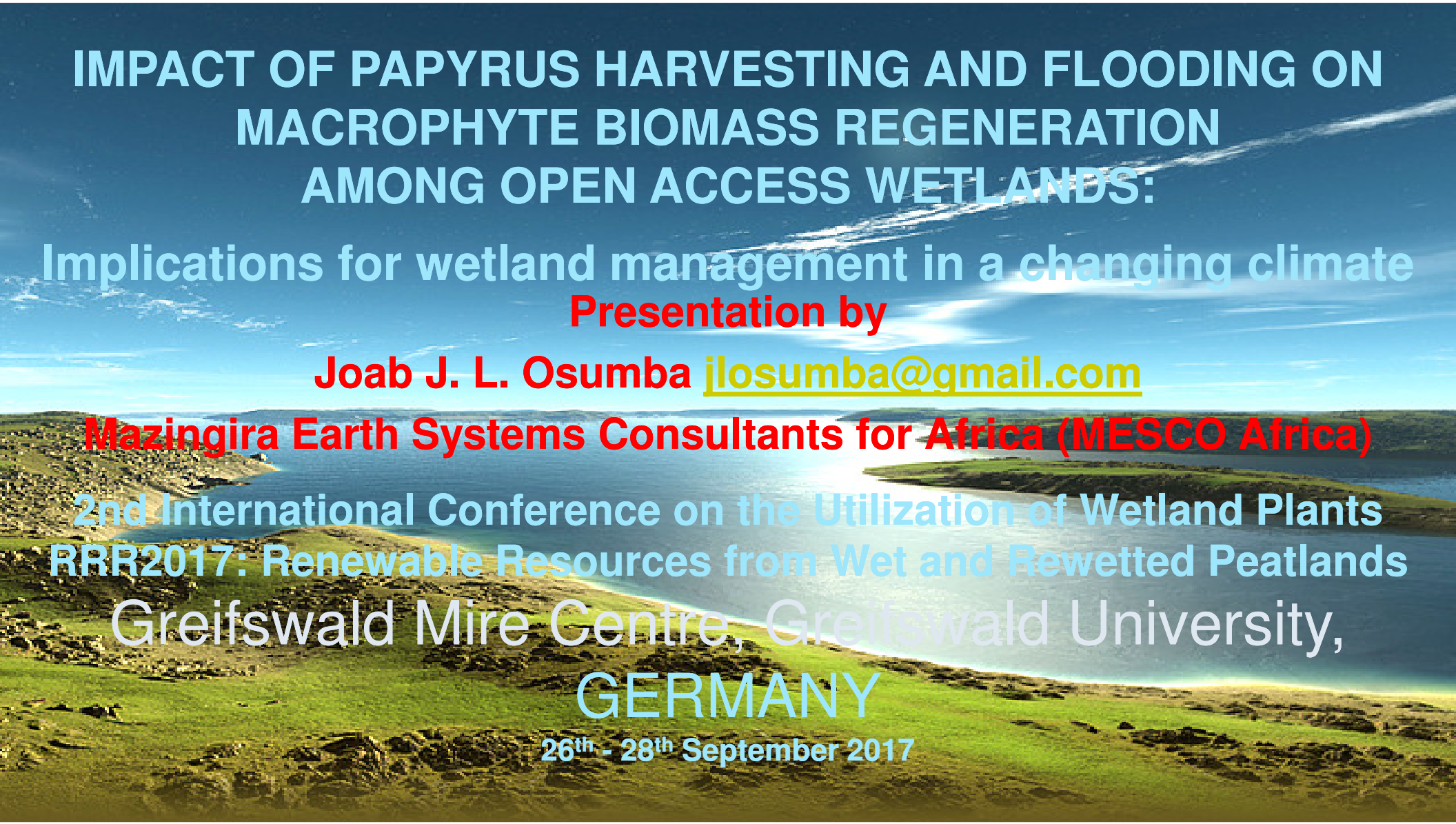

IMPACT OF PAPYRUS HARVESTING AND FLOODING ON MACROPHYTE BIOMASS REGENERATION AMONG OPEN ACCESS WETLANDS:

Implications for wetland management in a changing climate

Presentation by

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Introduction

- Papyrus is a plant with a rich history and tradition in global culture, academia and commerce, dating back to ancient civilizations of Egypt, Rome, Palestine and Greece

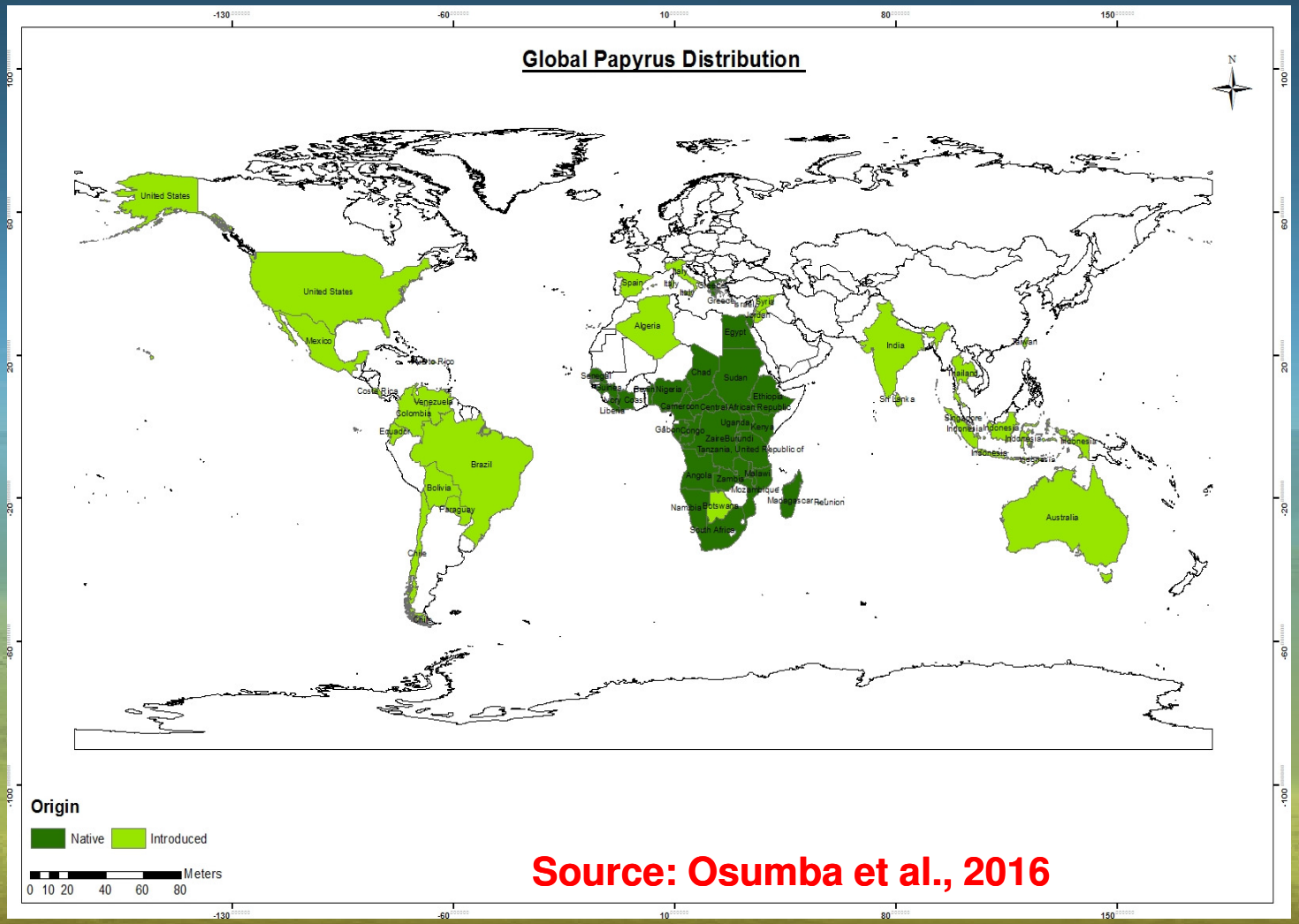
- The plant used to be cultivated in these empires, especially to produce writing materials but its use for that purpose was later overtaken by wood-pulp paper in the 10th century

- It is also a vital ecological and socioeconomic resource, especially for riparian communities living around papyrus-dominated wetlands

- Geographic distribution of papyrus wetlands has not been precisely established but some estimates are found in various literature

Origin, nativity and geographic distribution of *Cyperus papyrus*

- Dark green shows where papyrus is native, light green where it has been introduced
- Introductions are for studies or for ornamental purposes



Source: Osumba et al., 2016

Papyrus Biology

- Papyrus (*Cyperus papyrus* Linn.) is a perennial herbaceous monocotyledonous wetland sedge plant
  - The plant is known variously as papyrus, bulrush or reed.
- Papyrus grows to a height of 10 feet or 3.1-3.7m, but can grow up to 4-5m tall
- At its broadest, in ideal conditions, the culm can be 6 cm wide at the top and 15 cm at the base
- The sedge family Cyperaceae, to which papyrus belongs, comprises about 5000 species among 104 genera worldwide, distributed throughout all continents in both tropical and temperate regions

Papryus Ecology

- Papyrus is a flagship wetland macrophyte species
- The plant grows in freshwater wetlands, in wet swamps and along the margins of lakes and rivers
  - **Grows mostly on fixed ground but can pieces can break off and float in the open water**
- It is a dominant, major feature of freshwater wetland macrophyte in the tropics and sub-tropical regions of the world, mainly in Africa
- In its natural habitat cyperus papyrus occurs in large, dense populations, often lining bodies of water
- It is also a habitat for many kinds of wildlife

Papyrus ecology

- Monotypic stands are formed at continuously wet and nutrient-rich sites in which neither water stress nor nutrient shortage are likely to be limiting

- Often its presence is associated with other macrophytes in papyrus-dominated wetlands, e.g. *Phragmites, Typha*, etc.
- Ecologically spread from sea level up to 2500 m above sea level

Papyrus Agronomy

- Propagation is mainly by transplanting rootstock/ rhizome splits
- It is, however, recorded to produce seeds under favourable climatic conditions
- It needs full sun but also need to be sheltered from strong winds and, for best effect, should be allowed to form a large colony
- It can tolerate rainfall regime of 100-4200 mm p.a.; temperature range of 20-30^{0}C p.a.; and a pH range of 6.0-8.5
- It grows up to 1m deep in stagnant or slow-flowing water, anchored by a thick, woody rhizome
- The plant needs a muddy/ sandy substrate in water at least ½ m deep, with optimum water depth of 0-6” deep
- The plants need a muddy/ sandy substrate in water at least ½ m deep so that the culms will not topple
- The rootstock must remain submerged under water or at least the soil must be kept sufficiently moist during the growing season to obtain a fairly good crop

Current situation

- Despite the fact its presence is declining, interest in the plant is expanding worldwide
  - it has been re-introduced in many regions again, including Egypt
- Due to renewed interest emerging around papyrus, it has been re-introduced in many regions again
- Interest is growing in the areas of
  - socioeconomic purposes
  - ecological purposes
  - renewable energy biomass
  - climate change mitigation

The Problem

- Wetlands acreage is shrinking due to various pressures, including from climate change and from human use
  - However, production of papyrus biomass from papyrus-dominated wetlands is not yet well-studied, and available information is insufficient to generalise a conclusion across contexts
- Papyrus plant regeneration potential and biomass productivity is still poorly understood, and exploitation of the macrophyte is being undertaken without empirical guidelines for sustainable resource use
- In the Lake Victoria Basin, papyrus swamp acreage is reported to have declined, but there has been no empirical evidence to support the claim

Objectives

- A papyrus regeneration experiment was designed to quantify and predict the effect of harvesting on the dynamics of papyrus swamp stand regeneration [regrowth] and development parameters under different environmental conditions, including site, time and swamp water levels

- The combined effects of harvesting and swamp water level on papyrus regeneration potential were observed, and papyrus plant regeneration potential was evaluated

Methodology – study area and sampling sites

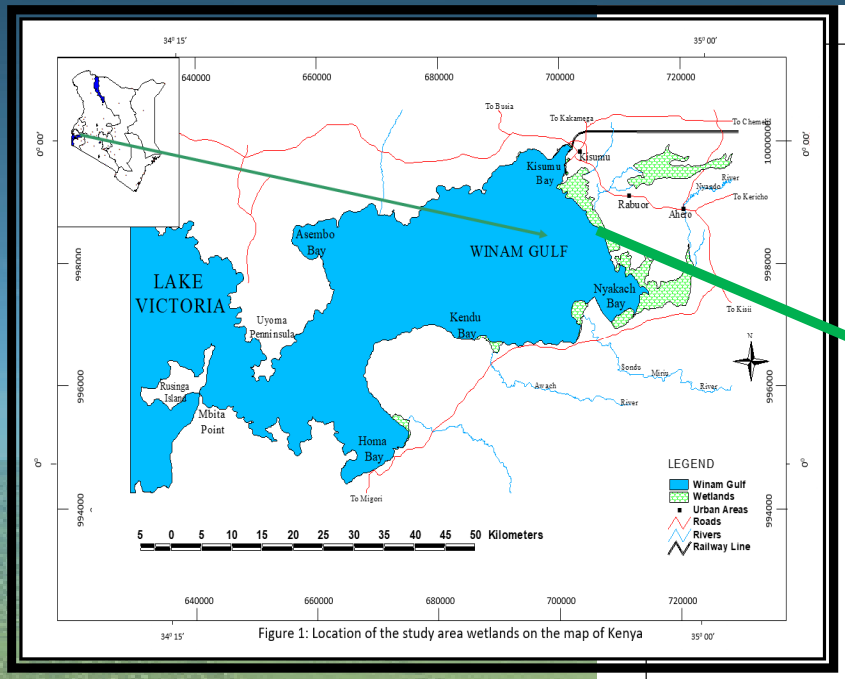


Figure 1: Location of the study area wetlands on the map of Kenya

Location of study area and sampling sites

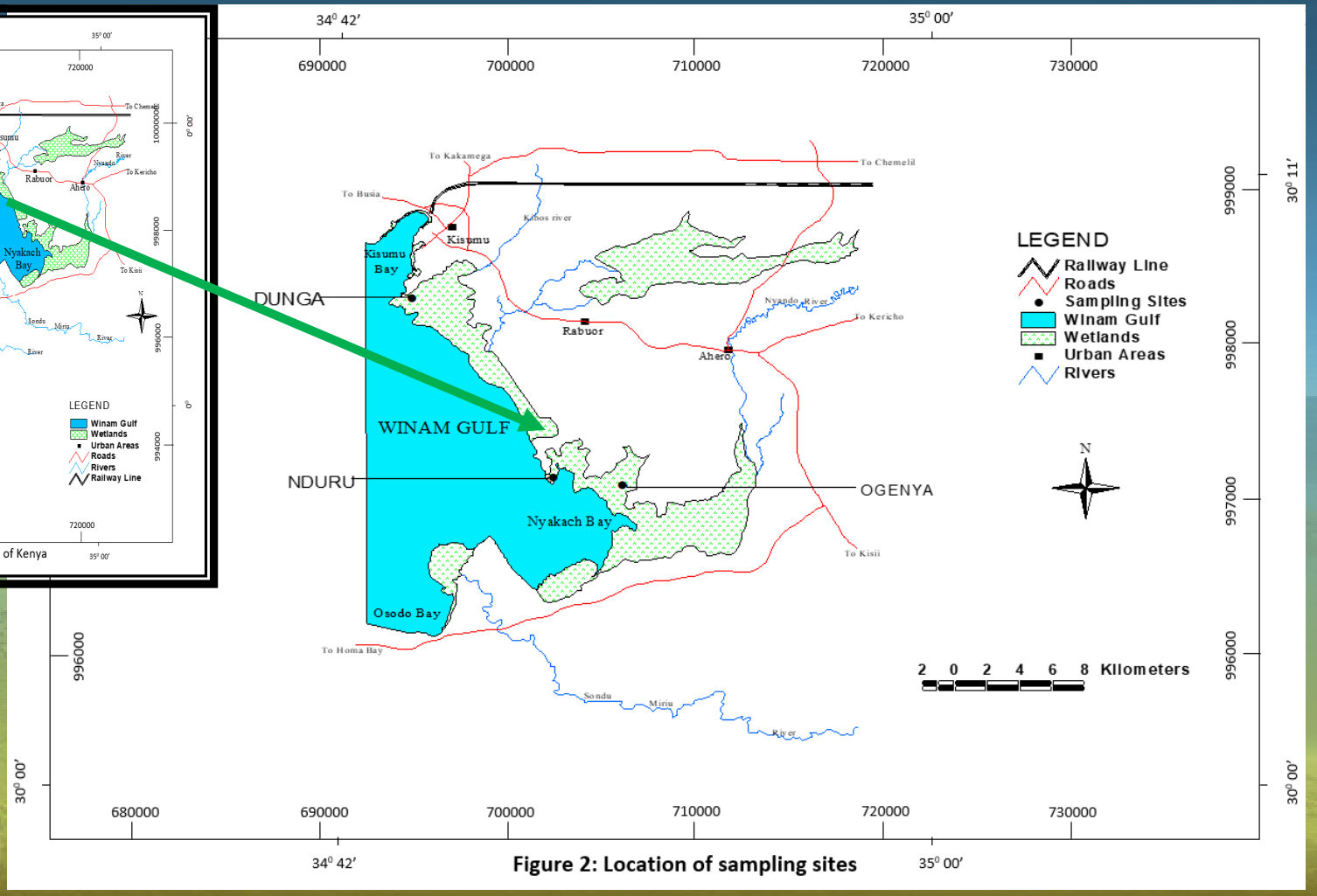
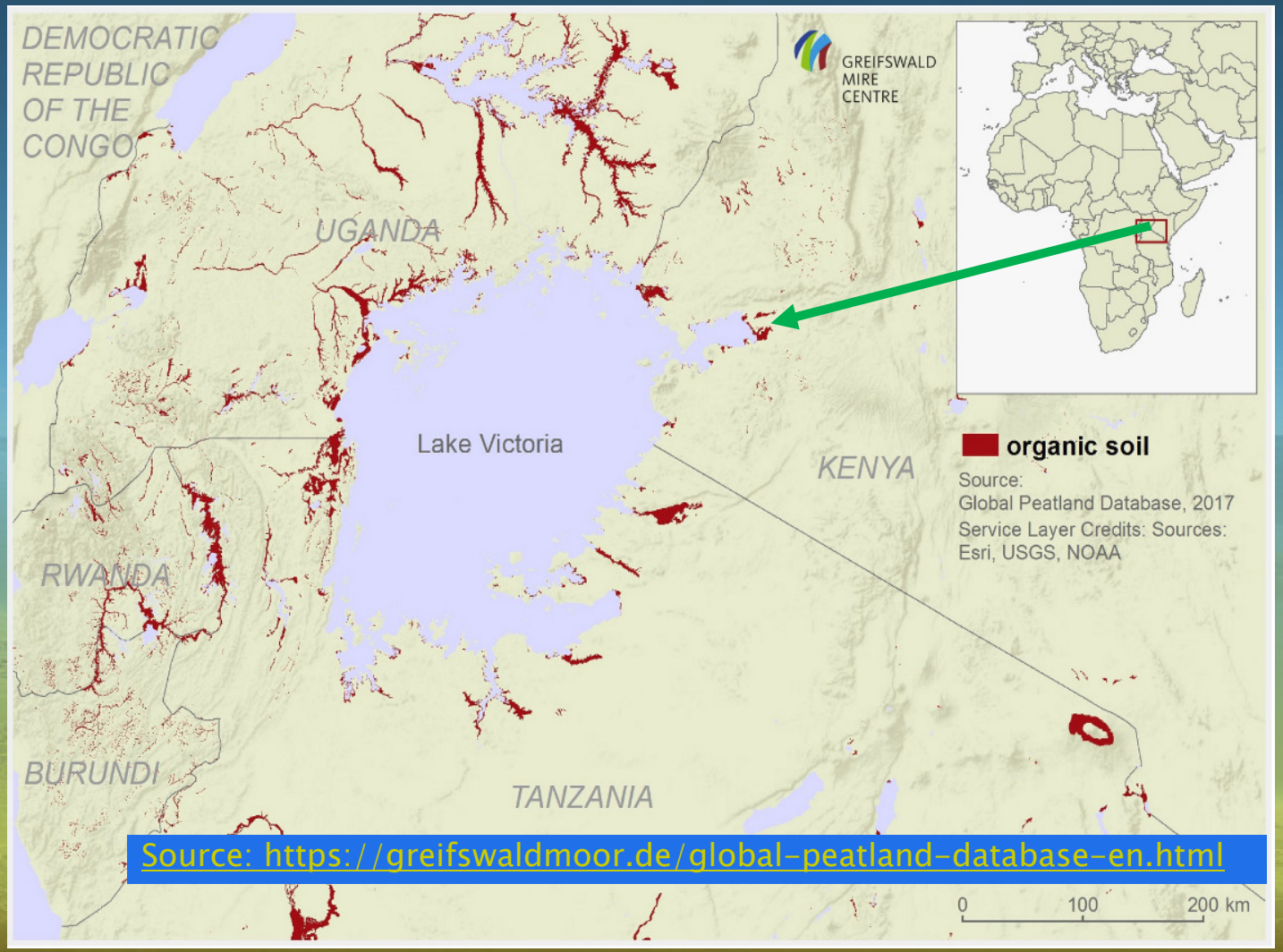


Figure 2: Location of sampling sites

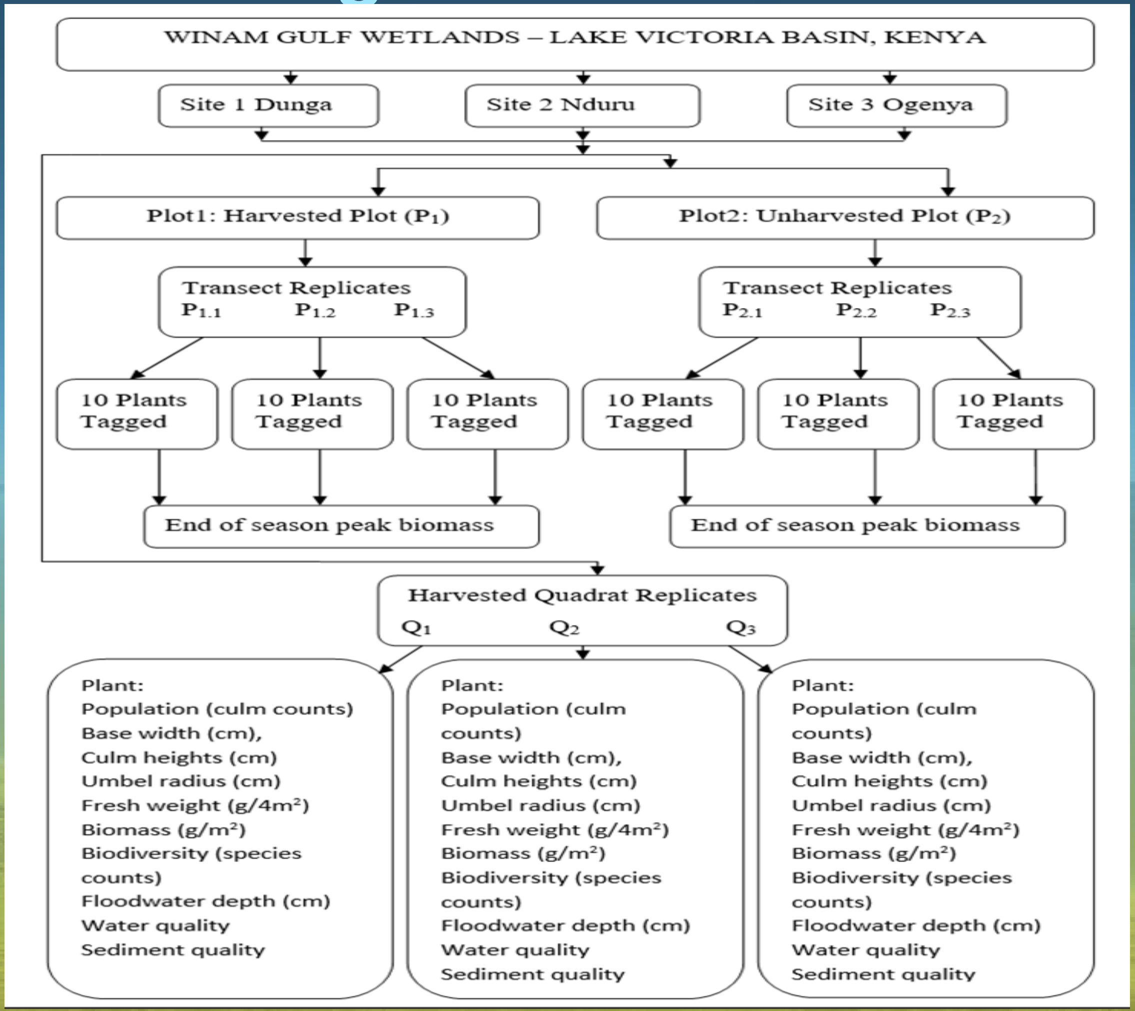
Methodology: Location of study area among the peatlands of East Africa

- The study area is Winam Gulf Swamps of Lake Victoria Basin Wetlands.
- Global peatland database indicates the study site (shown by green arrow) has peat



Methodology: Experimental Design

- Experiments were set to measure baseline, monthly and end of season papyrus harvest
- Other variables measured included papyrus population density (plant counts); papyrus base width; papyrus culm heights; papyrus harvest fresh weights; papyrus harvest biomass; flood water depth (intensity of flooding); water quality; sediment quality
- Papyrus Dry Matter (DM) accumulation was derived and used to estimate papyrus primary productivity in the swamps



Source: Osumba et al., 2016

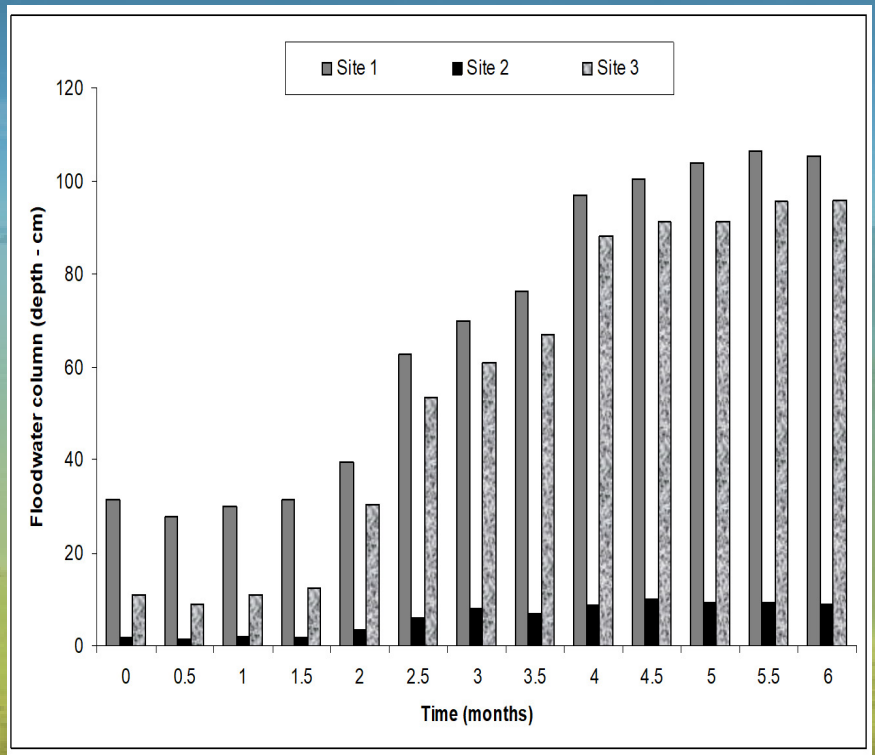
Measurements

- p

Harvesting

Results: Water depth/level

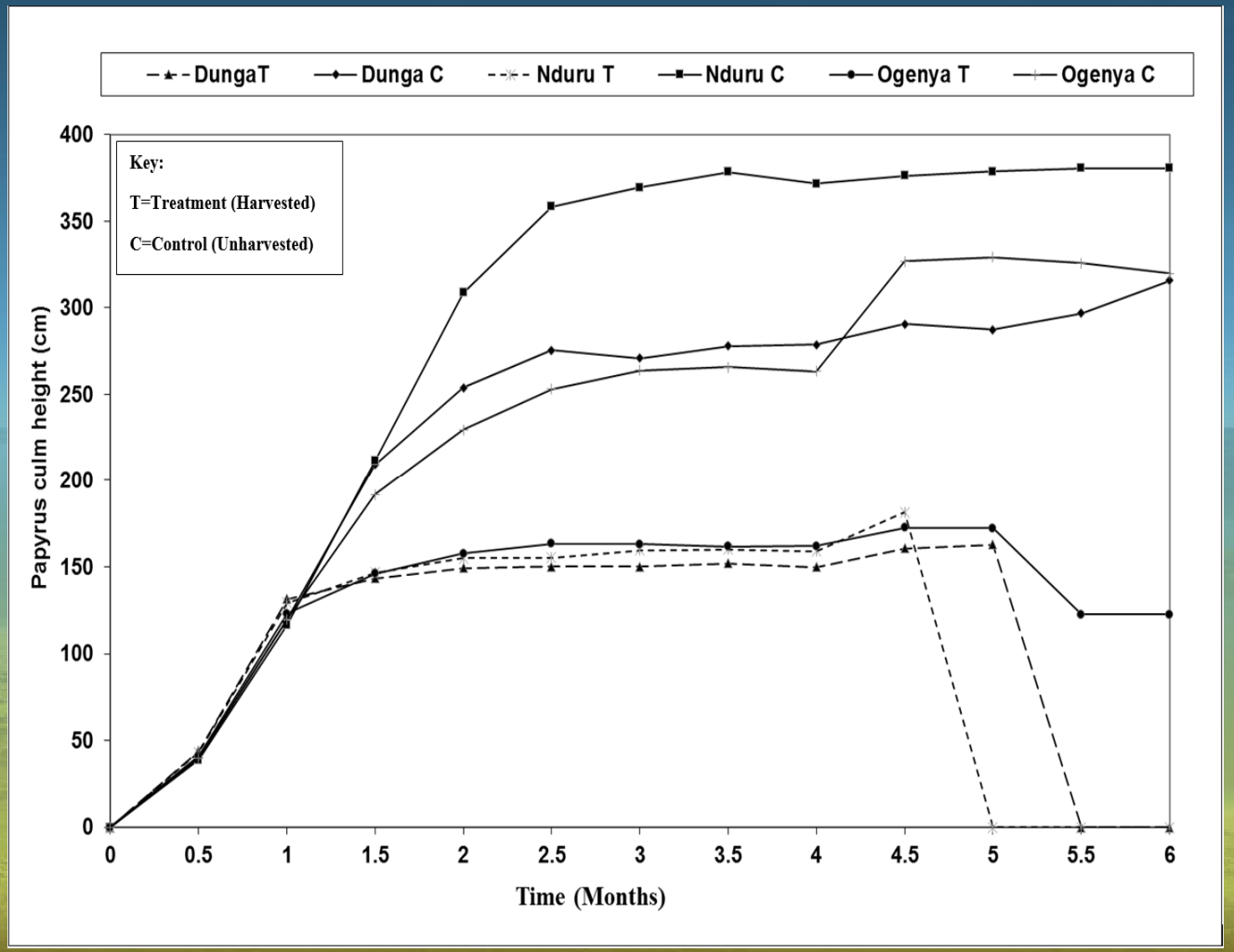
- Water depth/level was not controlled but was measured as the rainy season progressed
- Comparison was made with papyrus growth and regeneration after harvesting
- Swamp floodwater inundation level is reported to be inversely related to plant population density in monthly harvesting regime
- Swamp floodwater inundation level was found to be inversely related to biomass
- Results are supported by similar results reported elsewhere in Africa (Kalahari Conservation Society, 1989)



Average floodwater level in the experimental plots

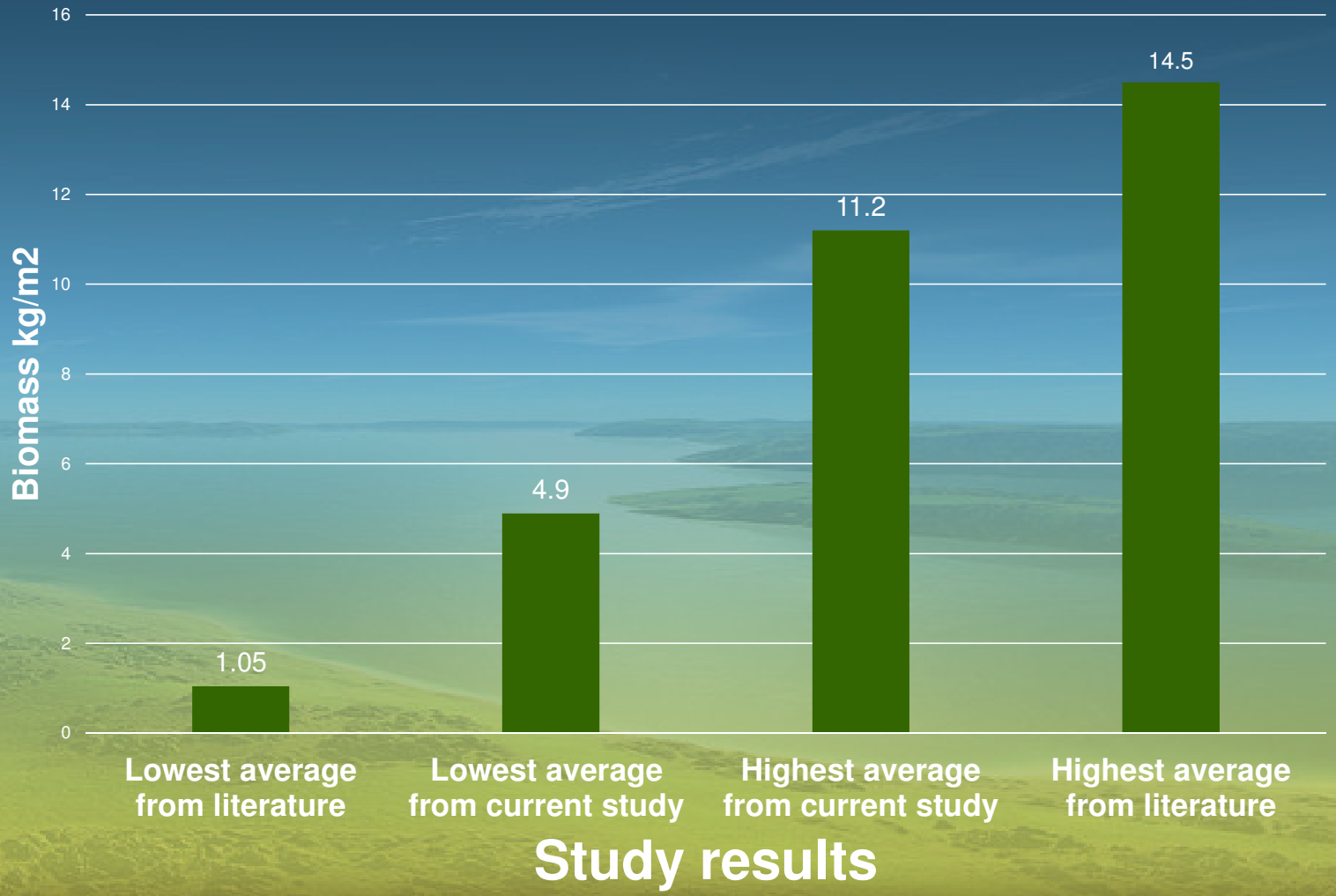
Results: Average growth heights of tagged transect plants

- All tagged plants started with the same growth vigour
- Growth of plants in harvested plots slowed down earlier, and died earlier, than those in unharvested plots



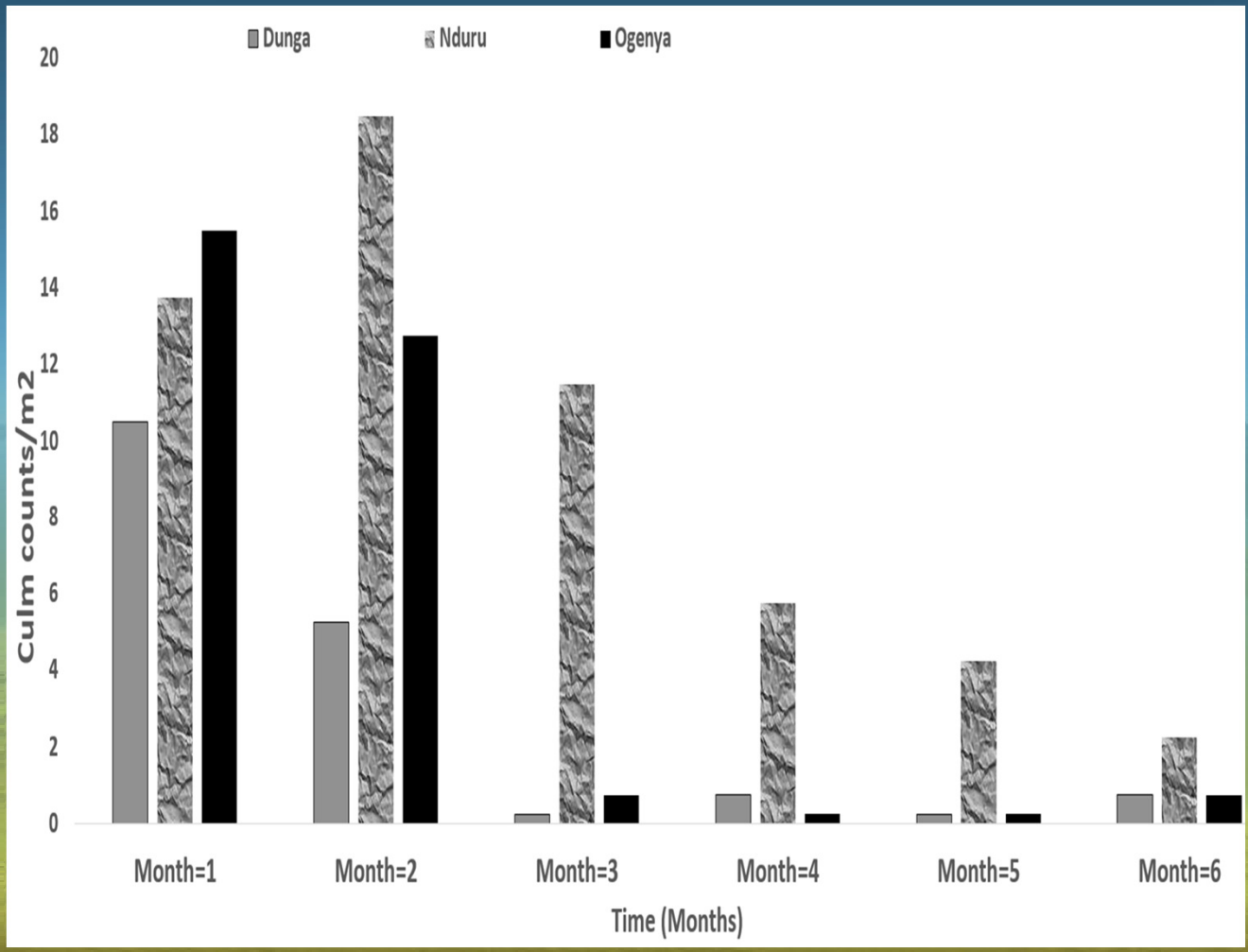
Results: Seasonal biomass accumulation

- Results fell in-between the lowest and the highest ever recorded
- Results indicating papyrus at the studied swamps are not operating at full potential, but again the potential is not yet severely weakened



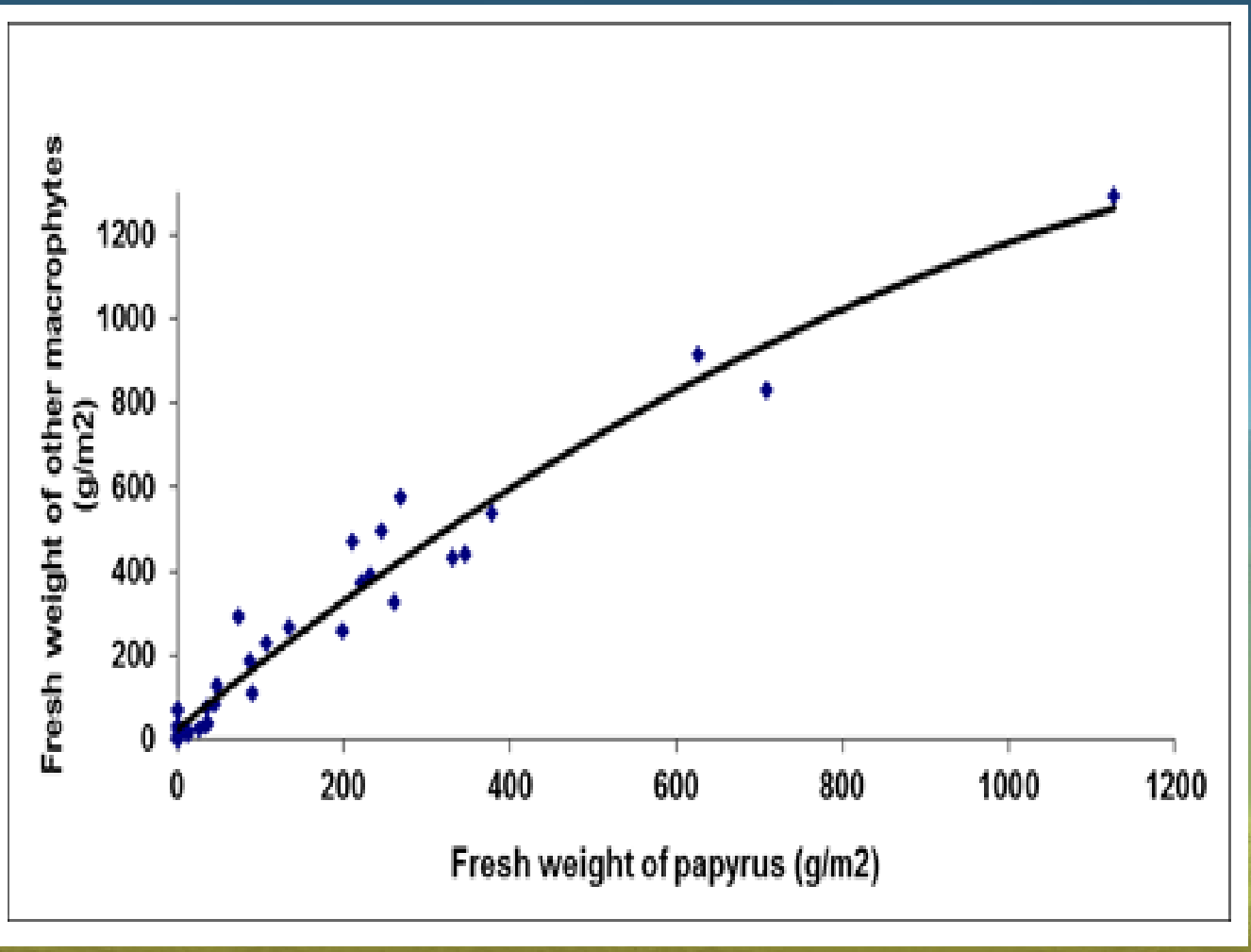
Results: Papyrus culm counts in the monthly harvest regime

- Regenerating papyrus plants are negatively affected by increasing swamp water depth
- #regenerated culms becomes fewer and fewer as the swamp water depth increases
- #plants were highest in the site with lowest water depth



Results: Fresh weight of papyrus against that of other macrophytes

- Regression analysis indicates that papyrus biomass is strongly related to the biomass of the other macrophytes



Socioeconomic uses of papyrus

- Habitat for fisheries and wildlife
- Fodder: grazing
- Construction: huts, purlins (*fitos*), door shutters, thatches, etc
- Handicraft: artefacts, ropes/ twines, baskets/ boxes, nets, mats, furniture, utensils, fish traps, fishing gears, trays, carpets, ceilings, brooms, packaging materials, etc
- Fuel: rhizomes, briquettes,,
- Medicine
- Food: the pith of the stem is eaten raw or cooked
- Ornamental landscapes
- Modern papyrus handicraft products are mostly used by the harvesters or traded locally, although some papyrus-derived handicrafts are sold to tourists

Ecological uses of papyrus

- Supporting the hydrological cycle, flood control and storm abatement,
- Controlling
- carbon sequestration
- Habitats for fish, birds and other aquatic wildlife
- Reservoirs for water storage
- Natural filters of pollutants, nutrients, eutrophytes, silt and sediment
- Stabilizers of shorelines
- controlling eutrophication
- potential sequesters of carbon in the peaty sediments formed under papyrus swamps, though this peat is rapidly oxidized during periods of low water, hence releasing its stored carbon

Conclusion

- Papyrus biomass production and regeneration potential in Lake Victoria Swamps is highly variable, depending on the hydrology of the swamp and the condition of the vegetation in the swamp

- Papyrus swamps in Lake Victoria have the potential to accumulate large amounts of biomass

- Converting this biomass into products with durable uses locks the carbon in the biomass out of circulation, thereby mitigating climate change

- Most of the uses are for durable products – which lock carbon out of circulation and delays its release back to the atmosphere

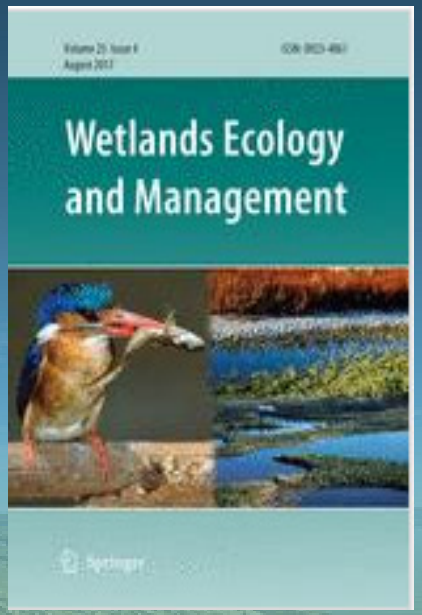
Recommendations

- Urgent need for sustained, systematic studies on papyrus biomass dynamics to strengthen understanding for sustainable livelihood support while mitigating climate change
  - Promotion of wise use of above ground biomass will preserve peat below the swamps
- Effective policy guidance for wise use and sustainable management of peat-forming wetlands in Africa
- Focus on adaptation aspects of paludiculture for Africa, but with mitigation benefits
- International cooperation on paludiculture, which includes Africa

Challenges

- Technical expertise for research on carbon tracking
- Funding for research

END – Thanks



Further reading

Osumba, JJL, JB Okeyo-Owuor and PO Raburu (2010). Effect of harvesting on temporal papyrus (*Cyperus papyrus*) biomass regeneration potential among swamps in Winam Gulf wetlands of Lake Victoria Basin, Kenya. *Wetlands Ecology and Management* 18 (3) 2010 333-341 (Print version) 0923-4861 (Online version) 1572-9834 Springer Netherlands 10.1007/s11273-010-9174-2

Osumba, J.J.L, J.B. Okeyo-Owuor and P. O. Raburu (2016). Papyrus Harvesting and Biomass Regeneration in Lake Victoria Wetlands: Implications for wetland management in a changing climate. Lambert Academic Publishing (LAP). Project: 137389. ISBN: 978-3-659-88242-5