LAKE VICTORIA TURNING GREEN: WHAT ARE THE IMPLICATIONS FOR FISHERIES AND AQUACULTURE

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Olokotum et al., (2020)

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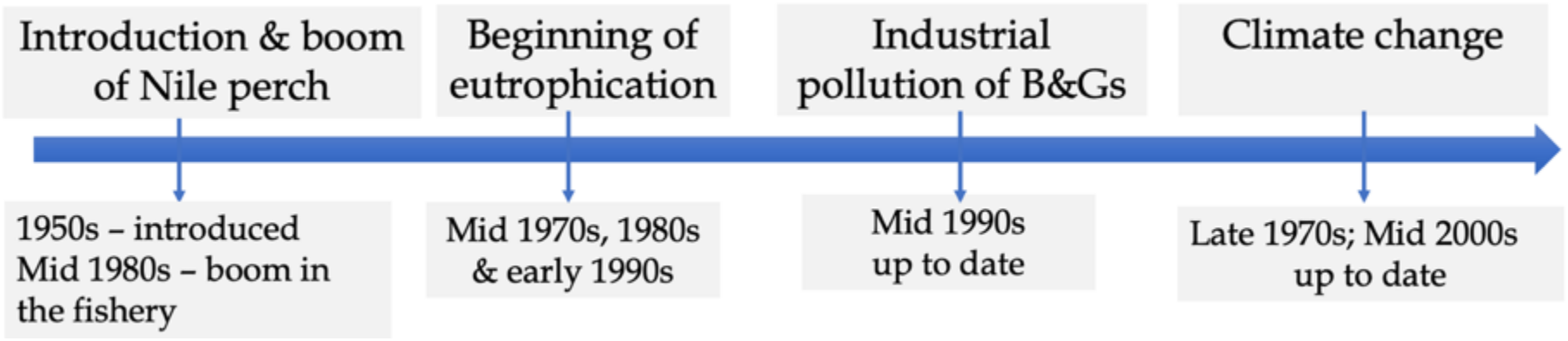
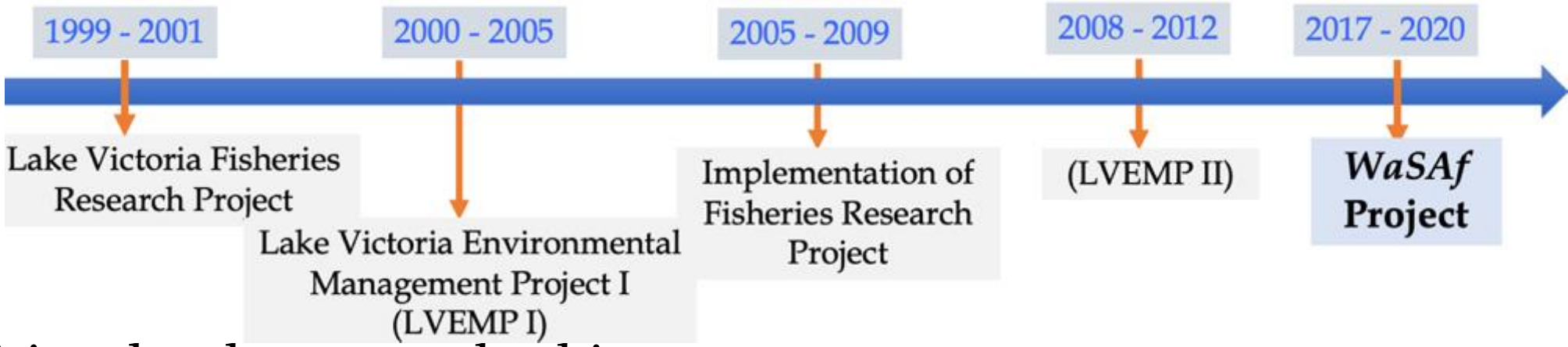
What's your experience of greening?

History and timing of greening





- Human activities that have resulted into
  - ➔Loss of 300+ Haplochromines = simplified food web
  - ➔Explosion of water hyacinth and cyanobacteria = cyanotoxins

- Interest in cyanobacterial studies in early 2000s (microcystins)

Matsuishi et al. 2006; Mkumbo et al. 2007; Mkumbo & Marshall, 2015

We are responsible for the greening

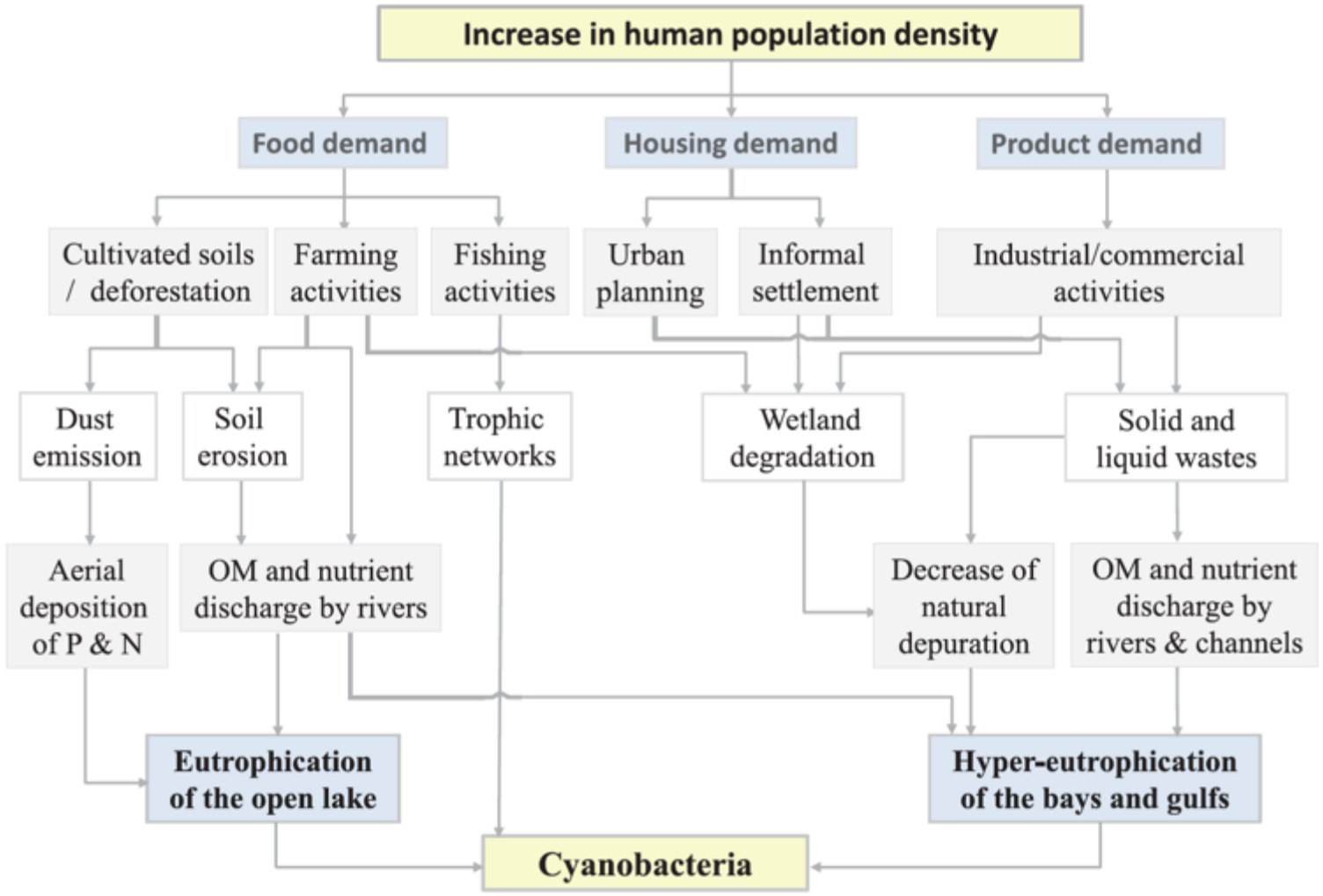
- The factors influencing dynamics of cyanobacteria - complex

B&Gs

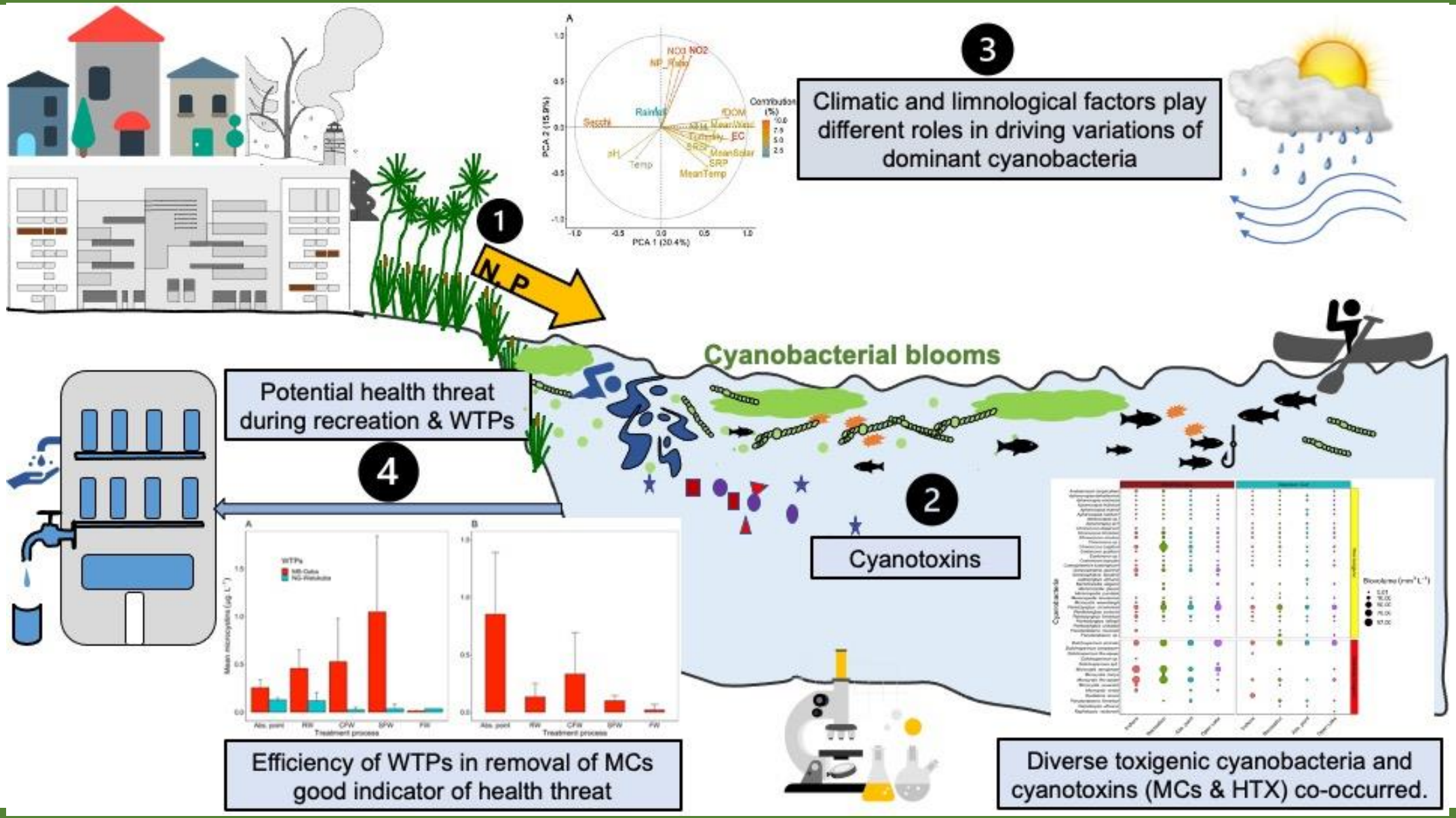
- Rapid urbanisation – direct discharge (N & P) e.g. a daily waste loading in Murchison Bay is up to 0.2% of its total volume (Luyiga et al, 2015).

Main lake

- Defforestation & intensive agriculture – aerial deposition (mainly P) (Tamatamah et al., 2005)



What is causing the greening!



The challenge of greening

There is eutrophication with massive cyanobacteria blooms (CyanoHABs)

➔Cyanotoxins e.g., CYN, ATX, STX, and MC

➔Exposure through consumption of water, recreation and fish

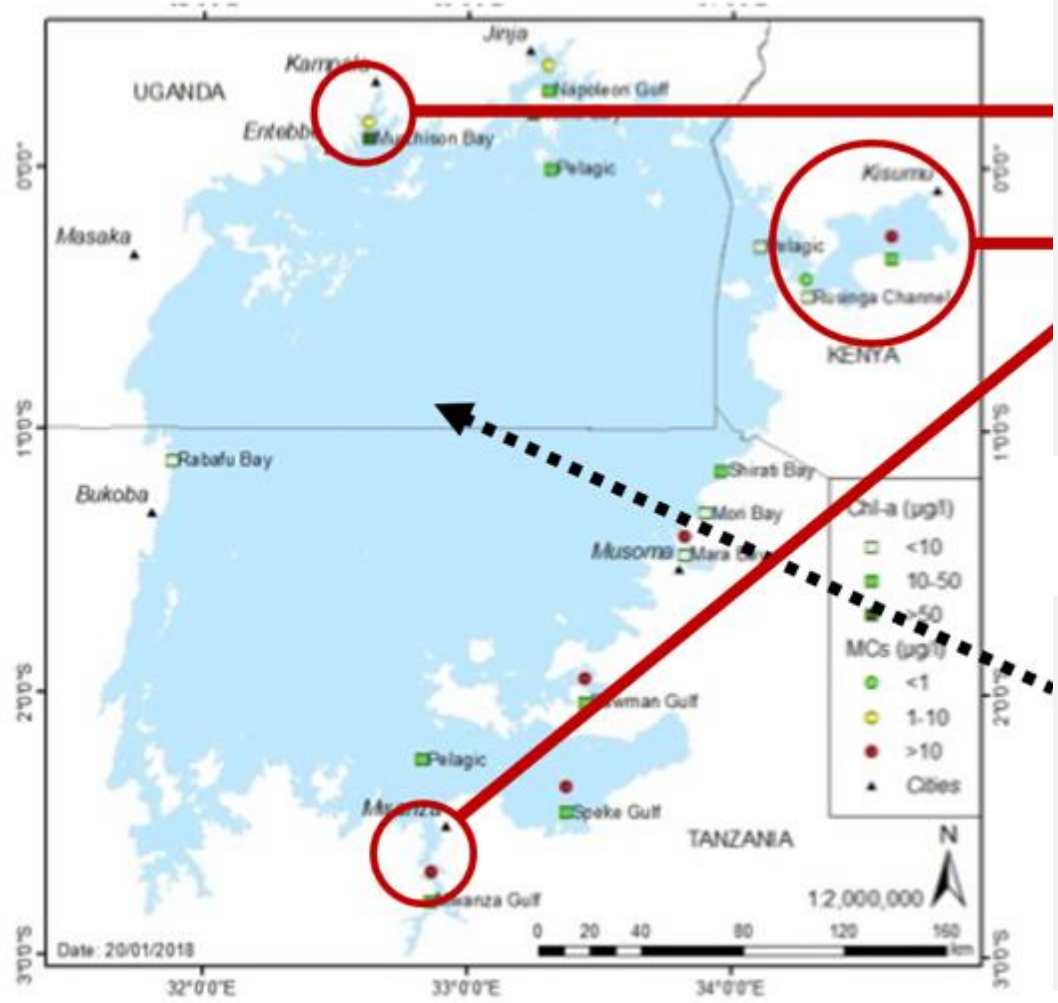
➔Conventional WTPs– inefficient in removal of cyanotoxins (Chorus and Bartram, 1999)

➔Bioaccumulation of cyanotoxins in fish (Hardy et al., 2015; Brown et al., 2018)

Thus, need for characterization threats from cyanobacterial toxins in northern Lake Victoria

The challenge of greening

Biomass, phytoplankton community, and potential toxicity of cyanobacteria



Bays & gulfs

→ Increase in Chl-a concentrations since the 2000's

→ Large dominance of cyanobacteria (*Microcystis* & *Dolichospermum*)

Major MC

5 - 30 MC variants with concentrations of 0.1 - 81 µg/L

(Okello et al., 2010; Sitoki et al., 2012; Mbonde et al. 2015)

Main lake

→ Low Chl-a concentrations since the 2000's

→ **Co-dominance** of phytoplankton community by diatoms and cyanobacteria

→ 3-6 MC variants with concentrations of 0.01- 3.5 µg/L

(Sekadende et al., 2005; Sitoki et al., 2012)

Consequences of the greening

Ecological impact of the blooms

- Change in fish communities e.g. decline in the stocks of Nile perch 2005 – 2011 (Mkumbo & Marshall, 2015)
- Disturbance of trophic network – lower and higher level

@LWM (2016)

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Sanitary risk

➔Contaminated water – **direct** exposure to toxins

➔Consumption fish food – **indirect** exposure e.g. up to 128.5 µg/kg of commercial fish species from LV (Semyalo et al., 2010; Poste et al., 2011)

➔Swimming – chances of direct water consumption and exposure through the skin

Satellite image of Ggaba WTP

How fish responds to greening effect

What is the the potential impact of this the greening?

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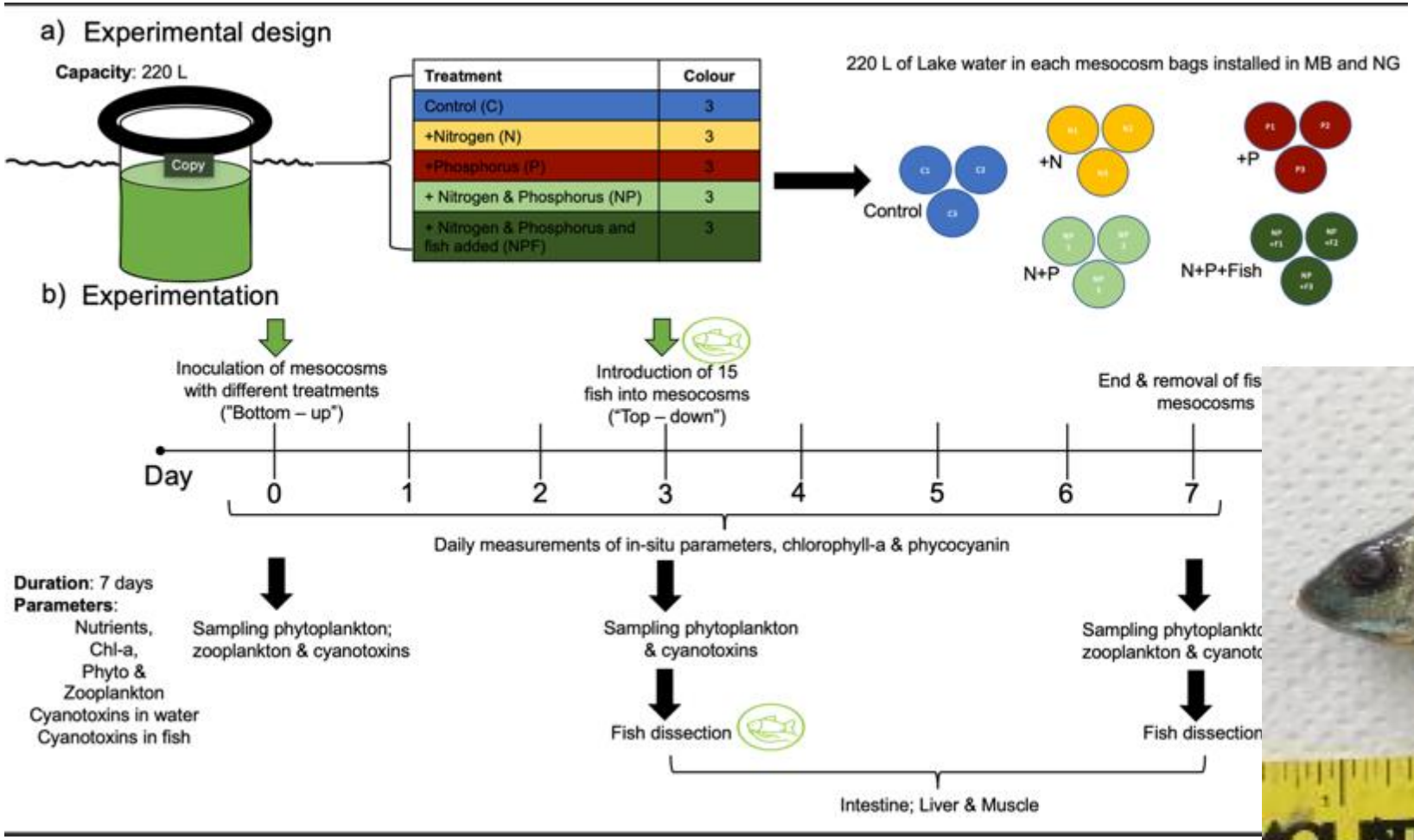
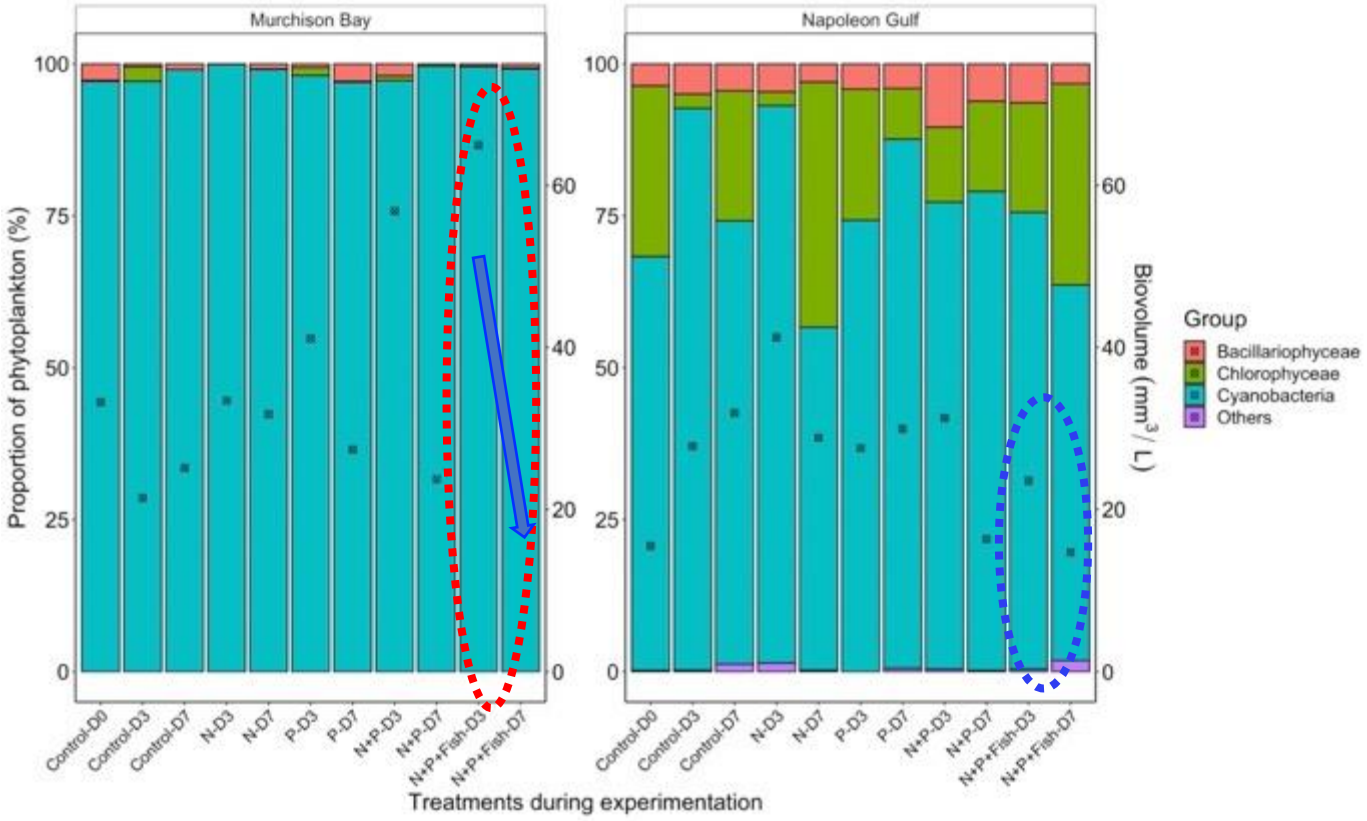
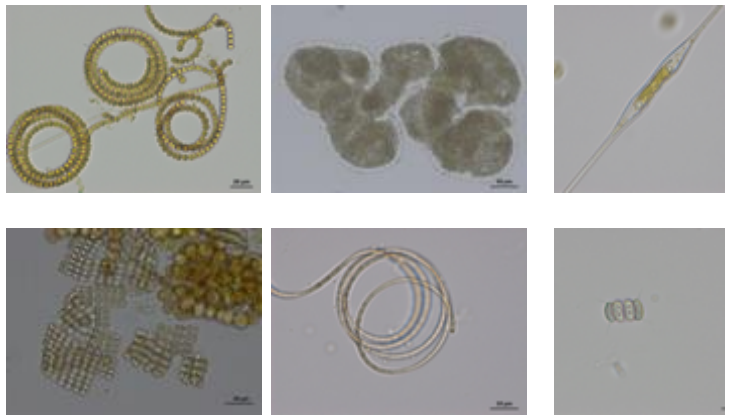
Consequences for fish



Phytoplanktonic response to fish addition





@Hamlaoui S.

Nile tilapia caused decrease in the total phytoplankton biovolume in both MB and NG mesocosms.

➔Consumption of cyanobacteria;

➔ Potential to control cyanobacterial biomass;

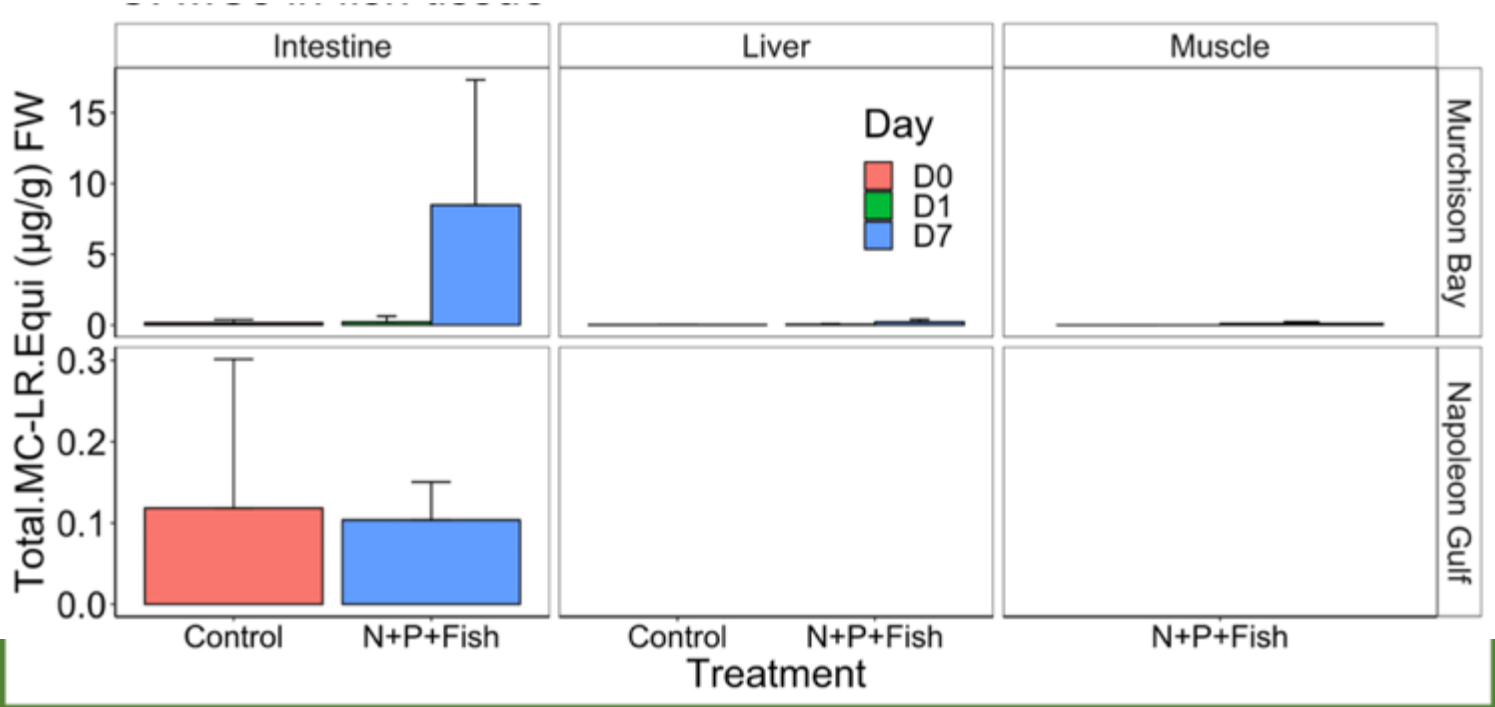
➔ Exposed to transfer of cyanotoxins

- The differences observed on the effects of fish addition mesocosms, may be dependent of the relative abundances of fish and cyanobacteria.
- Furthermore, large biovolume of M. aeruginosa might clog the gills

Consequences - Cyanotoxins in fishes

- Evidence of consumption of cyanobacteria resulted into MC
- Only 4 fish (7% of the fish) in the MB mesocosms tested positive for MC in the muscle

  ➔transfer (0.03 – 27.5 µg MC-LR g^{-1}) and possible biomagnification of MC in tilapia in MB



- Confirmed transfer and possible biomagnification of MC in the Nile tilapia muscle
- Increase in cyanobacteria blooms, results into contamination of the fish.
- Humans might exposed to chronic MC given that the total daily intake (TDI) for an adult consuming 200-300 g of fish is 0.04 µg MC-LR kg^{-1} day^{-1}.

What does it mean for fisheries and aquaculture

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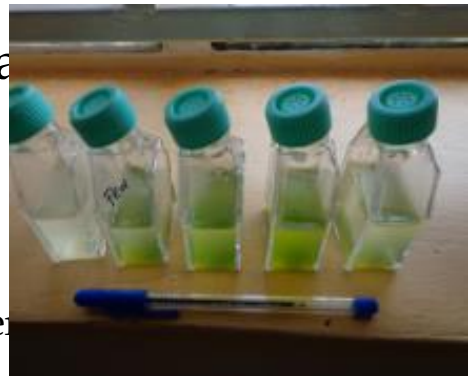
- There might be no sights for aquaculture in the inshore
- Offshore aquaculture development will be share
- Potential accumulation of toxins

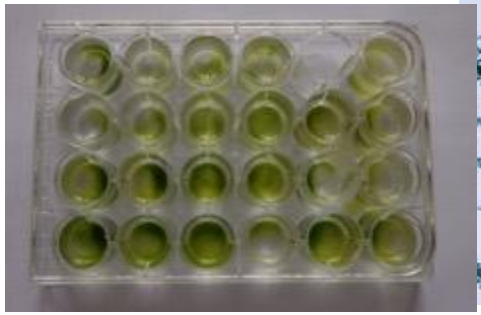
As fish feed supplements

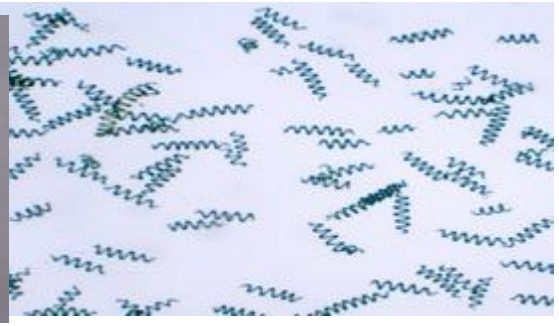
i. Turning an environmental nuisa
economic products e.g.:
   a. fish feed ingredient
   b. sustainable wastewater treatme

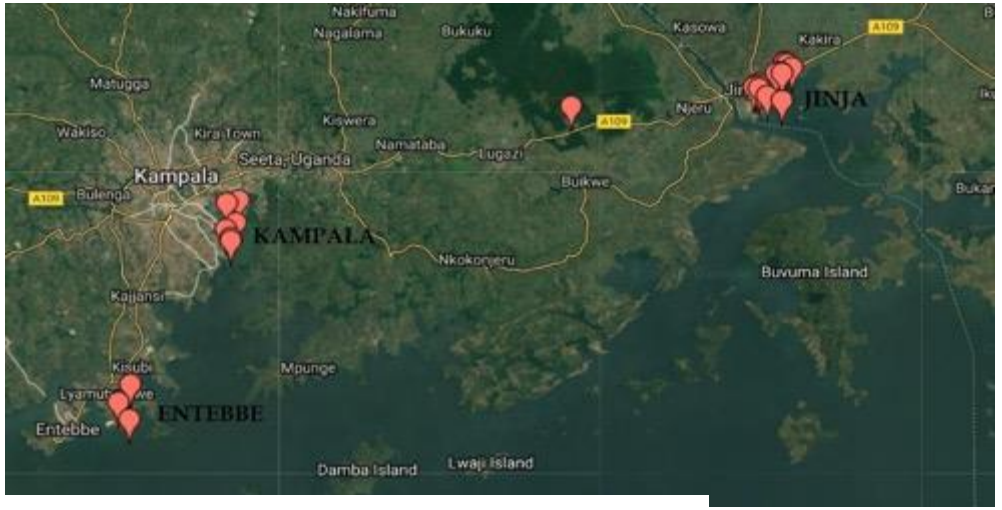


ii. Elsewhere especially in Asia, industries have integrated microalgae technologies to tackle pollution issues that generally affect fisheries

iii. In Uganda, there is little documentation on use of *Spirulina* for pollution reduction & as a fish feed ingredient







@Wanda et al. Research Team

Knowledge Sharing & Management Series

Sources of what we know about greening!


SUNDAYVISION 15
May 21, 2023

ALL YOU NEED TO KNOW ABOUT CLIMATE CHANGE

GREEN UG

SUGARCANE TO SOLVE SANITARY GAPS IN UGANDA WITH FIBRE PADS

Page 22

Algal Bloom crisis looms over L. Victoria

Poor waste management at Lambu landing site is one of the fctors cusing pollution of the lake, leading to algal blooms


Ruto fights back as probe into the Sh40bn gun fraud moves to Rome

DAILY NATION

Lake of poison

Lake Victoria, ironically described as one of the world's largest fresh water bodies, and our major source of fish, is rotting as industries, institutions and fish farmers serve it a lethal mix of poisonous filth

INSIDE: A 16-page pullout on the unfolding tragedy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Review

A review of the socioecological causes and consequences of cyanobacterial blooms in Lake Victoria

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ABSTRACT

Africa is experiencing high annual population growth in its major river basins. This growth has resulted in significant land use change and pollution pressures on the freshwater ecosystems. Among them, the Lake Victoria basin, with more than 42 million people, is a unique and vital resource that provides food and drinking water in East Africa. However, Lake Victoria (LV) has experienced a progressive eutrophication and substantial changes in the fish community leading to recurrent proliferation of water hyacinth and cyanobacteria. Based on

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What is required of fisheries and aquaculture

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Physical	Chemical	Biological

• Water Temperature
• pH
• Conductivity
• Dissolved Oxygen
• Turbidity
• Wind
• Solar radiation
	• Nutrients
	  • TN
	  • NO_3 - N
	  • NH_4 – N
	  • TP
	  • SRP
	  • SRSi
	  • fDOM
		• Chorophyll a
		• Cyanotoxins
		• Phytoplankton

How do we move forward

- Increasing population thus predicted increase in eutrophication and cyanobacteria
- Clear distinction in B&Gs and main lake of LV – with complex factors
- Understand the ecological fuctioning of the lake e.g. dynamics of cyanobacteria

- Monitoring of cyanobaterial toxins in water & fish for transfer and bioaccumulation
- Long term monitoring to develop decision tree with adotpion of WHO guidelines for drinking and bathing water
- Dissemination of public information for better use raw water – sanitary aspects

- Protection and restoration of numerous wetlands around the B&Gs to prevent direct nutrient loading into LV e.g.
  - Improved wastewater treatment
  - Sustainable land use management

Thank you

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