Sustaining lake Victoria by navigating environmental and social governance dimensions of cage culture in Tanzania

Betina Lukwambe[1], Mwita Chacha[1], Maria Claudia Lopez[2], Abigail Bennett[3]

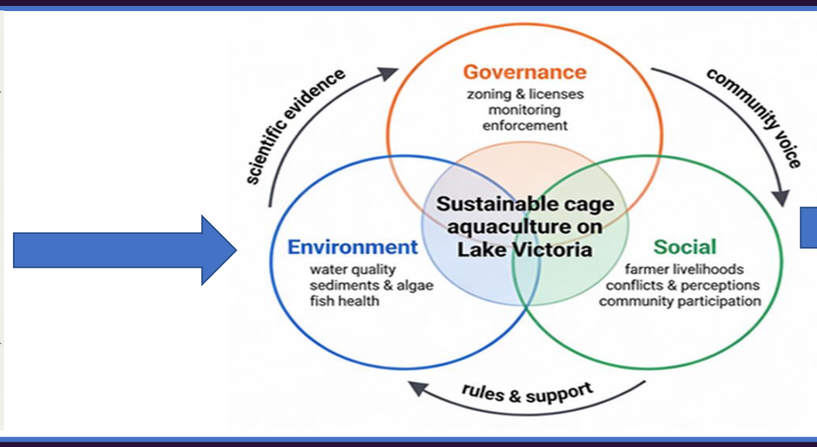
[1]Department of Aquaculture Technology, University of Dar es Salaam, Dar es Salaam, Tanzania

[2]Department of Community Sustainability, Michigan State University, East Lansing, MI, USA

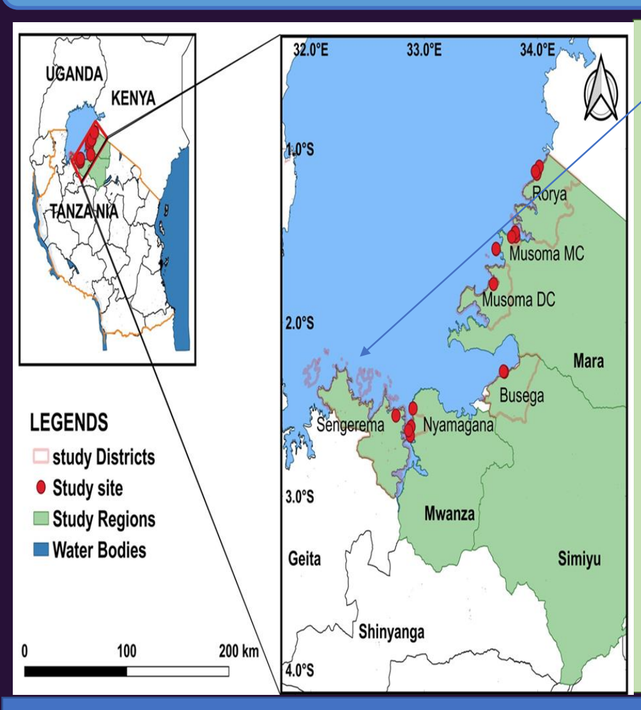
[3]Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI, USA

Email: blukwambe@yahoo.com

Background



Methodology

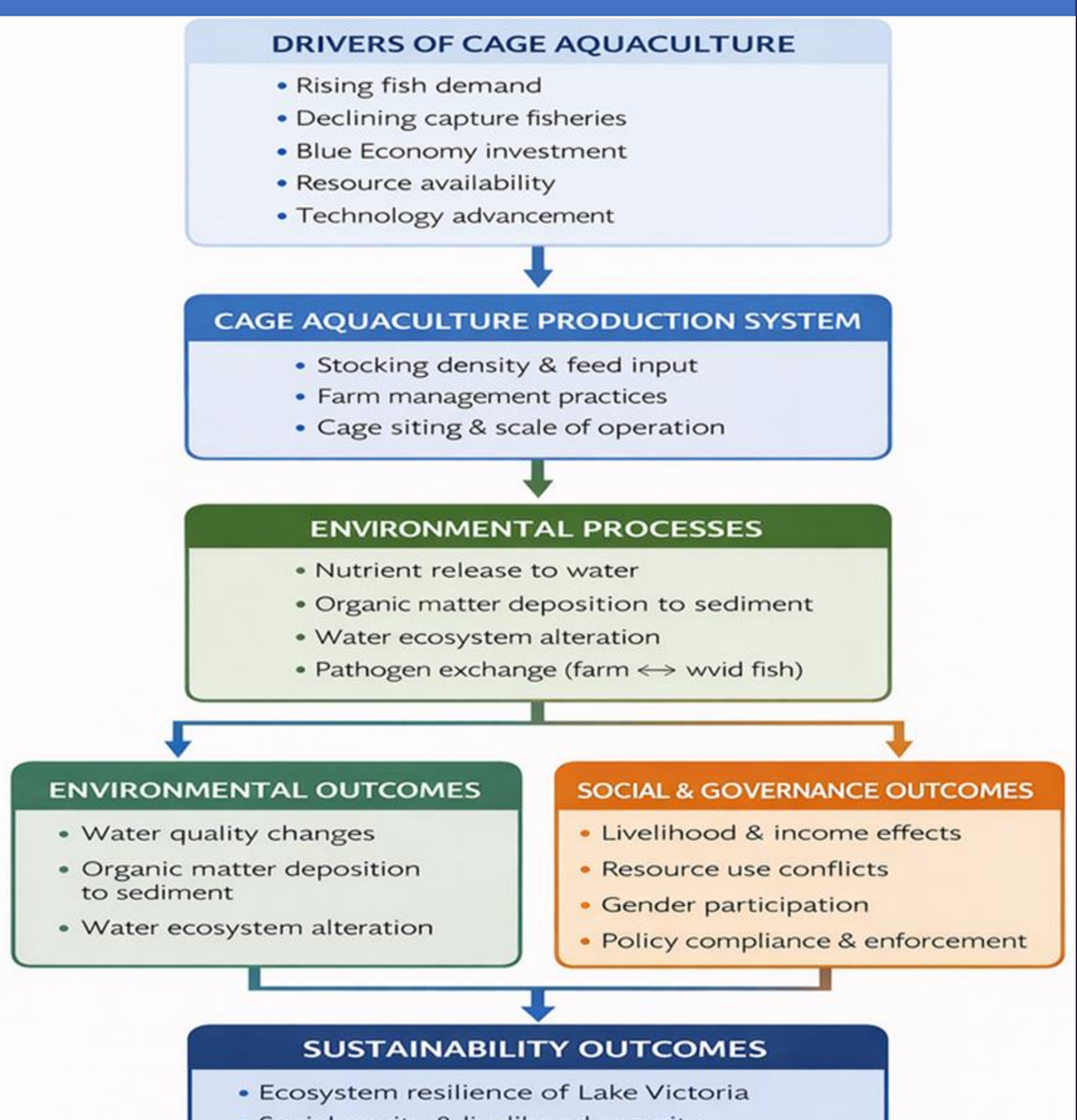


Study Site:

- ❑ Kiseko/Luchelele Bay, Nyamagana
- ❑ Farm: 12 cages × 100m³ (all active)
- ❑ Species: Nile tilapia @ 4kg/m³
- ❑ Sampling: 3 replicates/zone/season

Zone	Distance	Purpose
Cage zone	0 m	Maximum impact
Near-field	100 m	Dispersion gradient
Reference (control)	500 m (up-current)	Natural baseline

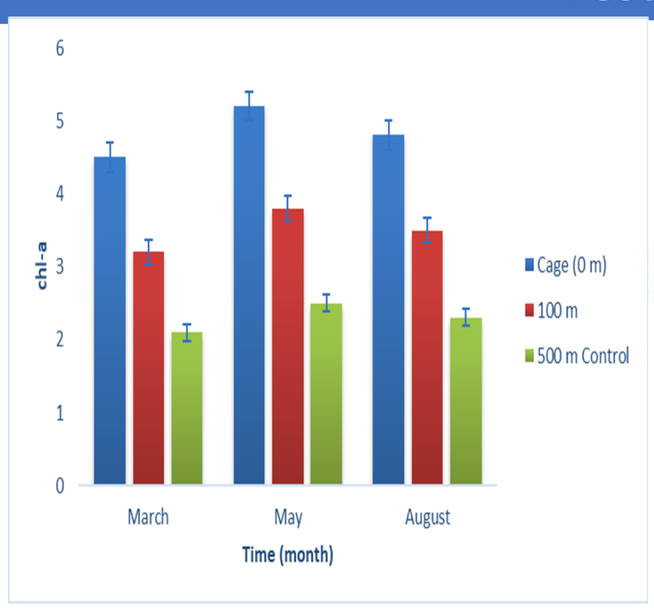
ESG Framework

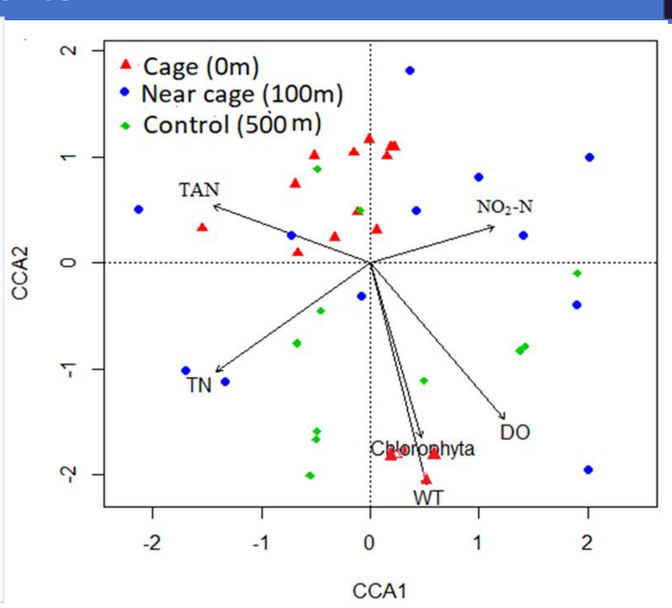


Integrated Environmental and Social-Governance Framework for Cage Aquaculture Sustainability

Nutrient loading was confirmed: NH_4^+ 0.08-0.10 mg/L
Hypoxia risk: DO 4.8-5.2 mg/L < 5 mg/L threshold (May-Aug 2025)
Feed waste dominant: 60% uneaten feed + fish feces drive pollution
TP critical: 0.10 mg/L (90% EIA limit) across seasons

Results





Time	Parameters	Cage (0 m) mean ± SE	Near- Cage (100 m) mean ± SE	Reference (500 m, control) mean ± SE	p (ANOVA)
MARCH	WT (°C)	25.6 ± 0.9ᵃ	25.4 ± 0.8ᵃ	25.3 ± 0.8ᵃ	0.72
	pH	7.7 ± 0.3ᵃ	7.6 ± 0.2ᵃ	7.5 ± 0.2ᵃ	0.65
	DO (mg/L)	5.4 ± 0.5ᵃ	5.7 ± 0.4ᵃ	5.8 ± 0.4ᵃ	0.41
	TP (mg/L)	0.09 ± 0.02ᵃ	0.07 ± 0.01ᵃᵇ	0.06 ± 0.01ᵇ	0.03
	TAN (mg/L)	0.05 ± 0.01ᵃ	0.04 ± 0.01ᵃᵇ	0.03 ± 0.01ᵇ	0.04
MAY	WT (°C)	25.4 ± 0.7ᵃ	25.2 ± 0.6ᵃ	25.1 ± 0.6ᵃ	0.69
	pH	7.6 ± 0.2ᵃ	7.5 ± 0.2ᵃ	7.4 ± 0.2ᵃ	0.60
	DO (mg/L)	5.2 ± 0.6ᵃ	5.9 ± 0.4ᵇ	6.0 ± 0.4ᵇ	0.01
	TP (mg/L)	0.08 ± 0.02ᵃ	0.06 ± 0.01ᵇ	0.05 ± 0.01ᵇ	0.01
	TA N(mg/L)	0.08 ± 0.02ᵃ	0.03 ± 0.01ᵇ	0.02 ± 0.01ᵇ	<0.001
AUGUST	WT (°C)	25.2 ± 0.8ᵃ	25.0 ± 0.7ᵃ	24.9 ± 0.7ᵃ	0.71
	pH	7.8 ± 0.3ᵃ	7.6 ± 0.2ᵃ	7.5 ± 0.2ᵃ	0.58
	DO (mg/L)	4.8 ± 0.7ᵃ	5.5 ± 0.5ᵇ	5.7 ± 0.5ᵇ	0.01
	TP (mg/L)	0.10 ± 0.02ᵃ	0.07 ± 0.01ᵇ	0.06 ± 0.01ᵇ	0.01
	TAN (mg/L)	0.10 ± 0.03ᵃ	0.04 ± 0.01ᵇ	0.03 ± 0.01ᵇ	<0.001

CHALLENGES

- •- Nutrient loading → hypoxia, cyanophyte blooms,
- • hyacinth risk
- •Pathogen spillover threatens wild fish health
- •Social-governance gaps limit monitoring & biosecurity
- •Carrying capacity undefined

WAY FORWARD

- •Real-time water quality monitoring
- •Science-based cage density limits
- •Precision feeding waste reduction
- •Mandatory biosecurity training

ACKNOWLEDGEMENTS