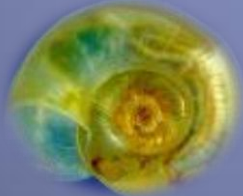




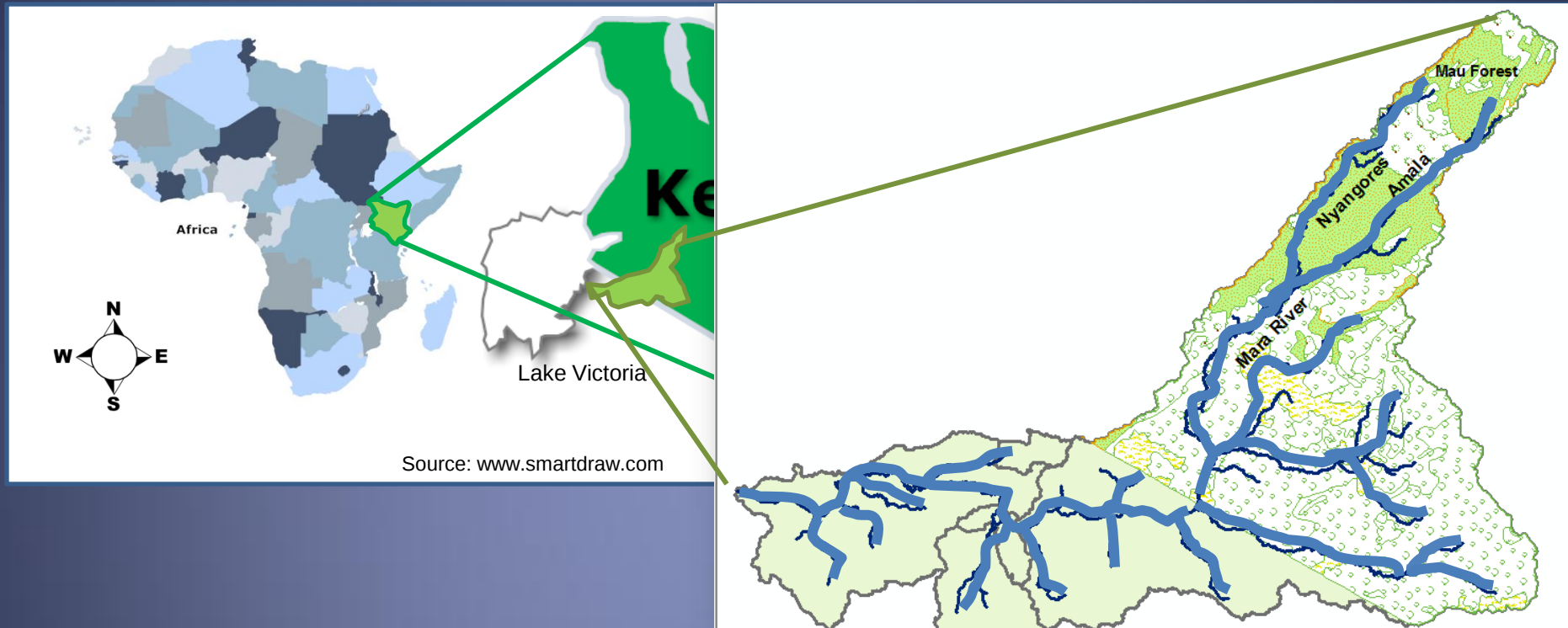
Variation in benthic macroinvertebrate assemblages with stream physico-chemical characteristics in headwater streams draining different land uses, Mara River Basin, Kenya.



Background

- Increase of human population, cattle grazing, subsistence activities and changes in land use has affected the aquatic ecosystems within the Mara basin
- The constant land demand for farming and grazing in Africa represented an annual average loss of 3.4 million Ha between the years 2000 and 2010, only second after South America (FAO, 2010).
- Consequently the reduction in the quantity and possibly water quality in the upper catchments within the Mara River and its tributaries.

Background: Location



- Catchment area = 13504 km² (Kenya 65% and Tanzania 35%)
- Main tributaries are Nyangores and Amala, flow from north-east to south-west
- Mara River = 395 km from the Mau Forest to its discharge in the Lake Victoria

Hydrological features:
Rainfall 1400 mm/year
Temperature 10 -19 °C

Hypothesis

- The existing land use has an effect on in-stream habitat characteristics
- Macroinvertebrate abundance, diversity and composition vary as a function of both land use and in-stream habitat characteristics



Study Area

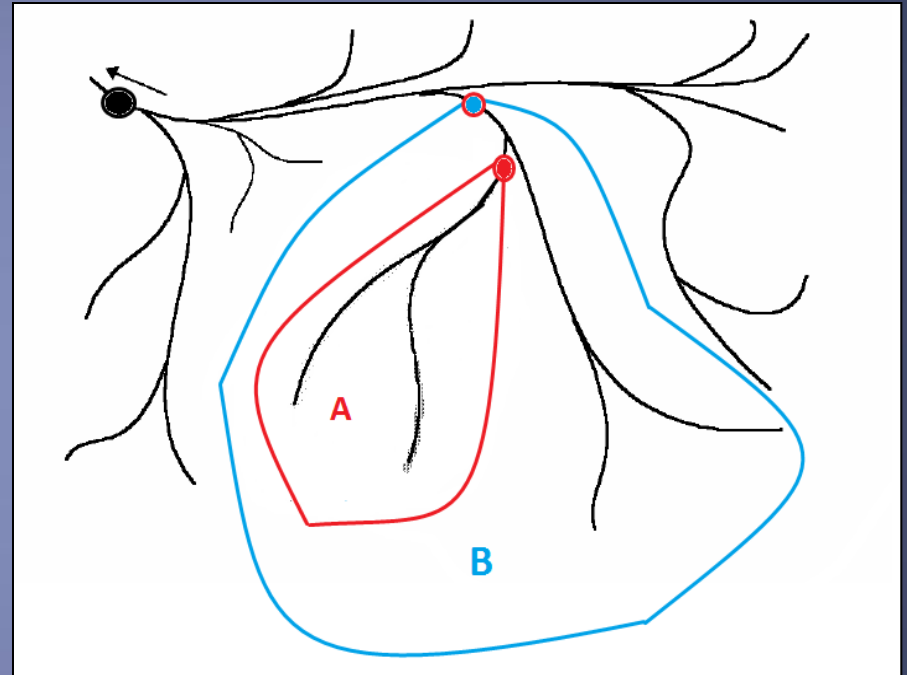


Source: GLOWS

- 25 sampling sites
- Amala (8) and Nyangores (17)

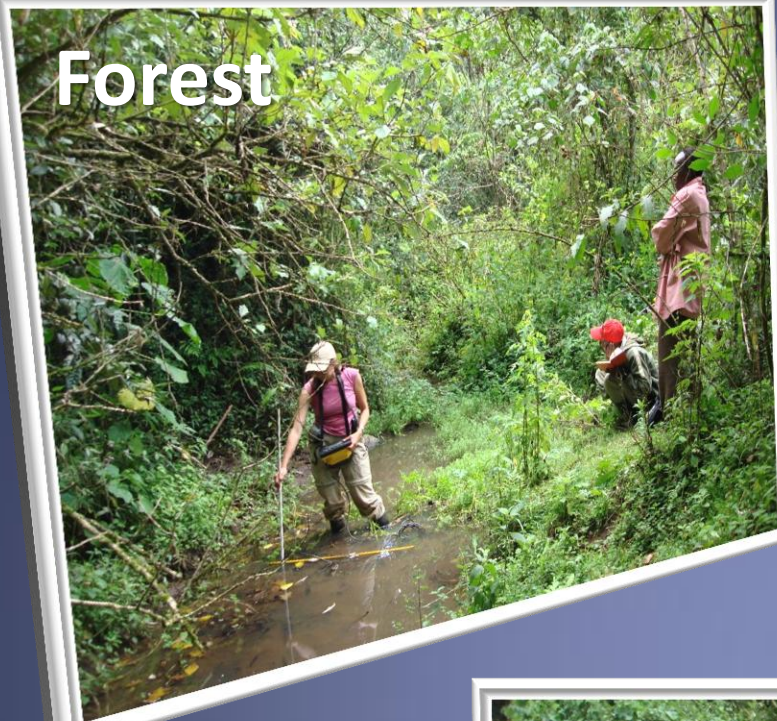
Methodology: Sampling Site Selection

- Selection of stream networks based on a single land use were tracked to points of confluence and change of stream order



- Samples were taken in three main land uses:
 - Forest (13)
 - Agriculture (e.g. tea, coffee, maize and livestock grazing) (6)
 - Mixed (a combination of forest and small scale agriculture) (6)

Forest



Mixed



Agriculture



Methodology: On-site measurements

- Physico-chemical parameters:
pH, DO, conductivity, T °C, turbidity.
- Hydro-morphological features:
V, width, depth, substrate type
- Site protocols
 - Level of disturbance
 - Rapid Field Bioassessment



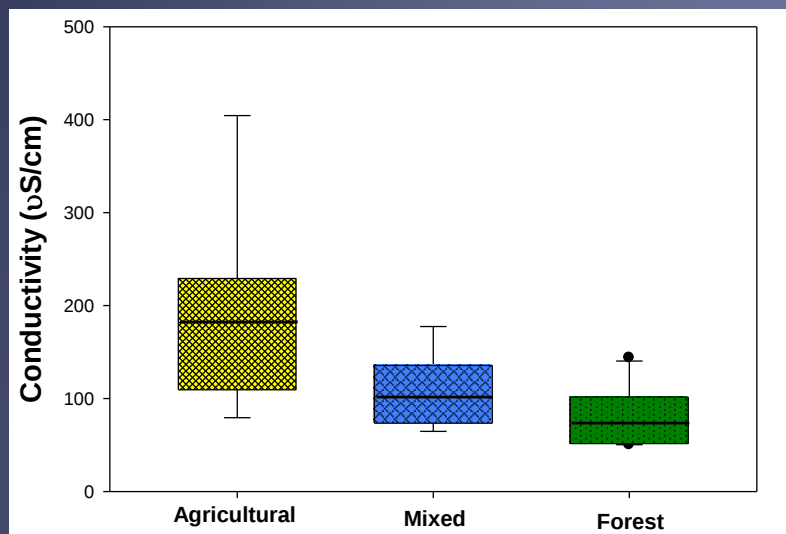
Methodology: Macroinvertebrates sampling

- Habitat assessment:
 - % coverage of each micro-habitat
 - 10 sampling units pooled together to get a composite sample

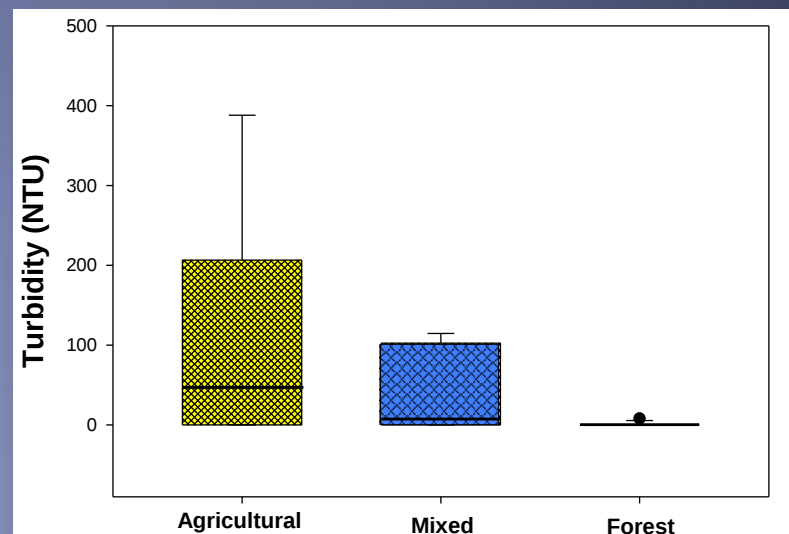


- Sorting and identification:
 - Family level, genus (Trichoptera and Coleoptera) and subfamily level (Chironomidae). Key used: Aquatic Invertebrates of South African Rivers (Gerber & Gabriel, 2002)

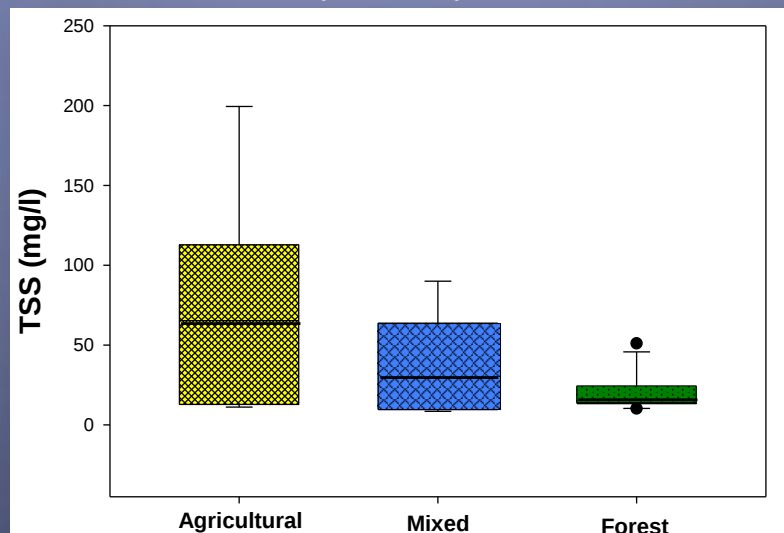
Results: Physico-chemical parameters among Land use types



(ANOVA, $n = 24$, $F = 7.1433$, $d.f. = 23$, $P < 0.01$)



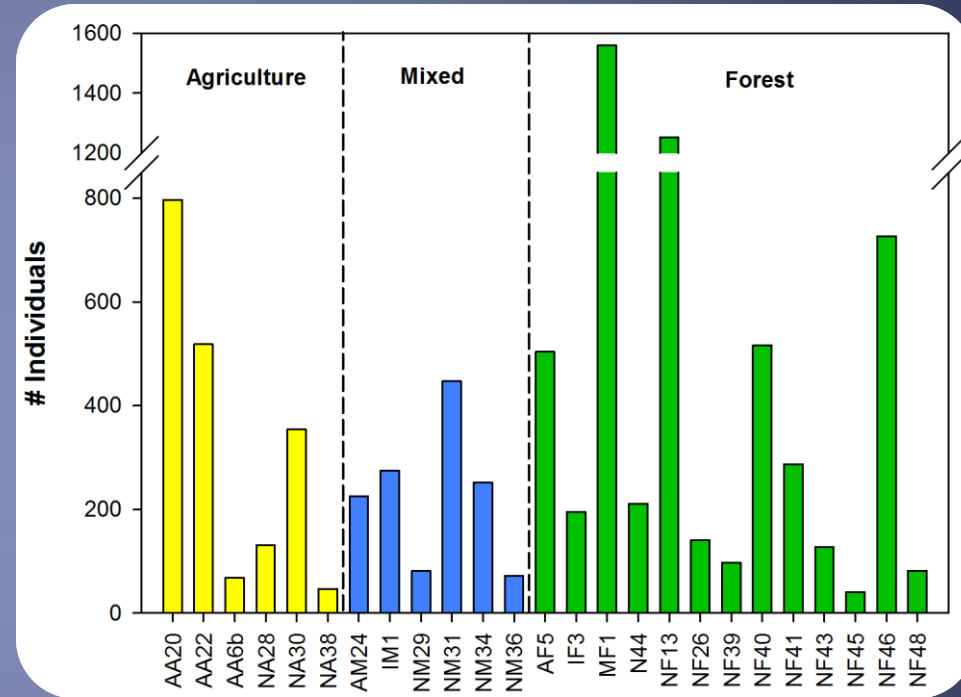
(ANOVA, $n = 24$, $F = 4.6597$, $d.f. = 23$, $P < 0.05$)



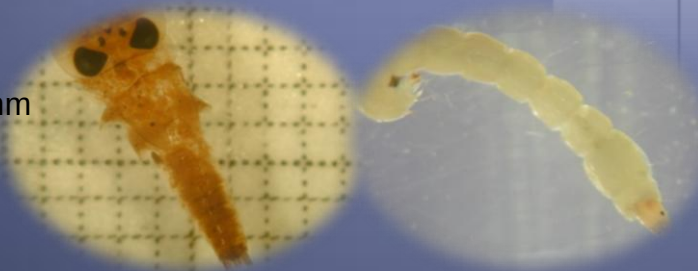
(ANOVA, $n = 24$, $F = 4.7932$, $d.f. = 23$, $P < 0.05$)

Macroinvertebrate assemblages

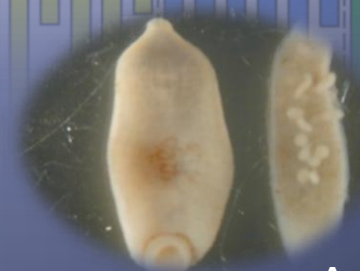
- A total of 9006 individuals within 75 taxa belonging to 13 orders were identified from the 25 sampling sites.
- The most dominant orders were: Ephemeroptera 41.28%, Diptera 30.83% and Annelida 17.21%.



Ephemeroptera



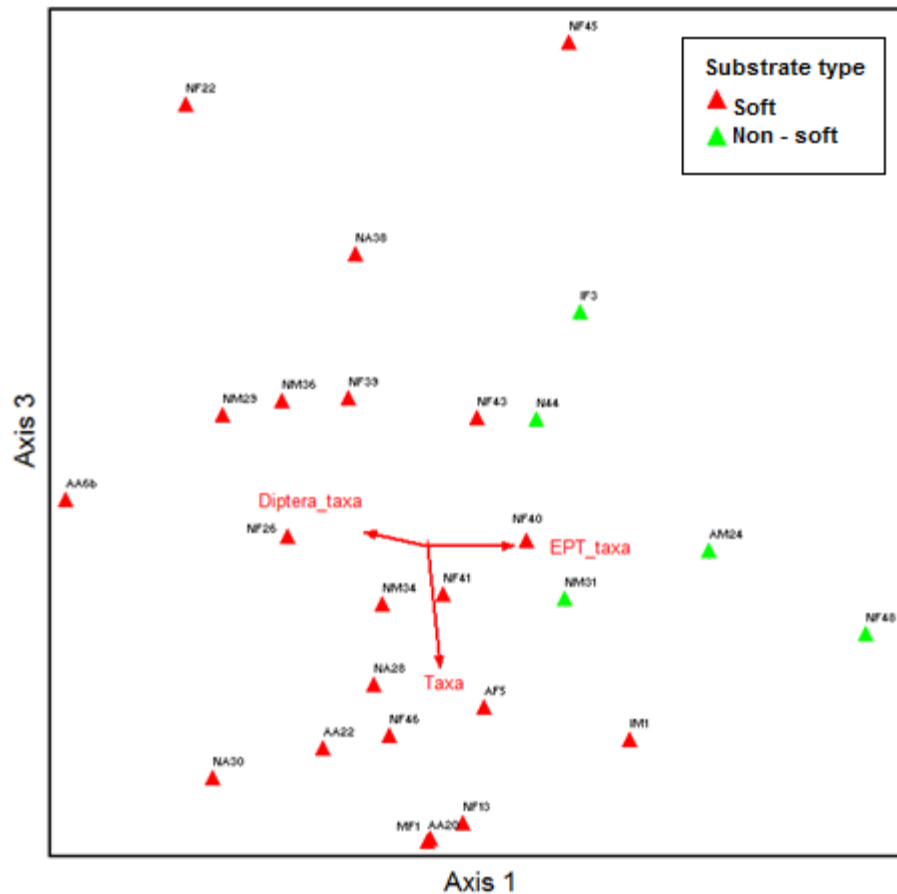
Diptera



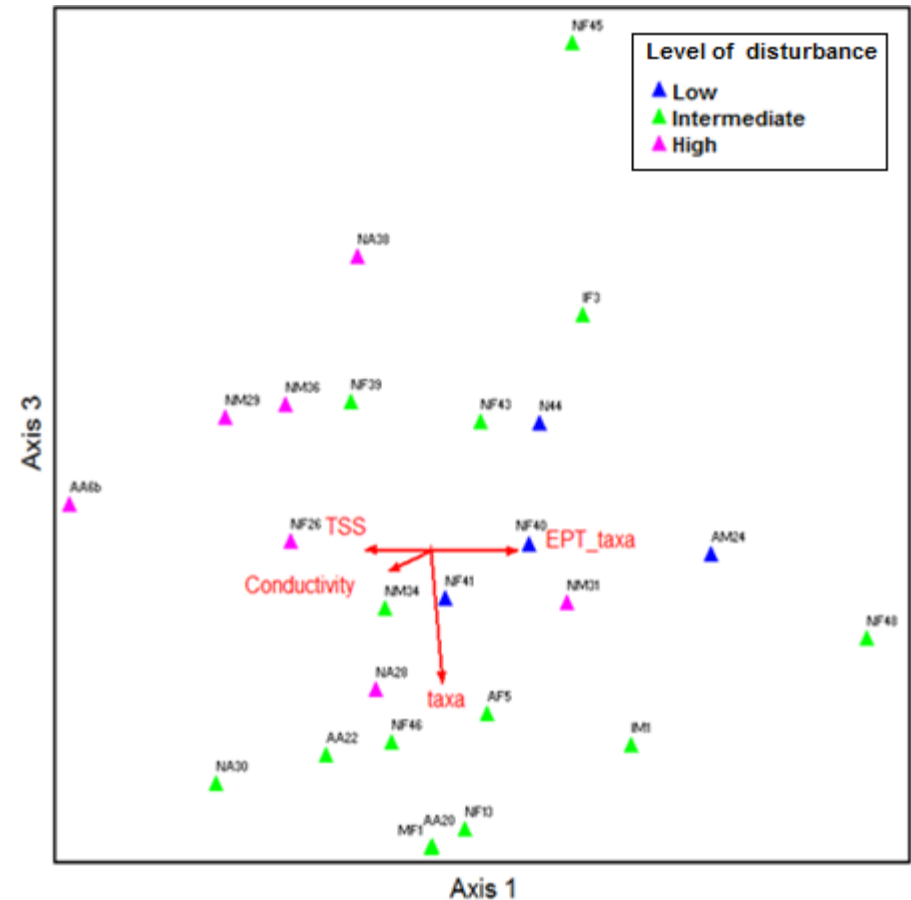
Annelida



Substrate type and level of disturbance



substrate type (PERMANOVA, $p < 0.05$)

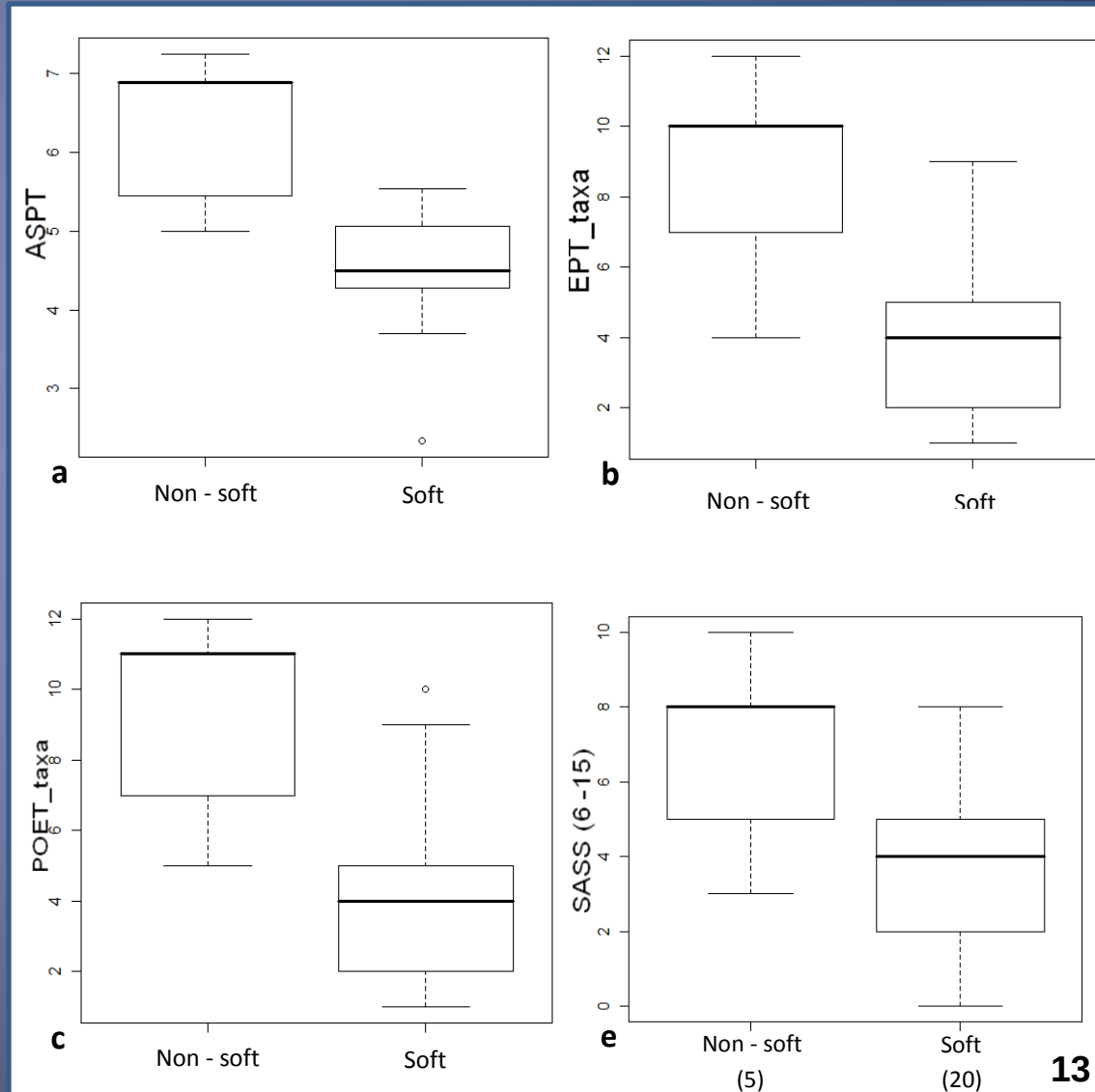


level of disturbance (PERMANOVA, $p < 0.05$)

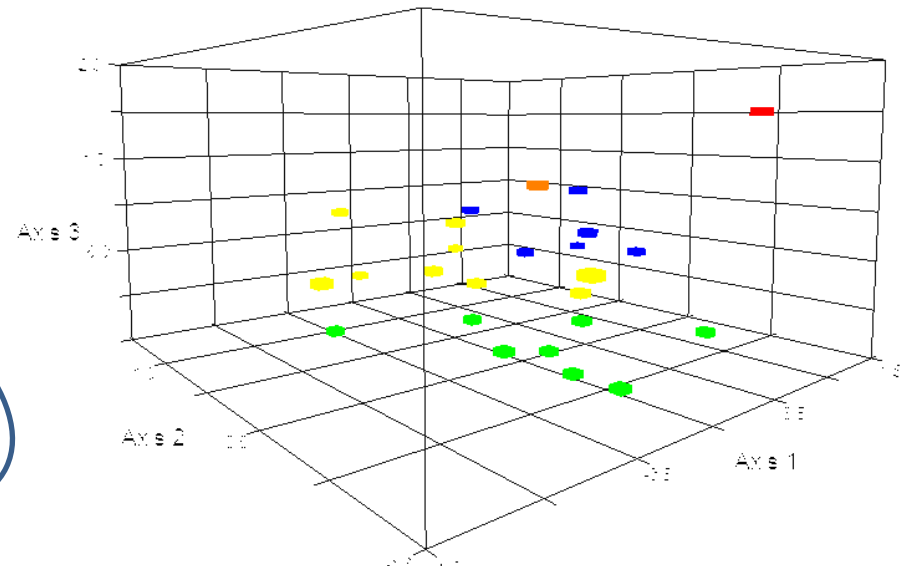
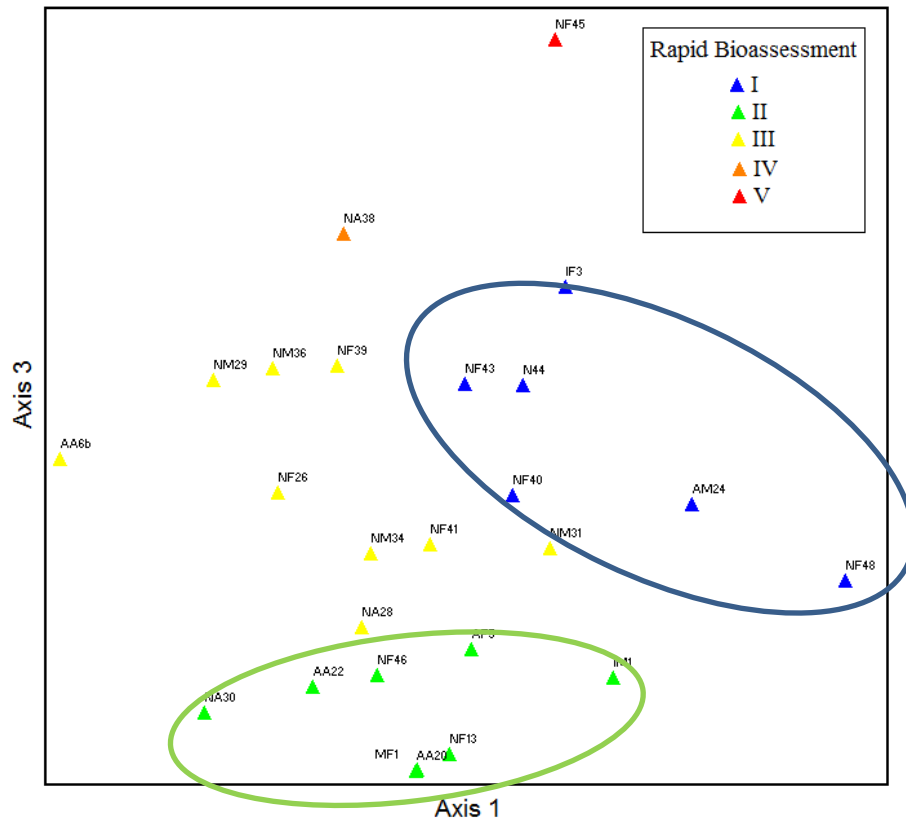
Substrate type

- T- test indicated a significant difference in several single metrics between substrate types.

- ASPT
- EPT_taxa
- POET_taxa
- COPTE_taxa
- SASS (sensitive taxa)
- SASS (most sensitive taxa)



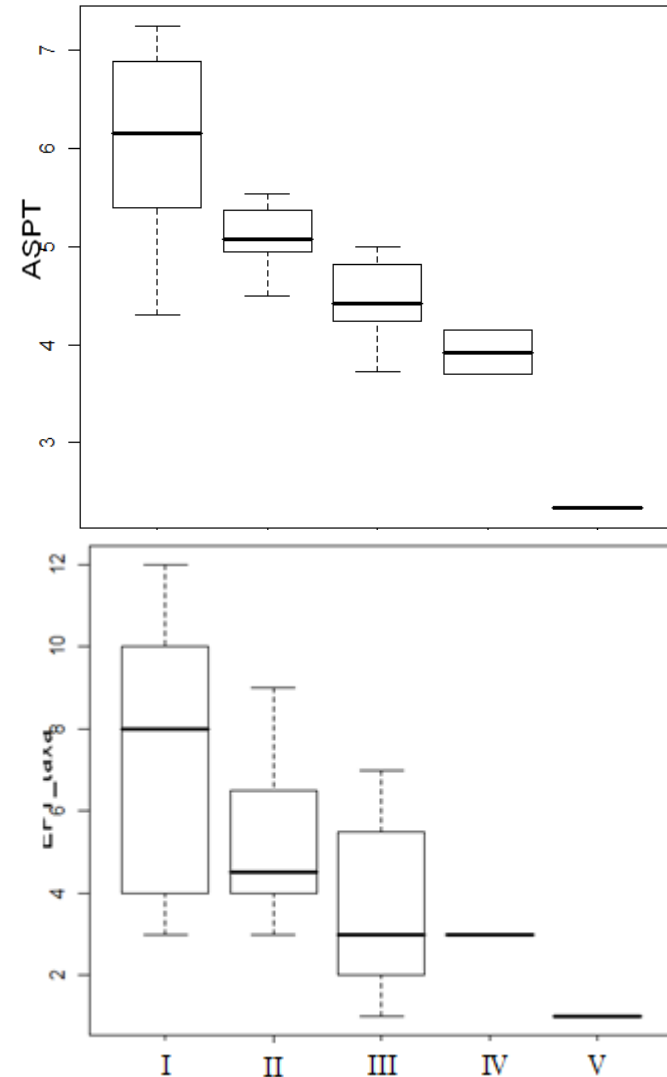
Rapid Field Screening



Significant difference in dispersion (PERMDISP, $p < 0.001$) and location (PERMANOVA, $p < 0.001$) among the sampling sites for the different classes

Rapid Field Screening

- One – way ANOVA test indicated a significant difference in several single metrics among
 - Total taxa
 - Family_taxa
 - SASS score
 - ASPT
 - EPT_taxa
 - POET_taxa
 - COPTE_taxa
 - SASS (sensitive taxa)
 - SASS (most sensitive taxa)



Conclusions

- **Macroinvertebrates** have remained a **key indicator of changes** in the physical and chemical conditions **of aquatic ecosystems**
- The results demonstrate that catchment land use had a direct influence on the physico-chemical parameters in the Mara streams but could not be reflected on the macroinvertebrate community .
- The **in-stream characteristics**, specifically substrate type and level of disturbance **were correlated to** the water chemistry with particular increase on the levels of **conductivity, TSS and turbidity**. The high concentrations were **negative correlated with the macroinvertebrate single metrics**

Recommendations

- An East African Score System should be developed and identification should be at a lower level since macroinvertebrate families have a general response
- There is need for research to cover the temporal patterns as opposed to this snap shot that only covered the base flow conditions in order to understand seasonal population dynamics of macroinvertebrates
- The results of this study are a good foundation in the attempt to identify suitable indicators for monitoring headwater streams in the Mara River catchment. In addition they can contribute to similar case studies in other catchments of the region



Thank You