The response of sediment source and transfer dynamics to land use (change) in the Lake Manyara catchment, Tanzania.

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CATCHMENT & RIVER SCIENCE WITH PLYMOUTH UNIVERSITY

IMIXSED PROJECT
Developing tools for sediment management

1. INTRODUCTION

Lake Manyara basin provides valuable ecosystem services [1]:
- Biodiversity hotspot / Conservation / Pastoralism / Agriculture / Ecotourism / Fisheries /…

Increasing socio-economic pressures [2]:
- Population growth / Economic growth / Migration /…

Trait

Productivity loss and **siltation** of water bodies

Decrease in natural vegetation cover due to **land use change** and **overgrazing**

Increased **vulnerability** to soil erosion

2. MATERIAL AND METHODS

- Watershed delineation from DEM and Land cover extraction from October 2016 Landsat images using ArcGIS software.
- Riverine transported sediment (sources) and lake sediment (sink) sampling.
- Sediment fingerprinting using Wavelength dispersive X-ray fluorescence followed by principal component analysis and Bayesian (un)mixing using the MixSIAR model [3].
- Gamma spectrometry to infer the activity of surface-elevated fallout radionuclides in the transported sediment.

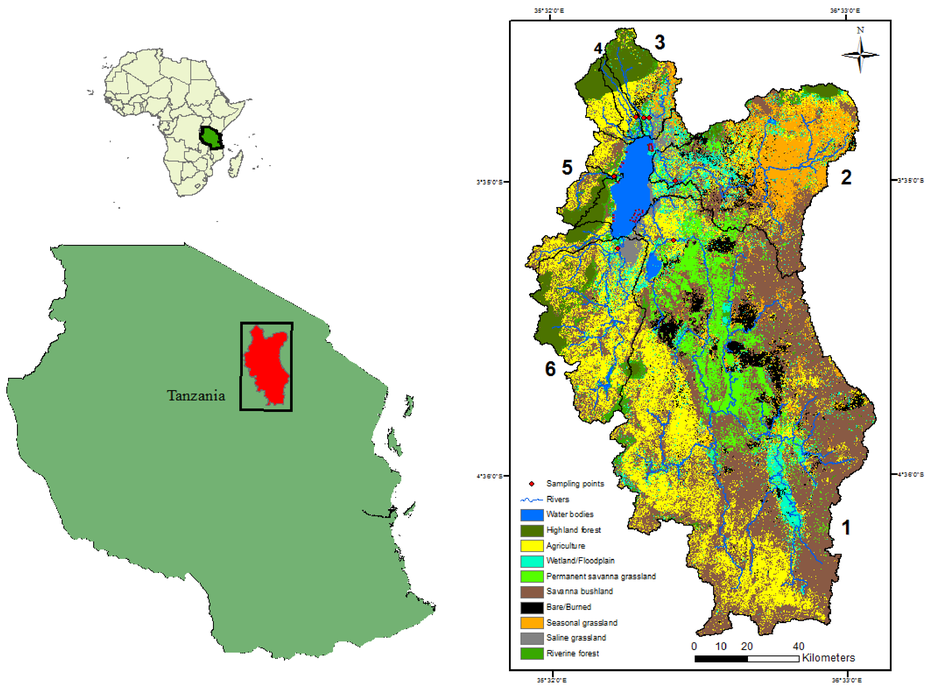

Figure 1: Overview map of the Lake Manyara catchment, located in northern Tanzania. The map shows the land cover, water bodies, sampling locations and catchment outline of the main tributary rivers with their unique number: (1) Tarangire, (2) Makuyuni, (3) Mto Wa Mbu – Simba, (4) Kirurumo, (5) Endabash in the Western Rift and (6) Dudumera.

3. Results and Discussion

Table 1: Percentages of land cover and area in the Lake Manyara catchment and it's tributaries.

Land Cover Type	Total Catchment	Makuyuni	Dudumera	Tarangire	MWM-Simba	Kirurumo	Western rift
Agriculture	23,33	12,61	42,50	22,60	16,55	44,80	29,17
Highland Forest	5,04	2,08	13,02	0,19	35,90	28,22	29,01
Riverine forest	2,49	1,90	6,52	1,04	7,00	8,12	10,42
Savanna Bushland	38,66	27,77	26,05	49,90	10,23	7,19	29,20
Permanent Savanna grassland	7,87	3,59	0,44	12,05	0,73	0,44	0,08
Seasonal grassland	7,24	34,58	0,23	1,97	12,38	0,28	0,00
Saline grassland	2,27	2,10	5,14	1,09	6,14	1,19	0,37
Bare / Burned	4,24	5,59	0,19	5,40	2,30	2,51	0,00
Wetland / Floodplain	6,17	9,55	5,27	5,35	8,57	6,25	1,35
Water Bodies	2,69	0,23	0,65	0,40	0,20	0,99	0,38
Catchment area	100,00	15,90	12,55	58,94	3,52	0,93	2,43

- Significant differences in land cover between the tributary systems.
- River systems form clusters in the PCA analysis, indicating that the fingerprinting technique is a good method for our case study.
- Lake sediment dominated by Makuyuni and Dudumera sources. Both catchments have low permanent vegetation cover and are dominated by seasonal cover, respectively pasture and agriculture.
- Excess 210-Pb is significantly higher in the Dudumera system, indicating higher contribution of surface eroded material. This could be a result of the high agricultural activity in the catchment.
- Area is important but non-linear factor.
- Other catchment characteristics such as relief, rainfall and connectivity are correlated with land cover but are also important independent factors and should be incorporated in following analysis.
- Difficult to disentangle human from natural environmental effects.

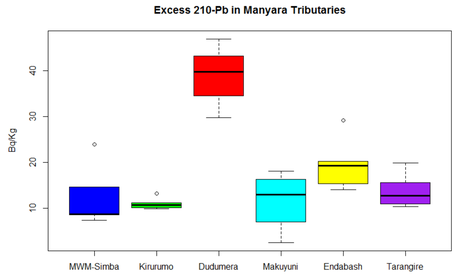

Figure 4 (left): Boxplots of the excess 210-Pb activity in the different Manyara tributaries. The high activity in Dudumera indicates a higher contribution of surface eroded material to the transported sediment,

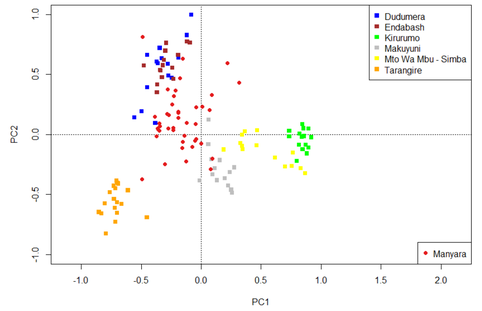

Figure 2 (top): Principal component analysis of the tracer elements of all the tributary sources and Lake Manyara sink.

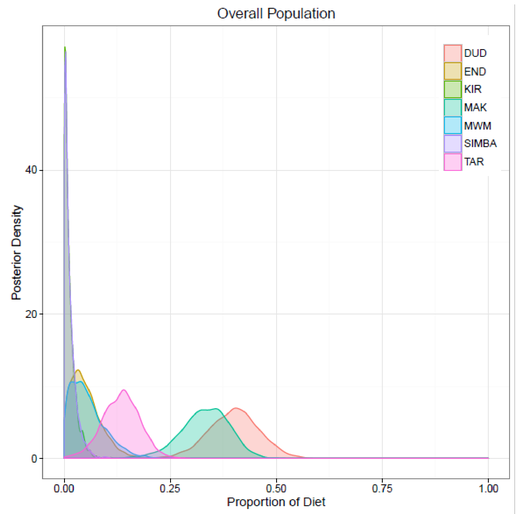

Figure 3 ((top): Proportional sediment contribution of the different tributaries to the lake. 40% from Dudumera; 33,3% from Makuyuni; 13,5% from Tarangire; 6,9% from Mto Wa Mbu – Simba; 1,3% from Kirurumo and 2,43% from Endabash,

4. Future research

- Reconstruct past land cover change with historical aerial photographs and Landsat imagery.
- Take sediment cores of the lake and tributary floodplains to look for changes in sediment sources and sedimentation rate in Lake Manyara and reconstruct source to sink dynamics in the catchment.
- Couple the previous two factors to infer the effect of land use change on soil erosion and disentangle anthropogenic from natural factors in the soil erosion and sedimentation process.
- Quantify the effect of soil erosion and siltation on the Lake Manyara ecosystem service provision.
- Contribute to a sustainable community owned sustainable management plan.

5. References

[1] African Wildlife Foundation 2003. Lake Manyara Watershed Assessment; [2] Kideghesho et al., 2013. Emerging issues and challenges in conservation of biodiversity in the rangelands of Tanzania. Nature Conservation 6: 1-29; [3] Parnell et al. 2013. Bayesian Stable Isotope Mixing Models. Environmetrics 24: 387-399.