River Ecology: An Overview

Dr. David Were

dwere51@gmail.com

david.were@mak.ac.ug

0783365652

Department of Environmental Management, Makerere University

Introduction

Definition of a river

- **The scientific term for any flowing natural waterway is a stream**
  - **so in technical language, the term river is just a shorthand way to refer to a large stream**
- **A stream / river is a body of water with a detectable current, confined to a channel, made up of a stream bed between banks (Wikipedia, the free encyclopedia).**

➢The physical factors that characterize them include size, amount of water flowing through them, flow consistency, and make-up of the bottom.

Introduction

Why interest ourselves in rivers ?

- Help distribute water across landscapes
- Provide habitats for aquatic biota
- Distribute nutrients and soil across landscapes
- Provide high quality recreational and aesthetic values to landscape.
- Filter pollutants introduced from the terrestrial inflows
- Help in processing of litter and other organic debris

Types of rivers

Several types of classification

Can vary depending on the interest and background

Perennial

Flow year round

R. Nile

vs

Periodic rivers

Flow during certain times of the year

R. Kidepo

Types of rivers

Exotic rivers

- **Flow through dry environments where little or no freshwater exists**
- **Could be perennial or intermittent**

R. Nile is a good example

Types of rivers

Man-made rivers

- **Carry freshwater from a source (such as a lake, natural river or reservoir) to where ever it's needed.**

The Grand Canal, China-world's longest and oldest water way 1,104 mi

Types of rivers

Pipeline rivers

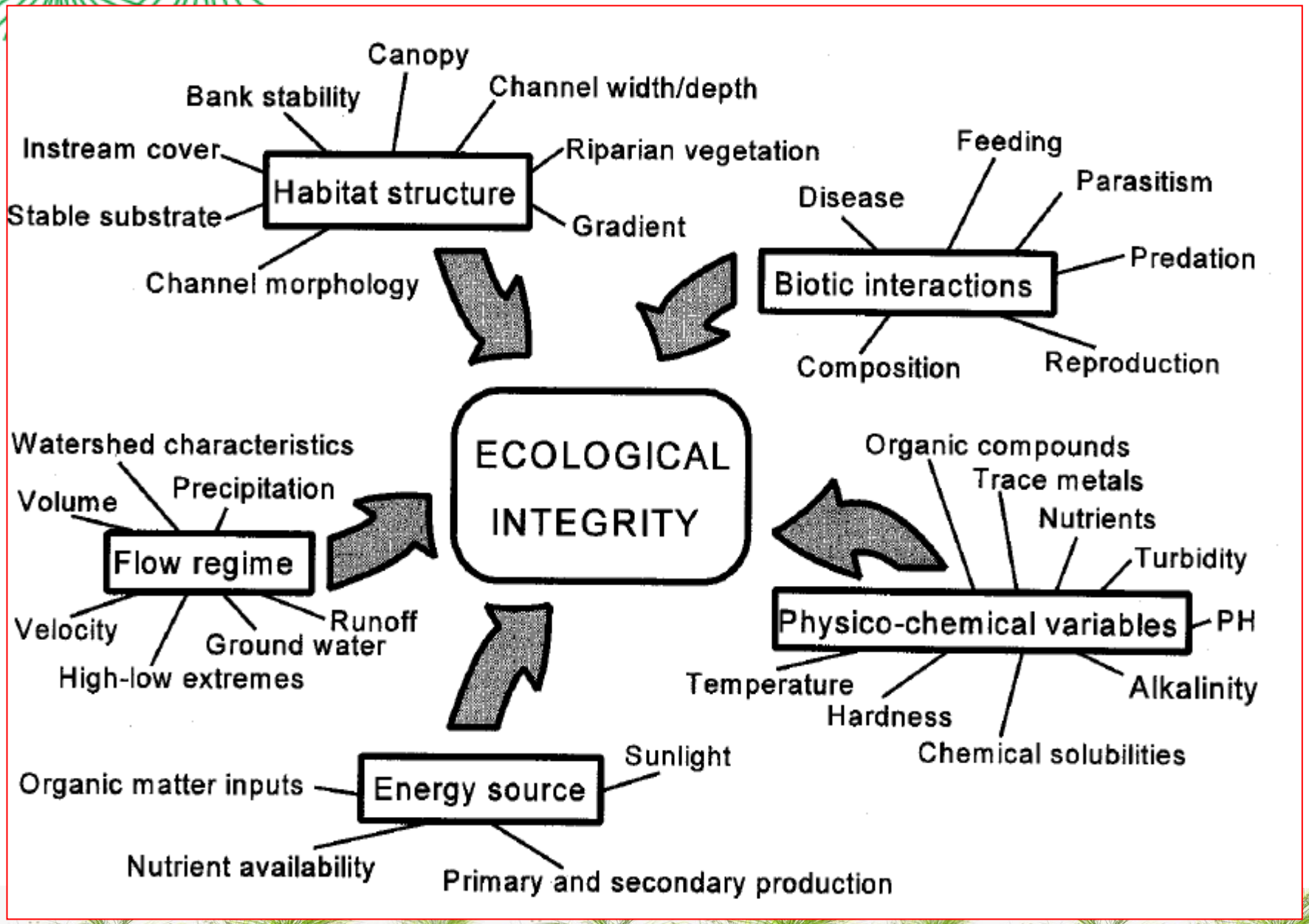
- **Form of man-made river used to transport freshwater over long distances.**
- **Could also be tap-offs for hydropower generation**

Great Pipeline River in Libya is a good example 1700 miles

Ecological Integrity of A River

- Defined as the ability of a system to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats of the region (Karr, 1991).

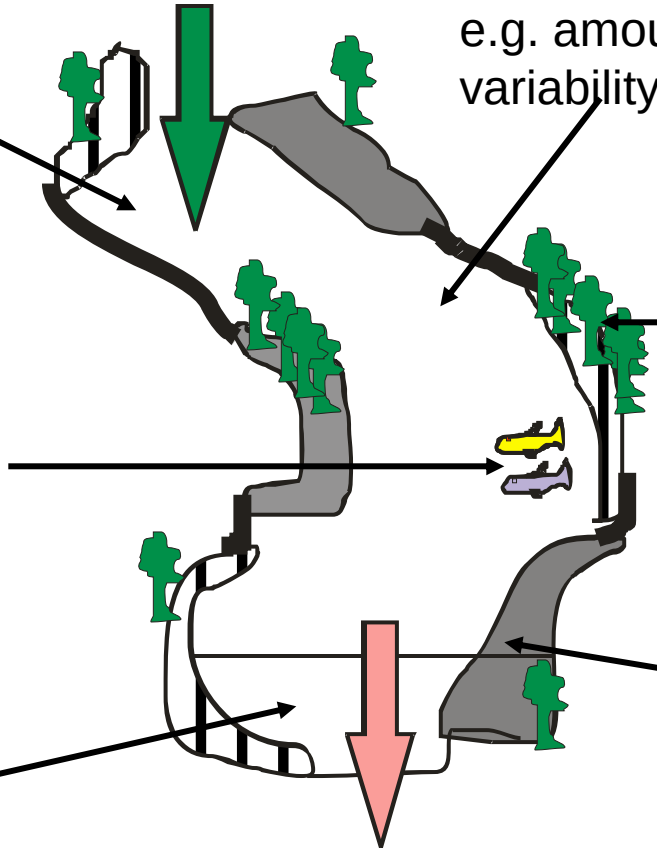
Components of Ecological Integrity



Parameters for Assessing River Integrity

Hydrology
e.g. variability of flow regime

Physical Habitat
e.g. amount, spatial and temporal variability



Rip. Vegetation
e.g. modified/unmodified

Biology
e.g. number or diversity of invertebrates, fish, benthic algae/macrophytes

Geomorphology
e.g. sediment load, instability

Water Quality
e.g. means or range of pH, temperature, BOD

River Ecology: The case of the Nile

Factors that affect the integrity of the Nile as a river habitat

Damming

- Several dams a long the Nile
- Impacts
  - Flow regulation
  - Fish migration
  - Water temperature

Factors that affect the integrity of the Nile as a river habitat

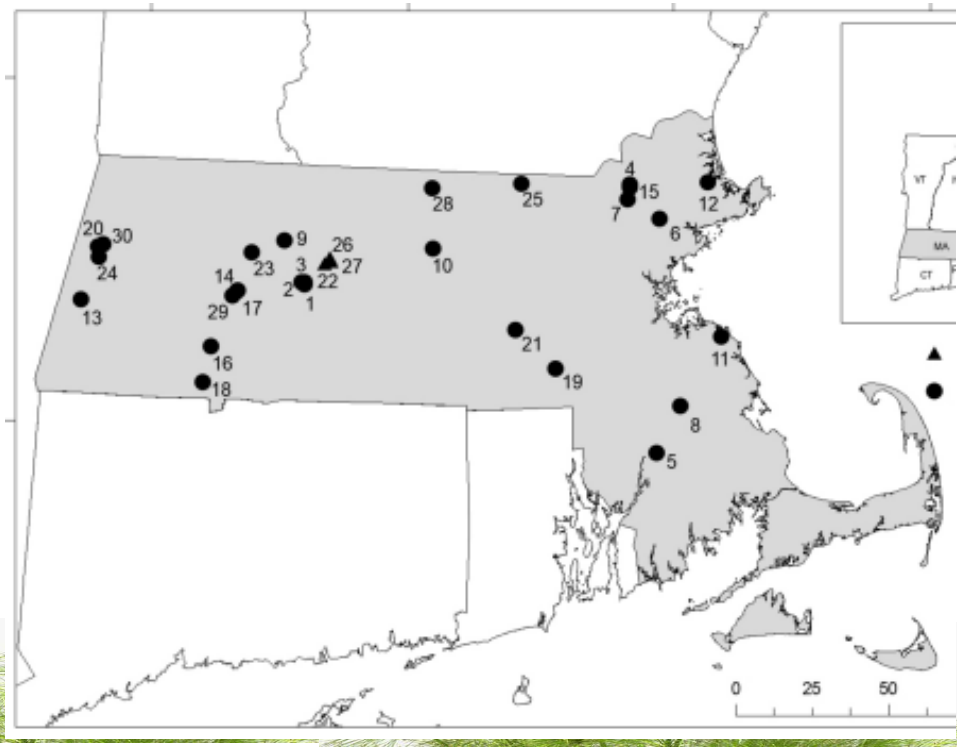
Damming

Impact on water temperature

Zaidel et al. (2021) conducted a research on 27 dammed rivers in the US

Results showed that:

- **Reservoir temperatures 0.20–5.25 °C higher than in upstream areas**
- **Reservoirs contributed to heating of downstream waters**



Factors that affect the integrity of the Nile as a river habitat

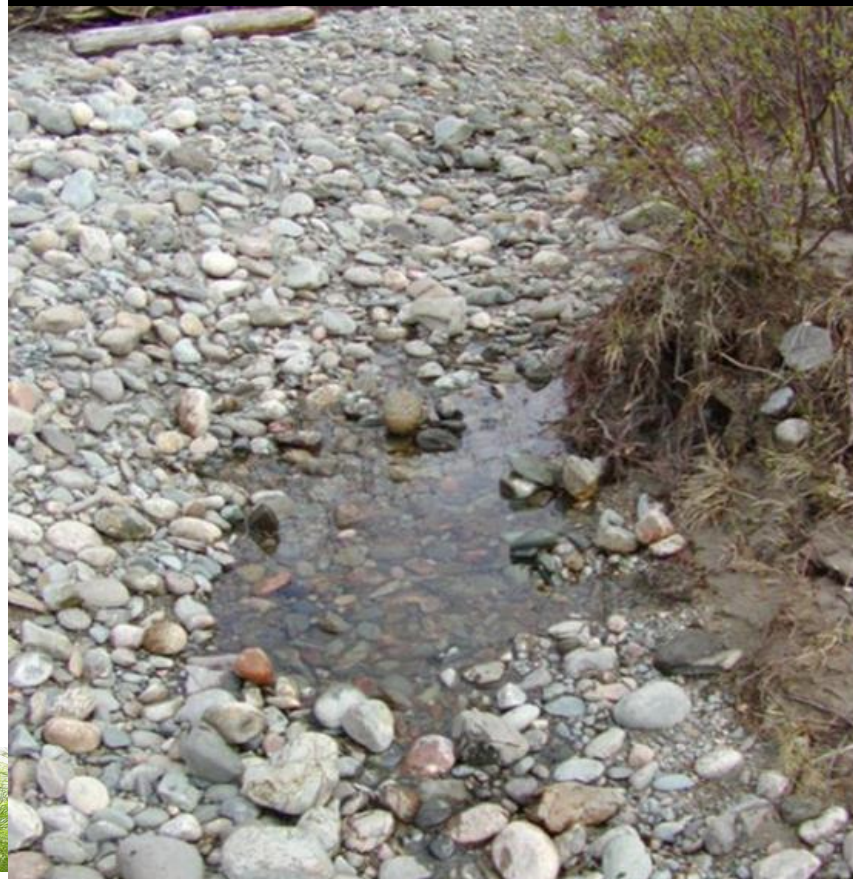
Damming

Impact on flow regime-*Hydropeaking*

- **Damming affects the volume of water released downstream**
- **Can sometimes cause intermittent drying of river channels downstream**

➢ **Was reported on River Nile in 2020 between Bujagali and Isimba dams**

A hydro peaked Austrian River



Factors that affect the integrity of the Nile as a river habitat

Channelization and regulation

- **Urban sections of the river in Cairo and Khartoum have been channelized with reap-rap**

Impacts

- **Riverbank habit loss**
- **Impedes vegetation establishment**
- **Affects water discharge**
- **Water quality issues due to loss of buffer zone**

Factors that affect the integrity of the Nile as a river habitat

Effluent discharge

- **Disposal of untreated industrial effluent into the river channel directly or its tributaries**

Impacts

- **Alteration of river water quality**
- **E.g. Dissolved oxygen in the Nile delta does not meet standards due to industrial/agricultural discharge – Morsy et al. (2020)**

Factors that affect the integrity of the Nile as a river habitat

Agricultural activities and water quality

- **Surface runoff from crop fields**
  - **nutrient and heavy metal pollution**
  - **Siltation**
- **Animal grazing /watering in the catchment**

Source: InfoNile

Factors that affect the integrity of the Nile as a river habitat

Water flow diversions

- Increasing number of flow diversions downstream
- Mainly for agriculture

Gezira irrigation canal, Sudan

An irrigation canal in Egypt

Factors that affect the integrity of the Nile as a river habitat

Water flow diversions

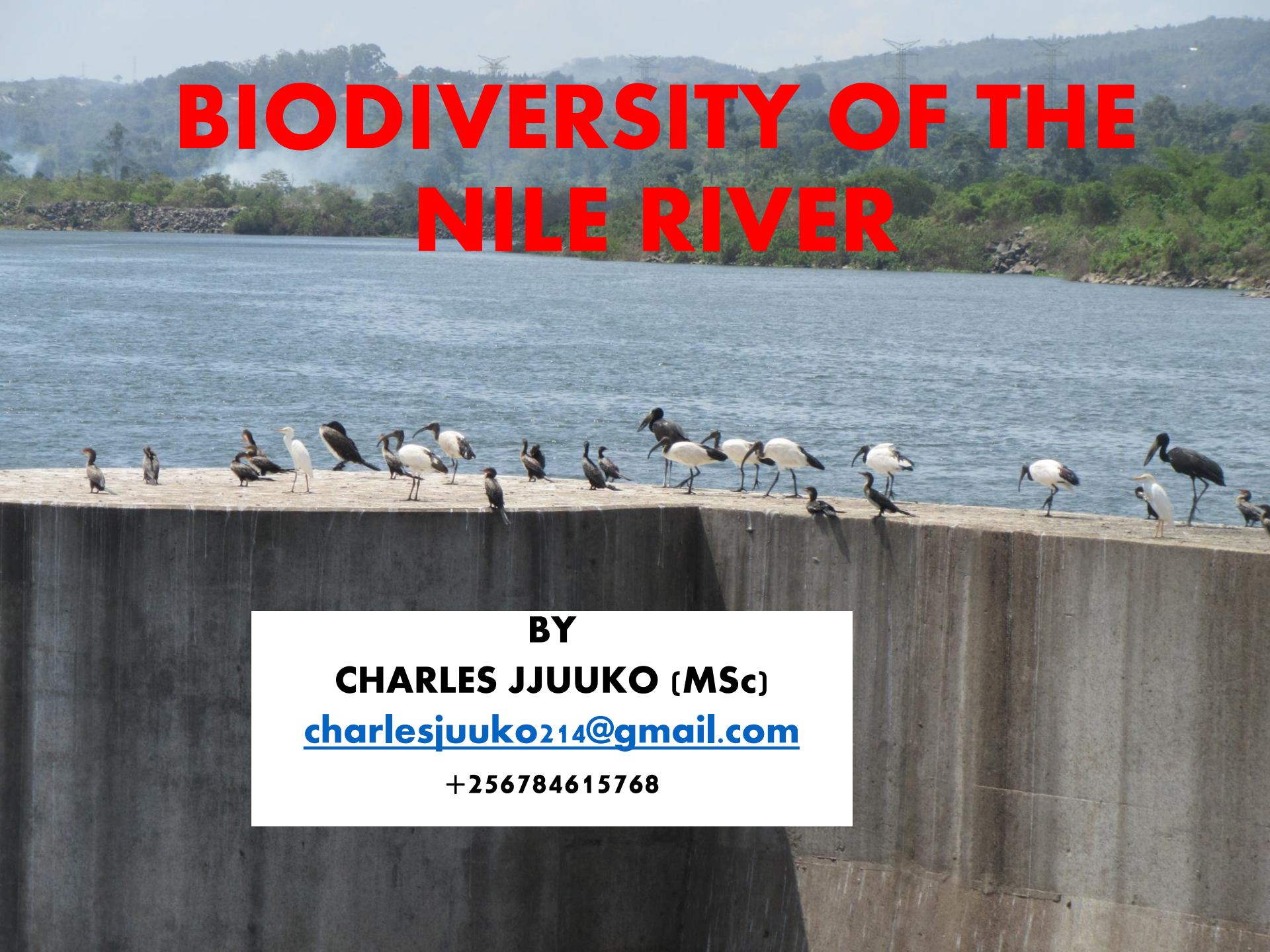
Proposed Jongeli canal project

- Initiated to divert water from the Sudd to Sudan and Egypt
- Project stalled in 1983
- There are talks to revive it
- Impacts on wetland and river ecology are immense

A view of Sarah, a digger used to dig the Jonglei Canal, lies in its current location since 1983, when canal construction ended

A river is beyond the water we see!

BIODIVERSITY OF THE NILE RIVER



BY

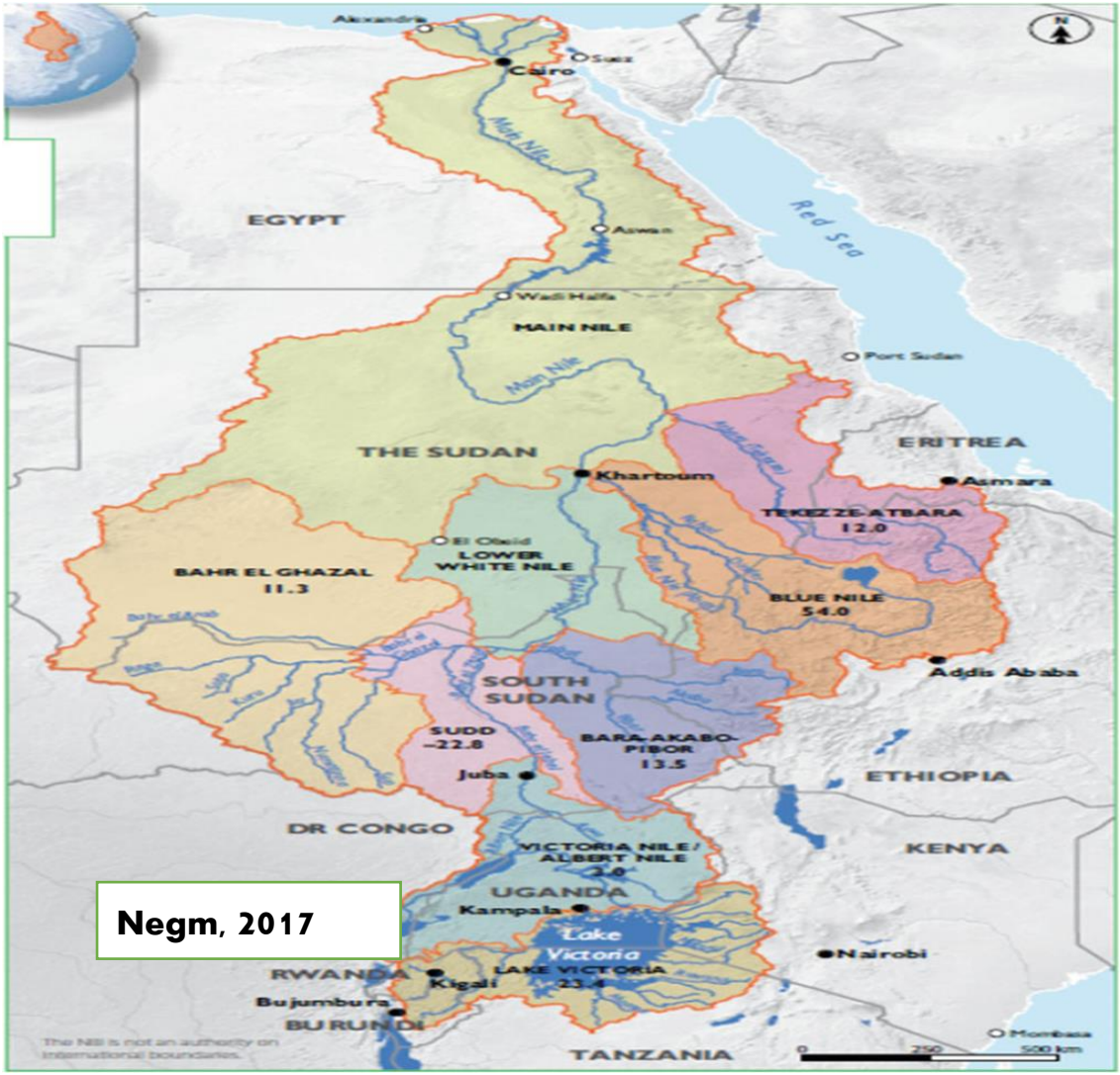
CHARLES JJUUKO (MSc)

charlesjuuko214@gmail.com

+256784615768

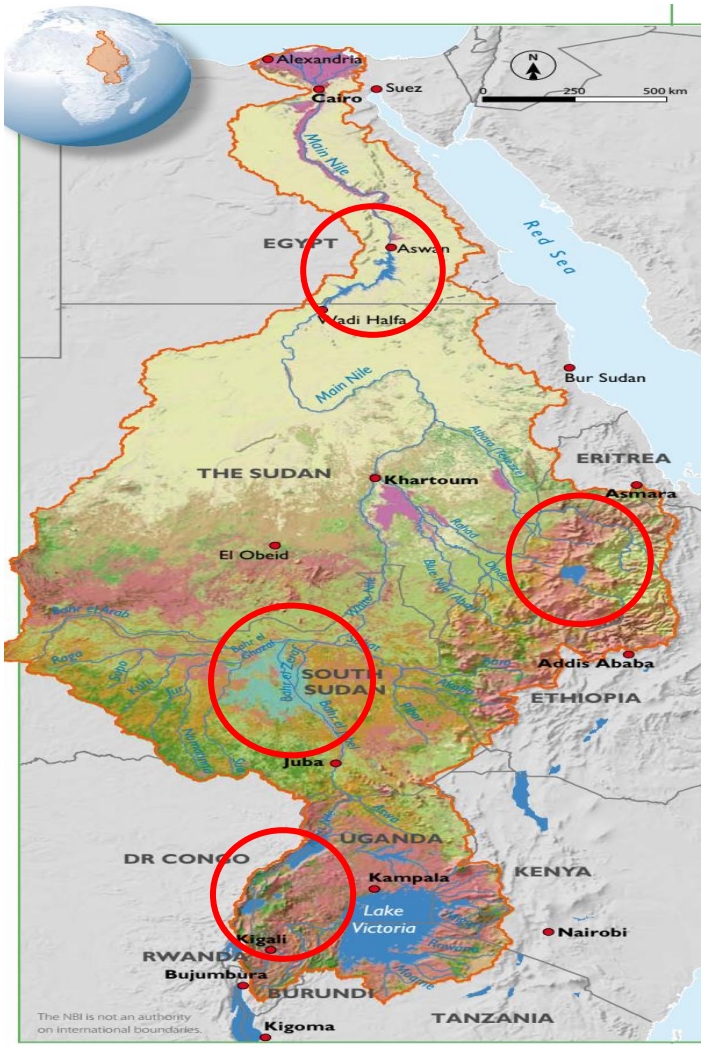
INTRODUCTION

- The Nile River is the longest river in world
  - Total length of 6,695 km
  - Drainage basin covers 3.18 million square kilometers
  - Covers 11 countries
    - Uganda, Kenya, Rwanda, Burundi, South Sudan, Sudan, DR. Congo, Eritrea, Ethiopia, Egypt and Tanzania
- The Nile Basin has a variety of ecosystems
  - mountains, tropical forests, high- and low-attitude wetlands, equatorial lakes, woodlands, and savannas



INTRODUCTION

- The Nile River is drained by two sub basins;
  - The Eastern Sub-basin
  - Nile Equatorial Lakes Sub-basin
- The Eastern Sub-basin has Lake Tana while the Nile Equatorial Sub-basin has Lakes;
  - Victoria
  - George
  - Edward
  - Albert
  - Kyoga
- Lake Nasser is the only lake in the desert



TRIBUTARIES OF THE NILE RIVER

- **Main tributaries and Lakes (from upper to downstream)**
  - **Victoria Lake – Upper Victoria Nile – Lake Kyoga – Lower Victoria Nile – Albert Lake –Albert Nile – Bahr el Jebal + Sudd Swamp + Bahr el Ghazal and Bahr Arab – Lake "No" – White Nile.**
  - **Tana Lake – Baro-Pibor-Sobat, Blue Nile (Abay) + Atbara (Tekeze), Main Nile, and Lake Nasser or the man-made lake of Aswan High Dam.**

- **Both the lakes and rivers in the Nile Basin have a series of wetlands along the shores or flood plains respectively**
  - **These are very rich in biodiversity including;**
    - **Birds**
    - **Mammals**
    - **Insects**
    - **Fish**

ECOREGIONS OF THE NILE BASIN

- **The basin has six main ecoregion**
  - **The Nile Delta**
  - **Lower Nile**
  - **Ethiopian Highlands**
  - **Lake Tana**
  - **Upper Nile**
  - **Lake Victoria**

THE SUDD

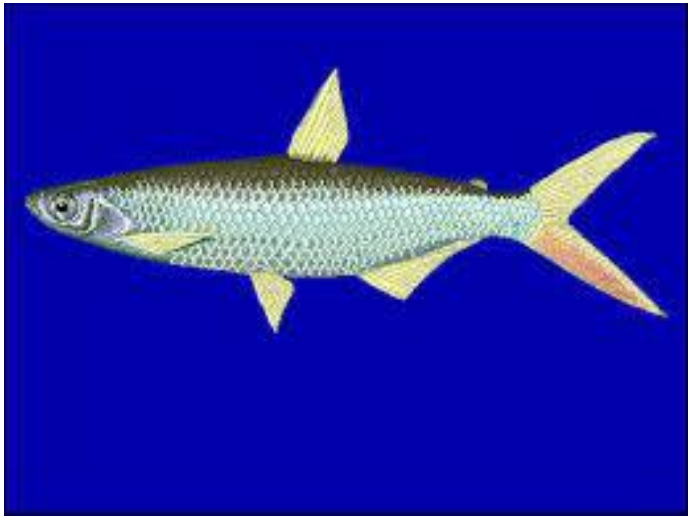
- One of the largest wetland in the world
  - Average area of 57,000 Sqkm
  - It can extend to 130,000 Sqkm depending on the discharge from the Albert Nile
- It interrupts the flow of water from the Albert Nile
  - Evaporation of at least 80% of the water
- The wetland has both permanent and seasonal sections
- The Sudd is one of the biologically diverse ecosystems in the Nile Basin;
  - fish, mammals, birds, reptiles, amphibians and other rare species

Source: Internet Photo

THE SUDD

- **It supports a rich biota of 22 families and 118 species of fish**
  - **These include 16 endemic species**
  - **Fish is dominated by *Cyprinids***
  - **Others include; *Alestiidae, Cichlidae, Mochokidae, Moryridae, Poeciliidae* and *Schilbeidae***

Cyprinids



Alestiidae

Mochokidae

Source: Wikipedia.org

Table 2 Number of fish species in the River Nile and Nile Basin lakes

Family	River Nile	Lakes Victoria and Kyoga	Lakes Edward and George	Lake Albert	Lake Tana	Sudd	Lake Nubia	Lake Nasser
Protopteridae	2	1	1	1	–	1		1
Polypteridae	3			1		2		1
Anguillidae	1							
Clupeidae	1							
Osteoglossidae	1					1		
Notopteridae	1					1		
Mormyridae	15	7	2	7		8	4	7
Gymnarchidae	1					1		1
Kneriidae	1							
Alestiidae (Characidae)	8	2		5		5	3	6
Distichodontidae	7					5		1
Citharinidae	2			4		3	2	2
Cyprinidae	25	17	4	5	24	9	4	13
Balitoridae	1				1			
Bagridae	6	1	1	3		5	4	2
Schilbeidae	5	1		2		3	2	2
Amphiliidae	1							
Clariidae	7	6	4	2	1	2	1	2
Malapteruridae	1			1				1
Mochokidae	15	2		3		5	2	6
Cyprinodontidae	7	7	4	2		4		
Channidae	1					1		
Centropomidae	2	(1)[a]		2		1		
Eleotridae	1					1		
Cichlidae	10	600 (+4)[a]	60	10	1	7	2	4
Anabantidae	2	1	2			2		
Mastacembelidae	–	1						
Tetraodontidae	1					1		1

Adopted from Negm, 2017

VEGETATION OF THE SUDD

Photo by: C. Jjuuko

- **The wetland is dominated by *Cyperus papyrus* esp. the permanently flooded section**
- **The seasonal part is dominated by *Oryza longistaminata***

Source: Internet photo

- **Other vegetation species include; *Phragmites, Typha, Coccinia grandis, Cayratai buensis, Luffa cylindrica, Vigna luteola***

BIRD SPECIES IN THE SUDD

- Its of great importance in harboring migratory birds;
  - Intra-Africa migrants
  - Palaeartic migrants
- It has over 470 bird species


White pelican *(Pelecanus onocrotalus)*


white stork *(Ciconia ciconia)*


black-crowned crane *(Balearica pavonina)*

BIRD SPECIES IN THE SUDD

- **Its home to over 80% of the world's population of shoebill stork (*Balaeniceps rex*)**
  - **Over 5000 individuals**
  - **Critically endangered according to IUCN**
- **Other notable bird species include**
  - **Ferruginous duck (*Aythya nyroca*)**
  - **Lesser kestrel (*Falco naumanni*)**
  - ***glossy ibis, marabou stork,***
  - **African open bill, cattle egret, and spurwinged goose.**

Source: ebird.com

MAMMALS

- **The sudd has over 100 mammalian species including;**
  - **White-eared kob, tiang, elephant, mongalla gazelle, and zebra**


Nile lechwe *(Kobus megaceros)*


Thomson's gazelle *(Eudorcas thomsonii)*


Rothschild's giraffe *(Giraffa camelopardalis rothschildi)*


sitatunga, *(Tragelaphus spekei)*

LAKE NASSER -MAMMALS

- **Mammals**
  - ***Vulpes vulpes*, *Hyaena hyaena*, *Gazella leptoceros*, *Gazella dorcas*, Nubian ibex and *Felis margarita***


Rhim gazelle *(Gazella leptoceros)*


Nubian ibex *(Capra nubiana)*


Hyaena hyaena

LAKER NASSER - BIRDS

- **The Lake has some of the following bird species**
- ***Gyps fulvus, Aquila chrysaetos, Chlamydotis undulata, Numenius tenuirostris, Rynchops flavirostris, Oenanthe moesta, Neophron percnopterus, Buteo rufinus, Aquila clanga, Aquila heliaca, Falco naumanni.***

Marmaronetta angustirostris

sociable plover (*Vanellus gregarius*)

Gypaetus barbatus

Terathopius ecaudatus

LAKER NASSER -AMPHIBIANS AND REPTILES

- **Over 51 species spread over 13 families including;**
- ***Bufo kassasii, Bufo regularis, Bufo viridis, Hemidactylus turcicus, Ptyodactylus hasselquistii, Ptyodactylus siphonorhina, Stenodactylus sthenodactylus, Tarentola annularis, Tropiocolotes steudneri, Acanthodactylus boskianus, Acanthodactylus scutellatus, Mesalina guttulata, Mesalina rubropunctata, Varanus griseus, Varanus niloticus, Chalcides cf. humilis, Psammophis aegyptius, Psammophis sibilans, Naja nubiae, Naja haje, and Trionyx triunguis***


Nile crocodile (*Crocodylus niloticus*)

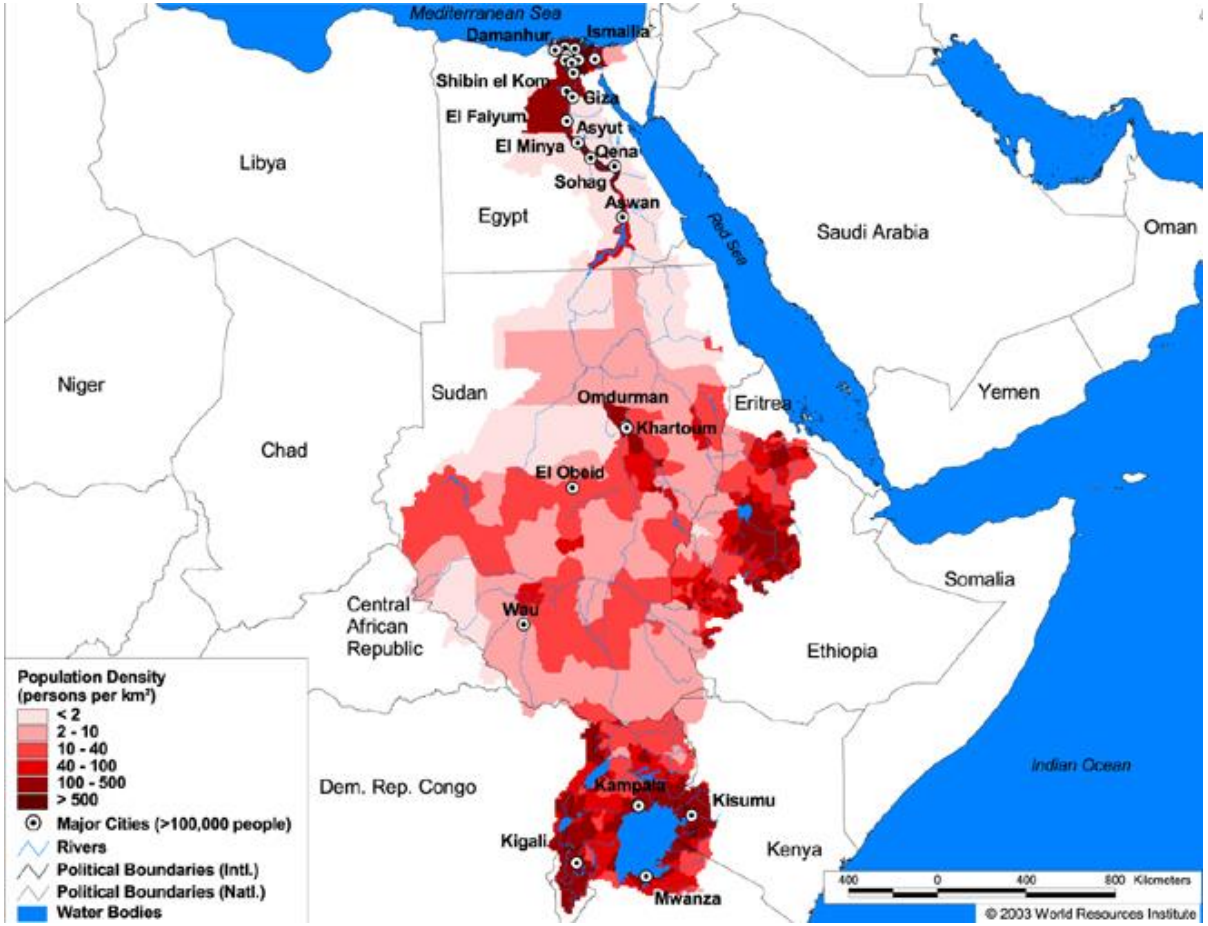

fringe-fingered lizard (*Acanthodactylus boskianus*)


Pseudotrapelus sinaitus


Saharan horned viper (*Cerastes*

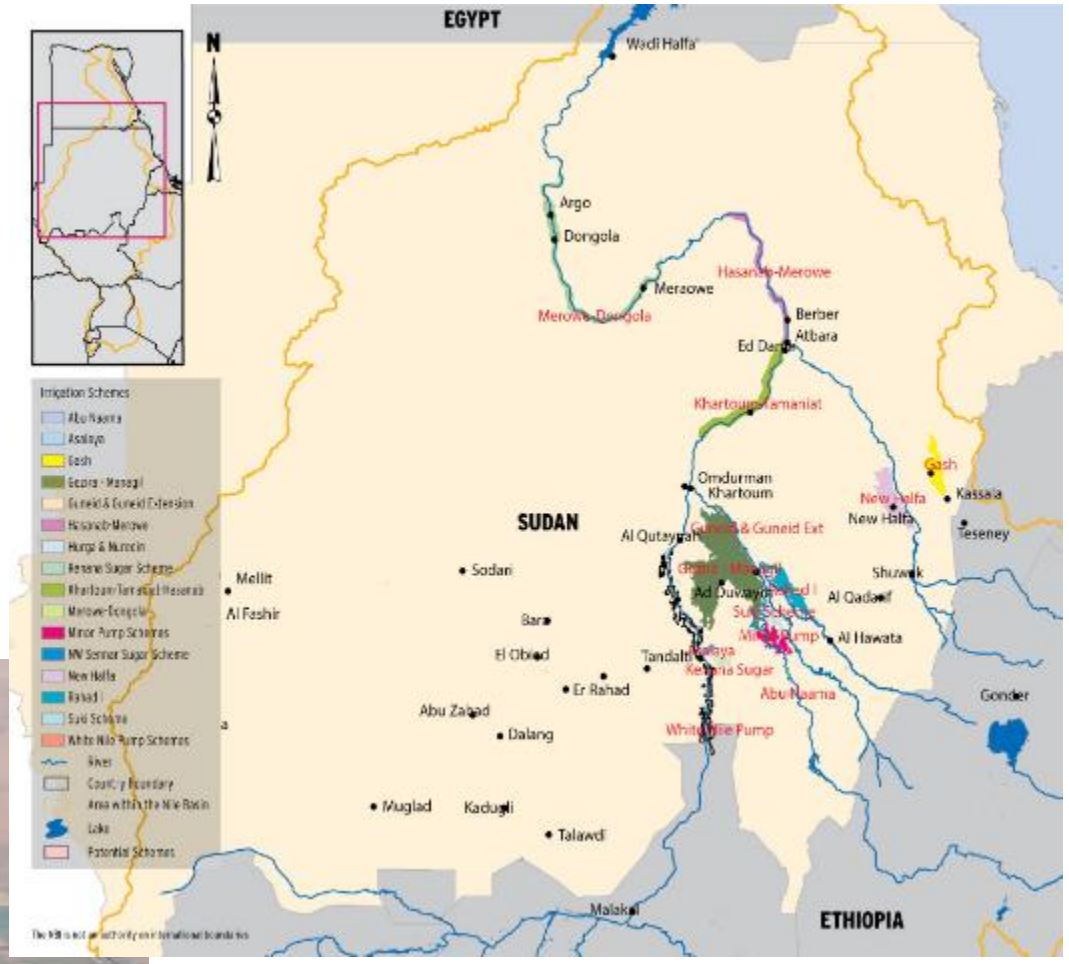
Threats to biodiversity

- Mainly through habitat destruction
- Increasing population
  - Pressure on Nile resources (Demand)
  - Egypt, Uganda, Ethiopia



Threats to Biodiversity

- **Extensive agriculture**
  - **Change in hydrology**
  - **Water diversion**
- **About 1.2 million hectares of crops**
- **The Gezira Scheme of Sudan – 588,000 ha**



Threats to biodiversity

- **Industrialization**
  - **Pollution - effluent**
  - **Vegetation clearing**

Threats to biodiversity

- **Overgrazing**
  - **In the Sudd region**
  - **Teso region in Uganda**

Threats to biodiversity

- **Oil exploration**
  - **In the Albertine Grabben – Lake Albert and its biodiversity threatened**
  - **Sudd region**

Threats to biodiversity

- **Hydropower construction**
  - **The Grand Renaissance Dam – Ethiopia**
  - **Bujagali, Isimba, Karuma - Uganda**
  - **Ayago Dam - Planned**

THANK YOU FOR LISTENING

END

Session 2

Interdependence of Rivers on other Ecosystems

Dr. David Were

Interdependence of Rivers on other Ecosystems

- **A river is not an independent ecosystem**

- **Connected to several other ecosystems**
  - **Wetlands**
  - **Forests**
  - **Grasslands**
  - **etc**

Interdependence of Rivers on other Ecosystems

Energy in rivers is primarily fixed in the catchment

- **Carbon is the "currency of life"**
  - **There are several sources of carbon into rivers**
  - **Catchment generated organic matter and nutrients get into rivers through different flow paths**

Interdependence of Rivers on other Ecosystems

Catchment sources of carbon into streams

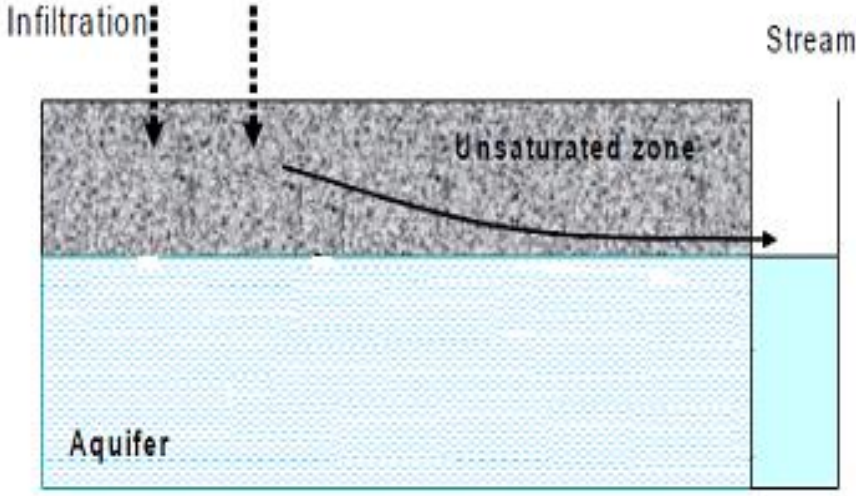
- Processed organic matter from upstream sources, e.g. leaf litter
- Terrestrial inputs derived from floodplain interactions
- Colonies of breeding marine birds
- Large mammalian herbivore inputs

Different flow paths that deliver OM/carbon to rivers

Litter fall

Animal subsidy

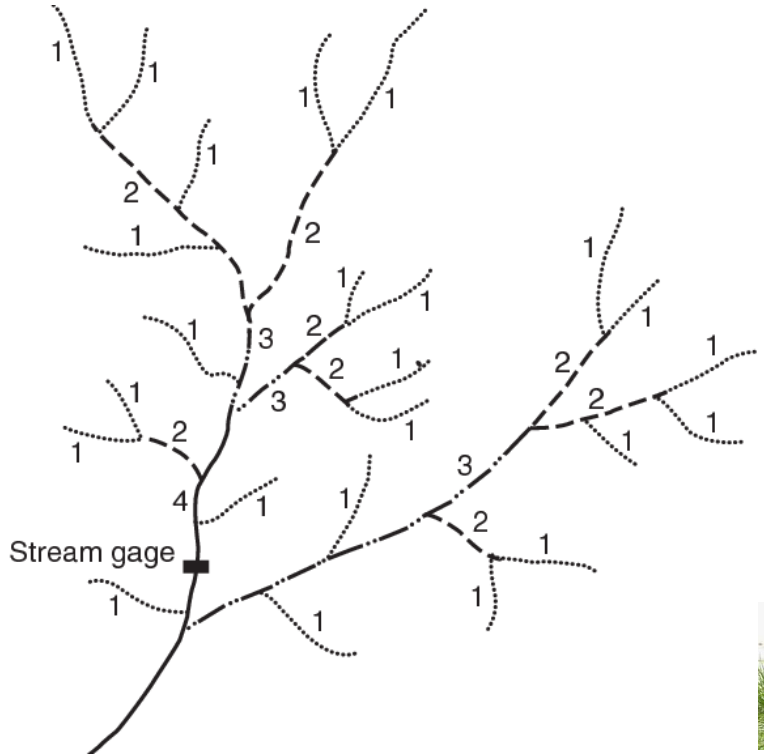
Overland flow



Subsurface flow

Interdependence of Rivers on other Ecosystems

- **A river has a network of "young rivers" searching for resources in the wider catchment**
  - **Management of rivers therefore only effective at catchment level**



Interdependence of Rivers on other Ecosystems

- **The characteristics of the catchment has a big bearing on river characteristics**
  - **Turbid river water is an indicator of catchment erosion due to loss of vegetation cover**

A section of the Blue Nile in Ethiopia-July season

Interdependence of Rivers on other Ecosystems

- **The characteristics of the catchment has a big bearing on river characteristics**
  - **Turbid river water is an indicator of catchment erosion**

A section of the Blue Nile in Ethiopia-July season

Interdependence of Rivers on other Ecosystems

- **The characteristics of the catchment has a big bearing on river characteristics**
  - **Turbid river water is an indicator of catchment erosion**

R. Tana, Kenya

So let's share experience on river-catchment management issues in your countries ?

Thank you