Impacts of pollution, land degradation and climate change on riverine biodiversity and ecology

By

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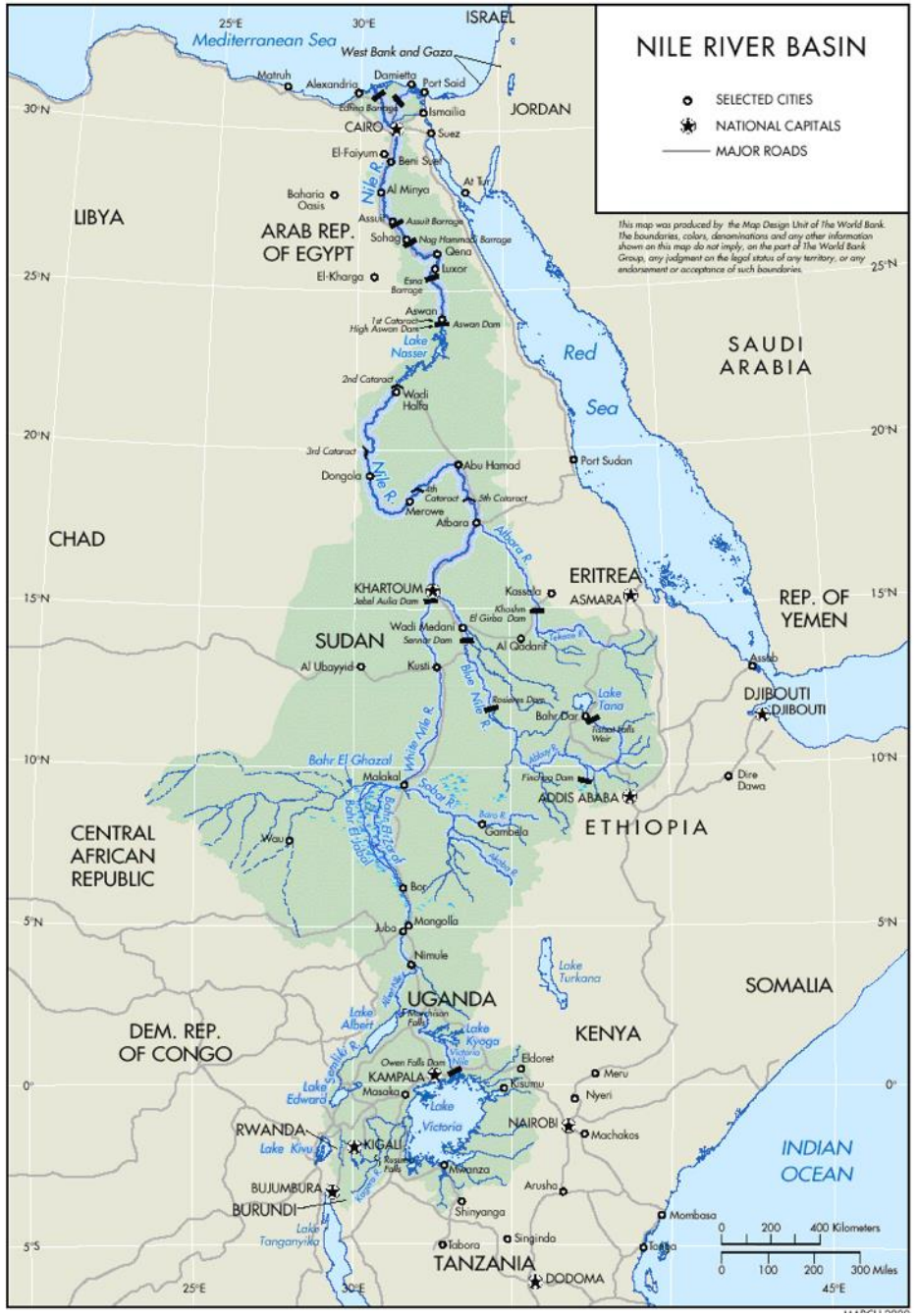
Presentation at the "River Nile Through the Eyes of Science: Current Issues, Threats, and Opportunities" workshop on 20th July 2022 at Lake Victoria Hotel, Entebbe, Uganda.

The River Nile…….

Geographical location

- Originates in Uganda (Lake Victoria, Africa's biggest lake), and flows northward and finally draining into the Mediterranean Sea (Nile Delta)
- Crosses several climatic regions: tropical rain forest to desert
- Longest river in the world (about 6,695 km)
- Total catchments area : 2.9 million Km^2
- Shared among 11 Member states of The Nile Basin Initiative (NBI)



http://www.nilebasin.org

The River Nile.....

Hydrology & Sedimentation

- Annual rainfall varies with region (0-120mm);
- Watershed area : 3.3 million km^2 (1/10 of Africa) comprising of 3 major catchments

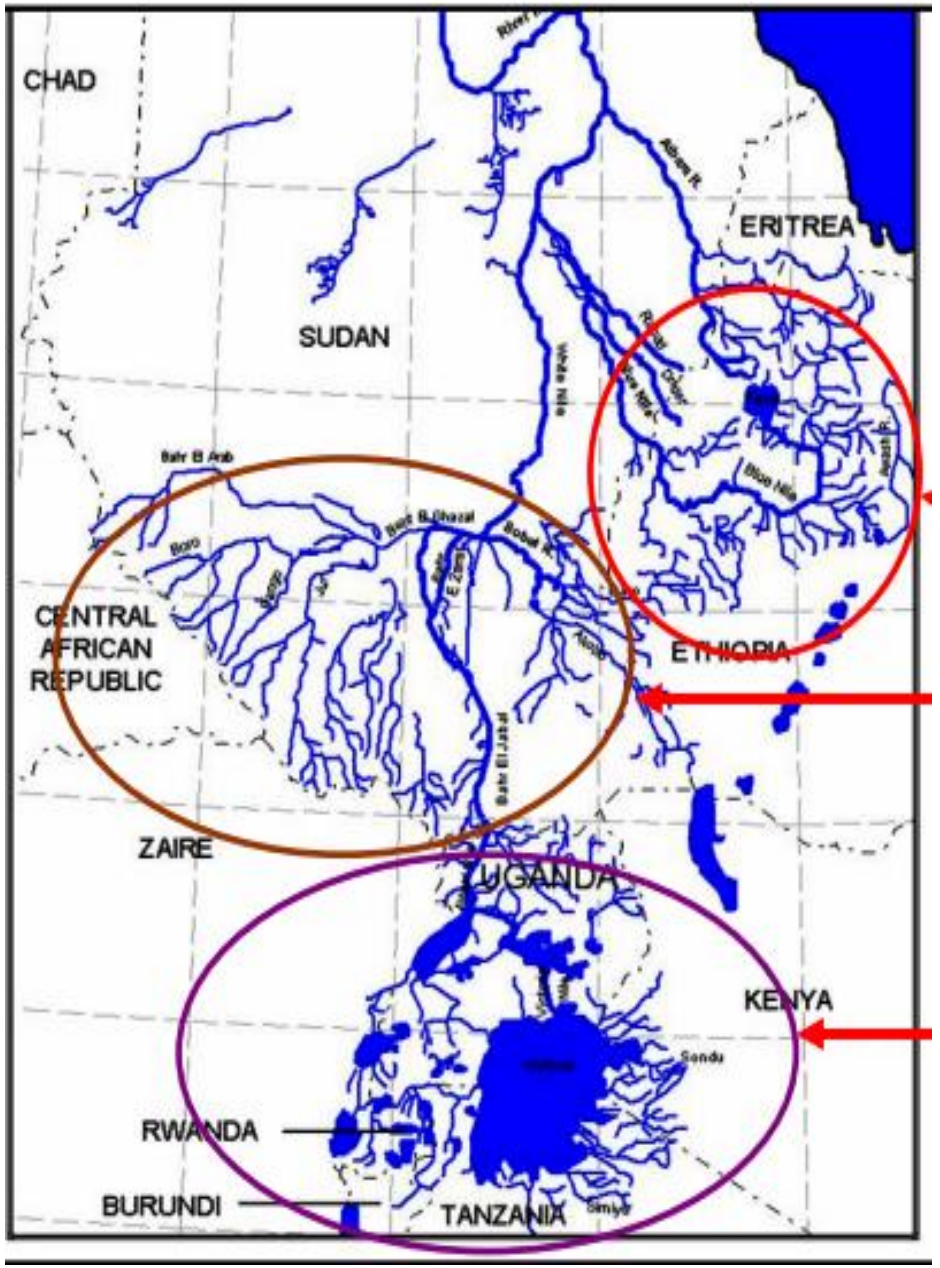
- The Plateau of Equatorial lakes (South)-28% (wide flat plain with swamps)

- Bahr EL Ghazal - Sudd (Center) -14%

- Ethiopian high lands (East) - 58%

Sedimentation

- Over 90% of sediment load comes from Ethiopian highlands
- Mean annual sediemnt load ~134 million tons at Aswan High Dam



UNESCO-IHP-International Sediment Initiative

The diversity of Rive Nile landscapes

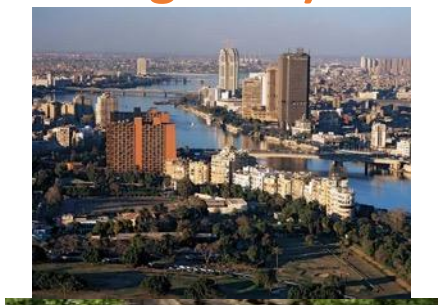
- **Different patterns and characteristics along its course** (bedrock and alluvial sections, straight & braided; meandering & stable islands; falls & deltas)

NBI; flicker.com; vecotours;

Human Impacts - different land use

A number of land use along the course of River Nile:

- **Hydropower Dams (Owen Falls, Bujagali HPP, Karuma, Isimba-Uganda)**
- **Agricultural: Irrigation (Reserviors) and Water abstraction**
- **Fishing and bathing (beaches)**
- **Oil & gas exploration**
- **Urbanization (All cities along the river; mostly in Egypt)**
- **Tourism & sports (Rafting and Navigation)**
- **Aswan High - the most imporatnt structure to regulate the flow of The River Nile in Egypt (Flood control, Hydroelectric power & irrigation)**

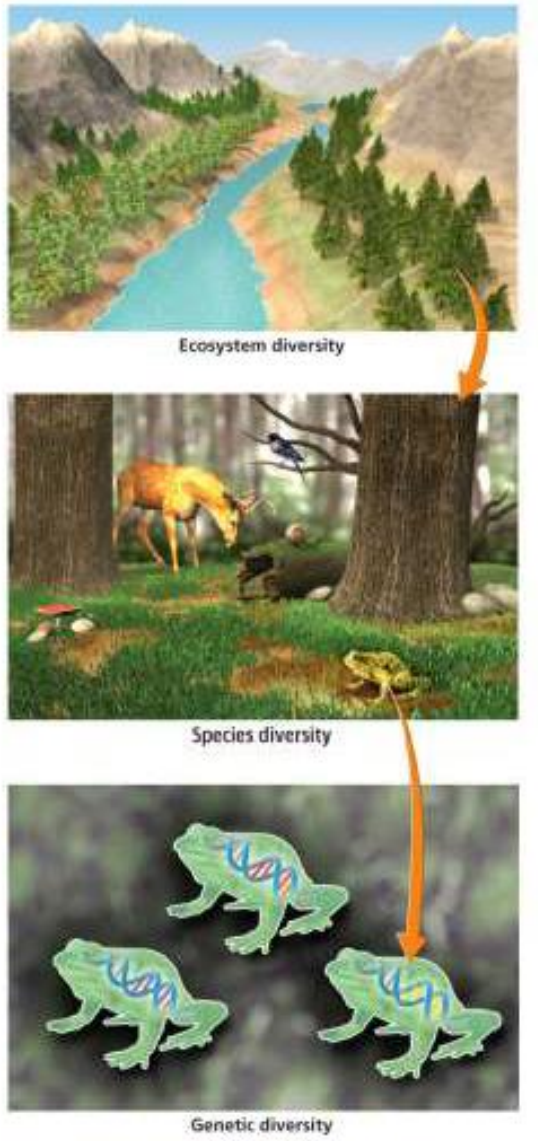







Biodiversity…..variety of living things (number/kinds)

- **Ecological diversity**
  - – different habitats, niches, species interactions
- **Species diversity**
  - – different kinds of organisms, relationships among species
- **Genetic diversity**
  - – different genes & combinations of genes within populations



Pearson Education (2008)

Biodiversity ……The Nile basin is quite diverse

- **The lakes, rivers and wetlands of the Nile basin support 545 species of fish (NBI)**
- **Reptiles- Crocodiles**
- **Amphibians**
- **Mamamals-Hippos,**
- **Avifauana (birds) - 300 species**
- **Flora – Papyrus, Phragmites, Typha, Juncus,**
- **Allien plant species.**

Threats to biodiversity

- **Climate change:** Changes in temperatures, acidity and patterns of water movement (including currents), largely caused by increasing atmospheric carbon dioxide, as well as impacts from damage to the ozone layer

- **Overfishing:** with attendant bycatch problems, from commercial , recreational fishing, illegal unregulated or unreported fishing (IUU.

- **Habitat degradation:** largely caused by fishing gear and degradation of fringing vegetation – which all support aquatic organisms.

Threats to biodiversity

- **Ecosystem alteration:** **caused by the introduction of alien organisms (water hyacinth and the Nile perch in Uganda)**

- **Pollution:** **including nutrients, sediments, plastic litter, noise, hazardous and radioactive substances; discarded fishing gear, microbial and trace chemicals such as carcinogens.**

Part I: Impacts of pollution on biodiversity in rivers

What is water pollution?

- **Water pollution occurs when a water body (e.g. river, lake) is contaminated due to the addition of large amounts of material without removal of harmful components, e.g. pollutants.**

- **The sources of are categorized as:**
  - **Point sources (direct discharge)**
  - **Diffuse (non-point) sources (indirect discharge)**

- **Affects all aquatic flora and fauna e.g., direct damage to individuals or whole communities.**

Types of water pollution

- **Ecological pollution:** caused by nature rather than human activities
- **Thermal pollution:** water being used as a coolant and returned to the aquatic environment at a higher temperature that affects water quality and aquatic organisms
- **Toxic pollution:** due to herbicides, pesticides, chemicals and industrial compounds
- **Microbiological pollution:** introduction of pathogens and invasive organisms
- **Organic pollution:** excess organic matter (manure, sewage) released into aquatic systems

Types of water pollution

Drainage Channel (Kampala-Uganda)

Wastewater from a Brewery (Kampala-Uganda)

Types of water pollution

Inner Murchison Bay, Lake Victoria receives wastewater from industries & drainage channels

Eutrophication:
Blue green algae and Water Hyacinth in the Inner Murchison Bay Lake Victoria

Types of water pollution

Effects of Copper mining Western Uganda

Lake George, Uganda

Effects of water pollution

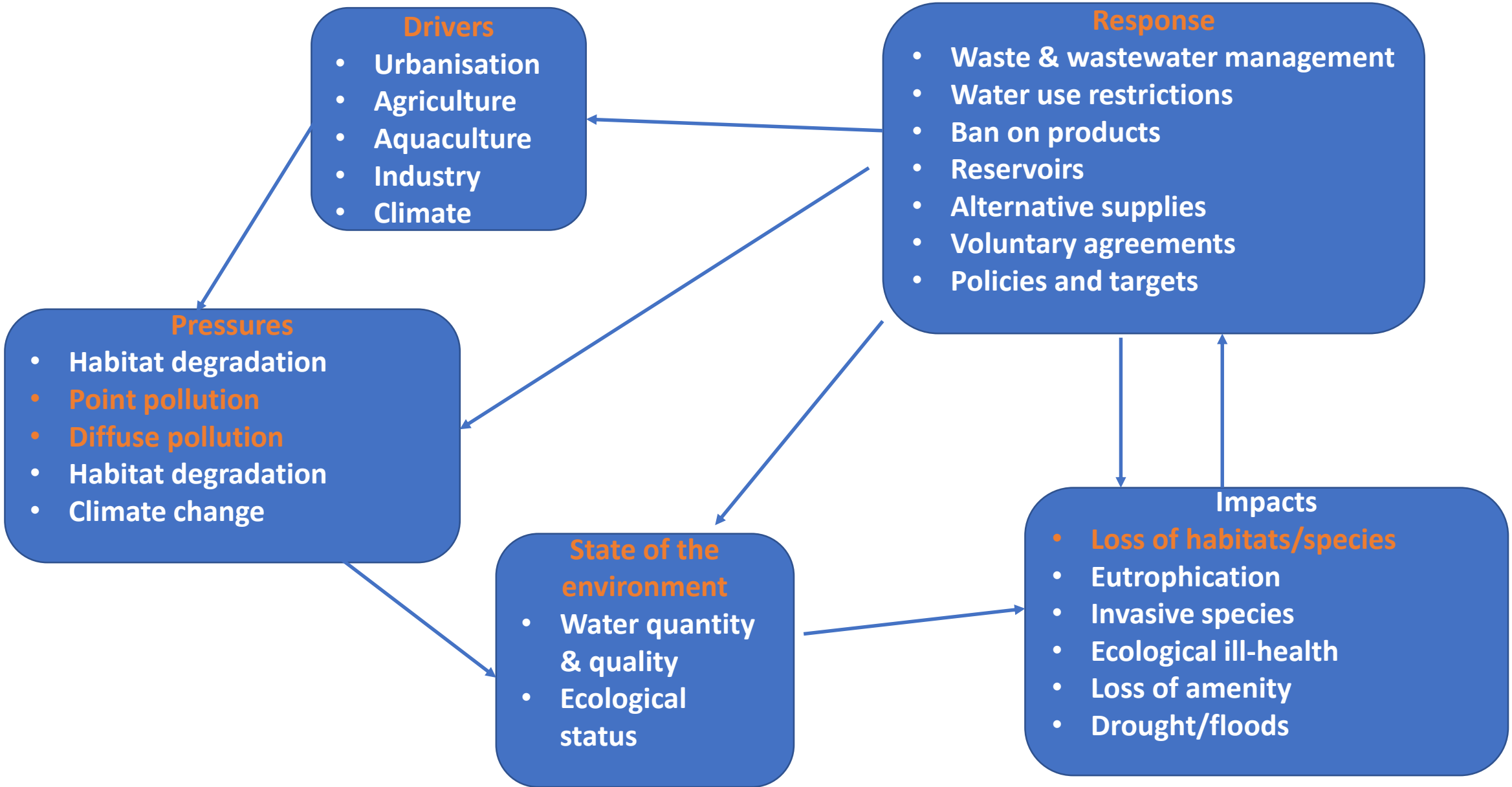
- **Death of aquatic organisms** - **macroinvertebrates, fish and aquatic birds**
- **Disruption of the food web and food chain**
- **Disruption of ecosystem services**
- **Contamination of groundwater sources and aquifers**
- **Spread of diseases**

Lake Victoria heavily polluted by deadly metals

By Taddeo Bwambale Added 22nd January 2020 02:45 PM

Water samples collected from three separate locations around the lake show it contains high levels of lead, arsenic, aluminum, and phosphorus, which are not good for human life when consumed in certain quantities.

Pollution and biodiversity and rivers – organic impacts



Current Ecological Status of River Nile

The currernt ecological status : **Good, basing on the EU Fish Index (50kg/ha)**

Area	Fish Catch Potential Tons year^{-1}	Actual Yields Tons year^{-1}	Percentages of Exploitations
Sudd Region	75,000	30,00	43%
White Nile Reservoir	15,000	13,000	86%
Blue Nile Reservoir	1,700	1,500	88%
Senner Reservoir	1,100	1,100	91%
Lake Nubia Portion	5,100	1,000	19.6%
Others	4,000	4,000	100%
Total	101,900	50,500	≈ 50%

Table 2. Calculated Potential and Effective Fish Catch from Different Inland Water Bodies of Sudan

Aquatic Ecology Monitoring on the Nile for Bujagali

Macro-invertebrates: Oxygen-sensitive types such as Ephemeroptera (mayfly) and Trichoptera (caddis) upper Victoria Nile.

Occurrence of snail species such as *Bellamya unicolor, Melanoides tuberculata, Gabbia humerosa* and *E. eliptica* **indicative of good water quality in the reservoir and potential for fish production**

Adopted from NaFIRRI (2012/13)

What can be done?

- **Voluntary clean up activities especially for toxic pollutants such as cans, plastics and metals - Global initiatives such as World Environment Day, World water Day, Wetland Day, Fisheries Day ……**
- **Raising awareness - mindset change**
- **Join special societies devoted to prevention of pollution e.g., InfoNile , NileWell**
- **Encourage SMART agricultural practices – avoid use of pesticides and fertilizers**
- **Prevent further degradation of the wetlands & encourage wetland and river restoration projects**
- **Improve wastewater treatment & disposal of solid waste - Do not litter!!**

Part II: Impacts of climate change (floods and disasters) on ecology of rivers

What is weather & what is Climate?

Weather	Climate
"What is happening in the atmosphere at any given time"	"Average weather over longer time frames" – usually 30+ years

Source: World Meteorological Organization

What is Climate Change and Global Warming?

Global Warming

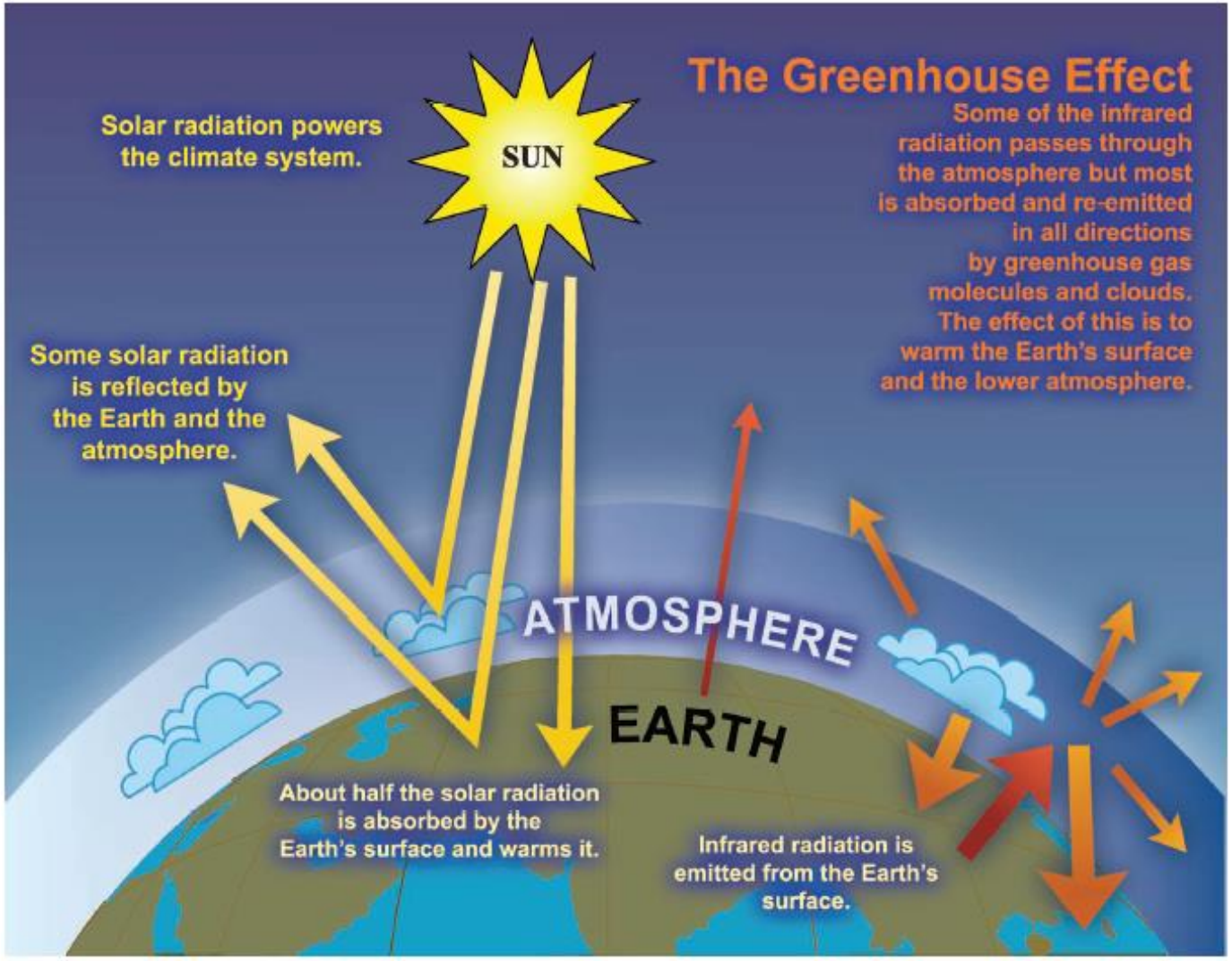
Refers to the overall warming of the planet, based on average temperature over the entire surface of the Earth

Climate Change

Refers to changes in climate characteristics, including temperature, humidity, rainfall, wind, and severe weather events over long term periods

Further information: WMO Website

What Is the Greenhouse Effect?



Source: IPCC 2007. Further info: WMO Website

Climate change in the River Nile region

- **Overwhelming scientific evidence of a warming trend in the Earth's temperature, and consensus on intensified extreme events such as floods and droughts…..**

(IPCC sixth assessment report 2022 - https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/)

- **While the Nile countries bear virtually no responsibility for the current human-induced changes in the global climate…..they are already suffering from its impacts.**

High vulnerability and sensitivity of the Nile Basin to impacts of climate change….due to multiple factors

- **High fragility of its natural systems: two-fifths of the basin consists of arid and semi-arid drylands.**
- **Dominance of poor and rural people in the upstream countries- heavily dependent on sectors such as agriculture, fishing, and forestry that are highly sensitive to climate variability,**
- **Limited possibilities for diversification into less climate-sensitive sectors.**
- **A rapidly growing population that is putting unprecedented pressure on the natural resource base.**
- **High exposure to natural disasters, especially floods and droughts.**
- **A prominent agricultural sector in the downstream countries that is almost totally reliant on Nile-fed irrigation.**
- **High dependency on hydropower for energy across the basin**

Impacts of climate change on ecology of rivers…..

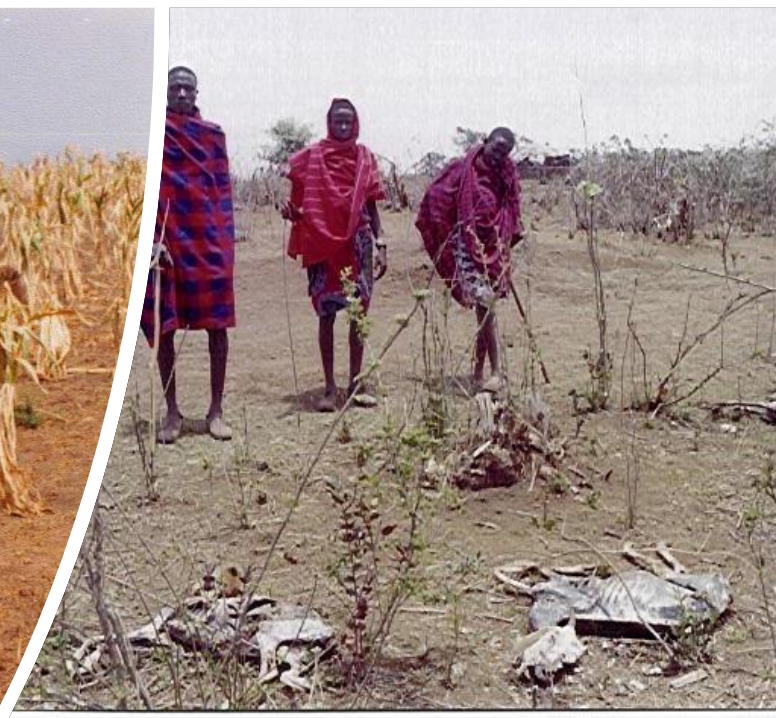
- Manifested primarily through changes in average temperature and precipitation - important drivers of flows of water in soils, lakes, rivers, wetlands, and groundwater aquifers.

- Higher evaporation and consequent increased losses from reservoirs.
- Higher evapo-transpiration rates and rising crop water requirements leading to an increase in demand for irrigation water, and increased vulnerability to drought of rain-fed agriculture.
- Hotter and longer dry periods- increase drought risks, especially in dry regions.
- Higher frequency and intensity of severe rainstorms-increased flood risk and serious storm damage.
- Higher water temperatures strengthen thermal stratification, increase algal productivity, accelerate microbial mineralization, and reduce oxygen dissolution, among other effects.
- Expansion of the range of vector- borne diseases such as malaria to higher altitudes due to warmer temperatures.

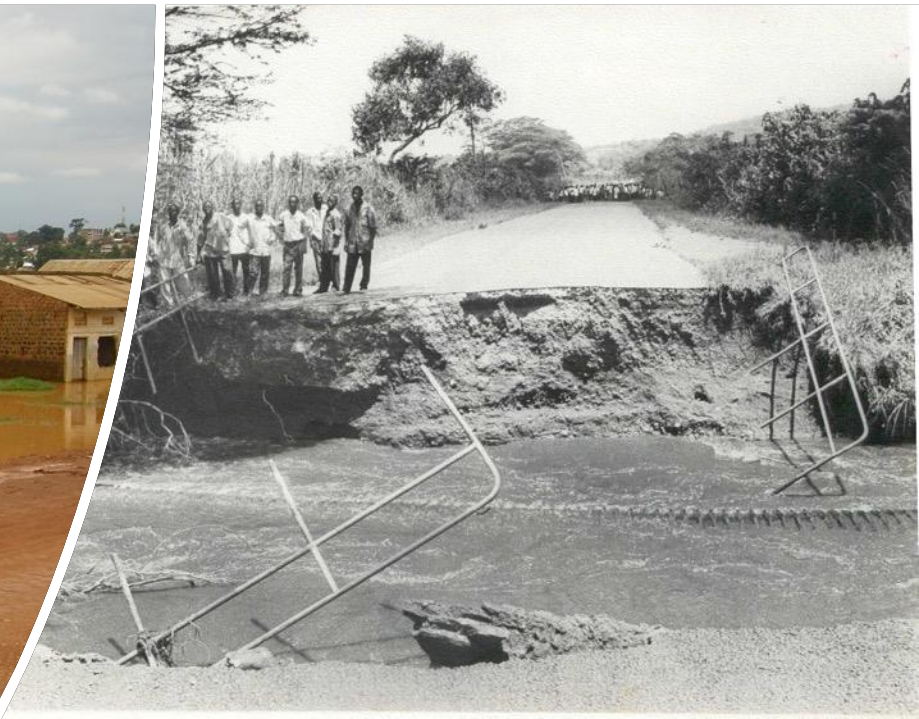
Impacts of climate change

- **Agriculture –** **reduction in agricultural output hence fall in economic growth and likely famine**

Impacts of climate change



Impacts of climate change



Climate change adaptation

- **Increasing per capita water-storage capacity by constructing reservoirs – both small and large.**
- **Interconnecting electricity grids and developing alternative power sources in regions with high dependency on hydropower.**
- **Introducing zoning and land-use planning to discourage people from constructing permanent settlements in floodplains and other areas subject to landslides and high flood risks.**
- **Expanding forests, and implementing measures to reverse deforestation.**
- **Mitigating the impact of drought by restoring soils and increasing their capacity to retain moisture.**

Climate change adaptation

- **Promoting measures aimed at increasing water productivity and water-use efficiency in irrigated agriculture.**
- **Mainstreaming climate-change adaptation and mitigation in all national development sectors.**
- **Increasing general awareness on climate change.**
- **Building capacity at regional and national levels for climate-change modelling and analysis, including downscaling of GCMs**

Part II: Impacts of Impacts of land degradation on rivers

Land degradation

- **The degradation of the natural resource base and environment is started with various human and economic development activities**

Land use change – Njoro River Catchment Case Study

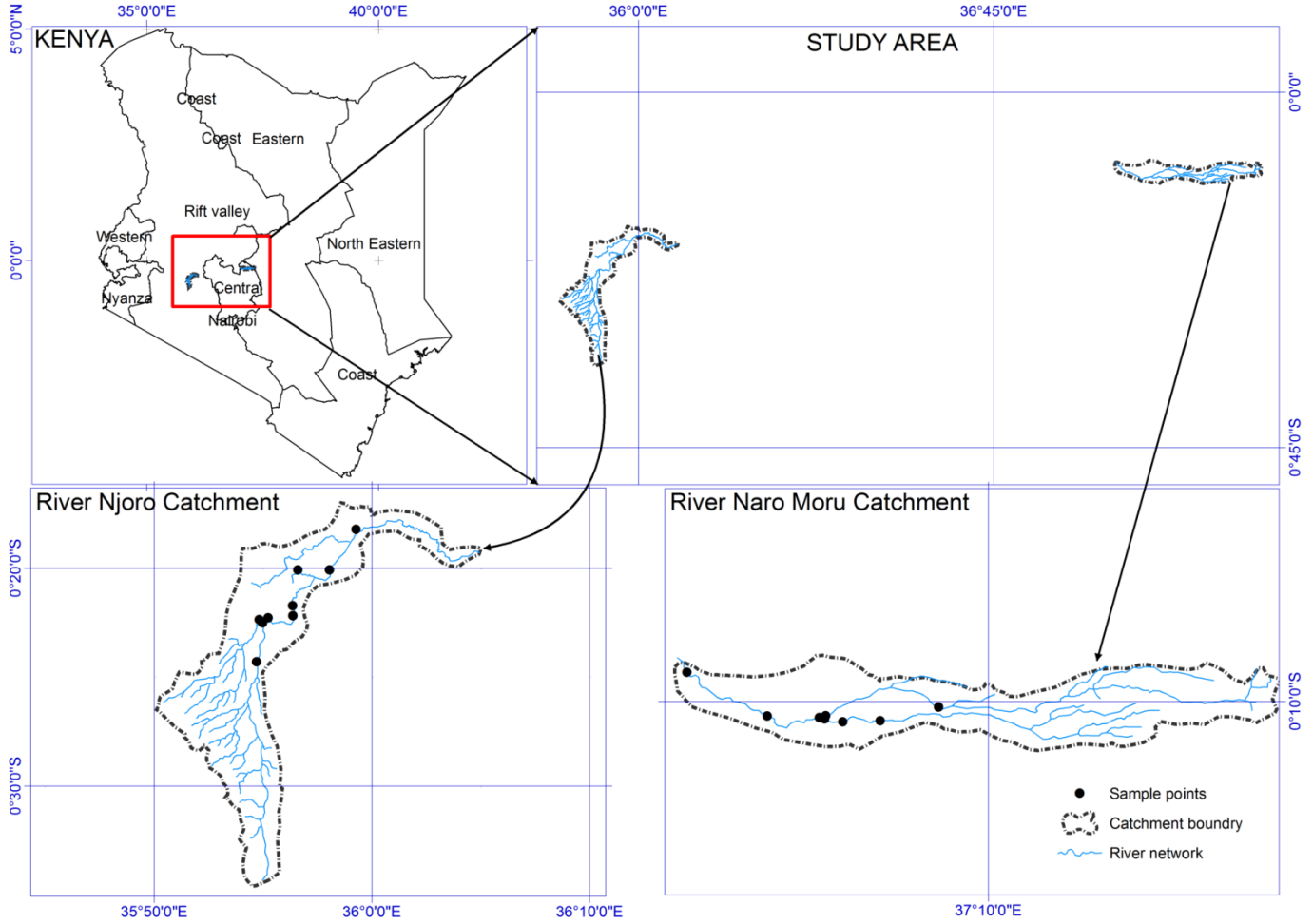
- **Njoro River catchment has experienced drastic land use and land cover changes over the past 3 decades (Kundu, 2007)**

- **In between 1970 and 1996, the area occupied by forest has reduced by approximately 47% (Bretschko, 1996)**

- **Activities:**
  - ✓ Agricultural practices
  - ✓ Livestock grazing
  - ✓ Deforestations

Land use change – Njoro River Catchment Case Study

Njoro River
Catchment: 127 km^2
Rainfall: 1012 mm/yr (bimodal)
Altitude: 2020-3060m (amsl)
Soil type: Erosive soils to loamy



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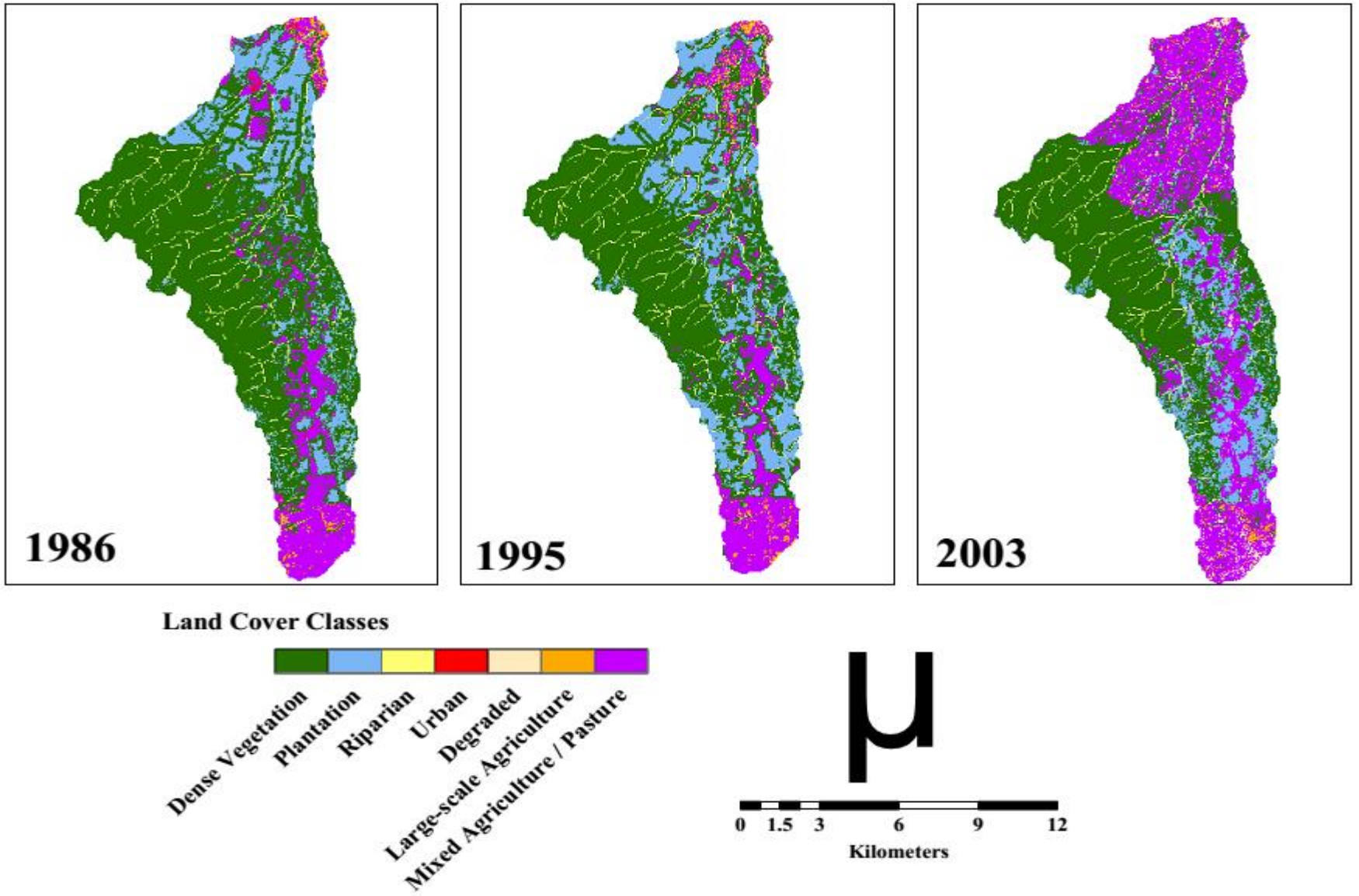

Source: Tracy et. al. 2005

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...with your health in mind!

HARNESSING DIETARY NUTRIENTS OF UNDER-UTILIZED FISH AND FISH PROCESSING BY-PRODUCTS IN UGANDA (NUTRIFISH)

(www.nutrifish.mak.ac.ug)

Australian Government
Australian Centre for International Agricultural Research

IDRC · CRDI
Canada

HARNESSING DIETARY NUTRIENTS OF UNDER-UTILIZED FISH AND FISH PROCESSING BY-PRODUCTS IN UGANDA (NUTRIFISH) – www.nutrifish.mak.ac.ug

- **Malnutrition (particularly micronutrient deficiencies) is serious challenge to human health and economic development in Uganda.**

The NutriFish project has:

- **Developed a simple app (Electronic Catch Assessment (eCAS) system (http://beta.smartcas.net) that can be used on the mobile phone to collect and transmit data on fish catches from local lakes, and can help the project monitor fish stocks and detect overfishing thus enhancing sustainability outcomes.**

- **Introduced a solar tent dryer technology. This innovation increases fish shelf life from 6-8 weeks to nearly 5 months, and has doubled incomes for women processors. Improvements in processing practices also resulted in reduced fish waste and loss.**

- **Utilized the small fishes to produce 5 fish-enriched products, especially targeted for mothers and their young children, who are particularly vulnerable to micronutrient deficiencies. The products are offering a more diverse and more sustainable diet.**

Interventions – Radio awareness campaigns

- **29 ‘spot messages’ broadcast in local languages on four FM radios**

- **Reach: Approx. 12 million people around project focus lakes regions.**

- **Positive feedback from value chain actors:**

  "*Mukene is wealth. We have learnt how to increase profits through the radio programs. It is good to listen to experts on radio rather than listening to false gossip that mukene is food for poor people“*
  (A fish processor in Lambu & listener to Buddu FM, Masaka District).

  ***" Quality of small fish depends on how clean the fish is. The radio program told us that we should not dry fish on the ground so that we loose the good price. We need to aim for the best price always that of human grade. That is what am telling my fish processors*"**

  (Listener to Pakwach FM at DeiB landing site).

Interventions – Nutritional education

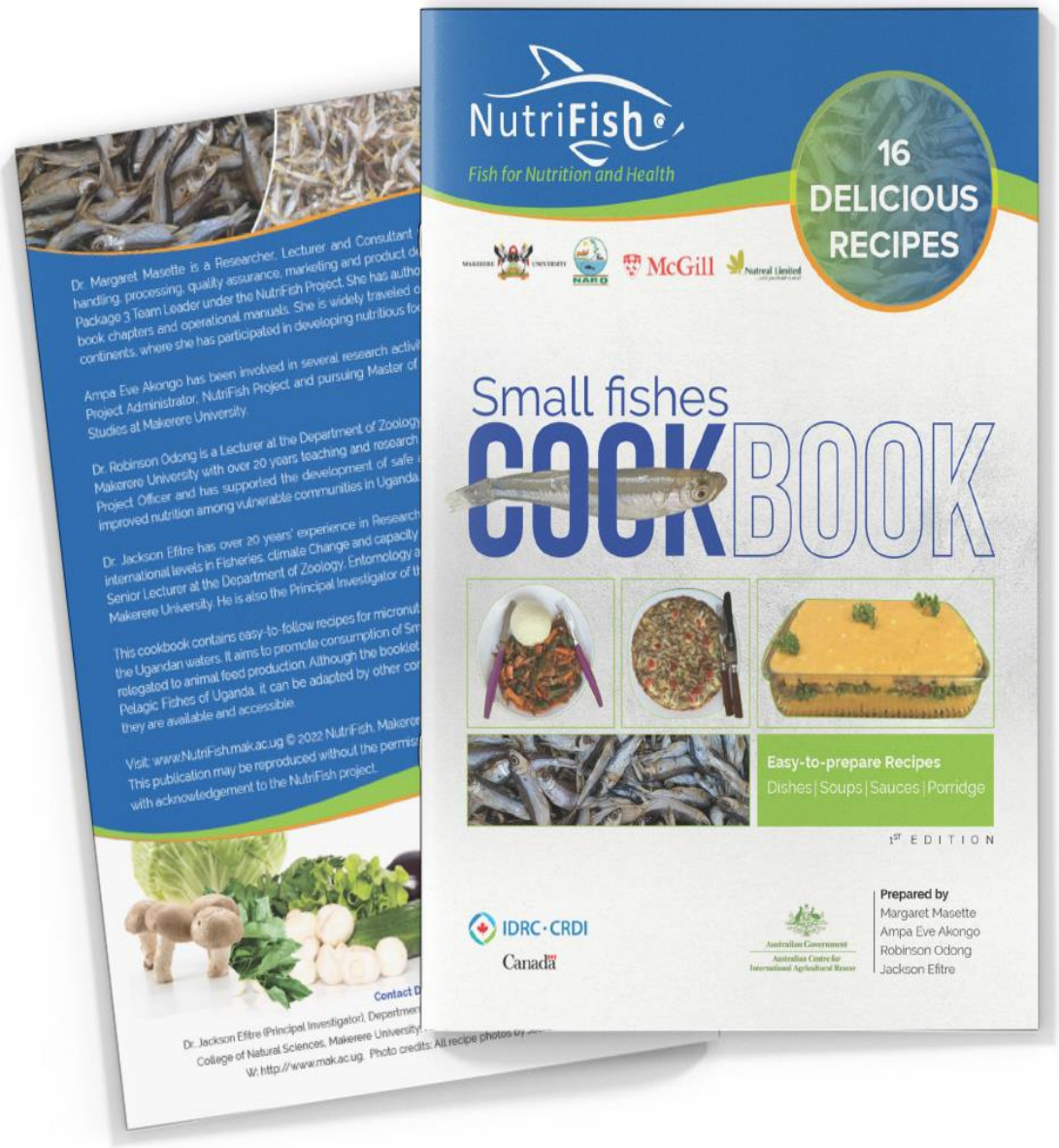
- A small fishes cookbook (www.nutrifish.mak.ac.ug) developed

- 85 (55 female and 30 male) fishing community members engaged in cooking demonstrations at the fishing communities.

- 176 (84 females and 92 male) members of the general public tasted the different dishes during *Harvest Money* Exhibition.

- High demand for the cookbook – new & exciting small fish recipes received positively.

- Engaging policy makes – Foreword signed by Minister of State for Fisheries



Interventions- training in value chain improvement & gender

- 68 (42 males and 26 females) value chain actors trained as Project 'Champions'
- Champions have shared knowledge acquired with 650 (405 females; 245 males) community members, thus increasing project reach.

- **Emerging outcomes**
  - better access to financial resources (loans) by women
  - ownership of assets such as boats hence improving incomes
  - improving attitudes towards consumption of USF
  - improvements in quality and profitability

Thank you!