INMS Component 3: Developing regional assessments of nitrogen management

East Africa region

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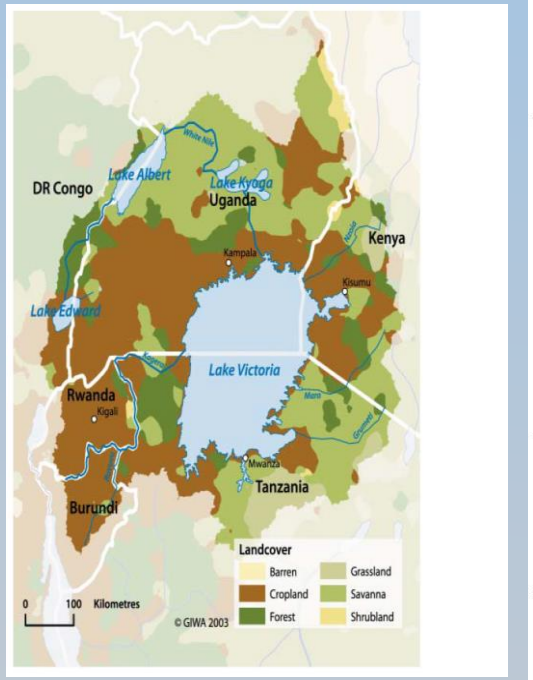
Context of the region: Description of the region - LVB, EA



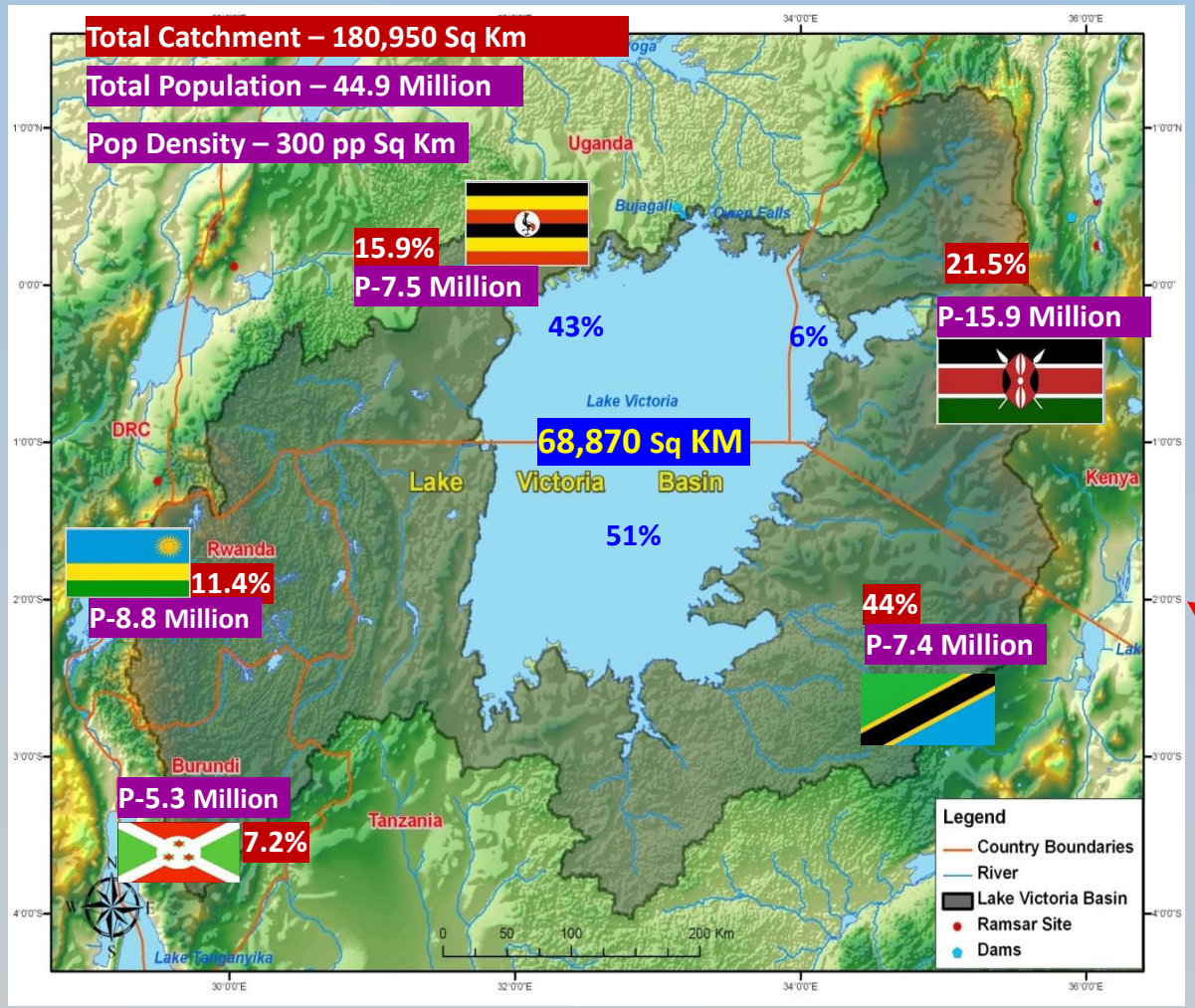


Fig 1. East Africa Lake Victoria Catchment region

Threat and Benefits

Threats

- Produce quality
- Eutrophication
- Hypoxia
- Water quality
- Ecosystem services
- Biodiversity
- Air pollution
- Health risks
- Floods & droughts

Benefits

- Crop productivity
- Fish production
- Animal produce quality
- C sequestration
- Food, feed and fiber
- Biodiversity

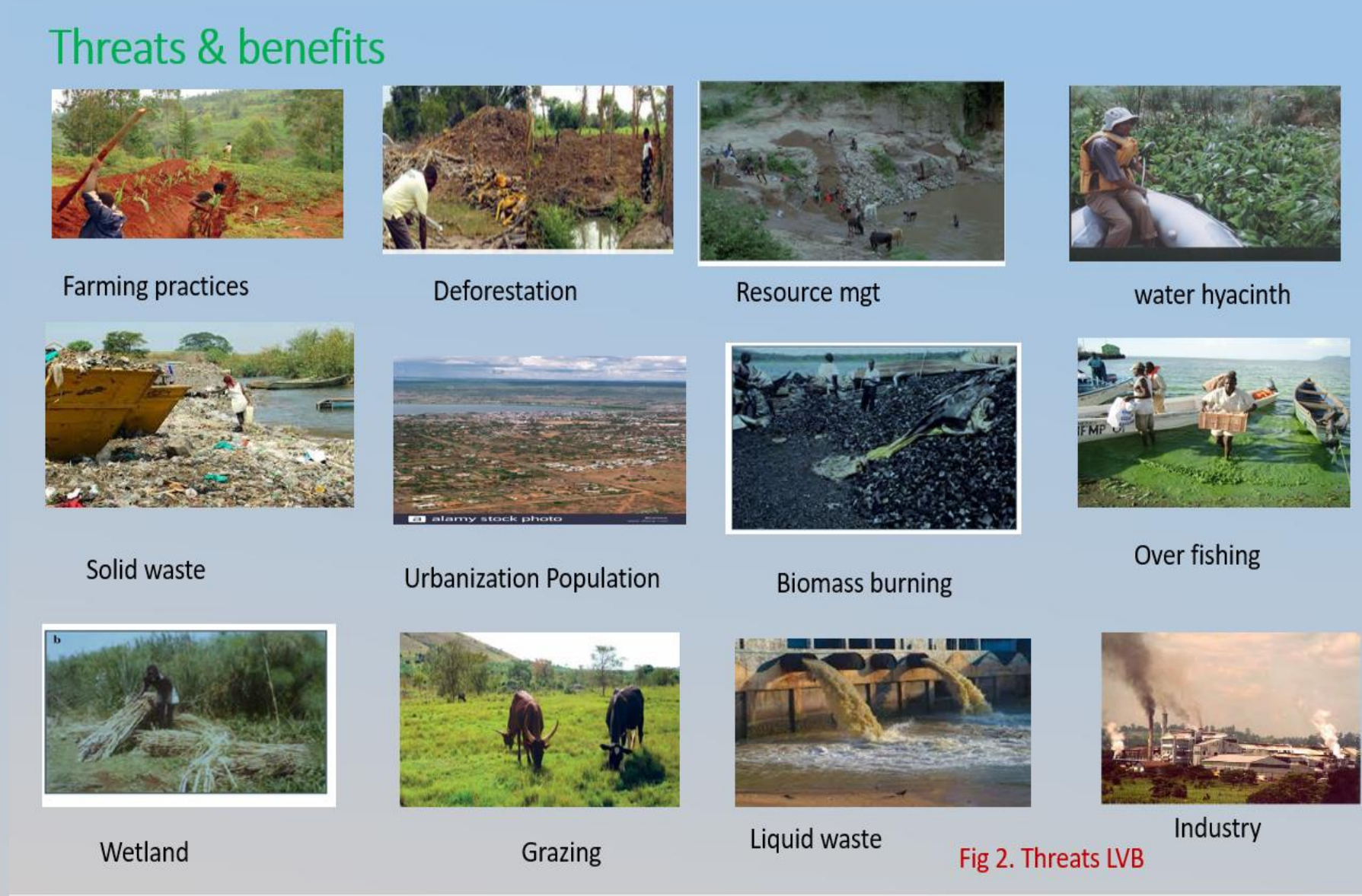


Fig 2. Threats LVB

N sources LVB

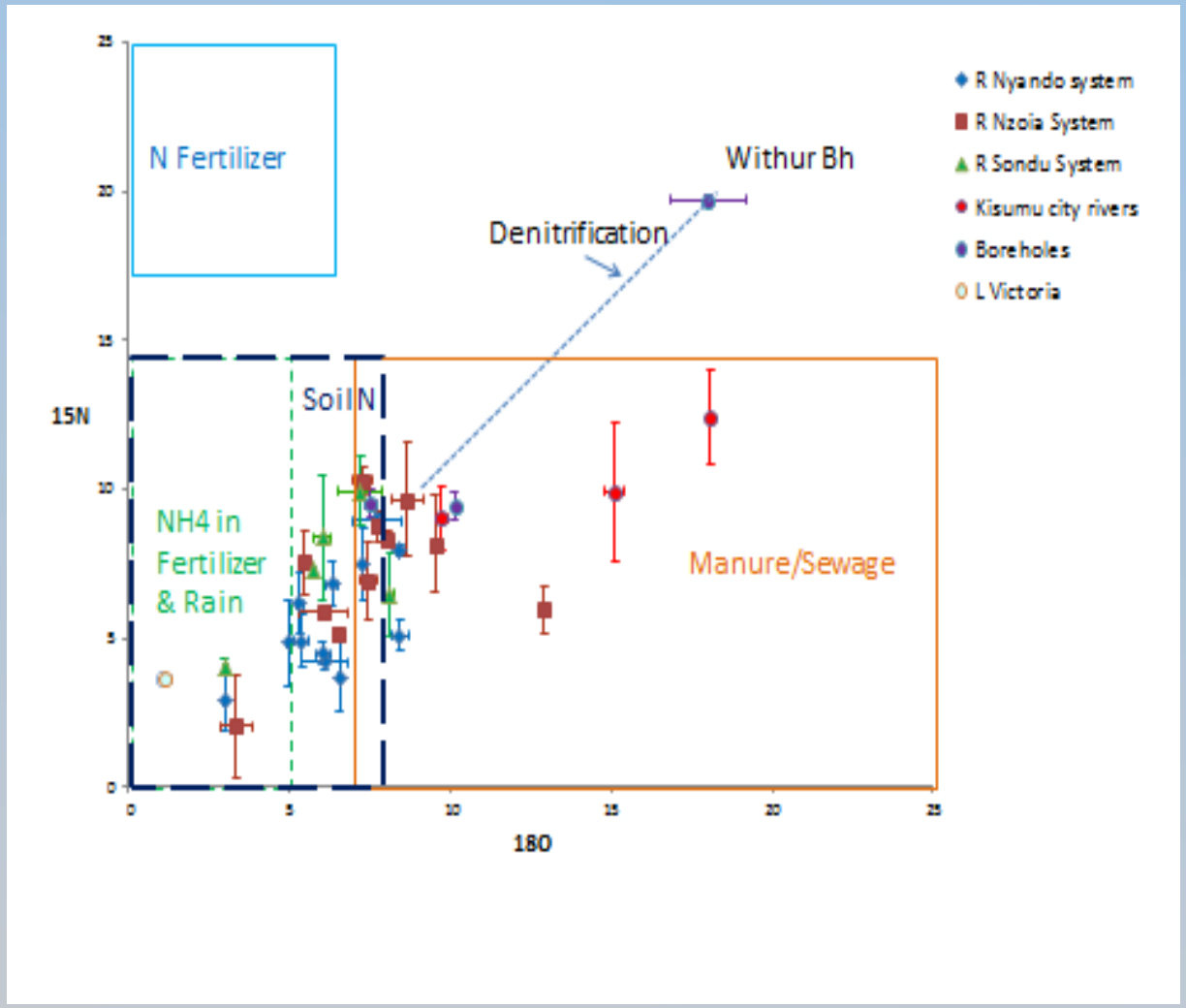


Fig 3. Tracking N sources Nitrate isotope (15N) versus Oxygen isotope (18O) (Benjamin et al., 2016)

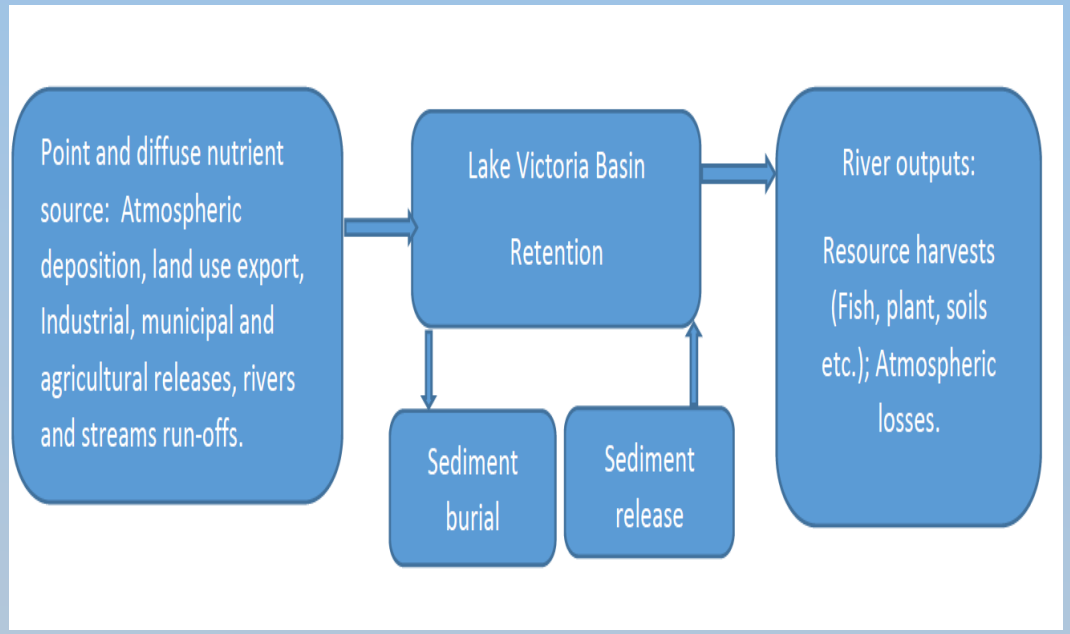


Fig 4. Input-output (Nancy., 2015)

- Soil N and manure/sewage are main source of nitrate to LVB.
- Manure and sewage are main source for groundwater nitrate.
- Tracking of nitrate levels by source in river Kagera (in progress)
- Mapping N source in Lake Victoria catchments (in progress).

Atmospheric N deposition and NO and N_2O emissions

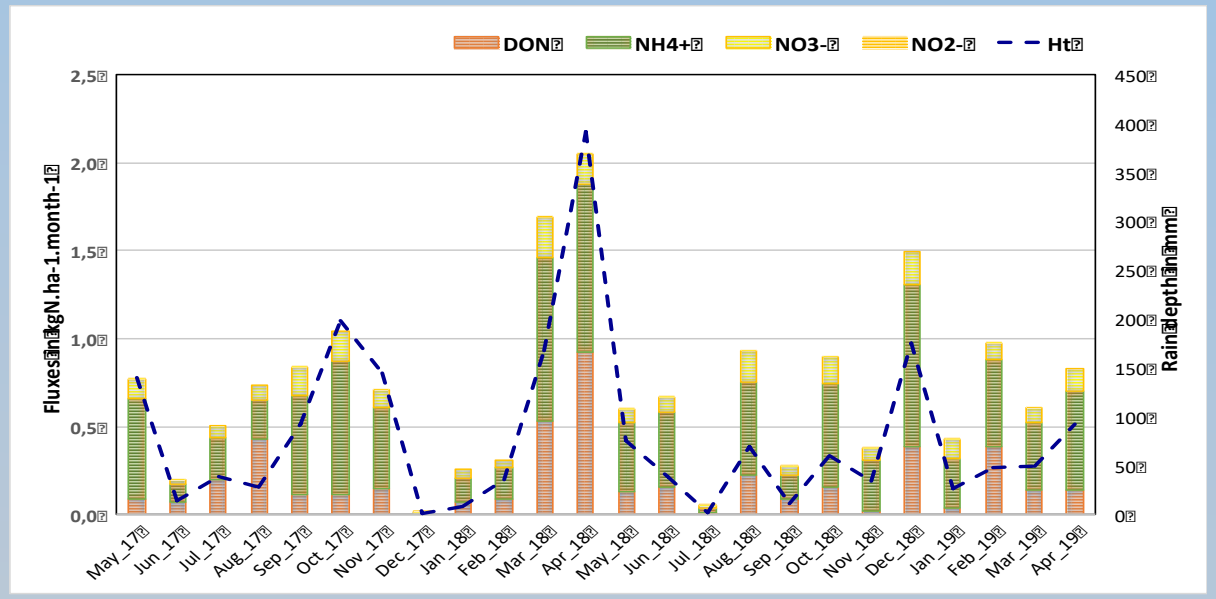


Fig. 5. Monthly wet deposition nitrogen budget at Mbita over the period 2017-2019 (Bakayoko et al, 2020)

DON deposition: 2.3 kgN ha^{-1} yr^{-1}
DIN deposition: 6.3 kgN ha^{-1} yr^{-1}
Total nitrogen wet deposition is around 9 kgN ha^{-1} yr^{-1}

Chamber method (wet and dry season)

N_2O = 2.4 ± 1.7 kgN ha^{-1} yr^{-1}
NO = 3.1 ± 2.1 kgN ha^{-1} yr^{-1}

Fig 6. Study site: Mbita, southwestern border of Kenya and Uganda (Claire &Corrine., 2019)

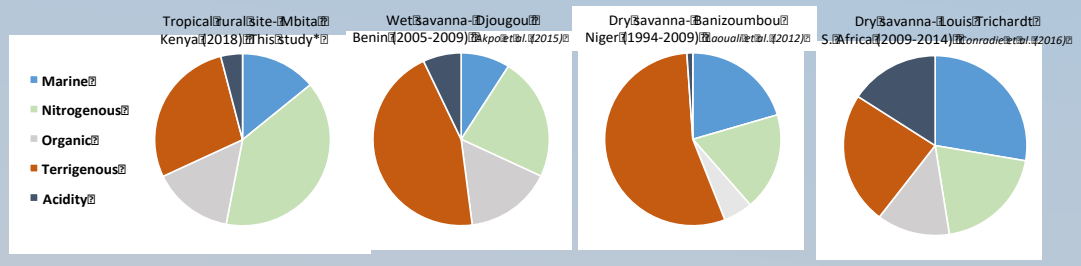
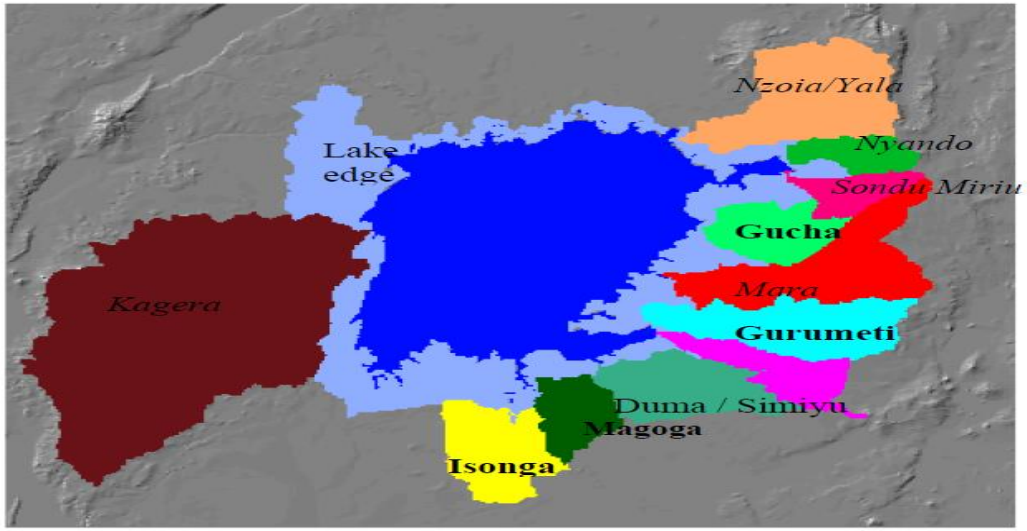


Fig 7. Chemical composition of rain (Bakayoko et al, 2020), Mbita (Kenya): Nitrogenous compounds represent 39% of the total chemical precipitation content.

Nitrogen budget

- NANI model (Zhou et al., 2014).
- Soil N mining is the main source of N in the Lake Victoria
- Watershed Budget 2005-2017(NANI model)- in progress.
- N budget at plot and farm gate spatial scales (CHANS model)- In progress.



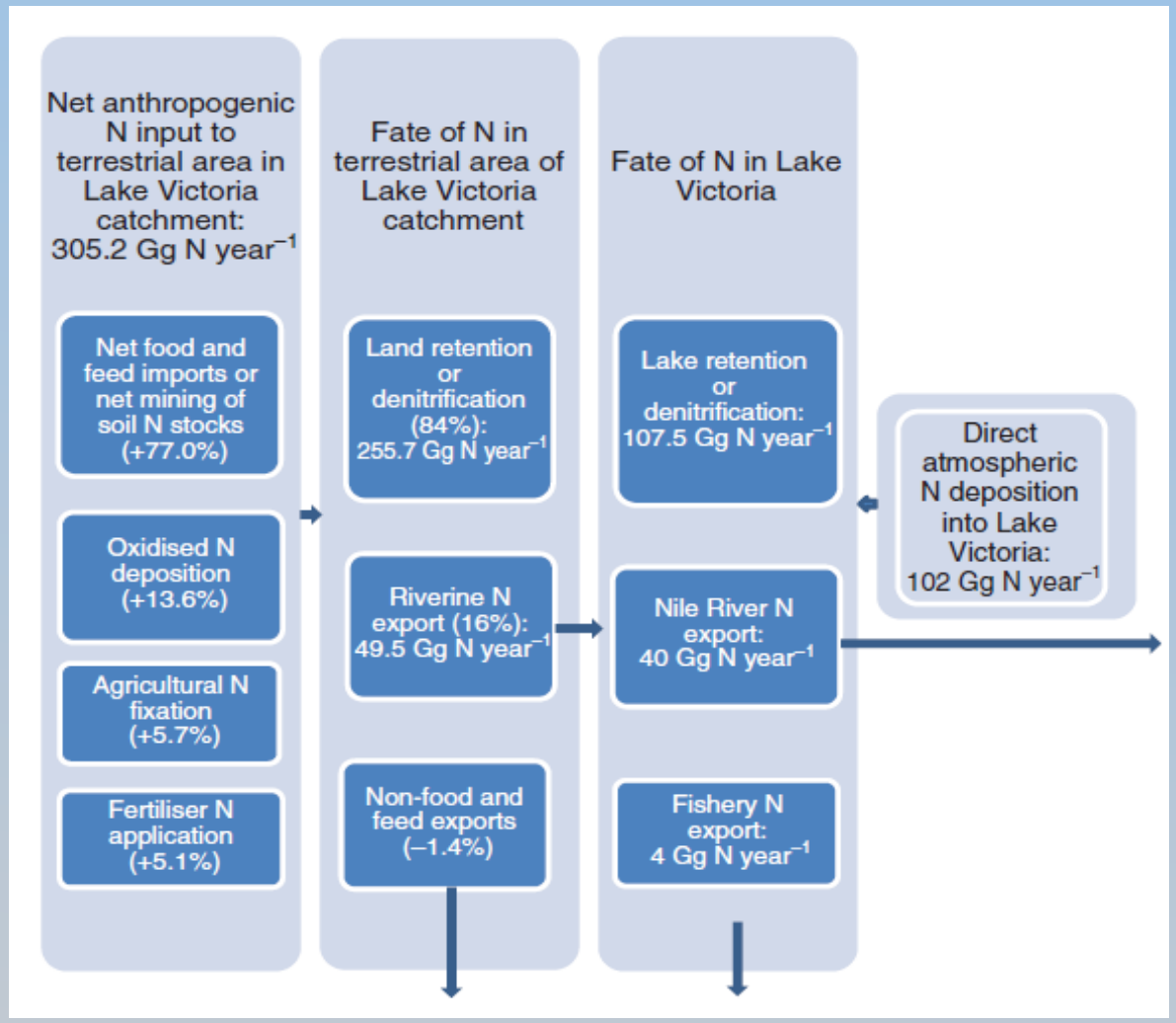


Fig 8. Spatial N budget by source, fates and by sector (Cargele et al., 2017, adapted from Zhou et al., 2014)

Knowledge gap and uncertainty

- Scarcity of data
- Livestock system
- Data was collected based on administrative and was not uniform & represent watershed level.
- Non-point and point source N loading from surrounding cities
- knowledge gaps on hydrological N fluxes from hydrological & agricultural systems of the LVB
- INSA (Integrated Nitrogen Studies in Africa)-capacity &knowledge

Table 1. Area-weighted means of NANI and its components (kg N km^{-2} yr^{-1}) for the Lake Victoria Basin (Zhou et al., 2014).

Budgetary item	Burundi	Kenya	Rwanda	Uganda	Tanzania	Average
Oxidized N deposition (+)	225.0	225.0	225.0	225.0	225.0	225.0
Fertilizer N application (+)	72.0	247.7	10.0	41.9	41.9	79.1
Agricultural N fixation (+)	160.7	35.9	210.1	38.6	38.6	137.5
Net food and feed imports or soil N stock mining (+)	947.2	2543.2	1974.6	584.0	584.0	1416.8
Human N consumption (+)	968.4	908.2	995.0	282.0	282.0	761.8
Livestock N consumption (+)	1044.2	2262.5	1816.9	603.4	603.4	1445.9
Crop N production (-)	981.8	348.8	706.2	185.7	185.7	631.1
Livestock N production (-)	86.7	278.7	131.1	84.9	84.9	153.6
Non food and feed N export (-)	36.7	44.3	31.5	2.6	2.6	31.1
NANI	1368.2	3007.5	2388.2	886.9	886.9	1827.4

Description of EA region in relation to agreed performance indicators (NUE)

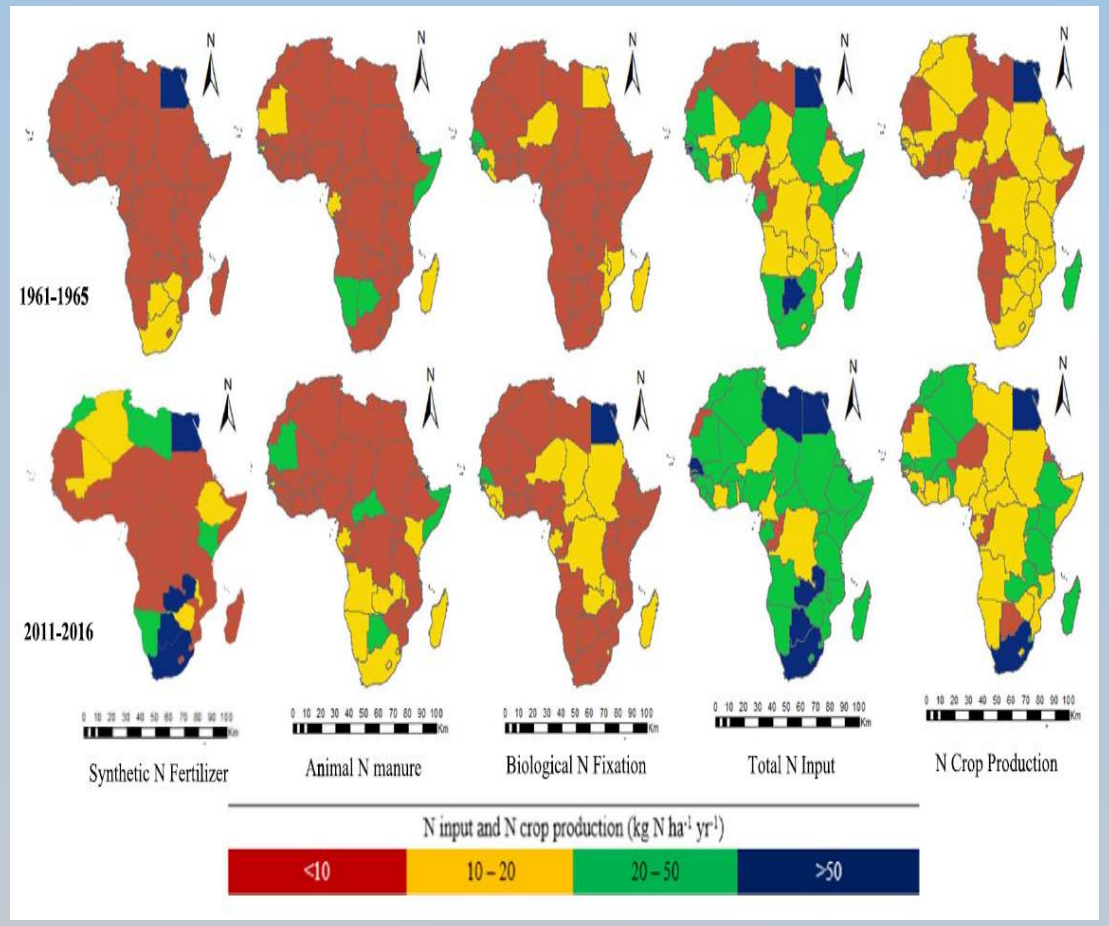


Fig 9.Historical change of NUE and N budget in component in Africa low N input and thatNloss is increasing in agricultural land (Elrys et al., 2019)

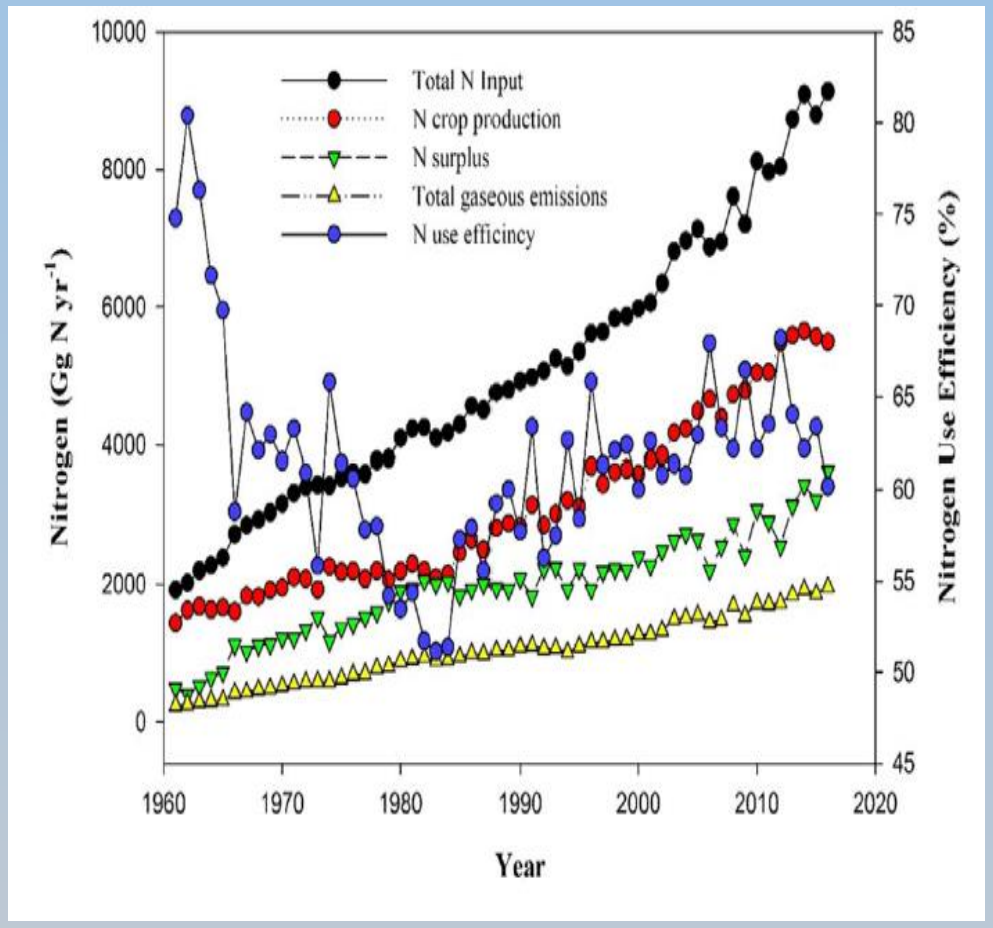


Fig 10. Historical changes in the total N input, NUE, N uptake by crops, and N surplus in Africa. NUE declined from 74% to 63% during the past five decades(Elrys et al., 2019)

Performance Indicators..

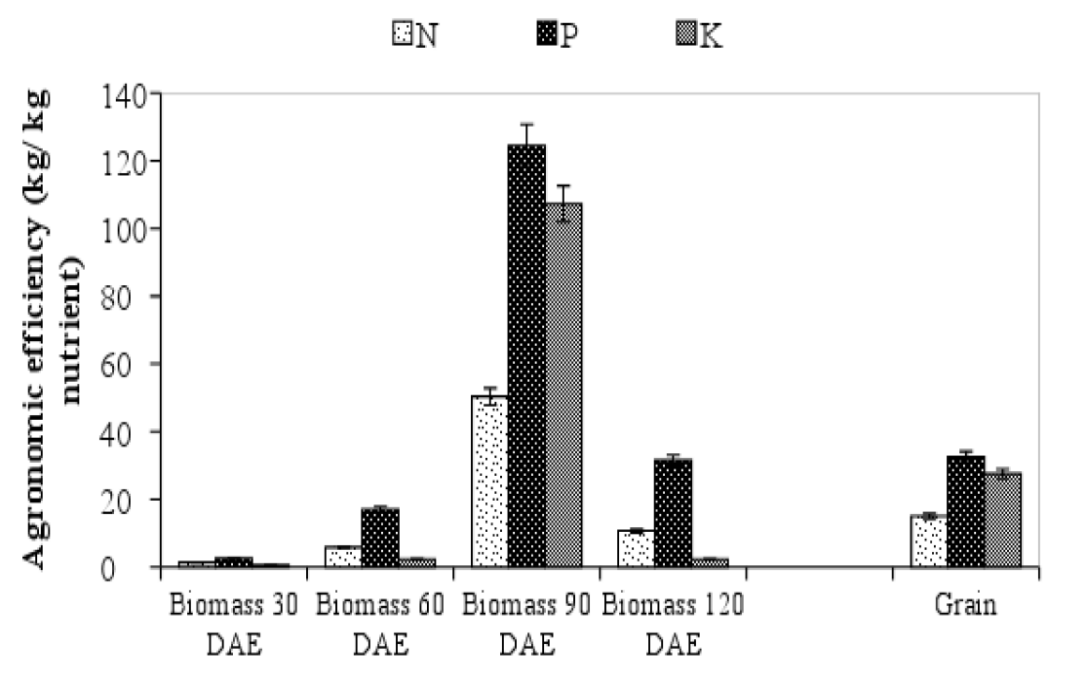


Fig 11. Agronomic efficiency (15 kg grain /kg nutrient) on maize biomass & grain yield at Alupe in Busia County Kenya (Hillary et al., 2018)

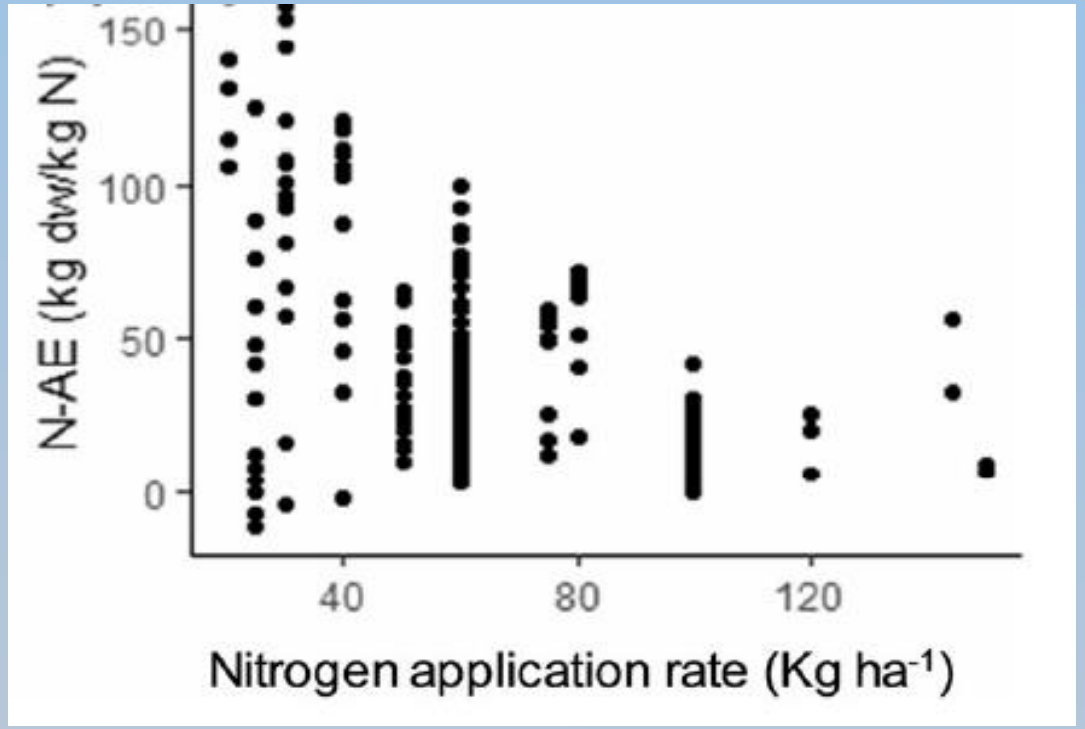


Fig 12. Agronomic nitrogen use efficiency (N-AE) as a function of fertilizer application rate in maize filed, Kenya (Stephen et al., 2018)

N budget (modelling at spatial scale (at plot and farm gate level and and temporal level)

Soil N budget (input and out put)

In African context unless you maintain nutrient balance, the issue of NUE remain a challenge

Barriers to better nitrogen management

✓Questionarries: (Kenya (68), Tanzania (89) & Brundi (65) farmers.
✓Researchers and fertilizer distributors
✓Literature

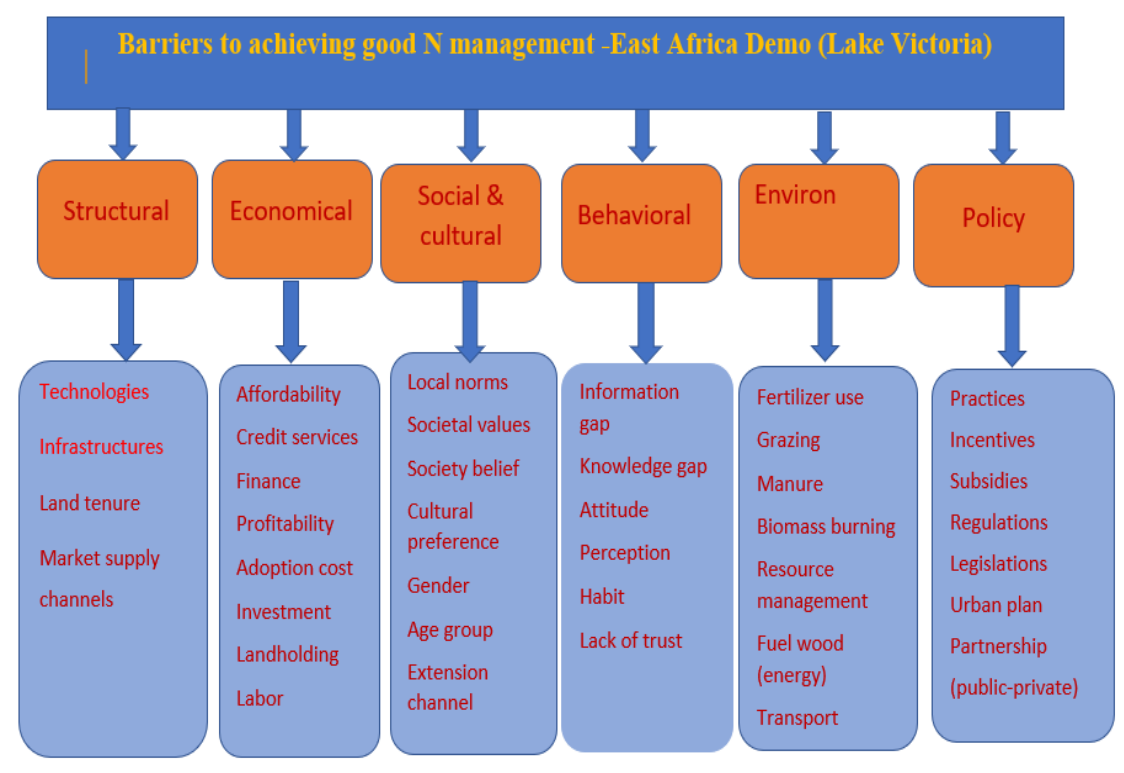


Fig 13. Barrier to better N management (Adopted from Wreford et al., 2017; Kongsager, 2017, and Activity 1.6)

Table 2. Barriers to better N management LVB

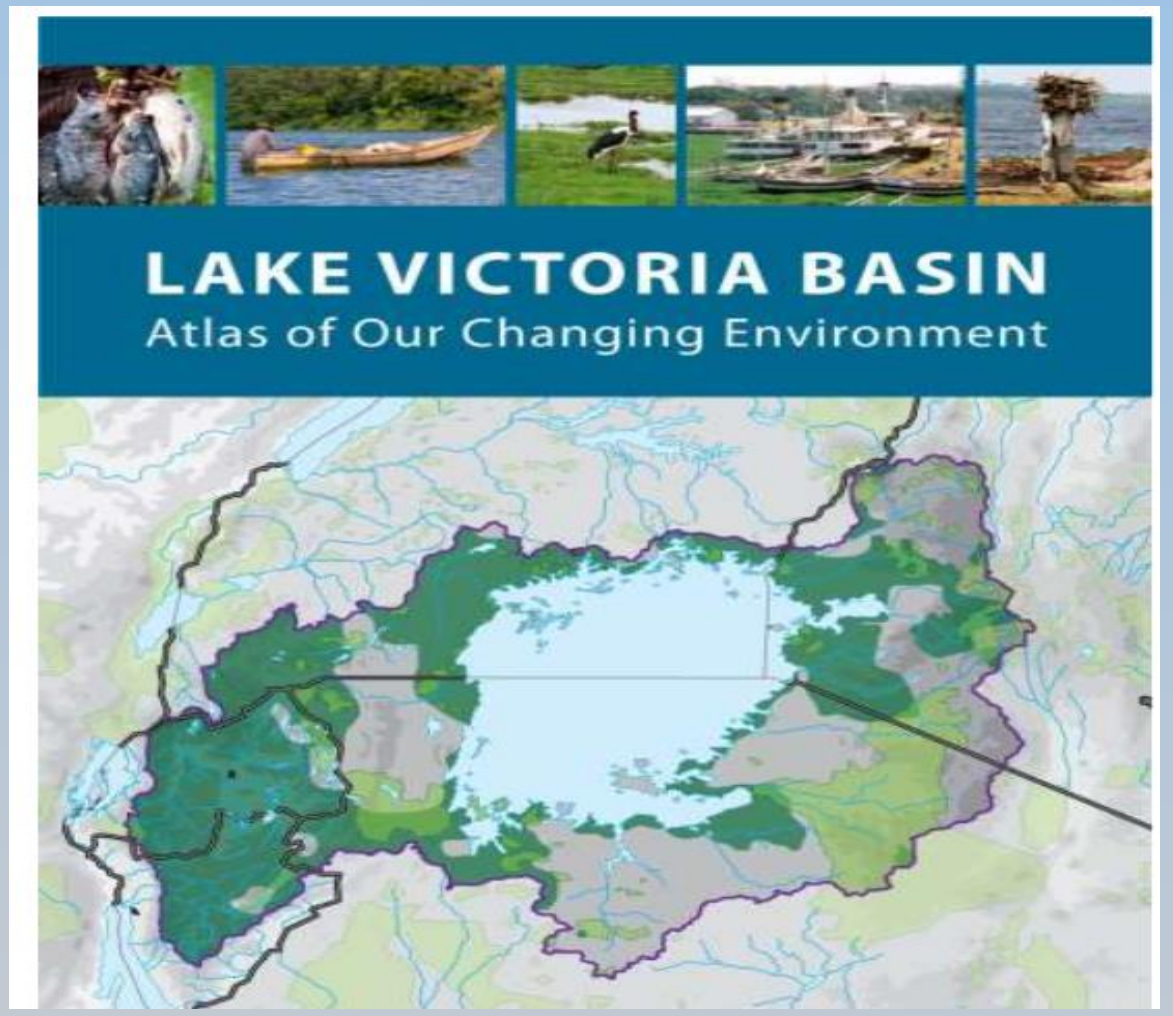
Category of Barriers	List of Barriers	NR	LR	R	VR
Institutional	Land tenure			3	
	Farm succession		2		
	Existence of associate contract		2		
Economical	Financial benefits			3	
	Cost of adoption				4
	Access to credit				4
	Competing pressure		2		
	Market availability				4
Social & cultural	Social- capital			3	
	Interest	1			
	Trust				4
	Gender				4
	Ethics		2		
	Religion/belief		2		
Sectoral Policy	Management practices				4
	Government support				4
	Regulatory framework				4
	Incentives				4
	Obligations				4
	Information, education & awareness				4
Knowledge information and technology (KIT)	Knowledge about climate change				4
	Perceived long-term horizon			3	
	Techniques/technology			3	
	Linkage of stakeholders				4
	Extension services				4
Infrastructure	Transport cost				4
	Storage facilities			3	
	Labor costs/availability				4

Table 3. Options to overcome barriers to better N management

Structural	• Efficient technologies (low cost wastewater treatment, NUE) • Infrastructures (sanitation, roads, market, transport & storage facility) • Land reform
Economical	• Access to credit & finance • Provide incentives & subsidies • Increase profitability
Social & cultural	• Awareness creation • Information & education • Address gender issues • Strengthening social capital
Behavioral	• Awareness creation • Information & education • Address gender issues
Sectorial	• Involvement of stakeholders in decision making
Policy	• Urban planning • Renewable energy sources • Public –private partnership • Regional integration of legal, institutional, and implementing mechanisms (exist)
Environmental	• Sustainable natural resource management (soil/land, water, forest) • Conservation & protection of biodiversity • Establish early warning system (climate)

Enabling Environment (Institution, policy, legal framework &strategy

- EAC established LVBC (Article 114 of EAC Treaty 1999) as a specialized institution.
- The establishment and operations of the Commission is governed by the Protocol for Sustainable Development of LVB (2003)
- LVB designated a common regional economic growth zone due to its huge environmental natural resources.
- **Police guidance to address challenges:**
  - Shared Vision & Strategy Framework of EAC
  - EAC Development Strategy (2016/17 - 2020/21)
  - LVBC Strategic Plan 2016-2021
  - Sectoral Council & Council's Decisions & Directives
  - Regional policies and strategies
  - Stakeholder engagement.
- Room for improvement: operationalization of policy recommendation.



LVB &GRID-Arendal., 2017)

Regional Future look & Implication for INMS

Scenario I. Current Practices

- Anthropogenic and natural drivers of N biological processes and N pollution such as land degradation, human settlement, deforestation, over exploitation of resources, climate change impacts etc... increases, implementation of policies need improvement and all these will have an implication on the increment of N losses to the environment.

Scenario II. Best practices

- Policy will be more integrated & operationalized, NUE, waste management, resource management, ecosystem, air, water, soil and biodiversity health will be checked. Mitigation of drivers of N loss to environment reduced.

Scenario III. Worst case

- Drivers will increase: poor farming practices, environmental conditions deterioration, pollution, land degradation, loss of forest and other land cover. N losses to the environment increases.

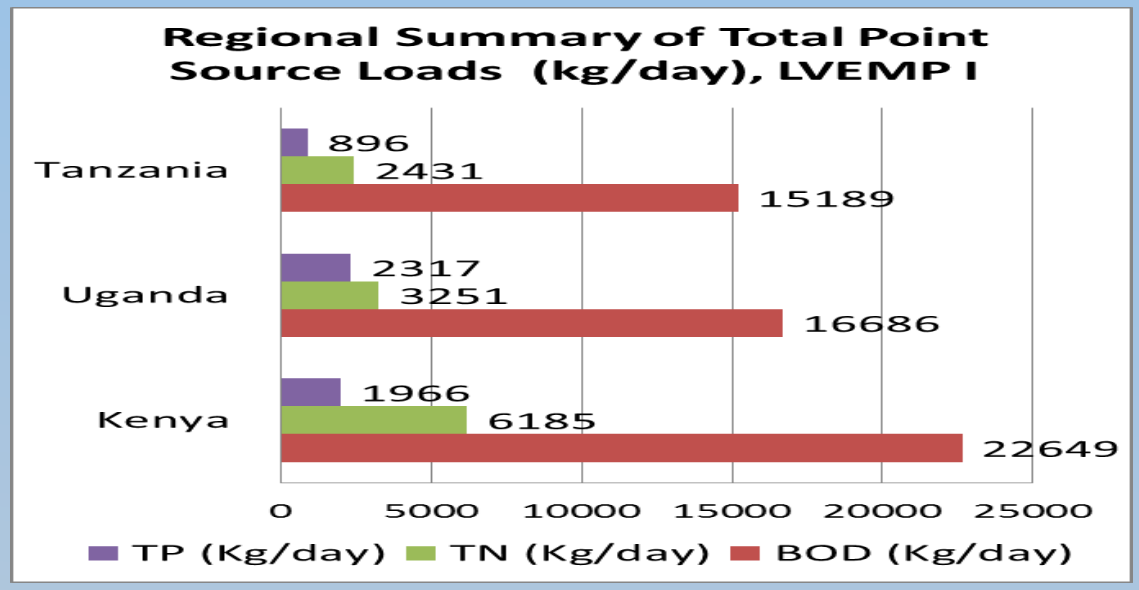


Fig 14. N load in Lake Victoria (LVB., 2020)

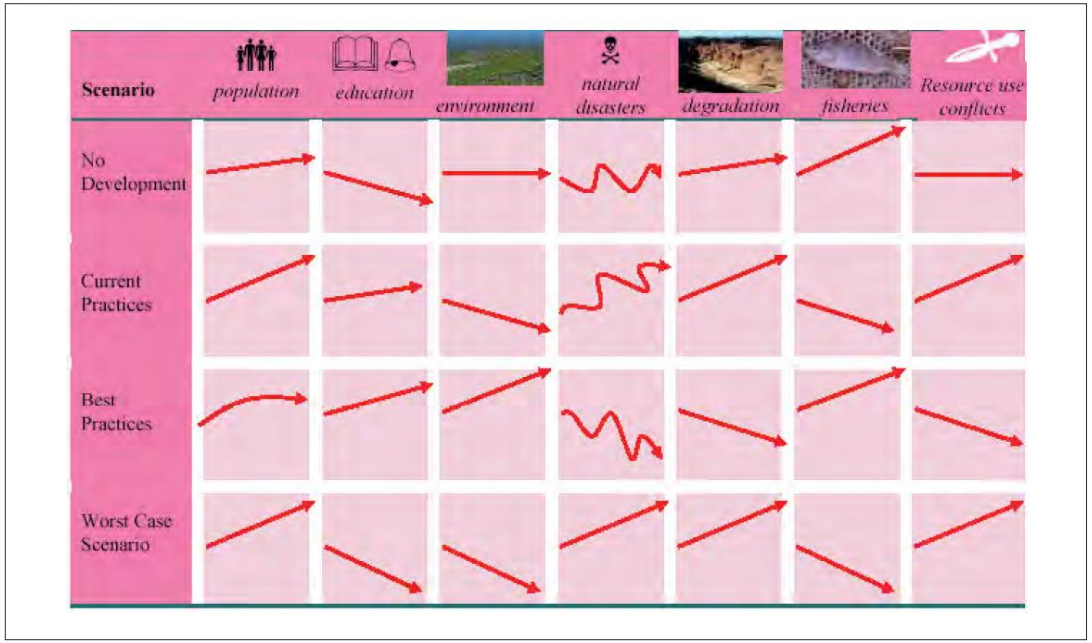


Fig 15. Scenario LVB (UNEP)

Thank You