VolkswagenStiftung

MARTIN-LUTHER-UNIVERSITÄT HALLE-WITTENBERG

MUHAS

UFZ

Workshop

Drug lifecycle control in Subsaharan Africa

From production to responsible safe disposal and elimination in wastewater treatment plants

(Med4Africa)

Center of Excellence in Phytochemicals, Textile & Renewable Energy

Center of Excellence in Phytochemicals, Textile & Renewable Energy (PTRE)

MOI UNIVERSITY
FOUNDATION OF KNOWLEDGE

SENTINEL
Linking Freshwater Pollution and the Risk of Schistosomiasis

Occurrence and removal of pharmaceutical residues in water: A case study of the lake Victoria basin

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31st August, 2022

Background

Fast runners

Great wildlife

Magical beaches

Sandy deserts

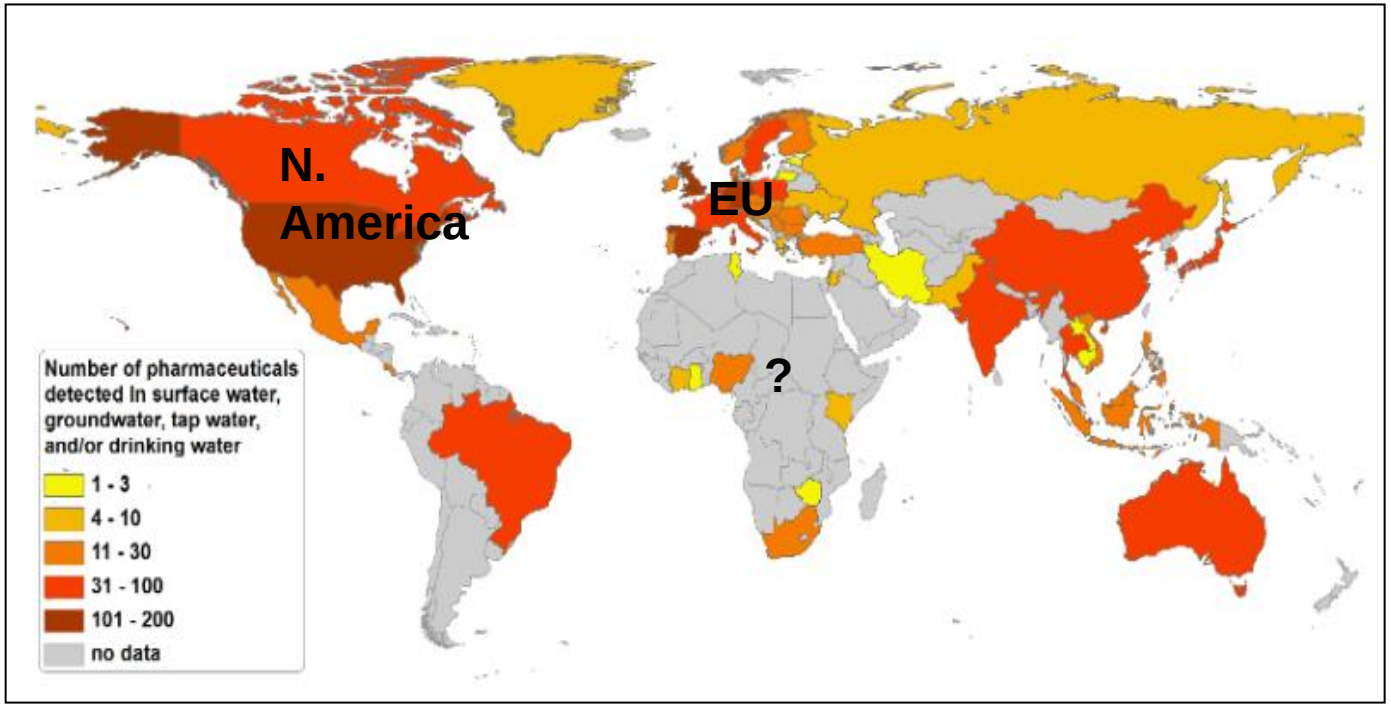
Beautiful mountains

Gorgeous landscapes

Background

But what about occurrence of organic micropollutants in Kenyan ecosystems…?

Global occurrence of pharmaceuticals



Aus der Beek 2016

- A lot of research on occurence of Pharmaceuticals in aquatic ecosystem but mostly in developed countries
- Limited information of the occurence and risk in developing countries especially in Africa

Sources and pathways into the environment

Human consumption

Pharmaceutical Industry

Agriculture/ Aquaculture

WWTP

Waste/ dumpsite

Manure/ Sludge

Surface / Ground water

Drinking water

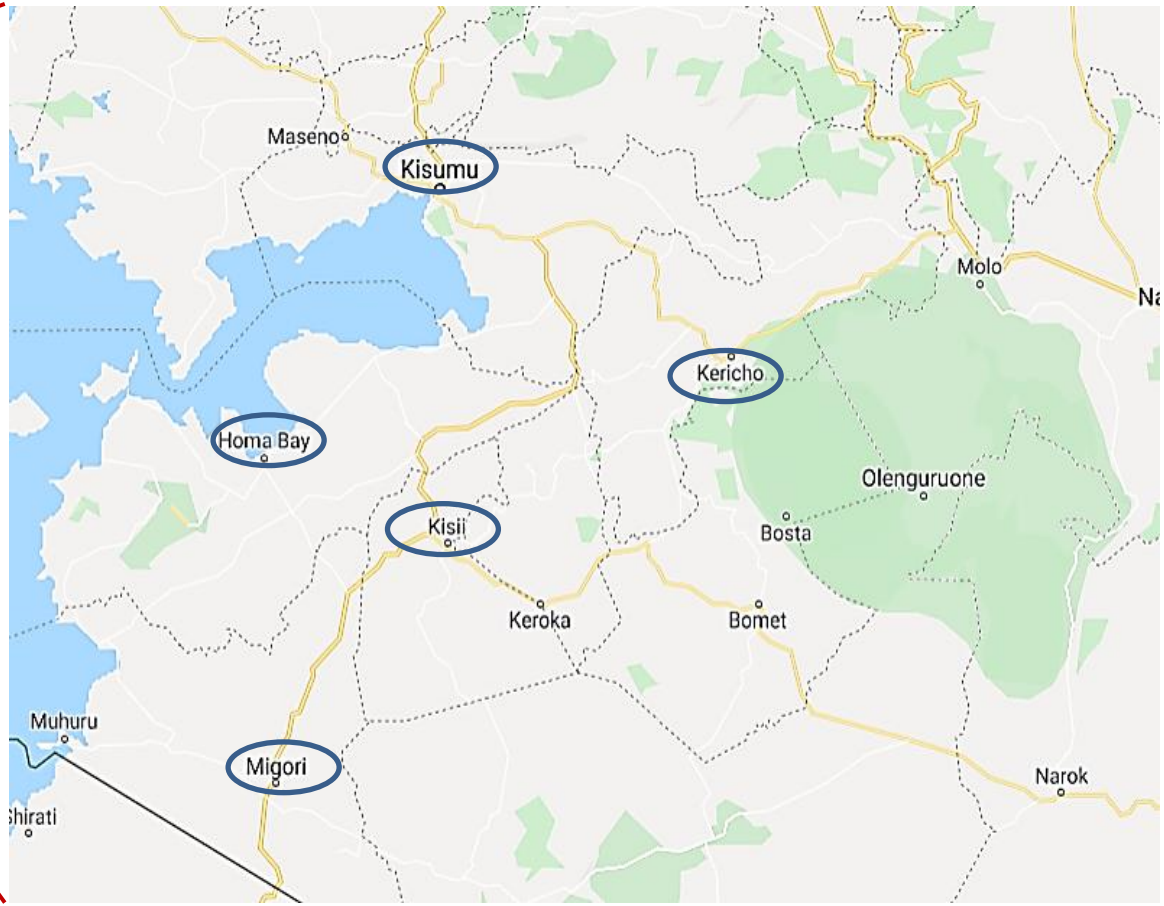
Aim of the study

1. Identify contaminants present in water, snails and sediment from surface water systems of western Kenya

2. Perform risk assessment based on toxic units for fish, crustaceans and algae for water and sediment concentrations

3. Prioritize compounds for monitoring and regulation

Study area: Lake Victoria South Basin



- 48 sites in 7 counties
- Land use: agricultural, urban and residential

Methodology – Sample processing

Sample preparation

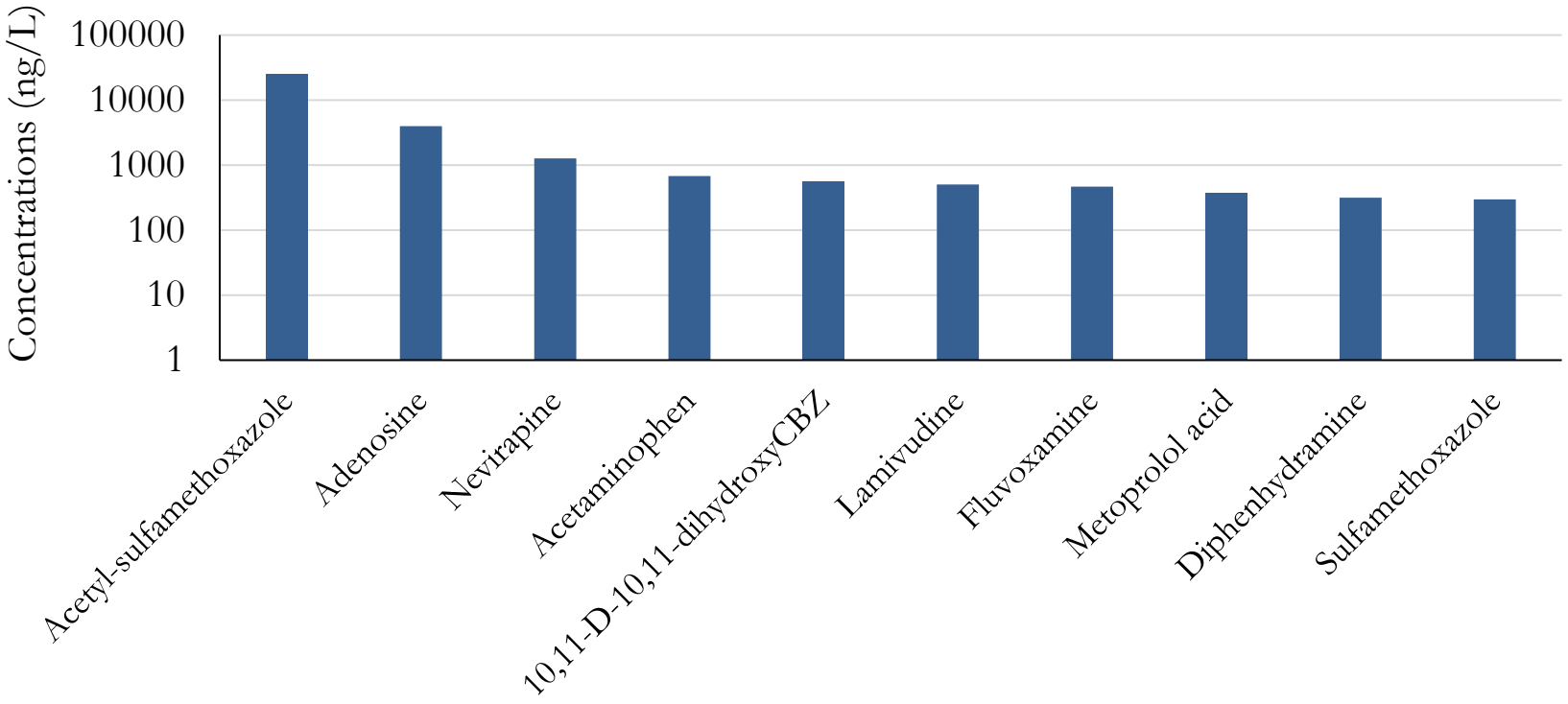
LC-HRMS

Sampling

- **Water**: direct injection. No sample preparation
- **Snail**: QuEChERS extraction
- **Sediment**:Pressurized Liquid extraction and flash chromatography clean up
- Target compounds and suspect screening (Kenyan list)

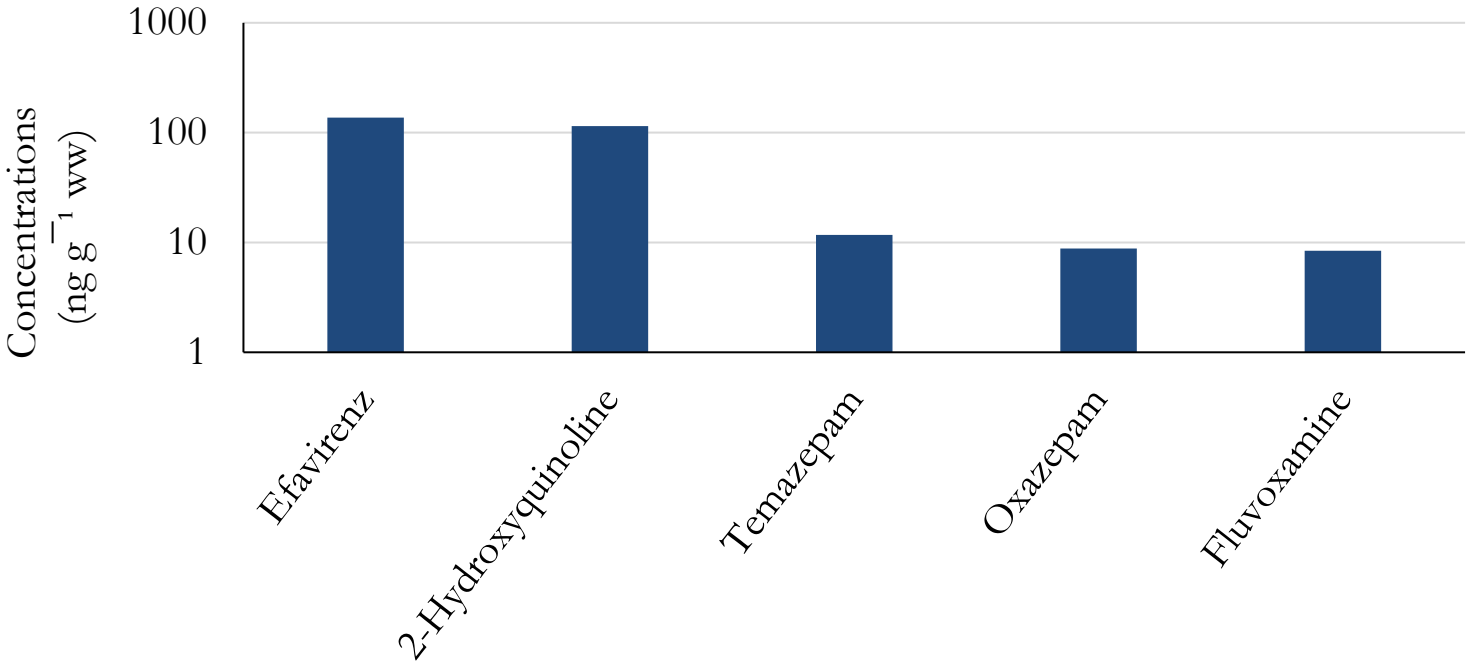
Results – What do we find in water?

10 compounds with highest concentrations



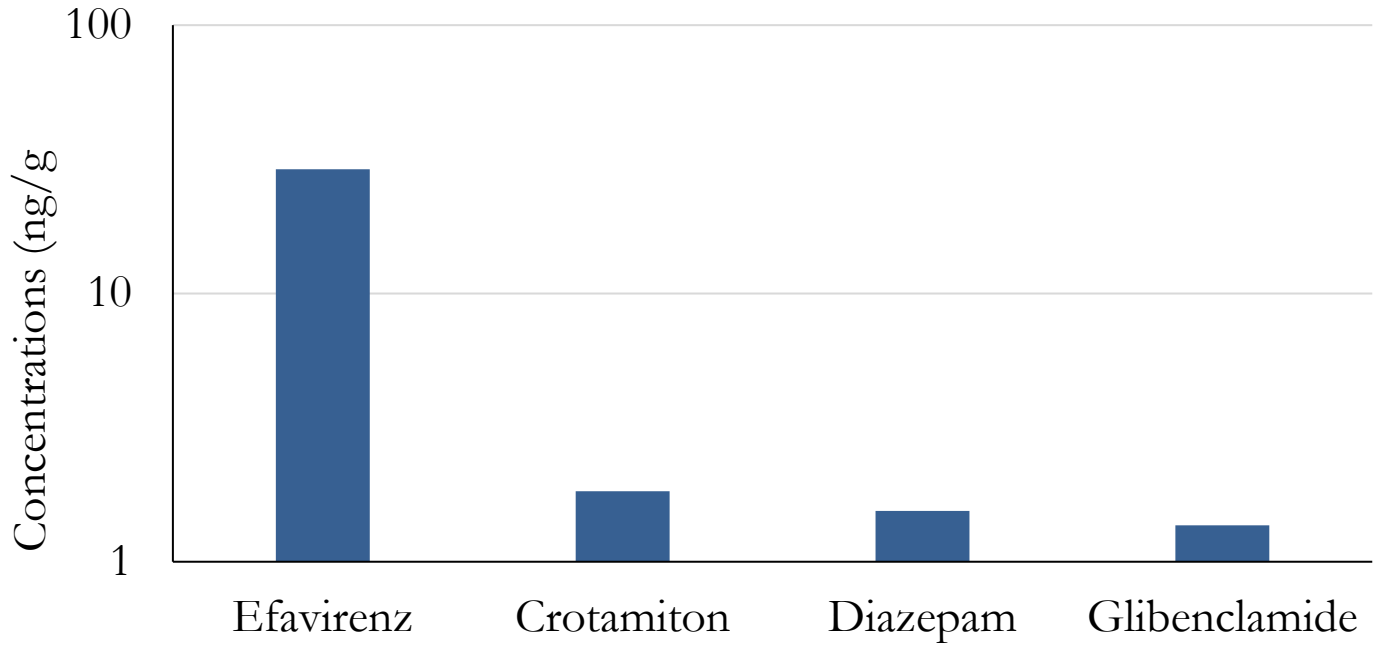
- 25 PhAC detected with concentrations up to 24 µg/L (acetyl-sulfamethoxazole).
- Additional 3 compounds including 2 antiretrovirals were quantified through suspect screening.
- Antibiotics and Anti-inflammatory/analgesic most frequently detected

Results – What do we find in snails?



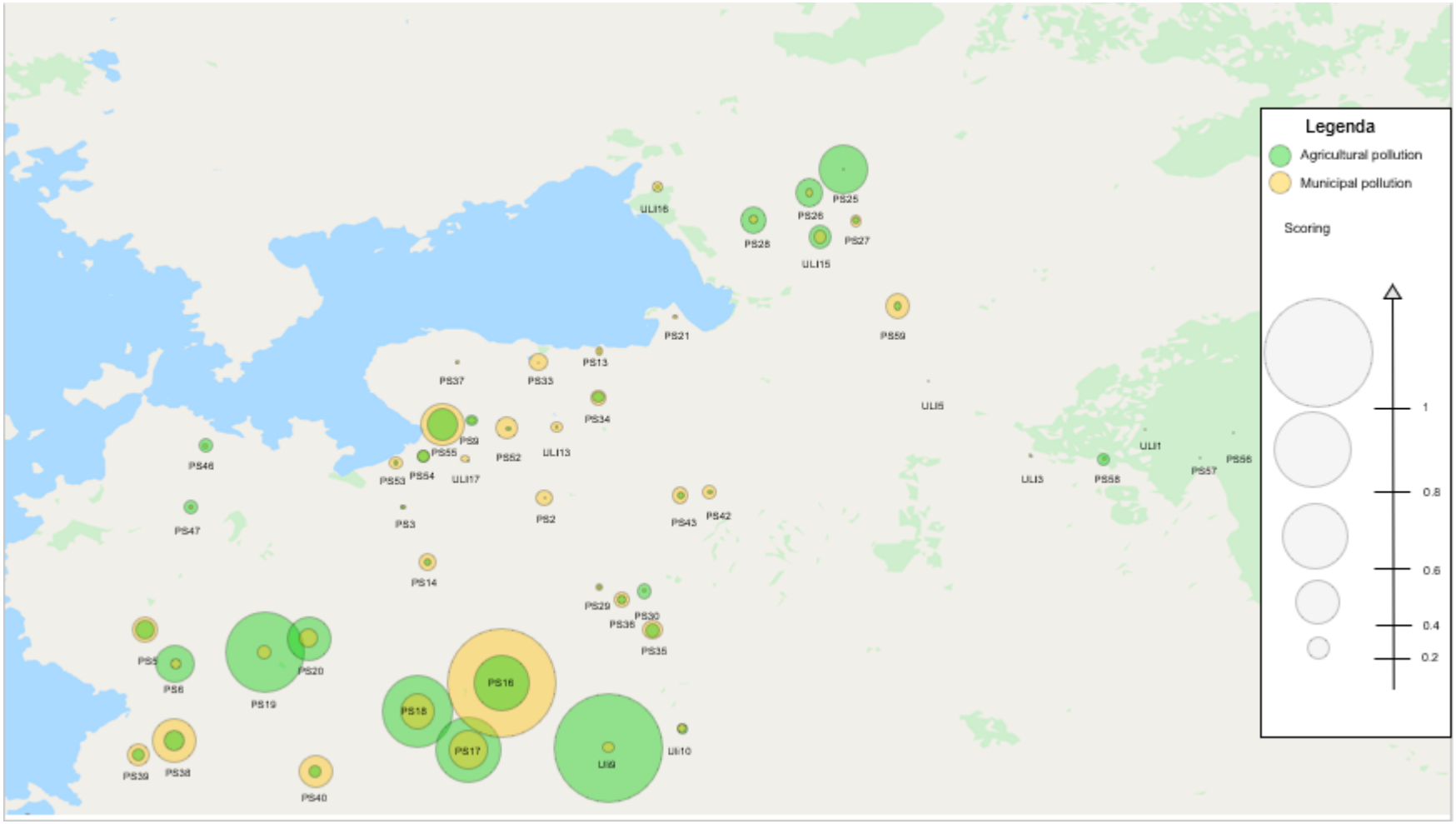
- 5 PhACs detected in snails with concentration up to 137 ng/g ww (Efavirenz)
- Snails acted as passive samplers
- Temazepam frequently detected in 98% of the sites sampled

Results – What about in sediment?



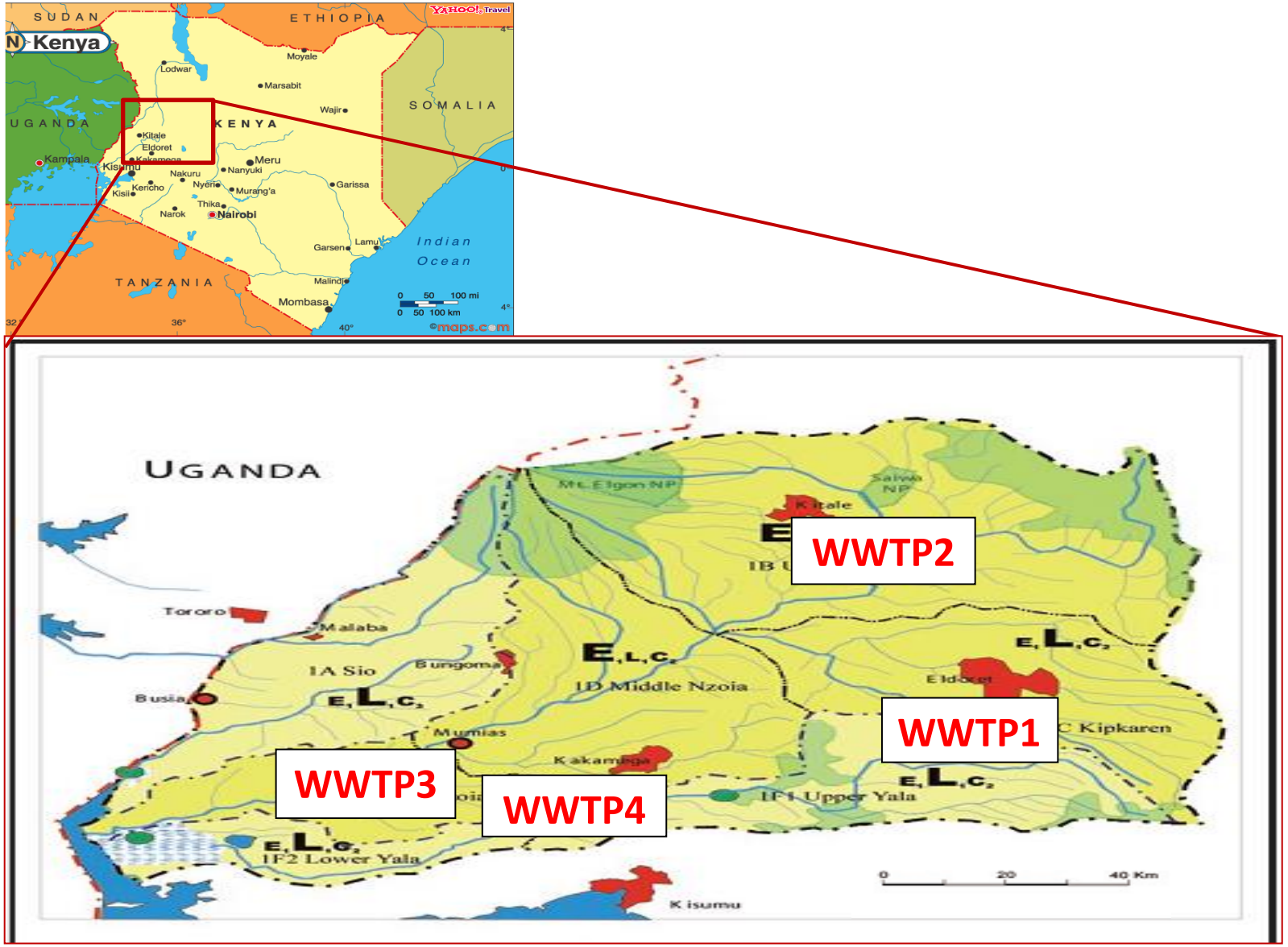
- 18 PhAC found in sediments with concentration up to 29 ng/g OC (Efavirenz)
- Antiretroviral drug efavirenz detected in 56% of the sites
- Anticancer drugs (anastrazole and bicalutamide) detected

Contribution from land use

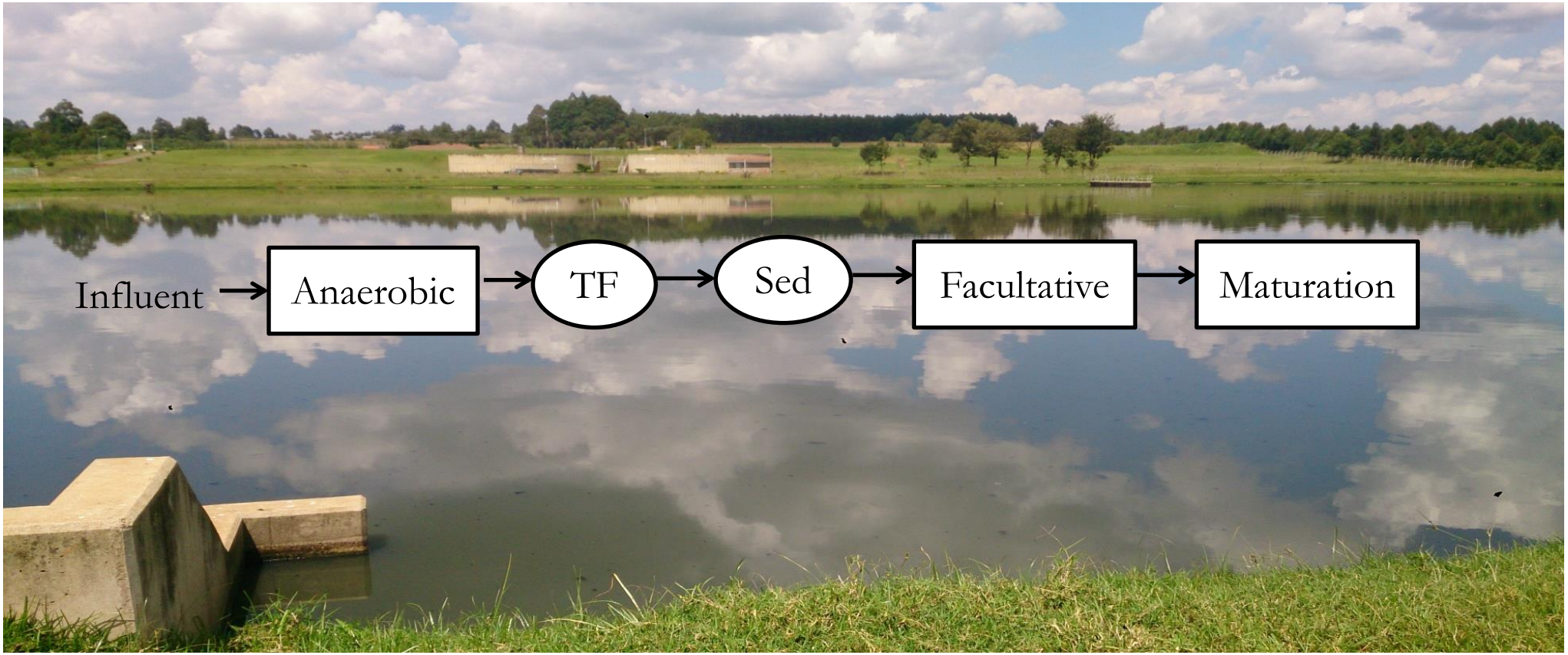


What if we intervened?

What if we had a WWTP?



Study area

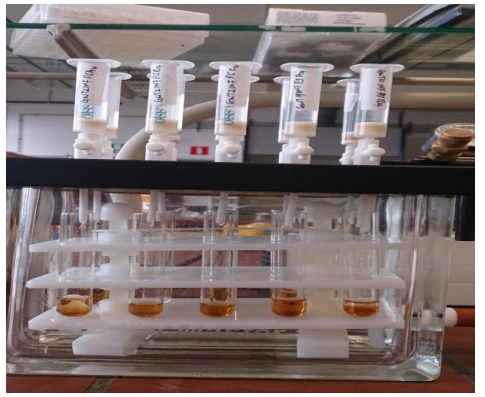


Sampling and sample processing

Sampling

Sample preparation

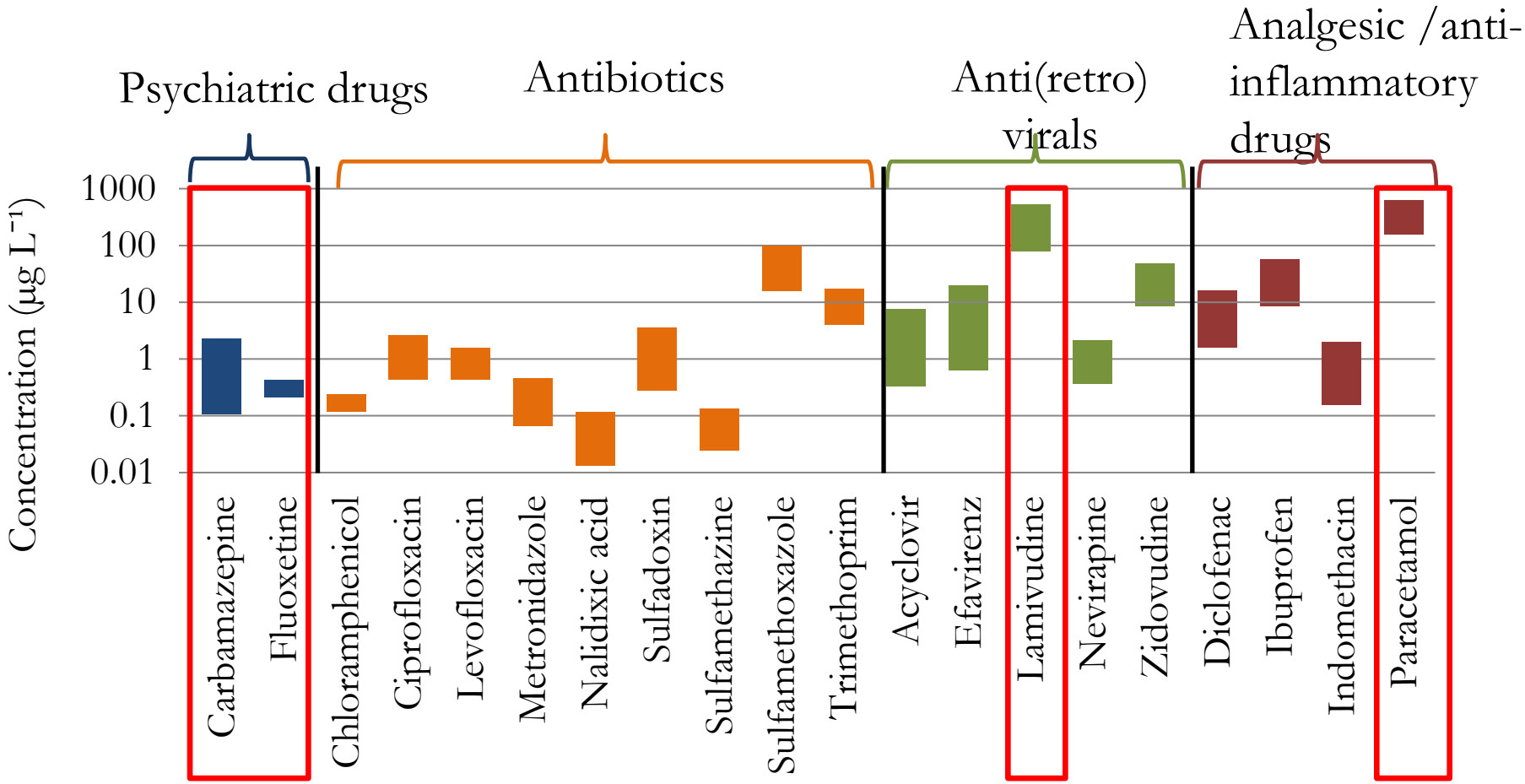
SPE process



Analyte elution

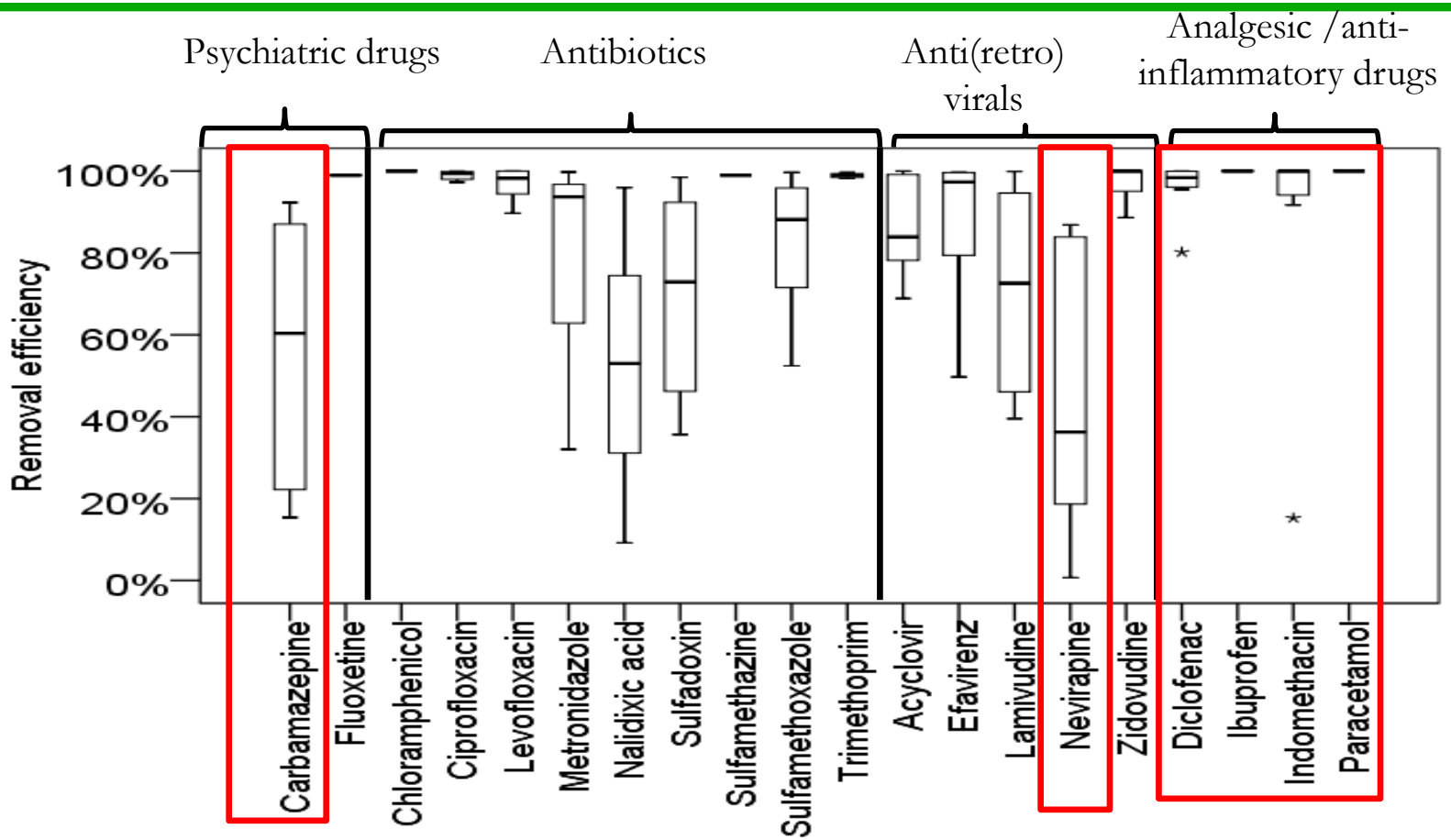
UHPLC-HRMS/ Data processing

Results – Influent concentration of pharmaceuticals



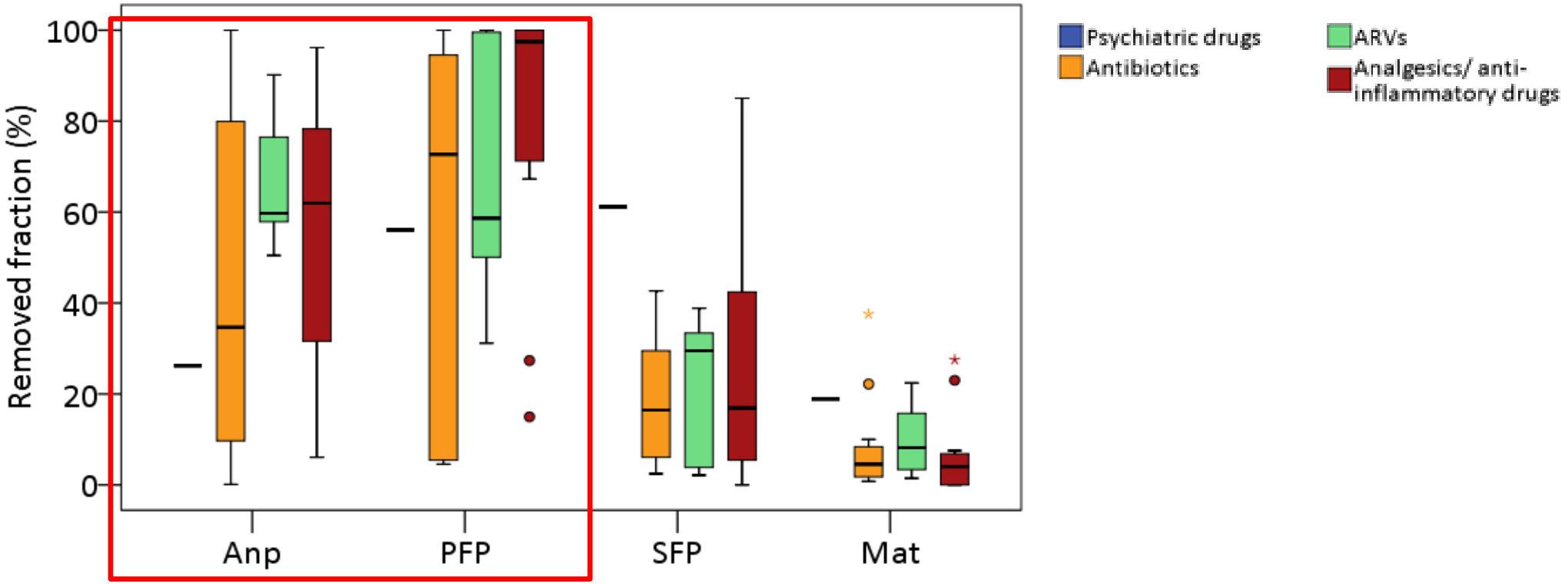
- 21 PhACs found in influent and 16 in the effluent
- Antibiotics most frequently detected
- Concentrations up to 405 µg/L (Lamivudin)

Results – Overall removal efficiency of pharmaceutical residues



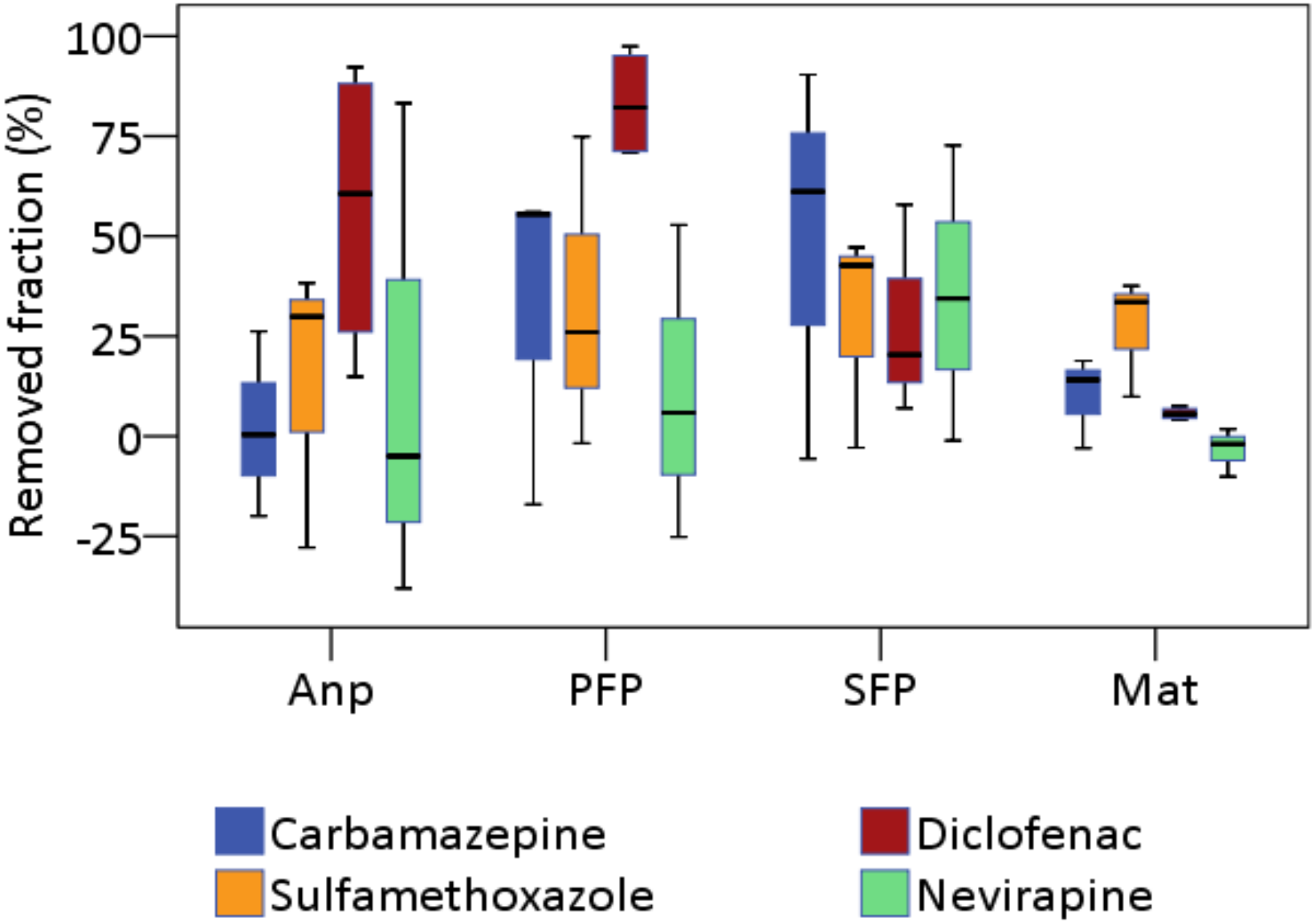
- Analgesic/anti-inflammatory drugs show good removal (>99%)
- Some including carbamazepine and nevirapine difficult to remove

Results – Removed fraction of pharmaceutical residues at each stage



- For most compounds, anaerobic and primary facultative ponds contribute to largest removal
- Secondary facultative and maturation ponds provide polishing towards PhACs not efficiently removed
- Maturation ponds removal through photodegradation

Results – Removed fraction of pharmaceutical residues at each stage



Conclusion

- First comprehensive chemical characterization in a large-scale study within western Kenya freshwater system

- Waste water contributes greatly to surface water pollution with concentrations up to 24 μg/L (water), 137 ng/g (snail) and 27 ng/g OC (sediment) reported with antibiotics and antiretroviral drugs contributing to pollution.

- WWTPs play an important role in removal with removal >99% for most compounds while some compounds (nevirapine and carbamazepine) recalcitrant

- Need for governments to invest in sanitation facilities and treatment plants

END
THANK YOU