



Workshop

Drug lifecycle control in Sub-Saharan Africa

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

(Med4Africa)



Pharmaceutical residues in Rivers: Implications on Ecological and Human health

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**29th – 3rd September 2022
Arusha, Tanzania**

OUTLINE



- **Background**
- **Pollution and Pathways of Pharmaceuticals in Rivers**
- **Concentrations of pharmaceutical residues in world rivers**
- **Implications on aquatic and human health**
- **Concluding note**

Background

- **Deterioration of water quality of freshwater systems is a challenge for humanity in the twenty-first century**
- **Over 1 billion people lack good water quality supply (WHO/UNEP)**
- **Evidence of alteration of the earth's natural ecological systems plenty**
- **What is driving these changes??**

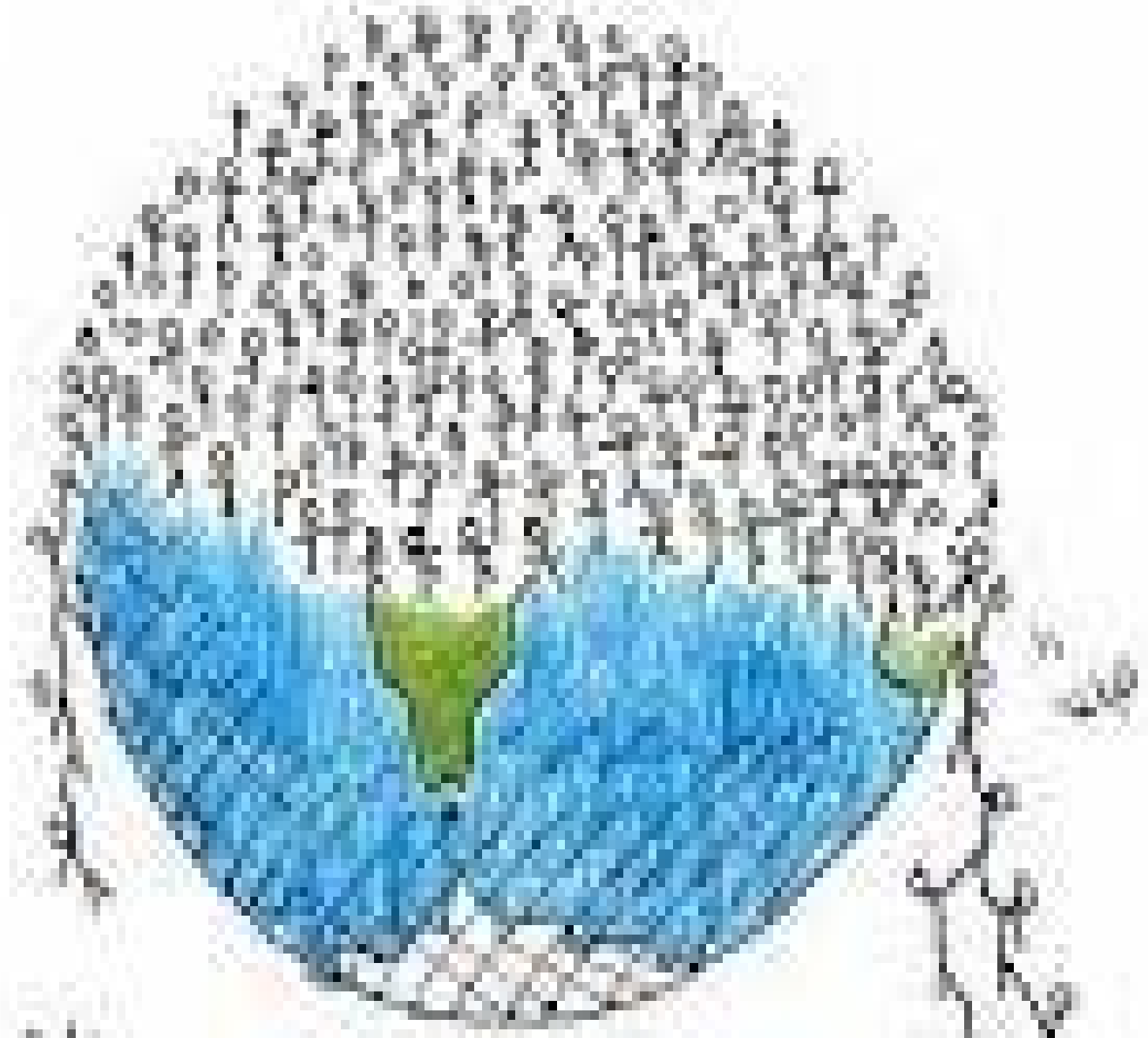


The Anthropocene epoch!

Population growth

Socio-economic prosperity

Climate change



Population growth



**Socio-economic
development**



Climate change



Pollution of Aquatic ecosystem

Why is it that aquatic systems are vulnerable to pollution?

- **Aquatic ecosystems act as sinks, accumulating and transporting numerous chemical contaminants released (Scholz and Mayer, 2008)**
- **About 90% of all the sewage produced in developing countries returns to the land and water untreated!!**
- **2 million tonnes of waste is discharged into aquatic ecosystems every day (UN Global Chemical Outlook report, 2019)**
- **LEADING TO LOSS OF ECOSYSTEM RESILIENCE**

Pharmaceutical pollution

Known water pollutants (numerous studies)

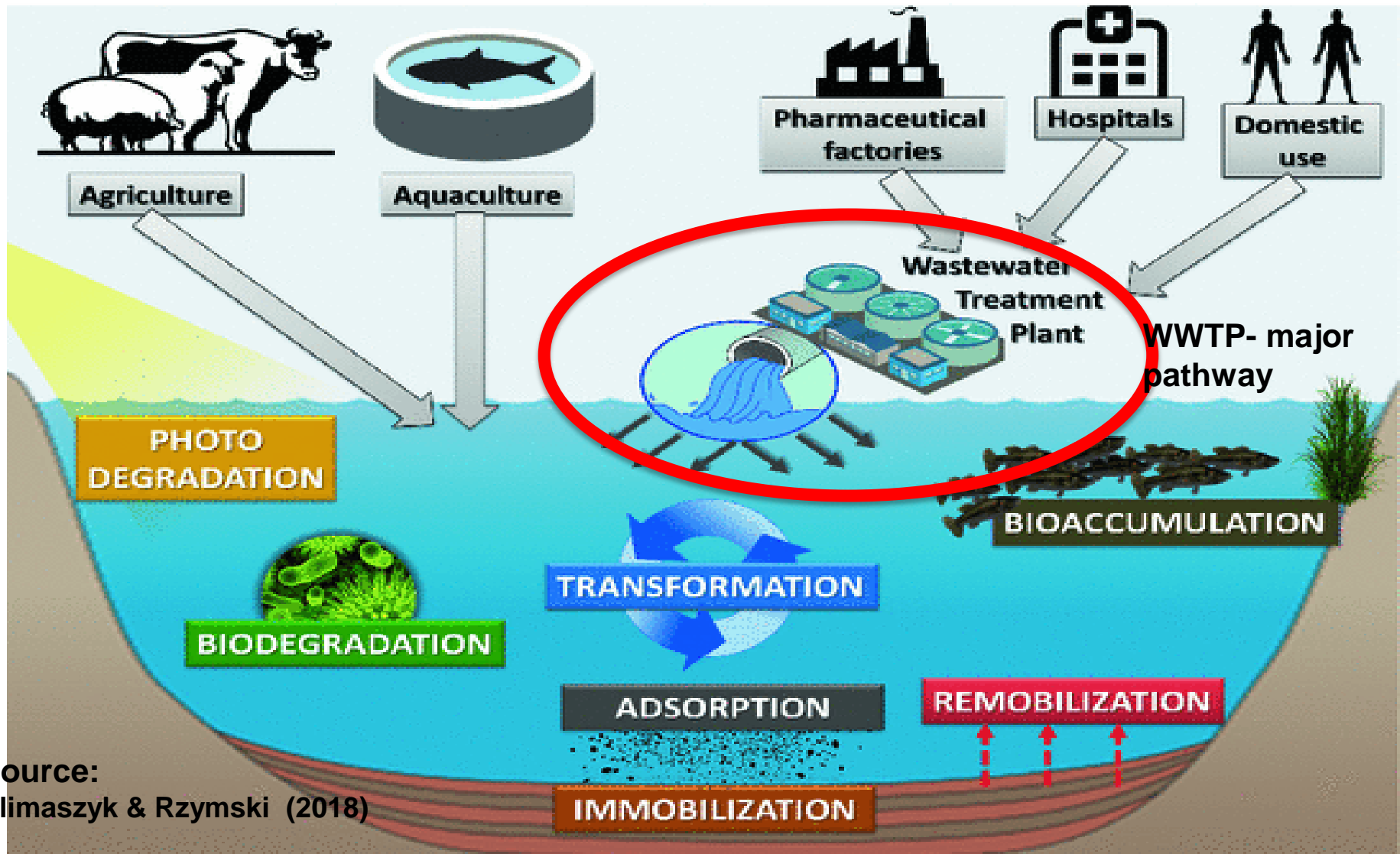
Nutrients, heavy metals, organics, inorganics

Emerging pollutants

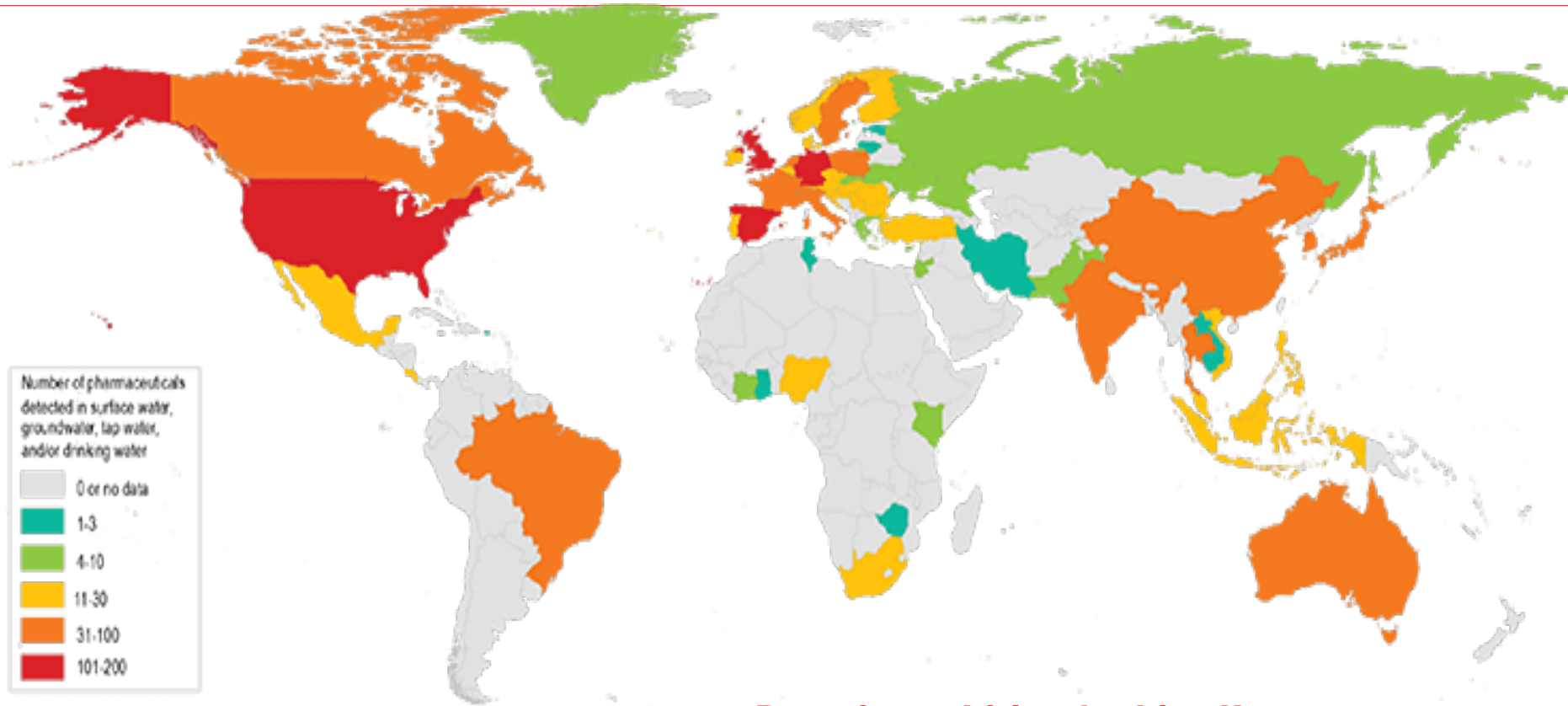
- insect repellents
- disinfectants, fire retardants, detergent metabolites
- microplastics and nanoparticles
- **veterinary and human pharmaceuticals**
 - Occurrence and concentrations of pharmaceuticals unknown in many rivers
 - Known to harm humans and wildlife
 - Poses environmental threat

How do pharmaceuticals find way into rivers?

Sources and pathways of pharmaceuticals into freshwater ecosystems



Global occurrence of pharmaceuticals in rivers



Data from Africa lacking!!

Source: (aus der Beek et al., 2016).



Status of pharmaceuticals in world rivers

Study by Wilkinson et al., (2022)

Studied 258 rivers in 104 countries covering all continents

Results

Most contaminated samples

- African and Asian countries
- Sites receiving discharge of treated and untreated sewage

Least contaminated samples

- Sites with limited anthropogenic influences
- Sites with limited use of conventional medicines
- Sites with sophisticated waste water treatment plants
- High riverine flows



Status of pharmaceuticals in African rivers

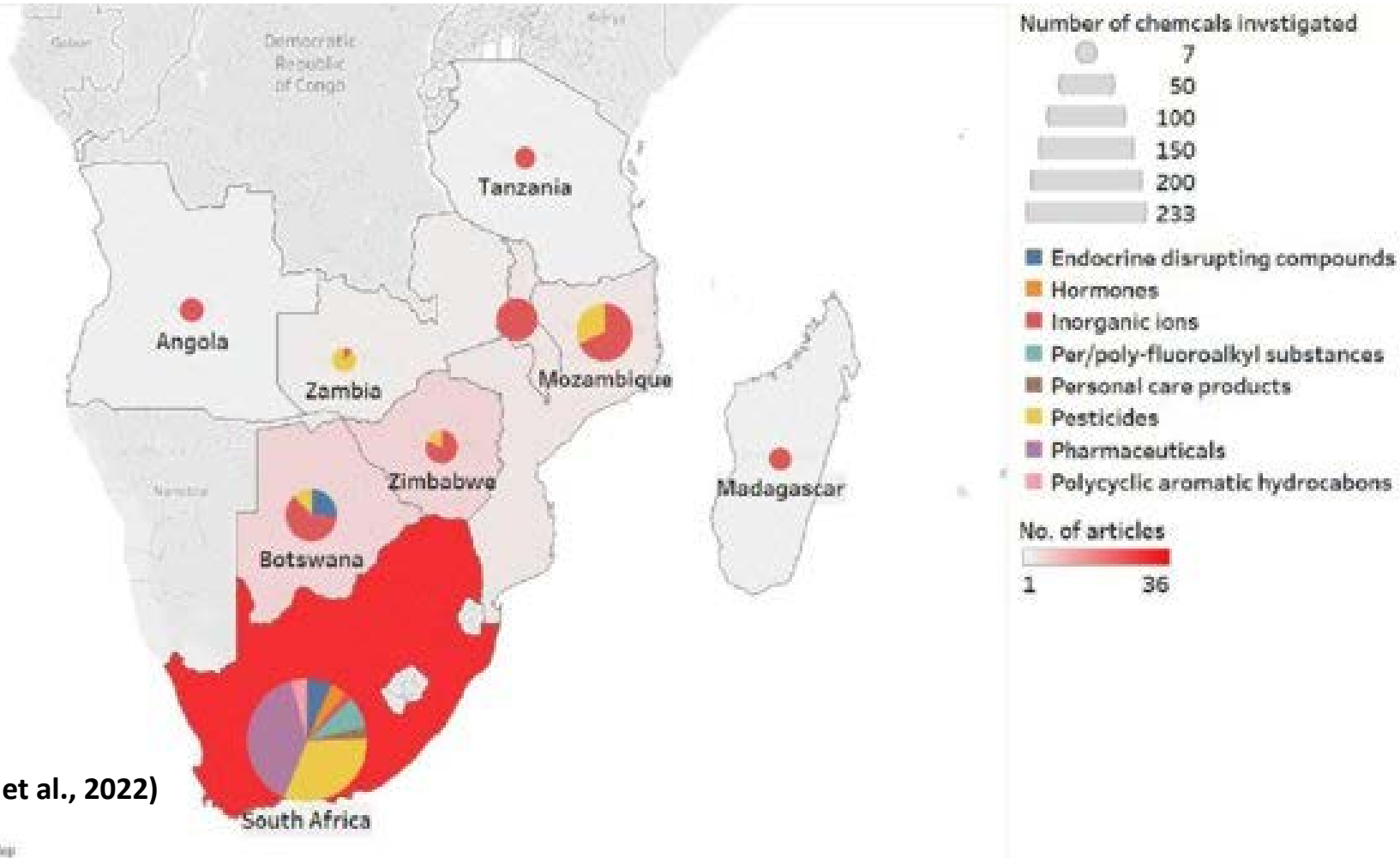
Study by Madikizela et al., (2017)

Commonly occurring in African river waters

- Non-steroidal anti-inflammatory drugs(NSAID)
- Antibiotics
- Anti-Retrovirals
- Anti-epileptics
- Anti-malarials

Studies on pharmaceuticals in African rivers scarce - only South Africa well studied

Studies on chemical pollution in aquatic systems in the SADC region



Concentration of some pharmaceuticals in world surface waters (ng/L)

Compound	Class of Pharmaceutical	PNEC (Grill et al, 2016; Huang et al, 2018)	AFRICA (Madikizela et al.,2017)	SADC (Selwe et al. 2022)	EUROPE (Ternes et al., 2005)	USA (Deo, 2014)
Carbamazepine	Anti-epileptic	500	10-1,700	9.5-1460	25 - 150	1,238
Diclofenac	analgesic	100	30-12,400	1-15,000	15-150	42
Ibuprofen	analgesic	26	40-85,000	1-58,710	nd-70	2,796
Sulfamethoxazole	antibiotic	590	2.2- 38900		nd-30	1,900
Erythromycin	antibiotic		0.4-1000	2-240		
Lamivudine	ARV		240-167,000			
Zidovudine	ARV		970-17,400			
Nevirapine	ARV		1480-5620			
Sulfadoxine	Anti-malaria		100-800			
17 - β - estradiol	Steroid hormones		1-66			

Implications on human health

- Antibiotic resistance genes (ARGs)
- Drug resistant infections responsible for 700,000 deaths globally each year
- Projected to increase to 10 million per year by 2050
- Increased risk of breast and prostate cancer
- Southern Africa is a potential hotspot regarding ARV contamination due to relatively high therapeutic use
- Ritonavir, Nevirapine and Efavirenz most persistent and prevalent in SADC surface waters

Other concerns

- Effect of mixtures unknown (additive, antagonistic, or synergistic)
- Effect on sensitive subpopulations (pregnant women, elderly, and children) unknown



Effects on aquatic organisms

. Anti-parasitics

- Reduced growth and reduced reproduction for aquatic invertebrates
- Dung beetle population died from exposure to ivermectin

Psychiatric drugs

- Exposure to psychiatric antidepressants drugs causes behavioural changes in fish, becoming more vulnerable to predators

Analgesics

- Exposure to ibuprofen and diclofenac causes reduced hatching success in fish
- Loss of vulture population species was reported in India due to exposure to diclofenac (Green et al., 2004)

Hormones

- Oral contraceptives causes feminisation of male fish and amphibians

Concluding note

- Paucity of data on pharmaceuticals residues in river water
 - At continental level (Africa)
 - At regional level(SADC)
- Prevalence of ARV, Analgesics and Antibiotics in African water bodies



Implications for water management and research

- More systematic and comprehensive water quality monitoring programs, especially for African countries where data is lacking
- The traditional fragmented approach to water management/governance and research is no longer viable, more integrated approach is essential
- Improving waste water treatment plants for effective removal of pharmaceuticals recommended

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Thank you all