Emerging Pollutants: Protecting Water Quality for the Health of People and the Environment

EXPOSURE ASSESSMENT OF EMERGING POLLUTANTS IN THE UMTHLATHUZE AND UTHUKELA RIVER SYSTEMS, KWAZULU NATAL, SOUTH AFRICA

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18 January 2023 / 12:45 CET, SA

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INTRODUCTION

Emerging Contaminants

Examples of Emerging pollutants (EPs)

- *They are known as newly identified or legacy chemicals whose effects are recently identified and their risk are poorly known.*
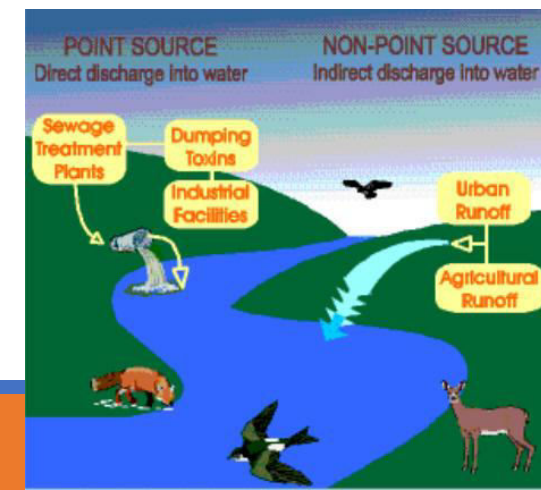
Pharmaceuticals Pesticides → Microplastics → Engineered nanomaterials (ENMs) → They persist and bioaccumulate

They reach aquatic environments through point and non point sources.

POINT SOURCE
Direct discharge into water

NON-POINT SOURCE
Indirect discharge into water

Sewage Treatment Plants
Dumping Toxins
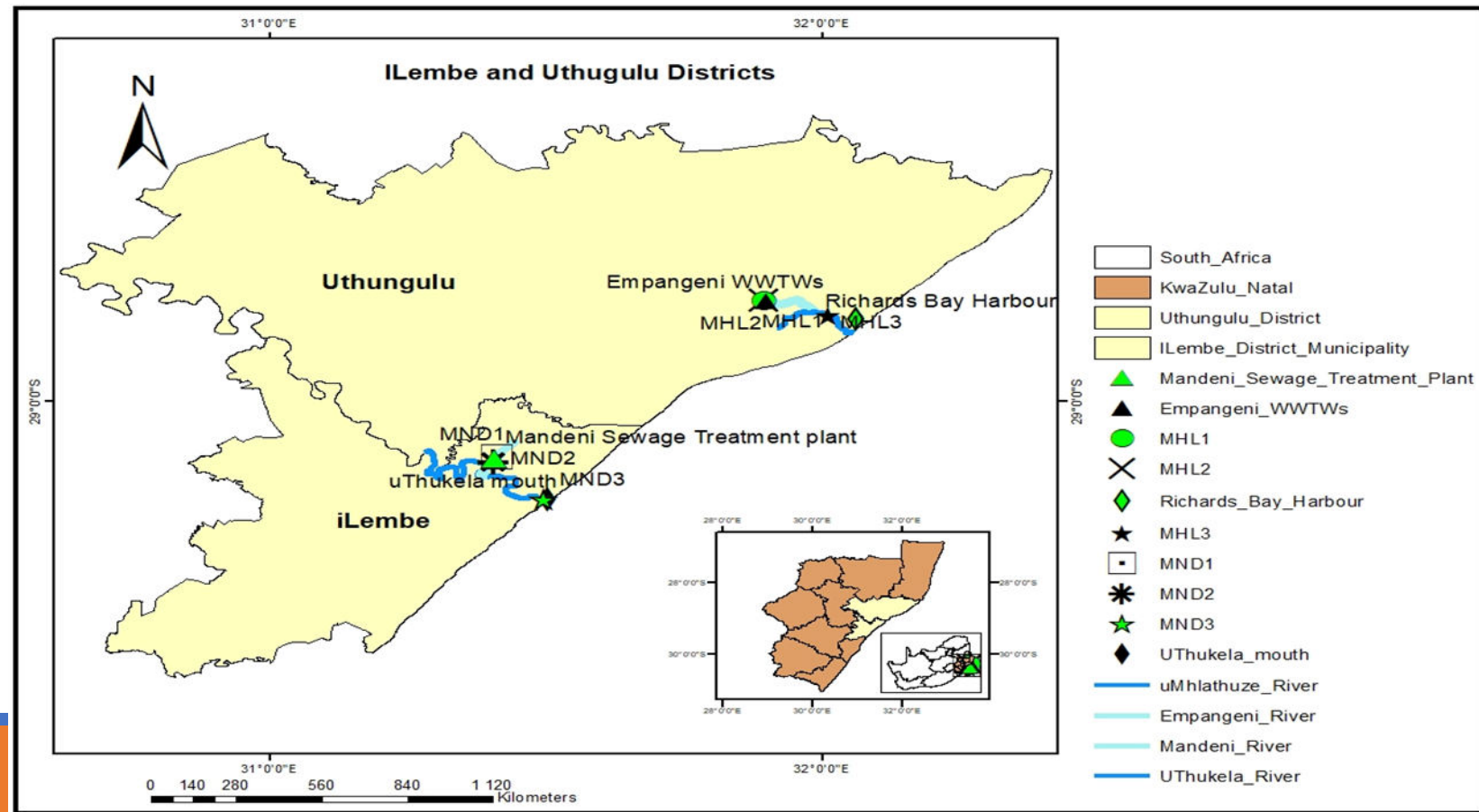Industrial Facilities
Urban Runoff
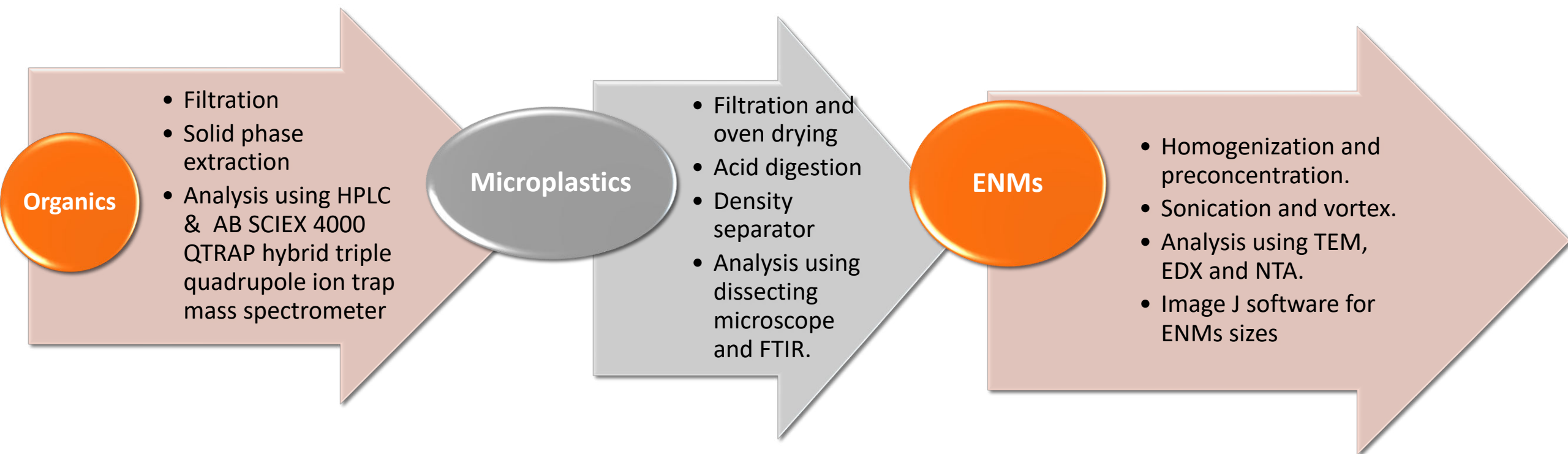Agricultural Runoff

NOVELTY AND AIM OF THE RESEARCH

➢Contamination profile of emerging pollutants have already been reported in surface water, drinking water, sediment and biota sampled in South African medias with varying concentrations.

➢Despite historical and recent knowledge of EPs, to date there is limited information about the occurrence of EPs in KZN, especially in non-urban catchments.

➢uMhlathuze and uThukela rivers flow through municipalities (uMhlathuze and iLembe District municipalities) that host significant economic hubs for the province as they support a variety of domestic, industrial and agricultural activities.

➢The aim of the current study was to investigate environmental exposure of various Eps' classes, namely, pharmaceuticals, lifestyle drugs, pesticides, microplastics and ENMs in surface water

STUDY AREA AND SAMPLE COLLECTION

➤ The selected study areas included the uMhlathuze and uThukela rivers, located in the KZN Province, spanning 4209 km^2 and 29 036 km^2, respectively.

➤ These are the largest rivers in the province, providing water for domestic, industrial, agricultural and recreation purposes.

➤ Surface water samples were collected seasonally during high flow (February and March) and low flow (July and October) between 2019 and 2021.

➤ Three sampling points were selected along the uMhlathuze (Mhl 1, Mhl 2 and Mhl 3) and uThukela (Mnd 1, Mnd 2 and Mnd 3) River systems.

SAMPLE PREPARATION AND ANALYSIS

Organics
- Filtration
- Solid phase extraction
- Analysis using HPLC & AB SCIEX 4000 QTRAP hybrid triple quadrupole ion trap mass spectrometer

Microplastics
- Filtration and oven drying
- Acid digestion
- Density separator
- Analysis using dissecting microscope and FTIR.

ENMs
- Homogenization and preconcentration.
- Sonication and vortex.
- Analysis using TEM, EDX and NTA.
- Image J software for ENMs sizes
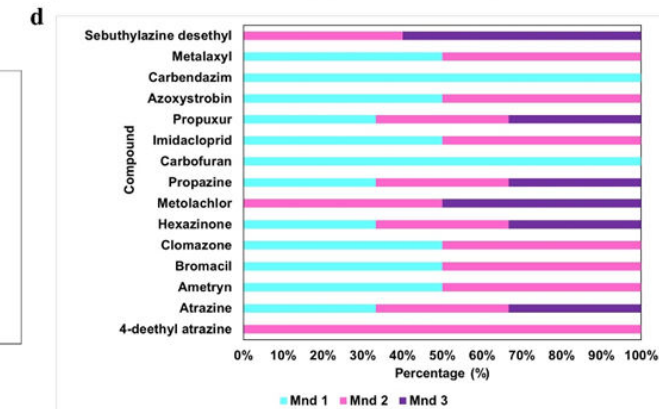
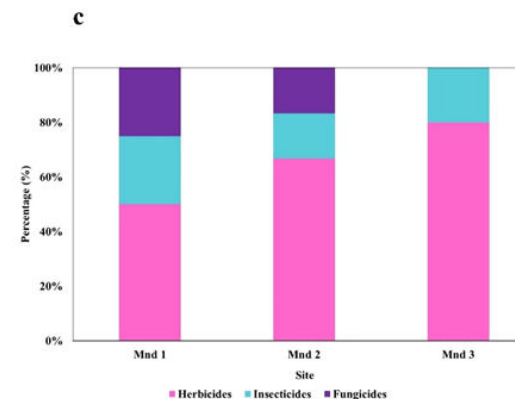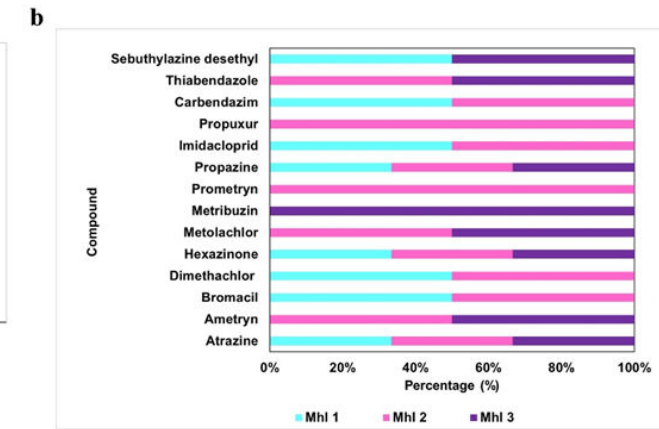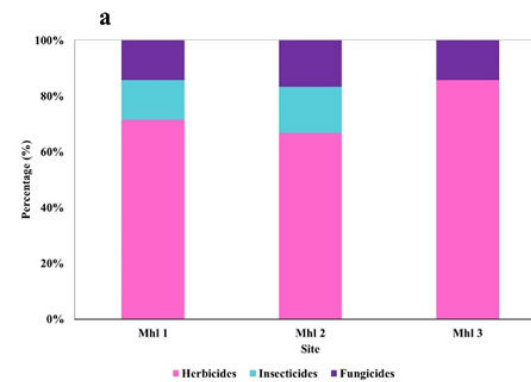# RESULTS AND DISCUSSION
Pharmaceuticals and lifestyle drugs

➢ 38 and 20 pharmaceuticals and lifestyle compounds belonging to 14 and 13 therapeutic classes were detected in the uMhlathuze and uThukela River, respectively

➢ In both systems the following discending order was observed: Mhl 2 > Mhl 1> Mhl, Mnd 2 > Mnd 1 = Mnd 3.

➢ At uMhlathuze River, fluconazole, sulphride, hydroxybupropion, nicotine, carbamazepine and bupropion TPs (threoaminobupropion, hydroxybupropion, and erythroaminobupropion) were present at all sites.

➢ At uThukela River, sulfamethazine, carbamazepine, and fluconazole were compounds that were detected at all sites.
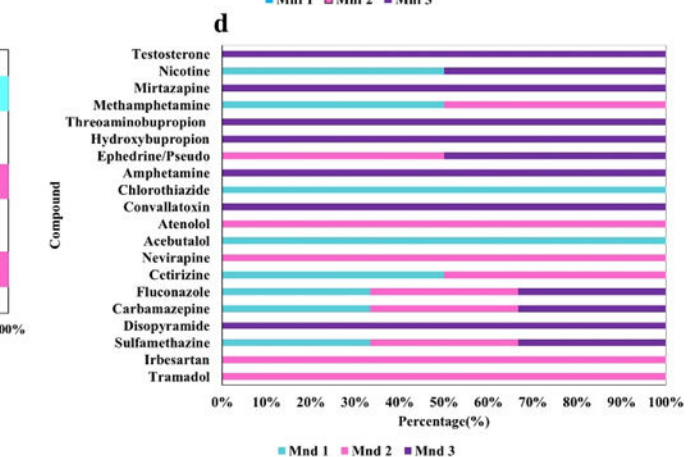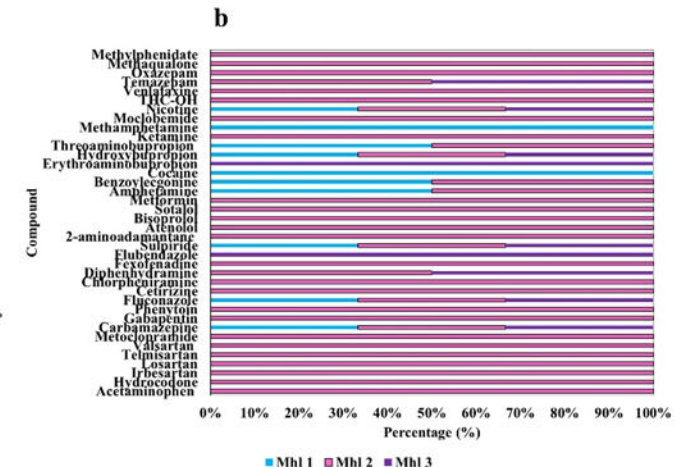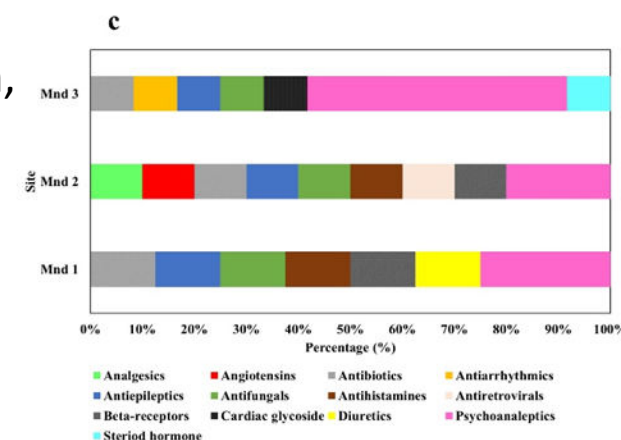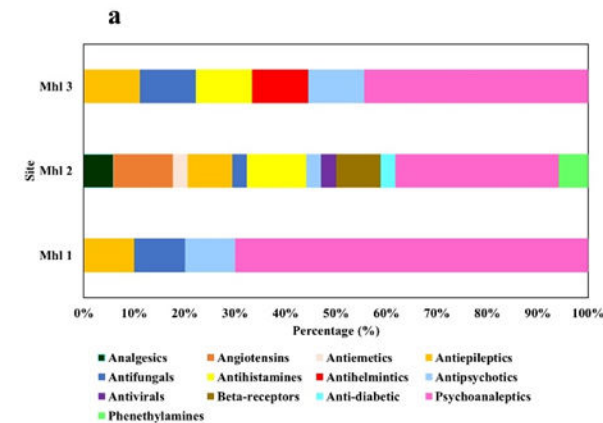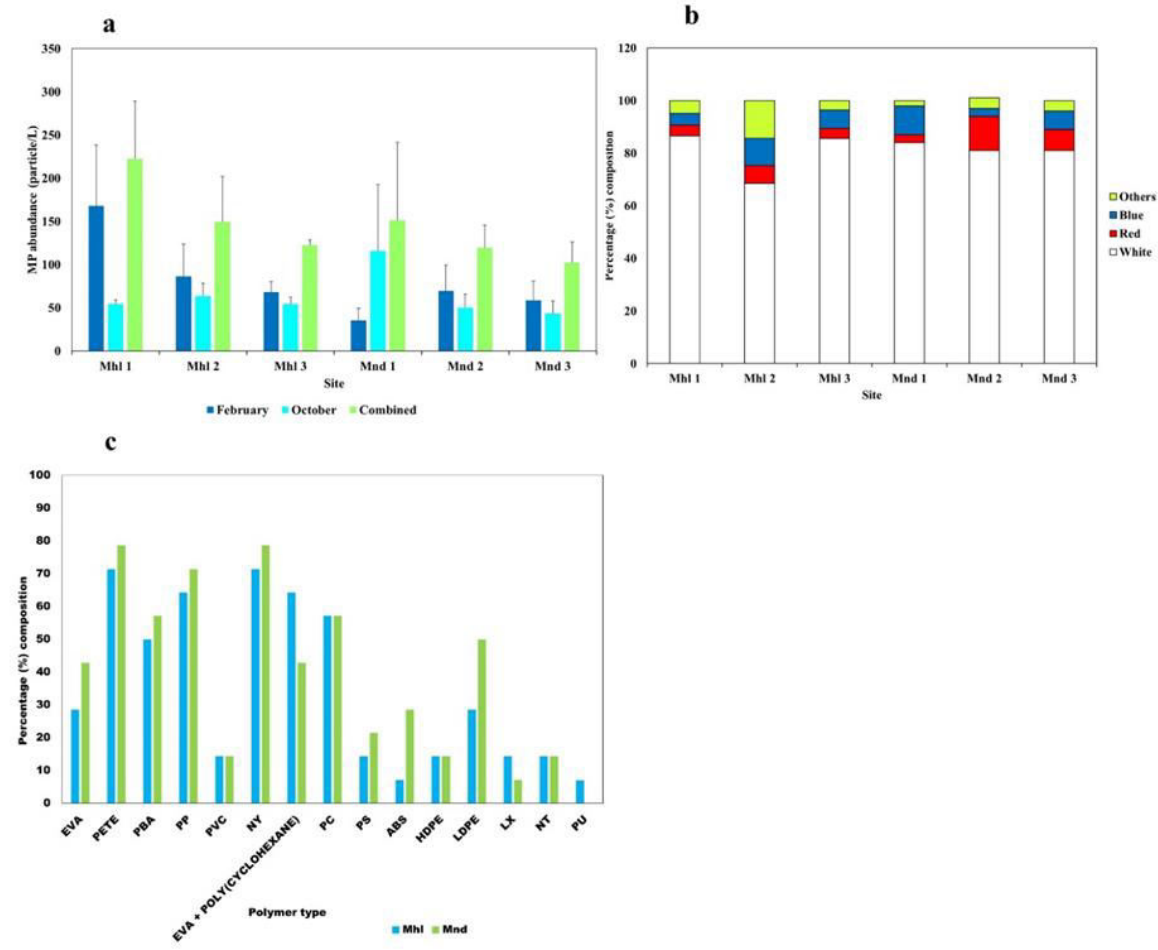
RESULTS AND DISCUSSION
Pesticides

➤13 and 14 compounds belonging to three (3) pesticide classes, namely, herbicide, fungicides, and insecticides, were detected in uMhlathuze and uThukela River, respectively.

➤Herbicides were the most prevalent compounds in the uMhlathuze River, as opposed to fungicides and insecticides.

➤The compounds, atrazine, hexazinone, terbuthylazine and propazine were detected in all samples from uMhlathuze River.

➤Pesticide compounds detected in uMhlathuze and uThukela River systems water samples were attributed to WWTP, run off from industrial and agricultural activities nearby study sites

RESULTS AND DISCUSSION
Microplastics

➤ The most common type of microplastic class detected were fibres at 97% and 99%, whilst the least were films at 3% and 1% for uMhlathuze and uThukela River systems, respectively

➤ Microplastics from uMhlathuze and uThukela River systems exhibited different colour profiles between respective river sites: Mhl 1: white > other > red and blue, Mhl 2: white > other > blue > red and Mhl 3: white > blue > red and other

➤ The colour profile in uThukela River was: Mnd 1: white > blue > red > other, Mnd 2: white > red > other > blue and Mnd 3: white > red > blue > other

➤ In both systems the microplastics types comprised of various polymers, including PP, PC, PS, NY, LDPE, HDPE, PETE, PVC, ABS, LX, NT, EVA, EVA + poly(cyclohexanone), PBA, and PE.

RESULTS AND DISCUSSION ENMs

➤ Metal-based ENMs (Zn, Si, Ti, Ca, and Fe) were detected in both river systems from all sampling events.

➤ The range for particle sizes deduced from the NTA and TEM-EDX analyses were 78.0–92.1 and 72.1–100.6 nm, as well as 106.6–117.6 and 103.3–106.9 nm for the uMhlathuze and uThukela River systems, respectively.

➤ From the uMhlathuze River, irregular, sheet-like, hexagonal and semi-spherical ENMs were observed, whereas ENMs in Mnd were predominantly hexagonal and near-spherical shaped.

➤ The findings confirmed that the nanopollution in the two river systems can be linked to anthropogenic activities

CONCLUSION

Environmental exposure by EPs was confirmed
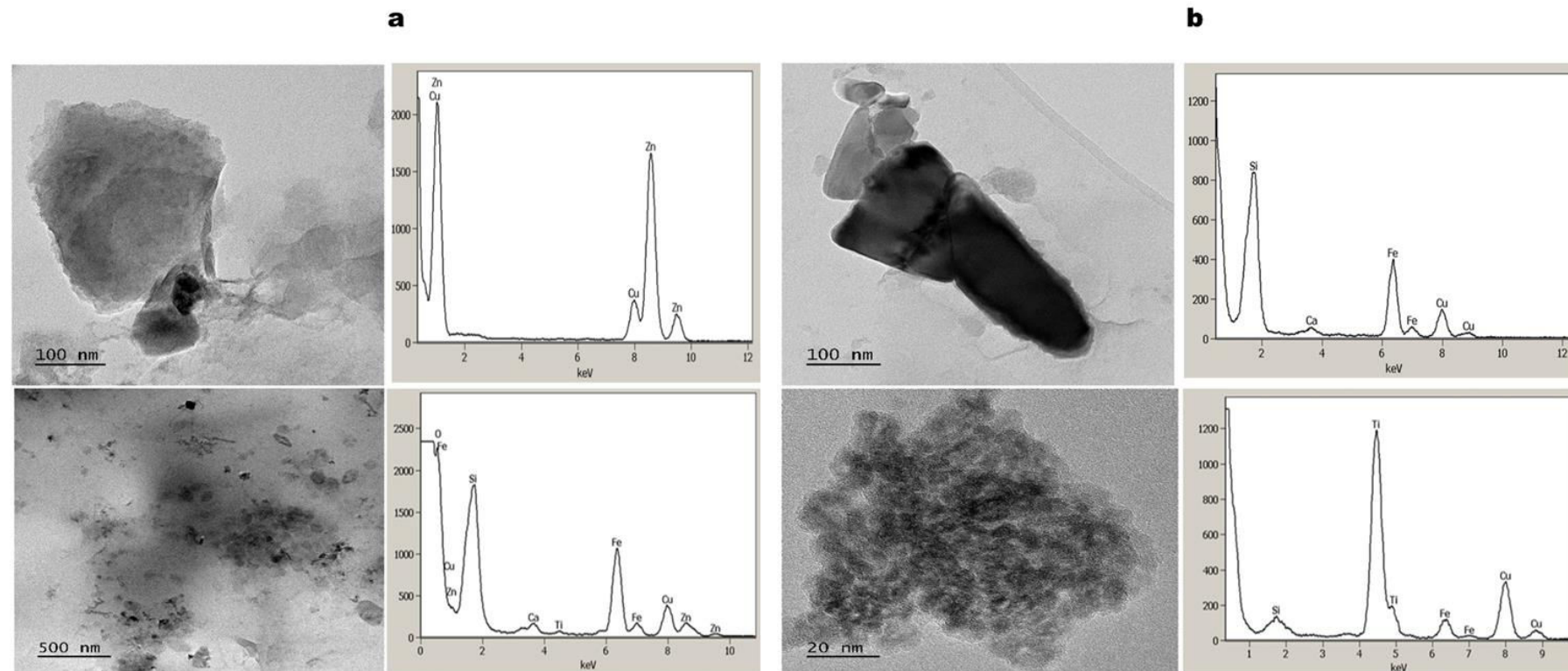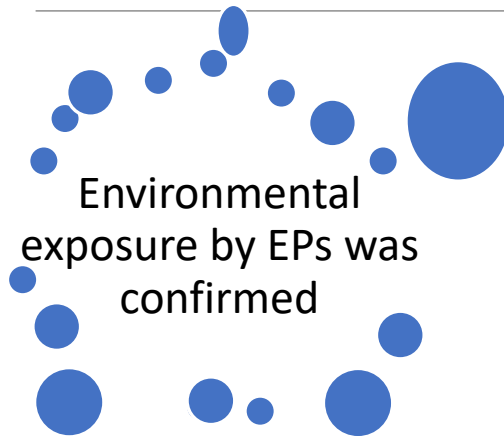
In both river systems, the highest detection frequency or abundance of contaminants were at sampling points that were immediately downstream of WWTPs effluent discharges (Mhl 2 and Mnd 2).

Presence results wasindicative of WWTPs' derived pollution input into rivers where some pollutants may not be adequately treated, and this was clear for EPs

This points out to the need for robust monitoring in order to establish strategies to mitigate pollution and protect water resources quality