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Practicum title: Collaborative monitoring approach: Utilizing the SASS technique to measure river health in the Mara River Basin and other Kenyan rivers.

Introduction

Freshwater ecosystems account for 0.01% of the World's water and approximately 0.8% of the Earth's surface, and despite their small proportion, these ecosystems are home to 100,000 species, approximately 6% of the global species (Dudgeon et al., 2006). Yet, these ecosystems are the most threatened by anthropogenic activities, including pollution, overexploitation, habitat degradation, flow modification, and introduction of exotic species and climate change (Strayer & Dudgeon, 2010; Vörösmarty et al., 2010). In the Anthropocene, freshwater ecosystems are imperiled by intensified threats such as changing climate, infectious diseases, harmful algal blooms, emerging contaminants, microplastics, etc. (Reid et al., 2019).

The inland waters in the Afrotropics are known to be rich in biodiversity and endemism. However, the water quantity and quality in tropical rivers are also threatened by multiple anthropogenic pressures, which consequently impact the aquatic biodiversity (Barlow et al., 2018; Carayon et al., 2020; Martins et al., 2020).

The Mara River plays a pivotal role in East Africa, acting as the lifeblood of the Serengeti-Mara Ecosystem. While the river is a crucial transboundary water body and the only perennial river in the Mara-Serengeti ecosystem, it faces threats from human activities. The Mara River basin has experienced significant transformations due to an expanding human population and demand for agricultural and settlement lands. These shifts have led to deforestation, escalated peak water flows, erosion, and heightened suspended sediments. Such disturbances imperil fish and macroinvertebrate habitats and provide avenues for transporting heavy metals from terrestrial systems into the river.

Thus, the practicum aimed to raise awareness of the dwindling freshwater ecosystems in Kenya and how macroinvertebrates can be used for biomonitoring in the face of changing climate and emerging stressors such as infectious diseases, harmful algal blooms, emerging contaminants, microplastics in these freshwater ecosystems.

My research addressed patterns of abundance and diversity in fish and macroinvertebrates and the potential contaminant these taxa might be exposed to in the Mara River Basin in the face of these several stressors. Additionally, I documented the critically endangered *Labeo victorianus* (Ningu) fish status in this river. As an affiliate with the National Museum of Kenya, a nationally mandated research institution, I collaborated with scientists in the Ichthyology and Entomology departments to explore biodiversity-related questions in the Mara River. Together, we spearheaded research to study aquatic ecosystems, which tend to be overlooked despite being biodiversity hotspots and home to some cryptic species.

To foster conservation efforts in the Mara River Basin, I collaborated with local environmental and conservation entities, including the Mara River Water Resource User's Association and the Maasai Mara Wildlife Conservancy Association. Our joint initiative for the practicum involved training local community groups to regularly monitor environmental health in the Mara River Basin. An integral part of this initiative is the creation of user-friendly invertebrate identification guides tailored for this ecosystem. These guides, paired with the South African Scoring System technique (SASS5), will enable comprehensive evaluations of the Mara River's health and integrity. Our insights are crucial in guiding stakeholders toward effective conservation strategies, emphasizing the significance of these taxa as environmental health indicators for the Mara River.

As part of the broader impacts of my doctoral research, I conducted workshop training at three universities in Kenya: Karatina University, Egerton University, and Jomo Kenyatta University of Science and Technology. These workshops aimed to build capacity and foster an in-depth understanding of Kenya's freshwater ecosystems, particularly the Mara River ecosystem.

Practicum objectives

1. Promoted students' capacity through workshops, lectures, and hands-on training on various techniques such as sampling, sorting, and identifying macroinvertebrates. The practicum also involved training the students on the South African technique of using macroinvertebrates for biomonitoring (SASS5).
2. The practicum mentored undergraduate students to pursue careers in conservation-related fields and encouraged them to advance their graduate studies in freshwater-related courses.

Details of the activities carried out:

The practicum activity entailed spearheading workshop training between January- and March 2024 at three universities in Kenya (February-Egerton University, March-Karatina University, and Jomo Kenyatta University of Science and Technology). I chose university students as the target group because the biomonitoring topic is quite advanced and unsuitable for high school students/ primary kids. For this workshop training, undergraduate students were selected from the conservation-related courses, which included Environmental Science, Natural Resources Management, Aquatic sciences, and fisheries. 105 undergraduate students from the three universities were trained during the workshop. Additionally, the students were mentored on possible career paths in science.

The workshop session was subdivided into 3 sessions. The first session entailed a seminar talk. During this session, the students were introduced to freshwater conservation in Kenya and some selected riverine ecosystems and why it matters. As part of this session, we had a Q&A session where students asked about career paths in science, particularly in freshwater conservation, and other questions related to the seminar. The second session encompassed a field practical to learn macroinvertebrate sampling techniques, sorting, and identification skills. This also involved using a microscope to identify the aquatic insects. The climax of this session was for the students to understand how macroinvertebrates are utilized for biomonitoring of riverine ecosystems.

The workshop training promoted a win-win situation, where the local community and students learned to conserve and protect the watershed while benefiting directly from these watersheds, i.e., access to sufficient, clean water and sustainable fisheries. The goal was to preserve and protect aquatic biodiversity in the Mara River basin, including the endemic and critically endangered *Labeo victorianus*. The biomonitoring technique was tested in the Mara, Njoro, and Ragati rivers. This technique has the potential to be upscaled to a national level to aid in the biomonitoring of Kenyan freshwater ecosystems.

Institutions	**Seminar date**	**Workshop date**	**Q&A session date**
Egerton University	02/23/2024	02/24/2024	02/29/2024
Karatina University	03/08/2024	03/09/2024	03/11/2024
Jomo Kenyatta University of Science and Technology	03/13/2024	03/14/2024	03/15/2024

Challenges

The prior plan was to have 4 pilot universities for these workshops. I succeeded in only 3 universities. If I had to redo the same activity, I would involve many universities and plan beforehand because some institutions have busy schedules. Thus, having extra time for additional activities within the semester might be challenging for them.

Outcomes

The training was impactful; I received several emails from students who needed mentorship or guidance on related topics, such as career paths, proposal writing, etc. The host institutions were also very grateful for the workshop training, which they believed would be essential skills in the student's future endeavors.

Professional development

By conducting university training, I enhanced my teaching and public speaking skills. Additionally, I built confidence, which enabled me to face the audience. The training also related to some ideas and concepts, especially from communication and leadership classes. These concepts included empathic listening and facilitation skills, which were highly utilized during the workshop training.

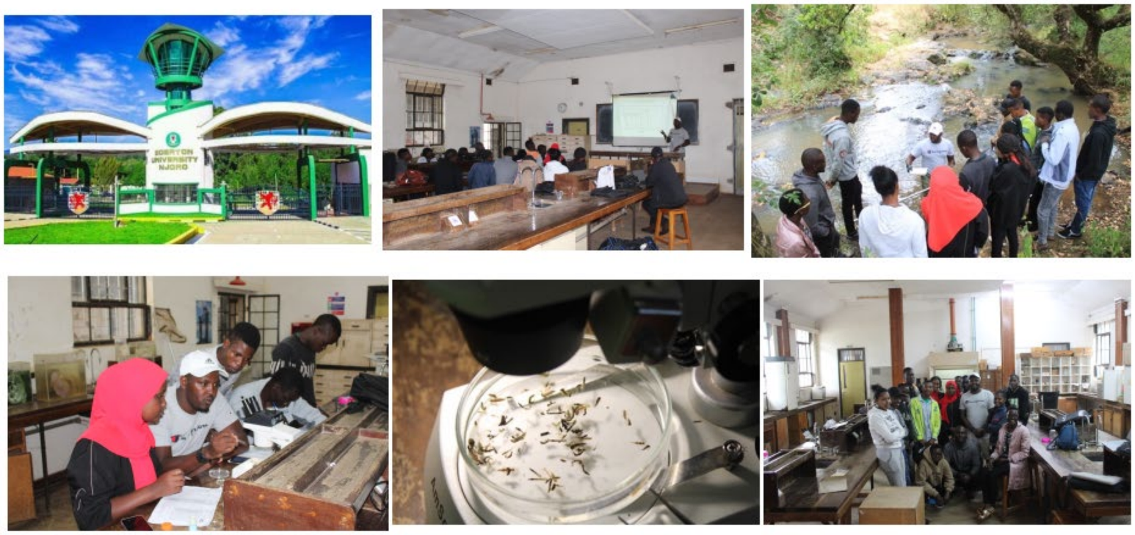
Conclusion

The practicum was designed to equip undergraduate students with theoretical knowledge and practical skills in freshwater conservation, specifically through studying and biomonitoring macroinvertebrates using the South African SASS5 technique. By integrating rigorous workshop training, lectures, and hands-on experience, this program enhanced the students' scientific capacities and fostered a deeper understanding of ecological health and conservation strategies. Furthermore, the practicum was a vital mentoring platform, inspiring students to pursue advanced studies and careers in conservation-related fields. Through these efforts, the program aimed to cultivate a new generation of environmental scientists and advocates prepared to address freshwater ecosystems' complex challenges. This holistic approach significantly contributed to the conservation efforts and sustainability of freshwater resources, ultimately benefiting local and global communities. The practicum also aimed to achieve educational benefits, skill development, and a broader impact on conservation efforts.

Acknowledgments

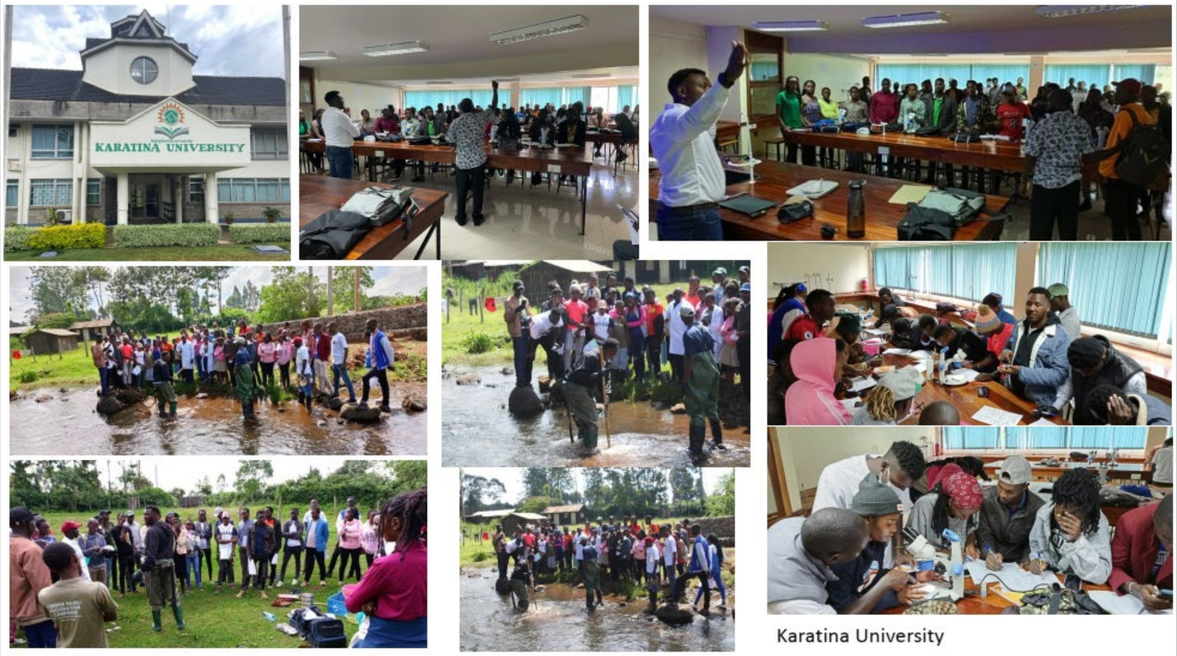
I am grateful to the collaborators who participated in this series of seminars and workshop training. They included Egerton University, Karatina University, Jomo Kenyatta University of Science and Technology, and the National Museum of Kenya. I would also like to thank the water users association of the Mara River, which also took part in the seminar session in Narok town.

Photos of the practicum



Egerton University

Jomo Kenyatta University of Science and Technology



Karatina University

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Appendix

SASS Score Sheet

SASS Version 5 Score Sheet

Version date: Sept 2005

Date (dd:mm:yr):			(dd.ddddd)	**Biotopes Sampled (tick & rate)** Rating (1 - 5)	Time (min)
RHP Site Code:		**Grid reference (dd mm ss.s) Lat:**	S	**Stones In Current (SIC)**	
Collector/Sampler:		**Long:**	E	**Stones Out Of Current (SOOC)**	
River:		**Datum (WGS84/Cape):**		**Bedrock**	
Level 1 Ecoregion:		**Altitude (m):**		**Aquatic Veg**	
Quaternary Catchment:		**Zonation:**		**MargVeg In Current**	
	Temp (℃):	**Routine or Project? (circle one)**	**Flow:**	**MargVeg Out Of Current**	
Site Description:	**pH:**	**Project Name:**	**Clarity (cm):**	**Gravel**	
	DO (mg/L):		**Turbidity:**	**Sand**	
	Cond (mS/m):		**Colour:**	**Mud**	
	Riparian Disturbance:			**Hand picking/Visual observation**	
	Instream Disturbance:				

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1				
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3				
Atyidae (Freshwater Shrimps)	8				
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8				
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1 sp	4				
Baetidae 2 sp	6				
Baetidae > 2 sp	12				
Caenidae (Squaregills/Cainfles)	6				
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13				
Leptophlebiidae (Prongills)	9				
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9				
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10				
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4				
Lestidae (Emerald Damselflies/Spreadwing	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8				
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6				
Libellulidae (Darters/Skimmers)	4				
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3				
Gerridae* (Pond skaters/Water striders)	5				
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3				
Notonectidae* (Backswimmers)	3				
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5				
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6				
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6				
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5				
Haliplidae* (Crawling water beetles)	5				
Helodidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving Beetles)	10				
Psephenidae (Water Pennies)	10				

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10				
Blepharoceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5				
Chironomidae (Midges)	2				
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5				
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6				
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					
No. of Taxa					
ASPT					

Other biota:

Comments/Observations:

Procedure:

Kick SIC & bedrock for 2 mins, max. 5 mins. Kick SOOC & bedrock for 1 min. Sweep marginal vegetation (IC & OOC) for 2m total and aquatic veg $1m^2$. Stir & sweep gravel, sand, mud for 1 min total. * = airbreathers

Hand picking & visual observation for 1 min - record in biotope where found (by circling estimated abundance on score sheet). Score for 15 mins/biotope but stop if no new taxa seen after 5 mins.

Estimate abundances: 1 = 1, A = 2-10, B = 10-100, C = 100-1000, D = >1000 S = Stone, rock & solid objects; Veg = All vegetation; GSM = Gravel, sand, mud SWC = South Western Cape, T = Tropical, ST = Sub-tropical

Rate each biotope sampled: 1=very poor (i.e. limited diversity), 5=highly suitable (i.e. wide diversity) Rate turbidity: V low, Low, Medium, High, Very High