in the south east of the Park (Lake Ihema) along the river.

The longest dry season is May-June to September and a short dry season between December and February. Drier areas tend to be used for pastoralism although with increasing population pressures cultivation is moving into these areas with less reliable rains.

Being near the equator temperatures are very constant. The average annual temperatures are lower in the districts bordering the lake at 20^{o}C and up to an average of 27^{o}C in the west. The mean minimum reaches 14.5^{o}C and a mean maximum reaches 27.5^{o}C. The average evapotranspiration is some 1200 mm per year.

Watersheds

The Kagera River is the main drainage line and base level of erosion of the Karagwe and Bukobe districts in northern Tanzania, the Mbarare and Rukai districts in southern Uganda and the Umutara prefecture and Akagera National Park in eastern Rwanda. Its sources are in the south in the highlands of Rwanda and Burundi, which are also the headwaters of the Nile.

The Karagwe and Bukobe districts can be divided into main drainage systems, separated by the high quartzite ridges and generally following these north-south lying geological structures. The western area is drained directly to the Kagera along the Rwandan border, by numerous smaller catchment areas of which the tributaries join the Kagera via lakes and swamps.

The Kishanda valley system drains the central part of the district, including country as far as south-west of Nyaishozi. It traverses the swamps below Nkwenda, where it is joined by tributaries draining the Kayanga, Kituntu and Rwambaizi areas. Further north, it crosses the swamps of the Kishanda valley, where the tributaries from Mabira join, and enters the Kagera in the north, just east of Murongo.

All land east of the hillrange, that runs from Kibare in the very north, to beyond Kimisi into Ngara, is drained by the Mwisa valley. The Mwisa river runs north, bending to the northeast, crossing the Kitengure plains, and enters the Kagera near Kyaka. Going southward, the Mwisa enters Lake Burigi.

The average annual discharge of the Kagera River at Kyaka is 184 m^3s^{-1} (equivalent to some 3.15 km/year) with a low ratio of maximum (540 m^3s^{-1}) to minimum (101 m^3s^{-1}) flows caused by large swampy areas in the upstream course in Karagwe District. Density of drainage lines reflect the underlying geological formation.

Geology, Landforms and Soils

Tanzania

Touber and Kanani (1994, 1996) mapped the landforms and soils of Bukoba and Karagwe Districts at scale 1:250,000, classified according to the revised legend of FAO-UNESCO Soil Map of the World (FAO-UNESCO, 1988).

A striking feature in the landforms of the Kagera Region are the high level, well drained land surfaces, which represent the remnants of old peneplains. This is in contrast to the low, flat plains surrounding the Kagera and Mwisa rivers, built up by alluvial sediments. The main differences between soils in this region are caused by differences in parent material (geology) and climate (rainfall).

In Tanzania, the Kagera Basin area is divided into three major geological zones:

1. **Precambrian Karagwe-Ankolean (A-K) metamorphic system:** underlie most of the central and western half of Bukoba District and a major part of Karagwe District. Two major parent materials are distinguished (i) quartzite, quartzite sandstones and conglomerates originating from sandy deposits, and (ii) phyllites and shales developed from clayey and silt sediments. These rocks are poor in nutrient-releasing minerals.

Strata of the first group appear in near vertical position as high ridges stretching in a north-south orientation, forming the backbone of Karagwe's landforms at elevations above 1500 masl. The highest hill ranges (about 1500 masl) in Bukoba District occupy the extreme northwest, comprise well drained, friable, shallow to deep sandy clay loams (*Leptosols* and *Ferralsols*) on the plateaux and hills developed on quartzites.

In Bukoba District, the large part of this system occupied by shale parent material appears as intricately dissected high and low hills (*Leptosols* and *Ferralsols*) and associated footslopes (*Phaeozems*) with dense drainage patterns bordering Karagwe District in the west. Many interfluves of this parent material are gently undulating 'islands' with soil complexes dominated by *Aricsols*, *Leptosols* and *Ferralsols*, among surrounding deep valleys at elevations above 1350 masl that merge with the highlands in the central-northern area of Karagwe District.

2. **Bukoban sandstone system**: is a dissected, gently undulating plateau (1250-1350 masl) representing the erosional product of the K-A system, dominated by very deep sandy clay to clay loams with sandy topsoils (*Ferralsols*). It extends from the Ugandan border, occupying the eastern part of Bukoba District adjoining Lake Victoria in a north south orientation. These rocks are poor to very poor in nutrient releasing minerals. Also present are rock outcrops and pockets of well drained, bouldery sandy loams to sandy clays (*Aricsols*).

The shorter face-slopes under the Bukoban escarpments comprise both reddish clay soils and brown sandy soils (*Aricsols*), giving way to a fringe of almost flat piedmont plains at 1100 masl (*Ferralsols* and *Arenosols*) that separate the uplands from the surrounding swamps in the northeast of Bukoba District.

3. **Late tertiary and quaternary alluvial system**: the major valley systems of Kagera and Mwisa Rivers have developed at an elevation of about 1200 masl, being part of the late Tertiary peneplain. Colluvial and erosional footslopes developed at the base of the higher valley slopes are very important agricultural lands. The lower land surface at the level of the Kagera River, is largely occupied by swamps and lakes along the Rwandan border.

At the upstream side in the west of Bukoba District, an extensive flat sandy river terrace along the Kagera River is made up of well to excessively drained brown loamy sand to sandy loams (*Cambisolos*), that splits up in a number of delta-arm levees, spreading out over the lake bed from the Kyaka-Bubale area eastward and comprising *Fluvisols, Arenosols* and *Gleysols*.

The flat to almost flat lowlands farther east comprise the greater part of a lacustrine plain of imperfectly drained silt over clay deposits (*Aricsols* and *Planosols*) at about 1100 masl (in earlier Quaternary times part of Lake Victoria). These terraces gradually merge into extensive swamps in the downslope direction in Bukoba District (*Histosols*). Soils developed on these sands, silts and clays have relatively more nutrient reserve.

Uganda

In Mbarara district, the geology and physiographic features of these plateaux exert significant influence on slope, aspect and erosional processes. The Nyabushozi, Kazo and Kashari hills on the Buganda Toro rock system are now composed of relatively soft rocks that are easily weathered. The hill tops have been leached to form lateritic caps similar to those found in most parts of the Buganda region. Parts of Ibanda and Kikagati are underlain by alluvial deposits containing fertile soils.

The southeast and northwest areas are underlain by sandstones, silt stones and slightly metamorphosed shales. Weathering over time has given rise to sandy loams that form the fertile crescent of the District.

Soil Productivity

Soils-Tanzania

The fertility status of soils in Karagwe District is moderate to good in general. Soils of relatively poor performance are found in the hotter and drier parts in the south, and similar areas bordering Rwanda in the northeast.

Soils in Bukoba District are generally poor to very poor in nutrients, with low to very low exchange capacities and of moderately strong acidity. Soils developed on the Bukoban system are the poorest, and not necessarily related to parent material but rather climatic factors of high rainfall.

Very strong contrasts in chemical properties are found between soils cultivated under homestead gardens and soils under grassland fallows. It is strongest in high rainfall areas, and diminishes towards the drier interior, where homestead gardens are also of more recent age.

Soils with extremely low base saturation (<20%) and with aluminium toxicity (>60% Al saturation) in the upper topsoils are found under grassland fallow in the Bukoban system and on clayey soils over shales in uplands and piedmont plains. High base saturation and near neutral pH is found on soils developed on quartzites of the Karagwe-Ankolea system towards the west.

Much of Rubale Division has limitations for rainfed arable farming. In addition, an important part of the well drained uplands soils consists of stony and gravelly material at shallow depth; wide flat valley floors are seasonally waterlogged. An additional problem is posed by sheet erosion, active on grazing land over silt-rich soils. The western part of Rubale is hilly, where steepness and shallow soil depths inhibit arable farming, while deeper soils of the narrow valleys are unsuited, due mainly to gully erosion development.

Table 2 Problem Soils in the Kagera Basin (Tanzania.....)

	1.	Risk of land degradation		Bukoba District	Karagwe District
2. Physical Soil Qualities	Dominant Soil Classes	Resilience	Sensitivity	%	%
Sloping, rocky, stony land with shallow soils	**Leptosols**	Low	Moderate to high	22	47.6
Land with impeded drainage	*Gleysols, Planosols, Histosols*			34	10.9
Droughty sandy soils, low moisture storage	*Ferralsols, Aricsols, Arenosols*	Low to moderate	Low to moderate	4-5	2.4
Human-induced erosion	*Acrisols, Leptosols, Ferralsols*	Low	Moderate	2.1	1.3
Accelerated erosion hazard	*Leptosols, Ferralsols, Acrisols*	Low	Moderate	5.7	2.2

Resilience = ability of a land system to return to its pre-altered state after change (i.e. restoration capability)

Sensitivity = degree to which a land system undergoes natural or anthropogenic change (i.e. ability to degrade)

Soils- Uganda

Mbarara soils are of medium to low productivity, related essentially to the availability of essential plant nutrients. Most soils are of low pH, except for the Rugaga series that are slightly alkaline and are of medium to high productivity. Acidity is strongly related to the main parent materials belonging to the Precambrian rock system consisting of gneisses, granitoid rocks, phyllites, shales and mud stones. Another factor affecting soil productivity in the District is the hilly terrain consisting of shallow soils characteristic of the Buganda and Koki Catena, where erosion is commonly manifested in rocky bare hills throughout the District.

The topography of the district influences both the physical and human environments. The high plateau has good climate and good soils hence supports high agricultural production compared to the gentle and low hills of Nyabushozi. With steep slopes, soil erosion becomes severe. Careless cultivation without incorporation of physical and agronomical water conservation measures have led to rapid washing away of the district's upland soils.

Cattle routes are common across the Rwampara hills, exacerbating the rate of soil erosion. Vast tracts of the hills in Mbarara are devoid of vegetation cover with evidence of degradation on slopes as a result of prolonged annual burning.

Extensive bush burning, over-grazing and overcutting of vegetation is common in most parts, exposure soil surfaces to erosion agent. Also, crop cultivation is extending into marginal areas where soil and water conservation measures are not practiced.

Natural Vegetation

Five distinct floras meet in the region: Guinea Congolian, Sudanian, Zambesian, Somali-Masaai and Afro-montane. The vegetation consists of floristically impoverished variants of the first four (WCMC, 1993). The region comprises the following main ecosystems:

Gallery forests : along the perennial water course of the main river Kagera and tributaries dominated by *Acacia Kirki* and *A. polycantha, Albizia* and some *Ficus*.

Dry forest patches include *Acacia Kirkii* and *Acacia polycantha, Euphorbia dawei, Olea europea* and *Haplocoelum galaense* on steep slopes in arid areas.

Sub-humid and semi-arid savannas on dissected hills with open shrub savanna with trees under 4 meters high and wooded savanna with trees over 4 meters high. Towards the east, in Rwanda and in western Bukoba district, the wooded savanna is made up of mostly deciduous and broad-leaved species, dominated by *Acacia-Combretum* association, often accompanied by *Euphorbia candelabrum*, interspersed with grassland. Other species in the wooded savanna (as reported in the former area of the Akagera National Park, Rwanda) are *Acacia senegal, Acacia siberiana, Albizia petersiana* and *Lannea* as well as *Hymenocardia acida, Crossopteryx febrifucum, Piliostigma thonningii* towards the south and *Acacia geradii* further north. The extent of wood cover varies according to degree of exploitation for grazing and wood. The grass layer has in general a good cover (over 30% basal cover, over 50% aerial cover) and the species comprise several communities:

(i) open grasslands dominated by short grasses mostly *Themeda triandra, Cympogon nardus, Panicum maximum* and *Hyparrhenia filapendula;*

(ii) floodplains dominated by *Botriochloa insculpta, Sporobolus pyramidalis, Chloris gayana* and *Themeda triandra;*

(iii) rocky and steep areas and crests of hills dominated by *Loudetia simplex, Andropogon duemmeri, Hyparrhenia lecontei* and *Eragrostis racemosa;* and,

(iv) those found over compacted lateritic pans, dominated by *Microchloa kundti, Harpachne schimperi* and *Sporobolus stefianus.*

The imperfectly to poorly drained wider valley bottoms and extensive sedimentary plains in Bukoba district consists of woody vegetation concentrated on termite hills. They have a similar vegetation composition, and *Setaria, Sporobolus, Hyparrhenia, Sorghastrum*, and *Themeda spp.* are common.

Poorer quality **open 'Miombo' woodlands** occupy the well-drained rangelands further east in Karagwe district of Tanzania. Those dominated by *Brachystegia-Julbernardia* woodland, with *Dahlbergia and Combretum* are the most widespread forms. *Acacia* woodland predominates on the clay soils on remnants of the late-Tertiary landscape and locally on flat valley bottoms. The dense cover of tall grasses is composed of *Hyparrhenia spp., Themeda triandra, Panicum maximum.* The dense reed-like hyparrhenia is burnt seasonally, in order to facilitate access for cattle grazing.

Lakeside woodland includes the *Stychnos usambarensis* in the far south of the Akagera Park and *Ficus spp. and Albizia spp.* along lake borders. Extensive **groundwater forests** still occupy the seasonally ponded parts of the clay pans in the Bukoba district and patches on the wettest parts of the Kitengure plains.

Swamp and lake systems of the Kagera basin consists of very tall, dense grasses, dominated by *Cyperus spp.* among dense stands of Papyrus. They are composed of a mosaic of emergent plant communities including (i) homogenous stands forming a floating mat of sedge *Cyperus papyrus* (ii) mixed helophyte beds with *Cladium mariscus, Typha capensis* and *T. domingensis, Miscanthus violceus* and *Thelypteris totta* (iii) short floating meadows of smaller cyperaceae, notably *Cyperus denudatus* and *C. pectinatus, Pycerus mundtii*, and *Leersia hexandra* and (iv) communities of rooted, floating leaved and freefloating euhydrophytes including *Nymphaea nouchali, Utricularia gibbosa* and *U. inflexa* and *Pistia stratiodes*. Swamps are most extensive on the Rwandan side of the Kagera River. In the dry season, swamps are frequently burnt for hunting purposes, rather than to facilitate grazing.

The wetlands support a number of globally threatened species and restricted range species, such as water turtles, crocodiles, monitors, snakes, otters and a large variety of water birds including herons, egrets, ducks, warblers and weavers. Some 180 bird species have been identified in the wetland habitats of Rwanda, including 6 European migrants.

The lakes and the river system is being increasingly threatened by **water hyacinth** (*Eichornia crassipes*) which leads to severe losses of aquatic fauna and flora both in terms of species diversity and populations. Control of water hyacinth is by mechanical and biological means through cutting back and use of two host weevils (*Neochetina eichomiae* and *N. bruchi).* Effective management will

require the identification and destruction of source populations upstream as well as management downstream through release of control agents and subsequent monitoring.

Table 1

District	Land surface km^2	Open water surface, km^2	Land and open water, km^2
Bukoba, Tanzania	5,601		
Karagwe, Tanzania			7,282
Mbarare, Uganda • Mbarara + Bushenyi swamp • Mburo lake • Mutukula lake • Kabandate lake • Mishera lake • Nakivali lake Total lakes		 559 13** 1.012 0.830 2.104 38** 54.946	
Rakai, Uganda • Karunga lake • Kijanebalola lake • Kachira lake Total lakes		 2.428 40 44** 86.428	
Kabale, Uganda • Kabale, Kisoro + Rukungiri swamps • Mutanda lake • Mukele lake • Bunyonyi lake • Chafari lake • Kayumbu lake Total lakes		 101 20.416 2.812 49**? 0.627 1.451 74.306	
Akagera National Park, Rwanda • wetlands		 60,000 ha	