Abstract Book

SETAC Africa 12th Biennial Meeting

SETAC 9th World Congress

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Sustainable Development in a Changing World: Integrating Environmental Science, Policy and Practice

Abstract Book

SETAC 9th World Congress/SETAC Africa 12th Biennial Meeting

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This book comprises the abstracts from the 9th World Congress/Africa 12th Biennial Meeting of the Society of Environmental Toxicology and Chemistry, conducted from 29 September–3 October 2025 in Johannesburg, South Africa.

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The specific purposes of the society are:

- Provide life-long learning and professional development opportunities for all career stages,
- Foster collaboration by increasing membership, engagement, diversity and partnerships,
- Provide world-class science communication forums for members and stakeholders,
- Develop leadership of SETAC and its members in the environmental science and environmental management community,
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SETAC publishes peer reviewed scientific research in its journals Environmental Toxicology and Chemistry (ET&C) and Integrated Environmental Assessment and Management (IEAM).

About the Abstract Book

The titles, authors and abstracts of the presentations given at the meeting are summarized in this book. Acknowledgments and disclosures are not included for space considerations, though we recommend that authors include them in the presentations themselves. Abstracts are not peer-reviewed and therefore should not be cited.

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1.01.A - Innovations in Aquatic Ecotoxicology: From Tradition to Future Thinking

1.01.A–T01 Integrated monitoring and toxicological assessment of PFAS in aquatic ecosystems: Human exposure risks in UK and Spanish populations and insights from cellular bioenergetic profiling

Eva Junque[1], Emilie Brun[1], Jonathan Barlow[2], Francesco Dondero[3], Heather Mercher[4], Mael Exner[1], Jon Barber[5], Arianna Bautista[6], Marta Llorca-Casamayor[6] and Iseult Lynch[1] (1)University of Birmingham, (2)Biocell Energetics, (3)University of Eastern Piedmont, (4)University of New Mexico Comprehensive Cancer Center, (5)CEFAS, (6)Institute of Environmental Assessment and Water Research - Spanish National Research Council (IDAEA-CSIC)

Per- and polyfluoroalkyl substances (PFAS) are persistent, bioaccumulative and potentially toxic contaminants increasingly detected in coastal and marine ecosystems. This study combines extensive monitoring of PFAS in aquatic environments and biota with mechanistic toxicity assessments to better understand environmental exposure pathways and human health risks. Comprehensive field campaigns were conducted between 2020 and 2024 across the United Kingdom (UK) and in 2024 in Spain, analysing PFAS concentrations in over 10,000 freshwater, groundwater and saline water samples, and 288 edible fish specimens from 16 species. Water samples were sourced from the UK Environment Agency's Monitoring Programme, while fish were selected to reflect local dietary habits. PFOS and PFOA emerged as dominant compounds, with regional variation: Spanish fish showed higher levels of long-chain and emerging PFAS (e.g., PFNA, 6:2 FTS), whereas UK fish had elevated PFOS. Average dietary intake in Spain exceeded EFSA's threshold by over fivefold, highlighting the urgency of mitigation in high-consumption regions. In the UK, freshwater hotspots for PFAS such as Moreton-in-Marsh underscored the need for targeted remediation. To complement field data, in vitro toxicological profiling was conducted using zebrafish embryo fibroblast (ZF4) cells exposed to 19 PFAS, assessed via Seahorse XF extracellular flux analysis and CCK-8 viability assays as a potential new approach methodology (NAM). Mid- and long-chain PFAS - particularly PFOA, PFDA, and Nafion BP1 - caused significant mitochondrial dysfunction and glycolytic shifts at concentrations as low as 250 - 600 µM. Effects were dose-dependent and followed known chain-length toxicity trends, confirming mechanistic links between PFAS structure and bioenergetic disruption. Work to integrate the findings into an Adverse Outcome Pathway for PFAS-induced mitochondrial disruption is underway. By integrating environmental monitoring with NAMs, this research provides a multidimensional evaluation of PFAS risks. These findings inform ecotoxicological models and regulatory strategies, while supporting the shift toward non-animal, mechanistic testing frameworks for complex contaminants.

1.01.A–T02 Multi-Generational Reproductive Effects of PFOS on *Daphnia pulex*

Ayesha Siddiqa[1] (1)WUR

Research has shown that PFOS induces zebrafish embryo and larval mortality, damages reproductive systems, causes abnormal hatching and development, and acts as an endocrine disruptor. At a lower trophic level, PFOS can cause water fleas, such as Daphnia pulex, to have a higher heart rate, reduced length, fewer offspring, worse reproductive quality, and suppressed growth. There is also evidence of PFOS having adverse transgenerational effects. A study found that PFOS had a transgenerational effect on the individual fitness and population growth of D. magna. However, studies on the reproductive transgenerational impact of PFOS on other water flea species are absent. This study aimed to use the laboratory exposure experiment for three generations of D. pulex to answer the research question: What are the effects of PFOS on the reproduction of D. pulex in a multigenerational test, including the neonate quantity and quality? The experiments performed with D. pulex lasted three generations, following the OECD guideline 211 for each generation. Two main multi-generation reproductive experiments were conducted: a chronic exposure and a recovery test. In the chronic exposure multi-generation test, the individuals of D. pulex were continuously exposed to PFOS across generations, while in the recovery test, only the first generation was exposed, moving future generations to clean environments. The chronic exposure multi-generation test results allowed us to understand the possible changes in effects across generations in a scenario of constant exposure. The multi-generation recovery test results were important for understanding the extent to which the impact of PFOS carries over across generations even after exposure has ceased. The cumulative sum of neonates across PFOS treatments, and all three generations, reacted very differently to the PFOS treatments. These dissimilarities show that the PFOS treatments had a transgenerational effect. In F0, the lower PFOS concentrations resulted in a higher number of neonates, while the numbers in the higher concentrations were similar to those in the controls. In F1, there is a significant increase in neonate production in high concentrations of PFOS ($p < 0.05$). In F2, the daphnids produced fewer neonates, falling back to similar numbers as F0. Our results are identical to the multigenerational PFOS exposure experiment performed with D. magna, which also found that the number of neonates increased in F1 but decreased in F2 to the F0 level in the higher treatments, meaning that D. Pulex may have the same response to the PFOS exposure as D. magna. Only in F1, the neonate number of the highest treatment and

recovery group was significantly higher than the control ($p < 0.01$), similar to the chronic exposure experiment results. However, F2 individuals had significantly prolonged brood production times in the highest treatment and recovery group compared to the control ($p < 0.01$). This finding is in concordance with the results of a study on the midge Chironomus riparius, where later generations also had increasing development times. Collectively, the PFOS exposure has significant transgenerational reproductive effects on D. pulex, including increasing the neonate numbers in the F1 and decreasing them in the F2 of Chronic Exposure,e as well as prolonging brood production time in the F2 of the recovery test, which is similar to the findings in the D. magna and midge Chironomus riparius. With these results of neonate quantity, their quality remains to be determined.

1.01.A–T03 The Effects of Single Antibiotics and Their Mixtures on Freshwater Ecosystems

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Although antibiotics frequently co-occur in aquatic environments, their combined ecological effects remain insufficiently understood under realistic mixture scenarios. To address this gap, we established 36 replicated freshwater microcosms and exposed them to sulfamethazine (SMT; 0.1, 1.0, 10 μg/L) and tetracycline (TC; 1.5, 15, 150 μg/L), both individually and in combination, over a 28-day period. SMT exhibited a half-life of 3.5 to 6.8 days, while TC degraded more rapidly (10 h to 3.2 days). While both antibiotics reduced green algal abundance at intermediate and high concentrations when applied individually, their combined exposure did not result in a consistent inhibitory effect, indicating a possible alteration in ecological response under mixture conditions. Zooplankton community structure was significantly affected by both individual and combined antibiotic treatments, with several species exhibiting increased abundance under specific exposure conditions. These responses underscore the need to account for species- and compound-specific hormesis thresholds. Notably, combined exposure induced both stimulatory and lethal effects at lower concentrations than individual compounds, suggesting enhanced toxicity driven by additive or synergistic interactions. Microbial community responses were compartment-specific under single-compound exposure: structural changes in the water column emerged from day 3, while sediment-associated shifts were primarily detected on day 14. However, no significant structural changes were observed in water-column microbial communities under combined exposure, suggesting potential antagonistic interactions between SMT and TC, possibly related to nonoptimal regulation of bacterial processes. Functionally, leaf litter decomposition was also accelerated across multiple treatments, indicating enhanced microbial activity and potential functional stimulation. These findings highlight the potential for non-linear and interactive effects of antibiotic mixtures on both community structure and ecosystem function, underscoring their importance in environmental risk assessments.

1.01.A–T04 Transcriptomic Response of Zebrafish (Danio rerio) and Eastern Oysters (Crassostrea virginica) following exposure to the short chain PFAS, Perfluorohexanoic Acid (PFHxA)

Jessica Donaldson[1], John Bowden[1], Christopher Martyniuk[1], Francisco Paneque[1], Amany Sultan[1] and Joseph Bisesi[1] (1)University of Florida

Per- and polyfluoroalkyl substances (PFAS) have raised significant concern due to their environmental persistence, widespread contamination, and extensive use in consumer products. While their chemical properties are useful for consumer and industrial goods, they also have been linked to potential deleterious environmental and human health effects following exposure. Research has largely focused on the “legacy”, long-chain PFAS. However, in recent years, these legacy PFAS have been phased out in many countries, ultimately leading to short-chain PFAS becoming prevalent in manufacturing and the environment. To address this knowledge gap for less studied PFAS, molecular tools are vital in identifying novel toxicity pathways and reducing reliance on animal testing. Thus, the overall goal of the current research is to evaluate the transcriptomic effects of PFHxA on zebrafish and eastern oysters. Zebrafish were exposed to 100 ng/g of PFHxA via a dietary exposure, and oysters were exposed to 200 ng/l, and 2000 ng/L of PFHxA via waterborne exposure. At the conclusion of the exposure, fish were euthanized, weighed, and measured and oysters were measured, shucked, and weighed. Sex was determined for zebrafish to evaluate sex-specific transcriptomic responses; however, as oysters are not sexually dimorphic, the sex of the oysters is unknown, and thus, they will not be separated based on sex. Zebrafish liver and oyster hepatopancreas were collected for mRNA extraction and RNA-seq library preparation. Gene set enrichment analysis was conducted using iPathways. The exposure is still underway for the oysters with sequencing results awaiting to be collected and analyzed. However, we anticipate that there will be evident differences in gene expression between control and exposed oysters. While the exact differences are unknown, the overall goal of the current study is to generate hypotheses on the specific effects of PFHxA in a bivalve. In zebrafish, lipid metabolism was identified as a potential target of PFHxA exposure in both sexes. In males, the PPAR signaling pathway was specifically impacted, suggesting that PFHxA may exert toxic effects through PPAR-mediated regulation of lipid metabolism. While the PPAR signaling pathway was not impacted in females, genes regulated by

PPARα and PPARγ were differentially expressed suggesting that PFHxA may still exert toxic effects via the PPAR signaling pathway in both females and males. Both studies are the first to evaluate sub-chronic dietary and waterborne exposure to PFHxA and its effects on the zebrafish and oyster transcriptome, respectively.

1.01.A–T05 A Web-Based Histology Atlas for the Freshwater Sentinel Species Daphnia magna

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Daphnia are keystone species of freshwater habitats used as model organisms in ecology and evolutionary biology. Their small size, wide geographic distribution, and sensitivity to chemicals make them useful as environmental sentinels in regulatory toxicology and chemical risk assessment. Biomolecular (-omic) assessments of responses to chemical toxicity, which reveal detailed molecular signatures, become more powerful when correlated with other phenotypic outcomes (such as behavioral, physiological, or histopathological) for comparative validation and regulatory relevance. However, the lack of histopathology or tissue phenotype characterization of this species presently limits our ability to assess cellular mechanisms of toxicity. Here, we address the central concept that interpreting aberrant tissue phenotypes requires a basic understanding of species' normal microanatomy. We introduce the female and male Daphnia Histology Reference Atlas (DaHRA) to establish the baseline knowledge of Daphnia magna microanatomy. We also include the developmental stages of female D. magna in the atlas. This interactive web-based resource of adult D. magna features overlaid vectorized demarcation of anatomical structures whose labels comply with an anatomical ontology created for this atlas. We demonstrate the potential utility of DaHRA for toxicological investigations by presenting aberrant phenotypes of acetaminophen-exposed D. magna. We envision DaHRA facilitating the future integration of molecular and phenotypic data from the scientific community as we seek to understand how genes, chemicals, and environment interactions determine organismal phenotype.

1.01.B - Innovations in Aquatic Ecotoxicology: From Tradition to Future Thinking

1.01.B–T01 Distinct Toxicological Profiles of Pesticide Metabolites Compared to Parent Compounds: Evidence from a Zebrafish Model

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South Africa's extensive pesticide use presents significant health risks via direct exposure and environmental residues in food and water. Limited data on human metabolism and toxicity of pesticide metabolites hinder accurate risk assessments. This study investigated the toxicity of glyphosate, imidacloprid, chlorpyrifos, mancozeb, and their metabolites using a larval zebrafish model, aiming to provide insights into the potential human health risks associated with low-level pesticide exposure. A physiologically relevant dose range for the pesticides was determined by translating internationally acknowledged human acceptable operator exposure levels to zebrafish relevant doses and estimating metabolite doses to account for unknown pesticide metabolism. Zebrafish larvae at 94 hours post-fertilization (hpf) were exposed to pesticides or their metabolites for 24 hrs to assess acute toxicity.. A 5-day exposure protocol was also used to evaluate neurobehavioral effects via larval locomotion using the light-dark transition test (LDTT), with activity tracked via automated systems (Daniovision and Ethovision, Noldus). Metabolites frequently exhibited greater toxicity than parent compounds. Desnitro-imidacloprid and 6-chloronicotinic acid, both imidacloprid metabolites, were more toxic than the parent compound at slightly elevated doses, inducing reduced locomotion, developmental delays, and severe malformations. Chlorpyrifos oxon caused 100% mortality at all tested levels, while chlorpyrifos oxon and chlorpyrifos-methyl caused significant motor deficits and developmental deformities. Glyphosate showed low acute toxicity, but its metabolite methylphosphonic acid induced developmental defects and yolk sac edema, while increased basal activity suggested neurotoxic stress. Mancozeb resulted in complete mortality and severe malformations, with its metabolite ethylenethiourea also reducing locomotion and inducing deformities. These findings reveal significant toxic effects of both pesticides and their metabolites at or near accepted exposure levels. Including metabolites in toxicity assessments is crucial for accurate evaluation of potential human health risks more accurately reflect potential health risks.

1.01.B–T02 Hydroethanolic extract of Bhoophone Disticha affect behavior and monoamine metabolites expression in a sex specific manner in Zebrafish

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Depression is one of the leading causes of morbidity and mortality worldwide. It occurs as a result of a multitude of different factors including environmental and genetic factors amongst others. Diagnosis is based on symptomatic behavioral criteria like depressed mood and suicidal thoughts. Multiple different biological mechanisms may underlie its etiology. It is estimated that 40% risk of developing depression is genetic, the other 60% non-genetic risk remains poorly defined, with diverse theories like childhood trauma. Prescribed antidepressant drugs include selective serotonin reuptake inhibitors (SSRIs). However, these drugs have undesirable side effects. For example, acute administration of SSRIs such as fluoxetine increase symptoms of anxiety for some individuals. This increase in anxiety is related to increased serotonergic function of SSRIs, which is believed to provoke an anxiogenic effect in animal models. The above factors have led to an investigation into natural products such as Boophone disticha (BD). BD is widely used by traditional healers in SA to treat depression probably due to its high affinity for the serotonin transporter. The aim of the current study is to use the zebrafish animal model to assess the effects of BD on behavior and brain monoamine metabolites. Thirty two zebrafish were exposed the 100mg/L of BD for 2 hours followed by a 30 minutes behavioral test captured by a video cameral linked to Ethovision software in zMVCSF. Brains were remove for liquid chromatography analyses of monoamine metabolites expression. Behavioral tests showed reduced locomotion in treated animals. Sex specific effects in changes of the monoamine metabolites were observed, probably explaining the sex specific response to antidepressant drugs.

1.01.B–T03 Pharmaceutical metabolite toxicity risk demonstrated in larval zebrafish: a proteomics approach with a twist

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The selective serotonin reuptake inhibitor (SSRI) sertraline (SER) is indicated for depression and is often used during pregnancy. However, existing literature suggests a potential link between gestational SER use and (cardiovascular and neurodevelopmental) pathology in exposed offspring. We thus aimed to evaluate the developmental toxicity risk of SER and its metabolite desmethylsertraline (DES), on the proteome during early development. Cord-blood concentrations of SER and DES were obtained from a previous study in humans. Zebrafish equivalent concentrations for umbilical cord-blood concentrations of SER or DES were calculated and administered to zebrafish embryos and larvae via immersion during early developmental stages (<5dpf). Quantified activity tracking and protein expression levels of serotonin transporter (SERT) confirmed that the human equivalent doses indeed resulted in a significant SSRI effect in exposed larvae, validating the physiological relevance of the study. A proteomic analysis was then conducted on pooled whole larval samples, using a label-free quantitative liquid chromatography-mass spectrometry approach. Protein identification was performed using both zebrafish and human protein databases. Activity tracking confirmed a relative hypolocomotive state, which is widely reported after zebrafish larvae exposed to various SSRIs. A reduced SERT protein expression in both larvae exposed SER and DES, confirmed that a relative anti-depressive therapeutic level was achieved in the zebrafish. Data from the proteomic analysis indicated no apparent developmental risk for SER. However, DES exposure resulted in several differentially regulated proteins, identified in both the zebrafish and human databases. Results from the two databases correlated and aligned with an increased risk for cardiovascular and neurodevelopmental dysregulation. Proteomic data suggest that DES, rather than SER, at physiologically relevant doses, may be responsible for adverse clinical outcomes reported after gestational SSRI use. Current data positions larval zebrafish as accurate tool for assessment of long-term risk after gestational SER use, as well as medicines development tool in this context. Furthermore, the added insights from zebrafish protein identification using a human protein database, warrants further exploration.

1.01.B–T04 Integrated In Vivo and In Silico Assessment of Chronic and Developmental Toxicity of Isoxaflutole and Cyprosulfamide Mixtures in Zebrafish

John Giesy[1] and Oluwabunmi Femi-Oloye[2] (1)University of Saskatchewan, (2)University of Pittsburgh @ Bradford

The widespread use of herbicides to enhance crop productivity raises growing concerns about their unintended effects on aquatic ecosystems, especially when combined with formulation additives like safeners. Cyprosulfamide (CPS), commonly used as an herbicide safener, is designed to protect crops from herbicide damage, but its environmental safety profile remains

underexplored. This study investigates the chronic and developmental effects of isoxaflutole (ISO), a widely used herbicide, and CPS, individually and in combination, on early life stages of zebrafish (Danio rerio) using a multi-endpoint testing framework. Following OECD guidelines, embryo and larval toxicity tests were conducted, assessing survival, hatching, growth, morphological abnormalities, heart rate, oxidative stress biomarkers (SOD and GST), and molecular interactions with the hatching enzyme receptor ZHE1 (PDB: 3lqb). Neither compound alone at ≤3 mg/L significantly affected hatching or cardiac function. However, ISO at ≥1.5 mg/L and CPS at 20 mg/L induced significant mortality and developmental abnormalities such as spinal deformities, pericardial edema, and craniofacial defects. ISO was more toxic (LC_{50} = 7 mg/L) than CPS (LC_{50} = 136 mg/L). Notably, the ISO+CPS mixture reduced ISO-induced mortality, suggesting an infra-additive (antagonistic) interaction—possibly due to CPS-induced detoxification mechanisms. Biochemical assays showed ISO alone altered SOD activity, while the mixture affected both SOD and GST, pointing to a unique mode of action. Molecular docking revealed both ISO and CPS bind the ZHE1 receptor with comparable affinities, though CPS interacted with additional key residues (Arg182, Tyr155), hinting at broader functional implications. These findings emphasize the ecological relevance of assessing formulated pesticide mixtures rather than active ingredients in isolation. The integration of zebrafish bioassays with molecular docking offers a powerful approach to understand potential developmental and mechanistic toxicity in aquatic organisms.

1.01.B–T05 High-Content Modeling of Human Tissues and Diseases in vitro

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Microphysiological systems are microfluidic three-dimensional miniature human tissue and organ models that accurately replicate the key biological and physiological parameters of their in vivo counterparts. These biomimetic microtissues are expected to augment conventional planar, static cell cultures, and bridge the gaps between existing pre-clinical animal models and the human body. Furthermore, multiple microtissues can be interconnected through microfluidics in a manner similar to their arrangement in vivo, thereby enabling the analysis of interactions among these models. In this presentation, I will discuss our recent progress in developing various human-based tissue mimics by integrating biofabrication technologies, sophisticated microfluidics, and volumetric tissue configurations. These platforms are likely to offer new opportunities for constructing functional tissue and disease models in drug discovery, therapeutic screening, and precision medicine.

1.01.P - Innovations in Aquatic Ecotoxicology: From Tradition to Future Thinking

1.01.P–TuWe01 Progress, Challenges, and Future Perspectives Poly and Perfluoroalkyl Substances (PFAS) in the African Environments

Tlou Chokwe[1], Linda Sibali[2], Sihle Mngadi[3], Precious Mahlambi[4] and Nomathemba Themba[2] (1)Capricorn District Municipality, (2)University of South Africa, (3)uMgeni-uThukela Water, (4)University of KwaZulu Natal

Per- or polyfluoroalkyl substances (PFAS) are a group of anthropogenic compounds that have been widely used in various industrial processes and consumer products while their ubiquitous presence in the environment has recently gained relevant attention. This study highlighted progress and milestones on PFAS contamination within multiple environments of African continent. The identification and quantitation of PFAS within African environments is important to the public at large because of lack of information. Two most studied classes of PFAS are perfluoro carboxylic acid (PFCA) (i.e., perfluorooctanoic acid (PFOA)) and perfluoro sulfonic acid (PFSA) (i.e., perfluoro sulfonic acid (PFOS)) while many more classes of PFAS created by industry are either not studied or not known or both. The presence of PFAS in water, sediments, soils, fish, dust, breastmilk, infant formulae, dust, atmosphere, and wildlife have been reported within the African continent. Southern Africa contributed more studies on the presence of PFAS in the environment with Central Africa contributing the least. Despite growing awareness of PFAS contamination in Africa, the number of studies, studied compounds, and concentration levels vary significantly across regions and matrices. While some countries in Southern and Western Africa have made progress in PFAS research, the overall disparity in research output highlights the urgency for increased attention, resources, and concerted efforts to comprehensively address PFAS contamination in African environments. This study also revealed PFAS contamination within freshwater environments, with non-existent data from marine environments. With the availability of more PFAS analytical standards, it is recommended to include a broader range of PFAS suites or classes in analytical analyses. Additionally, the use of emerging methods like extractable organic fluorine (EOF) and adsorbable organic fluorine (AOF) are recommended to be incorporated in analytical methods as screening total fluorine content, especially in developing countries. Further studies are warranted to understand the fate of PFAS in the environment and biota, as well as the adverse effects of

newly emerging PFAS in wildlife and humans. Collaboration among scientists, policymakers, also local and international communities is essential to mitigate the impact of PFAS in the African environment.

1.01.P–TuWe02 PFAS Contamination and Its Rising Toll on Food Security: A Hidden Global Threat

Veronica Ngole-Jeme[1] (1)University of South Africa

Perfluoroalkyl substances (PFAS), widely used in consumer products and various industries, have raised concerns due to their persistence, bioaccumulation, toxicity, and widespread environmental presence. Their contamination through soil and groundwater presents remediation challenges, particularly as industrial and agricultural growth has led to increased PFAS use in mass food production and preservation to meet rising food demand. Without proper monitoring and regulation of food production, PFAS contamination threatens food security, undermining Sustainable Development Goal 2 (SDG 2). Despite growing research on PFAS, comprehensive reviews on their implications for food security, such as reduced crop yields, livestock safety, and disruptions to fisheries and aquaculture, are scarce. This study reviewed the impacts of PFAS pollution on food quality and safety, explored potential health risks from chronic dietary exposure, and discussed mitigation strategies and alternative packaging approaches to safeguarding ecosystems. By integrating existing data and identifying research gaps, this study highlights the urgent need for sustainable solutions to protect food systems and ensure global food security. It also emphasizes revising global policies to reduce PFAS contamination in food production. Future research should focus on the regulatory and policy frameworks to mitigate PFAS pollution and enhance food security.

1.01.P–TuWe03 Passive remediation of acidic and metalliferous mine drainage using an engineered treatment wetland system (ETWS): An effective and sustainable approach for acid mine drainage (AMD) management

Abayneh Ambushe[1] and Beauclair Nguegang[1] (1)University of Johannesburg

Acid mine drainage is caused by natural oxidation of metal sulfides to metal sulfates leading to very acidic product water rich in soluble potentially toxic elements (PTEs), mainly aluminum, copper, iron, lead and zinc. To reduce PTEs present in AMD to the levels below maximum permissible levels (MPLs) for environmental discharge, the efficacy of an engineered treatment wetland system (ETWS) was duly explored for the treatment of real mine water. Precisely, the treatment chain was made up of free water surface wetland enriched with magnesite (MgCO3) without macrophyte (stage 1) and hydroponic floating wetland planted with vetiver grass (VG) (stage 2) both operating in step-wise connection at the same flow rate and hydraulic retention time of 1.61 litres/day and 40 days, respectively. The findings revealed an increase of pH from 2.8 to 11.6 and significant attenuation of inorganic contaminants in the following order: Cu and Ni (100% each) > Fe (99.98%) > Mn (99.79%) > Zn (99.23%) > Al (99.14%) > SO42─ (93.26%) and notable reduction of electrical conductivity (81%). Explicitly, the stage 1 played a vital role in pollutants removal while the stage 2 further polished the water to the desired standard proving the synergy of neutralisation without energy input and phytoremediation could yield the desired results in AMD management. From the findings, the proposed hybrid approach allowed to obtain a product water that can be discharged without any risk of causing ecological toxicology of receiving environment. Characterisation techniques, which include Brunauer-Emmett-Teller (BET), Fourier-transform infrared (FTIR) spectroscopy, powder X-ray diffraction (p-XRD) and scanning electron microscopy–energy dispersive X-ray spectroscopy (SEM-EDS), were used to underpin the fate of inorganic contaminants in MgCO3 and VG.

1.01.P–TuWe04 The Potential Effects of Coal-Fired Power Plant Closure Using a Bayesian Network Method

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South Africa currently faces chronic electricity shortages due to ageing and failing infrastructure in some of its old and inefficient coal-fired power plants (CFPPs) such as Camden and Kriel power stations selected for the study. To avert its immediate pollution challenges due to the old infrastructure, the national power utility is planning the closure of its CFPPs by 2030 to meet the minimum emission standards (MES). This paper evaluates the relative risks of multiple anthropogenic stressors emanating from the coal-fired power plants in the neighbouring community using the Bayesian Network – Relative Risk Method (BN-RRM) framework. The study results showed an effectively implemented emission reduction plan (ERP) after the closure of the CFPPs could reduce the PM10. Both the particulate matter with a diameter of 10 microns or less (PM10) and the particulate matter with a diameter of 2.5 microns or less (PM2.5) levels are more likely to have an adverse and

chronic impact on human health and the environment in the Mpumalanga Province of South Africa if left unmitigated, as shown in the current scenario for the air quality assessment endpoint. The biodiversity and recreational use assessment endpoints will improve, with little residual risk from the hazardous storage areas and the sewage treatment plants that may continue to leak and discharge nutrients, salts and toxicants post-closure of the CFPPs. However, the water pollution reduction plan (WPRP) coupled with other excellent water pollution management interventions, such as zero liquid effluent discharge (ZLED, that exist in the national power utility, should be effectively implemented for the salinity and acidity in the surrounding catchments to be kept under control. The current scenario indicated that the resource quality objectives (RQOs) at the three CFPPs are not being met for water quality variables. Therefore, the pollution reduction plan of the water quality parameters and toxicity is recommended to be effectively implemented to meet the set RQO targets for the two catchments. In addition, further studies involving an analysis of detailed metal concentrations and speciation in the water quality of riverine systems neighbouring the CFPPs could assist in understanding the level of eco-toxicological risk inherent in the study area.

1.01.P–TuWe05 Ephemeral Lives and Toxic Legacies: Contaminant-Driven Reproductive Disruption in Rapid-Maturing Killifish?

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Freshwater killifish of the genus Nothobranchius, specifically N. furzeri and N. orthonotus, inhabit ephemeral pans in semi-arid regions and exhibit rapid life cycles of less than four weeks to ensure reproduction before habitat desiccation These fish spend most of the year as dormant embryos buried in sediment, hatching only when rains refill the pans. Upon hatching, they grow fast and reproduce before the pans dry out, exemplifying life history evolution under extreme constraints. Understanding how environmental stressors affect the reproduction of the species is crucial when assessing biodiversity impacts in these vulnerable ecosystems. This study aimed to investigate the potential influence of environmental stressors on reproductive health in Nothobranchius species from the Karingani Game Reserve, located within the Great Limpopo Transfrontier Conservation Area in southern Mozambique. Specimens of N. furzeri (n=19) and N. orthonotus (n=40) were collected using sweep and seine nets. Gonadal and muscle tissues were sampled for histological examination and contaminant analysis. Concurrently, water and sediment samples were collected in triplicate at all sites. Gonadal development stages were assessed through standard histological techniques, while concentrations of metals and pesticides were quantified in water, sediment and killifish using Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Atomic Absorption Spectroscopy (AAS), and gas chromatography coupled to a micro electron capture detector (GC-ECD) respectively. Findings suggest variability in gonadal maturation stages between species, with N. furzeri generally maturing earlier than N. orthonotus. Despite the protected status of the reserve, detectable levels of legacy pesticides (DDTs) and known toxic metals (Al, As, Cu, Hg, Mn, Pb) were present in environmental and biological samples. These contaminants are known to influence reproductive processes, potentially causing delays or disruptions in gonadal development. The data suggest that these contaminants, even at low levels, may act as a chronic stressor to these fast-living fish populations. This work underscores the importance of incorporating contaminant monitoring into biodiversity conservation strategies, particularly in protected areas where pollution impacts are often underestimated.

1.01.P–TuWe06 Investigating the Sublethal Toxicity of Imidacloprid in Daphnia magna using the Adverse Outcome Pathway Framework

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Daphnia magna is used as an aquatic macroinvertebrate model species for laboratory toxicity testing for hazard identification and risk assessment of chemicals. However, these tests focus on lethality or immobility as endpoints. Acute lethal toxicity of pesticides is of concern, sublethal effects and exposure over a longer period are important for assessing the survival of invertebrate populations in the environment. Exposure to lower concentrations for prolonged periods may cause the same adverse effects as short-term exposure to high concentrations. To understand the broader implications of imidacloprid exposure, this study applied an Adverse Outcome Pathway (AOP) framework to identify and link key sublethal effects at multiple levels of biological organization in D. magna. Sublethal concentrations of imidacloprid were used to assess changes in metabolomics, respiration, heart rate, swimming behaviour, growth, and reproduction over a 21-day chronic exposure. The results indicate that imidacloprid exposure alters amino acid, carbohydrate, and lipid metabolism. These molecular changes were followed by a cascade of physiological impairments, including reduced heart rate, decreased oxygen consumption, and lowered swimming activity. Continued exposure results in reduced growth, leading to impaired reproduction and eventual mortality. It is proposed that these outcomes are linked by an initial unknown molecular initiating event and an unknown key

event linking lowered swimming activity with reduced growth and reproduction, warranting further investigation. This study highlights the limitations of focusing only on mortality, since it has been reported in several studies that D. magna is not sensitive to imidacloprid. It is therefore important to integrate molecular and physiological data for a more comprehensive risk assessment. The proposed AOP for imidacloprid exposure in D. magna provides mechanistic insight into how sublethal effects progress to population-level consequences.

1.01.P–TuWe07 A Multitrophic Approach to Water Quality Assessment in Gauteng Impoundments

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Water is vital for all forms of life, and understanding water quality through the lens of trophic interactions is vital, as contaminants can affect organisms differently depending on their position in the food web. South Africa's freshwater resources are under pressure due to low rainfall and widespread pollution from human activities such as industrial and agricultural activities, and wastewater discharge. The construction of dams helps manage these limited resources by supporting flood control, water supply, irrigation, and energy needs. Monitoring dam water quality is therefore essential to protect both ecosystems and the communities that rely on them. Water samples were collected from the three dams, and physical parameters such as pH, temperature, oxygen, and electrical conductivity were determined and all of which were within the Target Water Quality Range of the Water Quality Guidelines. Chemical analysis revealed no chemicals of concern. This study presents a multispecies, cross-trophic approach to assessing water quality in selected Gauteng impoundments. By incorporating organisms from different trophic levels—algae (Raphidocelis subcapitata), invertebrates (Thamnocephalus platyurus-beavertail fairy shrimp), and vertebrates (Poecilia reticulata, guppy)—we aimed to provide a comprehensive understanding of ecological health across biological scales. The water toxicity endpoints that were observed included growth inhibition in the algae and mortality in the shrimps and guppies. The toxicity testing revealed that the shrimps were the most vulnerable in all sites. Based on Persoone's toxicity classification system, two dams were classified as Class II, indicating slight acute toxicity with minimal ecological risk, while one dam was classified as Class III, reflecting moderate toxicity with potential impacts on aquatic organisms. Although toxicity levels were not alarming, the shrimps showed the highest sensitivity to the dam water, with increased mortality compared to the guppies and algae. This indicates a potential disruption to the aquatic food chain, as reduced invertebrate populations may affect food availability for higher trophic levels. Continued monitoring and appropriate treatment are recommended to protect both ecosystem stability and human health.

1.01.P–TuWe08 The Use of Indigenous Test Species: Metal Sensitivity Differences Between Daphnia magna and Caridina africana.

Victor Wepener[1], Marelize Marsay[1] and Simone Heyneke[1] (1)North-West University, South Africa

Freshwater ecosystems are increasingly at risk from trace metal contamination due to anthropogenic activities such as mining, industrial discharge, and agricultural runoff. Zinc (Zn) and Mercury (Hg) represent metals with divergent toxicological profiles: Zn is an essential micronutrient required in small quantities, yet toxic at elevated levels, while Hg is a non-essential, persistent, and highly neurotoxic metal prone to bioaccumulation and biomagnification. Evaluating their ecological risks requires both an understanding of their bioavailability and effects on local aquatic species. Conventional ecotoxicological studies often employ standard test organisms like Daphnia magna because of their regulatory acceptance, ease of culturing, and sensitivity. However, reliance on such model species may fail to capture the specific sensitivities of indigenous fauna. To address this limitation, we compared the acute and sublethal toxicity of Zn and Hg to D. magna and an indigenous tropical freshwater shrimp, Caridina africana. Acute toxicity assays were conducted following the standardised OECD202 (2004) protocols. Organisms were exposed to a gradient of metal concentrations to determine the acute LC50 concentrations and derived LC_{10} and LC_{20} values for sublethal exposures using probit analysis. Sublethal endpoints assessed were heart rate, respiration, and swimming behaviour. The acute toxicity assays indicated that Hg was significantly more toxic than Zn to both D. magna and C. africana. For D. magna, the 48 h LC_{50} was 89 µg/L for Hg and 1.9 mg/L for Zn. Caridina africana indicated greater sensitivity, with LC_{50} values of 1.2 µg/L for Hg and 1.2 mg/L for Zn. Exposure to Zn caused a reduction in heart rate in D. magna, while Hg induced bradycardia in D. magna and an elevated heart rate in C. africana. In contrast, Zn had no noticeable effect on the heart rate of C. africana. Oxygen levels decreased in both species following 24 h exposure, suggesting initial stress or metabolic suppression. However, by 48 h, oxygen consumption increased, indicating a possible metabolic adjustment or recovery phase. For both Zn and Hg, the higher exposure concentrations led to reduced swimming activity in both organisms, indicating a clear negative relationship between metal concentration and active behaviour. These results highlight species-specific physiological responses. These contrasting physiological and toxicological profiles emphasize the necessity of incorporating non-model, endemic species into ecotoxicological assessments to avoid underestimating ecological risk in native aquatic communities.

1.01.P–TuWe09 Comparative Effects of Ionic Silver and Nano-silver: Parasite Lethal Toxicity, Host Biomarker and Bioaccumulation Responses

Tarryn Botha[1], Anniemarie Oldewage[1] and Lutfiyya Latief[1] (1)University of Johannesburg

Infections by the parasite Macrogyrodactylus congolensis pose a considerable threat to Clarias gariepinus in aquaculture. Silver-based treatments have been proposed as an alternative to traditional methods (formalin, salt, and praziquantel). This study aimed to (1) determine the lethal concentration for $AgNO_3$ and nAg against M. congolensis, (2) assess biomarker responses in exposed fish, and (3) quantify the bioaccumulation in fish tissues. Parasites were exposed in vivo to a range of concentrations of ionic Ag and nAg for 12 hours. The LC10, LC20, and LC50 values of the parasite were determined using ToxRat®. In comparison to a control, infected fish were exposed to LC10 concentrations for 10 days to evaluate the biomarker responses in the gill, liver, muscle, intestine and brain tissues. The bioaccumulation in each organ was measured using ICP-MS. $AgNO_3$ exhibited greater acute toxicity (LC50 ≈ 0.17 µg/L) than nAg (LC50 ≈ 321.1 µg/L). Biomarkers of exposure (AChE and MT) showed increased AChE activity in the nAg group, whereas in ionic Ag-exposed fish, it had no significant difference compared to the control. Metallothionein levels remained constant across all three groups, with an increase in the intestine in the ionic Ag group. Biomarkers of effect (SOD, CAT and GSH) indicate lower SOD activity relative to the control in all tissues. Both ionic Ag and nAg had minimal impact on CAT activity in all organs except for liver tissue, which increased in the ionic Ag group. GSH concentrations decreased in the gill, liver and muscle tissue following exposure to both forms of Ag, but with an increase in the intestinal tissue with nAg and a decrease in the brain tissue for both Ag exposures. These biomarker responses were linked to the bioaccumulation of Ag in each tissue. Results of the study show distinct nAg-specific modes of action and organ-specific susceptibilities. These insights inform silver-based treatments in aquaculture for M. congolensis and the ecological risk assessments of engineered nanomaterials.

1.01.P–TuWe10 The Assessment of Oreochromis Mossambicus Muscle Tissue and The Yield Performance of Solanum Tuberosum in a Small-Scale Sandponics System

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Aquaponics, integrating hydroponics and aquaculture in a circular system, offers a promising approach to addressing food and nutrition security while promoting water conservation in South Africa. This technology is a sustainable means of food production that minimizes environmental waste by simultaneously cultivating plants and rearing fish in a closed-loop system. However, there is limited research on the functional and optimal operational aspects of small-scale sandponics systems, their impact on the quality of crops produced, and the health of the fish used during crop production. Therefore, this study aimed to evaluate the histology of muscle tissue in Mozambique tilapia (Oreochromis mossambicus) and the performance of Irish potato (Solanum tuberosum) in a small-scale sandponics system. Two potato cultivars (Moonlight and Taurus) were planted in a system linked to a 1000 L water tank containing 25 sexually mature Mozambique tilapia from January to June 2023. Fish histology and potato yield performance were assessed to gauge the efficiency of the system and to generate baseline data for future studies. The results showed that tuber production in the sandponics system was comparable to that under field conditions, with the Moonlight cultivar yielding the heaviest tubers (293 – 307 g per plant) with a short-oval shape, demonstrating its superior adaptability to this system. Taurus yielded lighter tubers (139-168 g per plant) that were either round or short oval, depending on the grow beds used for production. Histological analysis of fish revealed a higher prevalence of muscle tissue alterations in the control group than in the experimental group. However, both groups displayed a similar condition factor ($p < 0.05$), indicating good overall health. Despite the promising results, significantly high levels ($p < 0.05$) of metal accumulation (As, Cu, Mn, and Zn) in the fish were observed, raising concerns about their suitability for human consumption. This study demonstrates that sandponics system can effectively support potato production with fish maintaining good general health. However, further investigation is needed to mitigate metal accumulation to ensure the safety of fish for consumption.

1.01.P–TuWe11 Effects of Uranium, Manganese and Cobalt Exposure on Liver Histology of Cyprinus Carpio and Clarias Gariepinus at Different pH levels

Cobus van Dyk[1] and Ruth Furber[1] (1)University of Johannesburg

With the prevalence of mining and demand for metals in today's society, metal pollution in aquatic ecosystems remains a prevalent issue. Metal ions are particularly concerning pollutants as they can remain in aquatic ecosystems (both in sediment

and water) indefinitely because they do not break down into harmless compounds over time. pH plays a vital role in determining how soluble metal ions are in a system, with the general rule being that the more acidic the water of a system, the more soluble, and thus more bioavailable, the metal will be. However, very few exposure experiments consider this, choosing soluble metal salts in their exposures and leaving the pH near neutral. The literature is also very sparse on looking at the effects of metal mixtures that exist in aquatic ecosystems. The liver is a vital organ for detoxification and is often the most affected by pollutants. Histological analysis is a valuable tool in determining the tissue damage it may undergo, and thus the severity of the effect of pollutants. This study, therefore, aimed to examine the histological changes in the livers of Cyprinus carpio and Clarias gariepinus after chronic exposure to a mixture of Uranium, Cobalt and Manganese in an acidic (5.5 ± 0.25), neutral (7± 0.25) and basic (8.5 ± 0.25) environment. This is to compare the effects of a metal mixture at different pH levels across two common freshwater fish species. After a period of acclimation, three groups of C. carpio and C. gariepinus, each at one of the different pH levels, were exposed to 0.025mg/L of Uranium in the form of Uranyl Acetate, 0.01mg of Cobalt in the form of Cobalt Chloride, and 0.8mg/l of Manganese in the form of Manganese Chloride. These concentrations were selected based on their environmental relevance. Additionally, a pH control for each pH level and a blank control were included. Once exposed for 28 days, the fish were ethically euthanised, and the livers dissected out and prepared for histological examination. It is hypothesised that the livers from both species exposed to the acidic concentrations will show the most histological alterations, and the basic and neutral groups will have fewer alterations and be similar in severity. This study hopes to show a starting point for understanding the specific impacts of exposure to metal mixtures in aquatic ecosystems, and how the parameter of pH plays a role in the toxicity that metals can cause.

1.01.P–TuWe12 Mechanisms behind antidepressant-induced ocular toxicity in zebrafish

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The increasing use and environmental persistence of antidepressants have raised concerns about their unintended effects on aquatic organisms. Designed to modulate neurotransmission in humans, antidepressants have been shown to induce behavioural and developmental alterations in fish. These effects are often attributed to neurotransmitter imbalance. However, the mechanisms by which antidepressants disrupt the visual system remain poorly understood. This disturbance has high ecological relevance, as vision impairment can compromise essential behaviours such as foraging, predator avoidance, and mate recognition, ultimately threatening population stability. This study aimed to break down the ocular toxicity mechanisms of antidepressants in zebrafish (Danio rerio) embryos, focusing on two major classes: tricyclic antidepressants (amitriptyline and nortriptyline) and a selective serotonin reuptake inhibitor (sertraline). Embryos were exposed to sublethal concentrations of these compounds from fertilisation to 120 hours post-fertilisation (hpf). Visual function was assessed using the optokinetic response (OKR). Structural effects were evaluated via histological analysis of retinal architecture. Gene expression changes were assessed using mRNA sequencing and quantitative PCR at 48 and 96 hpf. Results revealed a significant, dose-dependent reduction in saccades per minute following sertraline exposure at 96 hpf and similar impairments with tricyclics at 120 hpf. Histology confirmed altered retinal pigment epithelium thickness and reduced eye diameter in treated larvae. At the molecular level, sertraline caused early upregulation of phototransduction genes (e.g. rho, gnat2, opn1sw1) at 48 hpf, with expression normalizing by 96 hpf despite persistent visual deficits assessed by OKR. Finally, mRNA Sequencing indicated disrupted expression of genes involved in photoreception, synaptic signaling, and muscle development, particularly at earlier stages. These findings demonstrate that different classes of antidepressants impair zebrafish visual function through both structural alterations and molecular pathways. The dissociation between gene expression normalisation and lasting behavioural deficits suggests critical windows of developmental vulnerability and highlights the need for temporal resolution in toxicological assessments. This work highlights the importance of incorporating behavioural endpoints into environmental risk assessments of pharmaceutical contaminants.

1.01.P–TuWe13 Evaluating the effects of herbicide spraying on fish health in the Bronkhorstspruit Dam

Cobus van Dyk[1] and Neo Radebe[1] (1)University of Johannesburg

Water pollution is an increasing environmental and public health concern in South Africa, affecting water quality and aquatic biodiversity in freshwater systems. The Bronkhorstspruit Dam, located south of Bronkhorstspruit town, is an important biodiversity area and a crucial water storage facility that has been affected by anthropogenic activities and, more recently, severely infested with the invasive water hyacinth, which has degraded the water quality. To address the hyacinth issue, glyphosate, a widely used herbicide, has reportedly been applied to control the infestation, raising concerns about its

toxicological effects on fish populations. Despite previous water quality assessments, there is no recent histology-based fish health data available for the Bronkhorstspruit Dam. This study aimed to provide a comprehensive histology-based assessment of Clarias gariepinus and Cyprinus carpio in the Bronkhorstspruit Dam. The health of the two fish species (n = 30 per species) was examined through histological assessment of key organs (gills, liver, kidney, spleen, heart, brain, and gonads). The water quality and presence of herbicides in the Bronkhorstspruit Dam and its inflowing rivers were evaluated using in situ and ex-situ sediment and water quality parameters. It is anticipated that fish inhabiting the dam will exhibit histopathological abnormalities and bioaccumulation of glyphosate, particularly affecting the liver and muscle tissues. The results of this study will provide valuable insights into the risks of glyphosate use, informing conservation efforts, agricultural practices, and regulatory policies that protect aquatic environments and human livelihoods.

1.01.P–TuWe14 Active Biomonitoring using Clarias gariepinus as an indicator species in Rietvlei Dam Within Rietvlei Nature Reserve

Irene Barnhoorn[1], Amina Nel[2], Cobus Van Dyk[2] and Saisha Kowlaser[2] (1)University of Venda, (2)University of Johannesburg

Rietvlei Dam (RD) is a reservoir in Irene that is supplied by the Sesmylspruit and feeds into the Hennops River. The dam is open to the public for recreational activities, not limited to, but including angling and kayaking. Industrial and domestic run-off, sewage effluent, and illegal dumping have contributed to pollution of the Sesmylspruit, which resulted in eutrophication, and has been a significant concern for this system. The system has previously been classified as hyper-eutrophic, with concerns such as phytoplankton blooms due to agricultural runoff and increased nutrient concentrations. It has not been assessed in terms of fish health in approximately twenty years, and as such, the current health status of fish inhabiting this system is unknown. This presentation reports on part of a larger aquatic health assessment study within Rietvlei Nature Reserve and will focus on a histological assessment of selected target organs of Clarias gariepinus using active biomonitoring fish were sampled from the system over three years and euthanised ethically prior to dissection on site. For the study, twenty fish were sampled from the system as a chronic exposure group (passive), twenty fish were exposed to the water in controlled cages as an acute 96-hour exposure (active), and twenty fish were used as a control group. The brain, gills, heart, kidney, liver, and spleen were selected and processed accordingly for histological analysis. Using light microscopy, any changes in histological structure were recorded. Determining the acute response to water from the system was necessary to confirm exposure risks for fish and communities that the system supplies water to. This approach can provide an understanding of acute health effects as a result of exposure to polluted water and provide important tissue response information when analysed alongside that of chronically exposed fish. It is hypothesized that the histological alterations will be more severe in the exposed groups compared to the control group. Further analyses will be done to determine any adverse effects related to organ function by analysing specific biomarkers.

1.02 - Marine Ecotoxicology: Anthropogenic Pressures on Changing World, Marine Organisms and Habitats, Current Challenges

1.02-T05 Poster Spotlight 1.02.P–TuWe15 and Discussion

Poster Spotlight: 1.02.P–TuWe15 - Do Fish in the Western Cape Coastal Areas Accumulate Pharmaceuticals from Agricultural and Urban Sources? A Case Study of Acetaminophen, Sulfamethoxazole, and Triclosan

1.02–T01 Insights Into The Stress Response Of The Red Seaweed Palmaria palmata Under Anthropogenic Pressure

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Seaweeds play vital ecological roles, and their aquaculture is rapidly developing globally. However, there is little information available regarding their response to anthropogenic pressures and potential vulnerability. The red seaweed Palmaria palmata is a species of commercial importance in the North Atlantic, growing in low-intertidal ranges where it is exposed to various stressors. This study aimed to assess its response to a) targeted oxidative stress; and b) mimicked acute environmental stressors. Vegetative sporophytes were sampled from wild populations, and individual blades were cut as experimental units. Hydrogen peroxide (H2O2) was used at concentrations ranging 0 – 2 mM to trigger oxidative stress. Fragments were removed for analysis at six time points over 28 days to evaluate shock, short-term and medium-term response, and their protein and

phenolic contents and antioxidant power were measured in vitro. Proteomics were conducted on samples of interest to assess metabolic changes. Heatwaves, hyposalinity, and exposure to wastewater treatment plant effluent were used as anthropogenic stressors at environmentally relevant levels. Seaweed blades were exposed for 2 weeks, followed by a 6-week recovery period. Growth, physiological health and photosynthetic ability were measured weekly, and fragments were frozen at regular intervals for UPLC-MS quantification of stress-related analytes. Low-to-medium H2O2 concentrations led to increased phenolic production and antioxidant activity, while higher concentrations killed the seaweed. Measured responses only lasted up to 7 days and were linked to decreased abundance of proteins involved in photosynthesis and growth metabolism. All stressors negatively affected growth rates after two weeks, but seaweeds recovered rapidly. Damage to photosynthetic ability lasted longer but was only caused by heat waves, either alone or combined with hyposalinity. Our results show clear effects of environmental stressors on the physiology of P. palmata. Stress leads to the activation of a phenolics-driven defence response, with trade-offs in photosynthetic activity and growth. Intense, repeated, or combined events may cause severe damage, both environmentally and economically. Omics methods are valuable tools for prevention and mitigation but are seldom used in algal research. Their development will strengthen and reinvigorate environmental and ecophysiological research on seaweed.

1.02–T02 Oil spill dispersant toxicity assessment for environmental regulation and monitoring in Senegal

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There is a scarcity of toxicity tests protocols and ecological risk assessment procedures in the Abidjan Convention (ABC) area, particularly with regard to ecologically relevant test organisms. A study using native model species was performed in Senegal to address this gap. The toxicity of a third-generation dispersant, Slickgone NS, was evaluated using a diatom, Nitschia palea, tested at 24 and 32°C, as well as a coastal burrowing amphipod. International test protocols were followed after some modifications. Potassium dichromate and zinc toxicities were tested as reference chemicals, in parallel with the dispersant, on diatoms and amphipod, respectively. The means of median effective concentrations (EC50) of Slickgone NS and dichromate for algae growth inhibition and that of median lethal concentrations (LC50) of Zn and Slickgone NS for amphipods were calculated using nominal chemical concentrations. The Predicted No Effect Concentrations (PNEC) for marine water and sediment were calculated from K2Cr2O7 EC50 and Zn LC50, respectively. At 24°C, Slickgone NS (EC50 = 25.5 mg/L) was less toxic than K2Cr2O7 (EC50 = 15.51 mg/L) for N. palea (p = 0.003). At 32°C, the difference was no longer significant (EC50 Slickgone NS = 37.4 mg/L; EC50 K2Cr2O7 = 23.7; p = 0.3). No significant difference was found between Slickgone NS LC50 (162 mg/kg sediment dry weight) and that of Zn (172 mg/kg sediment dry weight) for the amphipod (p = 0,4). These results confirm previous studies showing a relatively low toxicity of Slickgone NS and support its approval for use in OSPAR's countries. The PNECs of K2Cr2O7 for marine water and Zn for marine sediment were 0.0015 mg/L and 0,017 mg/kg sediment dry weight respectively. This project has established the first strain culture of N. palea and has developed a protocol for using a local amphipod species for sediment testing. Both protocols can be applied in Senegal and the ABC area, for testing of chemicals used in offshore activities or the toxicity of effluents or spills. The toxic threshold values for Slickgone NS on ecologically relevant species will benefit the revision of the licensed dispersants and support the decision-making of oil spill responders by contributing to the development of species sensitivity distributions for dispersant toxicity and by informing net environmental benefit assessment. The derived PNECs can be used by the Senegalese Standardization Agency to develop environmental quality standards for monitoring purposes.

1.02–T03 Pharmaceutical pollution alters river-to-sea migration success in Atlantic salmon (Salmo salar)

Tomas Brodin[1] and Jack Brand[1] (1)Swedish University of Agricultural Sciences (SLU)

Despite the growing threat of pharmaceutical pollution, we lack an understanding of whether and how such pollutants influence animal behaviour in the wild. Using laboratory- and field-based experiments across multiple years in Atlantic salmon (Salmo salar; n = 730), we demonstrate that the globally detected anxiolytic pollutant clobazam accumulates in the brain of exposed fish and alters river-to-sea migration success. Clobazam exposure increased the speed with which fish passed through two hydropower dams along their migration route, resulting in greater migration success compared to controls. We found that such effects may arise from altered shoaling behaviour in fish exposed to clobazam. Drug-induced behavioural changes, even

when seemingly beneficial, are expected to have wide-ranging consequences for the ecology and evolution of wild populations.

1.02–T04 Seawater Is Not Freshwater: Considerations for Conducting Chemical Exposures in Marine Ecosystems and Marine Ecological Risk Assessment

Kevin Armbrust[1] and Laura Basirico[1] (1)Louisiana State University

Marine ecosystems are the ultimate point of termination of waters draining the global terrestrial landscape. Chemicals used in terrestrial landscapes and entering freshwater streams and rivers, or used directly in coastal areas, become mixed in these systems and will be exposed to a more saline aquatic environment. Climate change is impacting chemical use practices in terrestrial environments; this is directly apparent in agriculture where new pest pressures necessitate new control strategies, with novel chemicals being used and entering aquatic environments. Aquatic risk assessment, consisting of assessed exposure and toxicity studies has historically focused on freshwater systems with the assumption chemical behavior in freshwater can be extrapolated to seawater. Chemical exposure assessment in a risk-based framework typically involves measuring a chemical's physical properties (solubility, soil adsorption, volatility, octanol-water partitioning) and degradation (hydrolysis, photolysis) in buffered distilled water or sterile freshwater. Research over the years has shown that these properties can vary considerably in a highly saline system typical of marine ecosystems. Work with various pesticides and oil constituents has shown that as chemical solubility decreases, solubility differences between seawater and freshwater increase dramatically. Similarly, differences in log Kow, a classical predictor or chemical bioavailability in aquatic organisms also becomes increasingly disparate between seawater and freshwater; as chemical polarity and solubility decrease increases in salinity drive increased partitioning behavior and presumably bioavailability. Such change in chemical property behavior has been suggested for enhanced toxicity in euryhaline species of aquatic organisms. Salinity also impacts chemical fate with chemicals subjected to alkaline hydrolysis becoming more easily degraded in the alkaline environment of seawater. Seawater can have dramatic effects on photodegradation. In some cases salinity accelerates photodegradation processes of chemicals such as benzobicyclone hydrolysate or sulcotrione, with magnesium ions playing a major role. However salinity will retard the photodegradation of other chemicals such as chlorinated aromatics, likely through photonucleophilic substitution processes. Salinity can additionally impact degradation product distribution for compounds whose degradation rate is not impacted by salinity. The impacts of salinity on chemical properties must be addressed in the design of marine toxicity experiments and should be considered in the problem formulation stage of an ecological risk assessment.

1.02.P - Marine Ecotoxicology: Anthropogenic Pressures on Changing World, Marine Organisms and Habitats, Current Challenges

1.02.P–TuWe16 OSPAR mussels biomarkers in caged brown mussels Perna perna for monitoring coastal water pollution in Senegal

Ketil Hylland[1] and Fatou Tabane[2] (1)University of Oslo (UiO), (2)Centre régional de recherche en écotoxicologie et sécurité de l'environnement

There is a scarcity of bioindicator species for contaminant monitoring in Africa meanwhile several studies have reported cases of pollution by numerous chemical contaminants. The aim of our study was to evaluate the use of one possible species, the filter-feeding coastal bivalve Perna perna, for contaminant monitoring in coastal areas. P. perna collected from an unpolluted area of the Senegalese coast were transplanted to the Dakar harbour and to a reference location in the open coast in the vicinity of Dakar. After four weeks of exposure, mussels from the polluted site were transferred to the reference site for depuration for another four weeks. After exposure at the polluted site, individuals bioaccumulated polycyclic aromatic hydrocarbons (PAHs) as well as more lead, copper and selenium than mussels at the reference site. Transcripts of biotransformation enzymes were downregulated whereas transcripts for antioxidant enzymes were upregulated in the gills of mussels at the harbour site compared to the reference location. Digestive gland acetylcholinesterase and lactate dehydrogenase activity were decreased in mussels at the harbour site compared to the reference location. No significant difference was observed for gills glutathione S-transferase activity. Changes in digestive gland histology were observed and stress-on-stress time decreased. At the end of the four-week depuration period, there were signs of recovery. The results demonstrated that the measurement of OSPAR biological effects can be used with caged P. perna to monitor coastal environmental pollution in Senegal and other African countries.

1.02.P–TuWe17 Polychaetes as Biomonitors of Metal Contamination in the Ramsar-Designated Berg River Estuary, South Africa: A Site-Specific Approach

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The Berg River Estuary, a Ramsar-designated site of ecological significance in South Africa's Western Cape, faces increasing pressure from urbanisation, agriculture, and associated metal contamination. The need for biologically relevant monitoring tools in this system has prompted the exploration of polychaete worms as potential biomonitors. Polychaetes are benthic invertebrates known for their sediment interaction, site fidelity, and metal accumulation capabilities—making them excellent indicators of estuarine health. This study explores the biomonitor potential of polychaetes by comparing species diversity and metal uptake across sites with contrasting pollution gradients. Specifically, polychaete assemblages from sites known for high species abundance (Sites 2 and 3) were compared to those from historically contaminated and urban-impacted zones (Sites 5 and 8). These locations were selected to represent ecologically rich versus metal-impacted habitats within the estuarine system. Field-collected specimens were morphologically identified to assess diversity and community composition, while sediment samples were collected to determine background metal concentrations. Sediment and polychaete samples were digested with nitric acid and analysed for a range of metals using an ICP-MS. Preliminary results indicate that Sites 5 and 8 exhibited the highest concentrations of cadmium (Cd), copper (Cu), and zinc (Zn), which corresponded with elevated total organic content—suggesting reduced metal mobility and enhanced accumulation potential in these fine-grained sediments. In contrast, Sites 2 and 3 showed lower contamination levels and more diverse polychaete communities. Although bioaccumulation analysis is still ongoing, preliminary ecological insights support the utility of polychaetes for site-specific assessments. Distinct differences in polychaete assemblage structure were observed across the sites, which may be linked to sediment quality and contamination history. For instance, pollution-tolerant families such as Capitellidae and Spionidae were more dominant at the highly contaminated Sites 5 and 8, while more sensitive families like Orbiniidae and Sabellidae were primarily found at the less polluted, species-rich Sites 2 and 3. This research forms part of a broader effort to develop biologically integrated monitoring frameworks for South African estuaries. Findings are expected to elucidate the usefulness of polychaetes as sentinel species in metal-contaminated environments and inform future conservation and management strategies for the Berg River Estuary.

1.02.P–TuWe18 Risk Assessment and Biological Effects of Pharmaceuticals Discharged via a Wastewater Treatment Plant in the Marine Environment

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Growing concern over the environmental impacts of pharmaceuticals and personal care products (PPCPs) has prompted scientific efforts to develop reliable approaches for evaluating and monitoring these substances in aquatic ecosystems. The development and validation of effective risk assessment tools to address the ecological implications of PPCPs is of particular importance. In this study, the effectiveness of a model based on dose-related risk and effect evaluation was examined. This model, which estimates predicted environmental concentrations (PECs) and allows for comparison with predicted no-effect concentrations (PNECs), was combined with in vitro assessments of whole effluent toxicity to characterize potential PPCP-related hazards. Concentrations of commonly used PPCPs in Norway were quantified in both influent and effluent wastewater samples and subsequently used to calibrate a fate and transport model. More than 90% removal efficiency was observed for 12 out of the 22 PPCPs detected. Interestingly, removal rates varied widely—from 12% to 100%—and showed no clear dependence on the compound class or initial concentration. Detected PPCPs in treated effluents were analyzed to determine their individual contributions to the overall environmental risk. No significant risk was identified for the 30 targeted compounds. Furthermore, model simulations offered insights into the temporal and spatial distribution of discharge plumes, providing useful data for future environmental monitoring initiatives. To evaluate the general toxicity of the effluent, bioassays using PLHC-1 fish liver cells were conducted, assessing endpoints such as cell viability, reactive oxygen species (ROS) production, and ethoxyresorufin-O-deethylase (EROD) activity. Overall, this study supports the application of risk-based monitoring approaches over conventional removal efficiency criteria and highlights the need to incorporate PPCP pollution into regulatory frameworks governing aquatic environmental protection.

1.02.P–TuWe19 Bringing Digital Pathology to Environmental Science: Machine Learning-Based Detection Of Tissue Lesions In Fish

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Histopathological assessment of tissue change is a cornerstone of environmental monitoring, but it relies heavily on expert pathologists and is time- and resource-intensive. This approach cannot sustain rising data volumes and a dwindling number of trained pathologists. Digital histopathology, rapidly adopted in health sciences, offers a promising solution. Here, we present a novel application of machine learning (ML)-based digital histopathology to assess liver lesions in two bioindicator fish species: Atlantic cod (Gadus morhua) and common dab (Limanda limanda). Liver samples were collected during North Sea surveys (2017 and 2021), processed into whole-slide images (WSIs), and annotated by trained histopathologists for lesion types relevant to pollution monitoring: steatosis, melano-macrophage aggregates (MMAs), leucocyte infiltration, granulomas, fibrosis, necrosis, neoplasia, and parasitic infection. In a preliminary study focused on steatosis, MMAs, leucocyte infiltration, and granulomas, which share inflammatory relevance, WSIs were processed using QuPath software, and tissue areas were quantified. Manually annotated subsamples were used to train ML models based on pixel intensity, colour, and object features. Random forest classifiers and watershed algorithms were employed to detect and quantify lesions. Lesion presence and quantification were compared to scores from trained pathologists using accuracy metrics, Fisher's exact test, and binomial logistic regression. ML models successfully identified and quantified all tested lesions. Comparative accuracy scores exceeded 80% for all four lesions and surpassed 95% for MMAs and granulomas, aligning with diagnostic standards in medical ML. Accuracy for leucocyte infiltration was lower (85%), with significant species-specific differences. Discrepancies between model outputs and traditional scoring, particularly for steatosis and leucocyte infiltration, highlighted the limitations of subjective grading and the need for biologically defined thresholds. This study demonstrates the feasibility of ML-based digital histopathology in environmental monitoring. Models performed robustly despite limited training data and arbitrary thresholds. Further development of this method will lead to more objective, scalable, and reproducible workflows for tissue analysis. Expanding datasets and refining models will improve accuracy and facilitate future use for a broad community of scientists.

1.02.P–TuWe20 Distinct patterns of metal accumulation in deep-sea grenadiers Coryphaenoides armatus and C. yaquinae from the Clarion-Clipperton Zone: Baseline data to inform deep-sea mining impact assessment

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Deep-sea mining poses serious ecological risks, especially in unique and biodiverse regions like the Clarion-Clipperton Zone (CCZ) in the Pacific Ocean. Disturbance of seafloor sediments can release bioavailable metals, increasing exposure risks for deep-sea fauna. Baseline data on metal concentrations in resident fauna from the CCZ are currently lacking, limiting the ability to conduct robust ecological impact assessments. This study addresses this gap by quantifying concentrations of Cd, Cu, Fe, Hg, Mn, Ni, and Zn in liver and muscle of two ecologically important deep-sea grenadier species, Coryphaenoides armatus and C. yaquinae, collected from an exploration contract area in the CCZ. We assessed how metal concentrations vary with tissue type, species, and body size. To visualize individual metal accumulation profiles, we applied z-score standardization and heatmapping, a novel approach in this context, which revealed distinct species- and size-specific patterns. Across both species there was consistent tissue partitioning, with higher concentrations of essential metals (Cu, Fe, Zn, Mn) in liver, which decreased with increasing fish size, particularly in C. yaquinae (Cu: ↓25.74–1.21 mg kg^{-1}; total length: ↑369–699 mm). Essential metals in liver showed strong co-variation, likely reflecting shared regulation or uptake. Non-essential metals like Cd and Hg showed species- and size-specific covariation patterns, suggesting differences in exposure or detoxification. Mercury concentrations in muscle tissue increased with body size in both species, with a stronger relationship observed in C. armatus (Hg: ↑0.58–2.28 mg kg^{-1}; total length: ↑461–1108 mm). In many individuals, mercury (in both muscle and liver) and cadmium (in liver) concentrations exceeded sublethal toxicity thresholds reported for other marine fishes. Notably, liver cadmium levels averaged 3.67 ± 1.98 mg kg^{-1} in C. armatus and 4.97 ± 2.09 mg kg^{-1} in C. yaquinae. Results highlight differences in metal regulation between closely related deep-sea species and suggest that current background levels may already impose physiological stress. This study provides ecologically relevant baselines and illustrates how differences in physiology, diet, and life history mediate metal bioaccumulation. By resolving species-specific patterns of metal accumulation, this study provides critical reference data for environmental monitoring and ecological risk assessment in regions targeted for future deep-sea mining.

1.02.P–TuWe15 Do Fish in the Western Cape Coastal Areas Accumulate Pharmaceuticals from Agricultural and Urban Sources? A Case Study of Acetaminophen, Sulfamethoxazole, and Triclosan

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Pharmaceutical contaminants in aquatic environments raise significant ecological and health concerns, particularly in regions with intensive urban and agricultural land use. In the Western Cape, South Africa, agricultural runoff, wastewater treatment plants effluents and informal settlement effluents are suspected sources of pharmaceuticals affecting coastal waters and marine life. Some compounds are used exclusively for humans (i.e., anti-retroviral drugs) while others such as antibiotics (i.e., Sulfamethoxazole) are used by humans and livestock. This study evaluated the presence and accumulation of three commonly detected pharmaceuticals Acetaminophen, Sulfamethoxazole, and Triclosan in fish from the coastal zone, aiming to assess the contaminant distribution, concentration levels and likely sources. To address this, fish samples were collected along the coast of the Western Cape between 10 km to 150 km offshore by the Department of Forestry, Fisheries and the Environment in the Western Cape. Liquid chromatography-mass spectrometry analysis of pharmaceutical concentrations in the fish using dry mass, for Acetaminophen ranged from non-detect (ND) to 30.2 ng/g with higher levels closer to the coast, suggesting significant contamination from wastewater and effluents. Sulfamethoxazole concentrations, though lower (ND to 4.9 ng/g), were consistently detected in fish closer to the coast as well as in some of deep ocean fish such as monk. Triclosan, the pharmaceutical found at the highest concentration during the analysis (ND to 184 ng/g), reflects the widespread use, environmental persistence, and strong lipophilic and bioaccumulative properties. These findings indicate a pattern of pharmaceutical accumulation in fish likely driven by proximity to urban wastewater discharge and agricultural runoff. The elevated nearshore concentrations suggest the likely role of human activities, as well as the poor processing of wastewater treatment plants and contaminant transport to marine systems, emphasizing the need for enhanced pollution control measures. By providing insight into contaminant concentration and bioaccumulation in fish, this study advances our understanding of pharmaceutical distribution in coastal ecosystems and supports informed regulatory decisions to protect marine biodiversity and water quality in regions affected by urban and rural pollution.

1.03.A - One Health Approach to Protect Human Health in a Changing Environment

1.03.A–T01 Possible Sources Of Trace Metals In Obese Females Living In Informal Settlements Near Industrial Sites Around Gauteng, South Africa

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Trace metals have been reported in the literature to be associated with obesity. Exposure to some trace metals such as manganese (Mn), chromium (Cr), nickel (Ni), cadmium (Cd), and lead (Pb) may pose a serious health risk to individuals living around a polluted environment. The present study assessed the levels of trace metals in the blood of obese females living around industrial areas in Pretoria, South Africa. The study was carried out using a mixed methods approach. Only females with a (Body mass index) BMI ≥ 30.0 were considered. A total of 120 obese females participated in the study (site 1: 40—industrial area, site 2: 40—industrial area, and site 3: 40—residential area), aged 18–45 and not in menopause. Blood samples were analysed for trace metal content using inductively coupled plasma mass spectrometry (ICP-MS). The mean concentrations of trace metals were in the order Mn > Pb > Cr > cobalt (Co) > arsenic (As) > Cd (site 1), Mn > Pb> Co > As > Cd (site 2), and Mn > Cr > Co > As > Pb > Cd (site 3). The blood Mn from site 1 ranged from 6.79 µg/L–33.99 µg/L, and the mean differences obtained from the participants from different sites were significant ($p < 0.01$). The blood levels of Mn, Pb, Cr, Co, As, and Cd were above the recommended limits set by the World Health Organization in some of the participants. The present study noted, among others, exposure to industrial activities, lifestyle decisions such as the use of tobacco products by their partners indoors, and the method used for cooking as factors that might have accounted for the blood levels of Mn, Pb, Cd and Co. The study showed that there is a need for constant biomonitoring of the levels of trace metals in the blood of those living in these areas.

1.03.A–T02 Connecting Pollutant Exposure and Changes of Land-use around Mining Areas: Focusing on Common Lizard Species as an Indicator

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Base metals such as copper, iron, and lead have been utilized since ancient times. In recent year, there has also been growing

demand for a wider variety of metals, including rare metals for cleaner energy production and digital transformation, the exploitation of which is happening extensively in a limited number of countries and regions. Although the extraction of mineral resources fosters economic growth in mineral resource-rich countries, inadequate regulatory frameworks can result in substantial pollution burdens. Pollution sources and industrial and residential urban centres often overlap, and land-use changes continuously with population influx. Conventional biomonitoring has not adequately addressed how land-use changes affect exposure patterns, potentially overlooking high-risk populations near contaminated sites. This is partly because terrestrial biomonitoring is less generalized than aquatic monitoring, as terrestrial environments exhibit greater diversity due to variations in vegetation and anthropogenic activities during urbanization. In this context, we have used lizard species (Trachylepis wahlbergii) as a novel biomonitoring target to reflect land-use changes. This lizard species and its ecologically and genetically close relatives are commonly seen in tropical to sub-tropical and savanna climate regions that often overlap with mineral-producing countries. The species exhibits broad habitat tolerance, successfully colonizing both natural (bare ground, native vegetation) and human residences. This makes the species ideal to compare exposure trends between different land uses. Kabwe, Zambia, exemplifies urban development with ongoing lead pollution from past mining. Previous lizard sampling in 2017 indicated higher lead concentrations in bare land than in green areas, underscoring the need to consider ground surface conditions alongside other common factors like distance and wind direction. In this study, we conducted additional sampling and analysis to follow up on prior findings. Organs of 166 lizards (N=110 in 2021, N=56 in 2023) were collected and analysed for metals and metalloids (lead, copper, cadmium, chromium, and arsenic). The analytical results of the 5 elements in biological samples were generally higher than those reported in other animals in the same area, which is consistent with the result from 2017. The comparison among the same site in 2017, 2021, and 2023 showed that the contamination level has not changed in the 5 years. The metal exposure trends were intensively evaluated for lead, which is the major concern due to distinctive contamination sources in this area. Since the most significant and obvious factor that affects metal concentration in organs was distance from the mine, the residual from the expected concentration based on linear regression with the distance was employed as the index to evaluate the effects of land-use difference. The results were consistent with the prior findings, showing less accumulation in areas with vegetation. The increased number of sampling points enabled quantitative analysis using land surface condition indices such as NDVI (Normalized Difference Vegetation Index) and NDWI (Normalized Difference Water Index). In addition, based on time-series analysis of satellite images and exposure patterns, the emerging industrial introduction of slag from other pollution sources was indicated. The current result suggested that land-use patterns should be considered when evaluating exposure risks and planning field monitoring in metal-contaminated land, alongside common parameters such as distance and wind and/or water current direction. Developing a universal land-use classification algorithm and model, combining the results of field monitoring and consecutive satellite image analysis, will help increase the efficiency of biomonitoring and the reflection of the result into better urban development strategies. Additionally, the current lizard species has been proposed as a useful indicator that reflects the effect of environmental changes, including land-use shift, on the fluctuation of pollutant exposure amount. Biomonitoring of this species has the potential to visualize the impact of human economic activity on exposure level and can be generally applied to other mining-related areas experiencing ongoing urbanization.

1.03.A–T03 Climate Change, UV Radiation, and Their Effects on Ecosystems and Society in Low- and Middle-Income Countries

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While climate change is widely recognized for its visible manifestations—extreme weather events, sea-level rise, and habitat loss—its less perceptible consequences remain underexplored. Among these is the intensification of solar ultraviolet (UV) radiation, driven by a combination of stratospheric ozone depletion and shifting atmospheric dynamics. In low- and middle-income countries (LMICs), where adaptive capacity is limited and environmental monitoring infrastructure is often inadequate, the compounding effects of climate change and UV radiation present a silent but potent threat to both ecosystems and human well-being. This presentation investigates the synergistic relationship between climate change and UV radiation, highlighting how rising temperatures, altered cloud cover, and aerosol changes are affecting UV exposure at ground level. We explore how these changes are influencing biological systems—from phytoplankton productivity in coastal waters to crop viability and pollinator health on land. For communities in LMICs that rely heavily on natural resources and subsistence agriculture, these ecological shifts translate into food insecurity, disrupted livelihoods, and heightened vulnerability. The health implications are equally stark. Increased UV radiation contributes to higher rates of skin cancers, cataracts, and immune suppression, particularly in regions with limited healthcare access and low public awareness. Moreover, climate change can amplify UV-related harms by exacerbating poverty, migration, and inequality, creating feedback loops that are difficult to break without targeted intervention. Using case studies from southern Africa, South Asia, and the Andes, we illustrate how environmental stressors intersect with social inequities to deepen climate injustice. We also examine opportunities for integrated adaptation

strategies—such as nature-based solutions, localized UV monitoring, and public health education campaigns—that are sensitive to local realities and resource constraints. By framing UV radiation as a critical but often invisible dimension of the climate crisis, this presentation calls for a more holistic understanding of environmental risks in LMICs.

1.03.A–T04 Ecological and Human Health Risks of Heavy Metal Exposure in Mining Communities in Ghana

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Ghana's gold mining industry, while economically vital, poses serious concerns regarding heavy metal contamination and its impacts on human and environmental health. This study assessed heavy metal distribution and associated risks in 70 mining communities across the country. Soil samples were analyzed using X-ray fluorescence spectrometry, and human health risks were evaluated via Average Daily Dose (ADD), Hazard Index (HI), and Cancer Risk (CR) across oral, inhalation, and dermal exposure routes. Ecological risks were assessed using the Modified Degree of Contamination (mCd), Pollution Load Index (PLI), and Potential Ecological Risk Index (PERI). Arsenic, chromium, and nickel emerged as key contaminants, with cancer risk levels exceeding acceptable thresholds in several communities. High ecological risks were observed, notably in Nkroful and Nsutam. The findings underscore the urgent need for targeted soil remediation, safer mining practices, and enhanced public health interventions. This study provides critical evidence to support policy and guide sustainable mining practices in Ghana.

1.03.B - One Health Approach to Protect Human Health in a Changing Environment

1.03.B–T01 Caffeine as a Chemopreventive Agent Against UV-Induced Skin Carcinogenesis

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Ultraviolet (UV) radiation is the most prevalent environmental carcinogen and a major contributor to skin cancer development, leading to 5.5 million cases annually in the United States—more than all other cancers combined. Despite the widespread enjoyment of sunlight, its harmful effects necessitate the development of effective strategies for skin cancer prevention. UV exposure generates approximately 100,000 potentially mutagenic DNA lesions per hour in each human diploid cell. In response, cells activate the ATR kinase to regulate the cell cycle and promote cell survival. Our previous study demonstrated that genetic inhibition of ATR in the skin suppresses UV-induced carcinogenesis in a mouse model. Notably, caffeine is a widely consumed compound that nonspecifically inhibits ATR, and several human epidemiological studies have reported a dose-dependent association between caffeinated coffee intake and reduced risk of skin cancer. To investigate the timing-dependent effects of caffeine on UV-induced skin carcinogenesis, we compared two schedules of topical caffeine application in a chronic UVB mouse model. In both groups, mice received equivalent cumulative doses of UVB over 19 weeks. In the "immediate caffeine" group, caffeine was applied topically within minutes after each UV exposure throughout the irradiation period. In the "delayed caffeine" group, treatment began only after 14 weeks, when UV exposure had ceased and initial tumors had appeared. Remarkably, immediate caffeine treatment significantly augmented UV-induced apoptosis, reduced tumor development, and lowered the frequency of mutations in the promoter region of CDKN2A, which encodes the p16 tumor suppressor. In contrast, delayed caffeine application showed no protective effect. These findings provide novel insight into the mechanisms by which caffeine suppresses UV-induced skin carcinogenesis and underscore the critical importance of application timing for effective chemoprevention.

1.03.B–T02 Data-Driven Calibration of Low-Cost pm2.5 Sensor Measurements in Pretoria

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This study addresses data gaps in air pollution monitoring by deploying low-cost sensor to measure PM2.5 pollution levels and leverages on machine learning to calibrate the sensor data. Fine particulate matter (PM2.5, particles with an aerodynamic diameter ≤2.5 μm) is a critical indicator of air quality and is linked to an estimated four to nine million premature deaths annually. Despite the growing health burden, Sub-Saharan Africa remains largely data-deficient due to sparse air pollution monitoring infrastructure. In South Africa, this gap raises concerns about the underestimation of exposure and the limited understanding of temporal variability in PM2.5 concentrations. Low-cost sensors (LCSs) like PurpleAir have gained global traction for monitoring PM2.5 pollution due to their affordability and ease of deployment. However, their field performance in

real-world conditions must be validated against reference-grade monitors to ensure reliability. In this study, we collocated two PurpleAir sensors with an Oizom reference monitor over a three-month period, (February—April 2025) on the rooftop of the School of Health Systems and Public Health, University of Pretoria, South Africa. We applied machine learning (ML) techniques to assess sensor performance in terms of linearity, accuracy, inter-sensor consistency, and sensitivity to meteorological variables (temperature, relative humidity, and wind speed). Data were cleaned and processed in Python, with daily (midnight-to-midnight) averages computed. Exploratory data analysis and outlier detection were performed before applying ML calibration models. Strong temporal agreement was observed between the LCSs and the reference monitor, with P PM2.5 peaks noted in late February, mid-March, and mid-April—likely driven by dust storms, traffic emissions, and seasonal meteorological changes. PM2.5 levels frequently exceeded the WHO daily guideline of 15 µg/m³. Inter-sensor correlation was high ($r > 0.97$), indicating consistent pollutant tracking despite calibration differences. Among the models evaluated for calibration, random forest regression achieved the best performance ($R^2 = 0.90$,MSE = 5.32), followed by multiple linear regression ($R^2 = 0.88$,MSE = 5.94), and feedforward neural networks ($R^2 = 0.73$,MSE = 13.93). Random forest regression outperformed the others, demonstrating its effectiveness in adjusting for meteorological influences, similar to other calibration-focused studies in the literature. These findings highlight the potential of LCSs for high-resolution temporal mapping of air pollution—an underutilised capability in South Africa. Future work will expand to long-term, multi-source PM2.5 datasets, integrating LCSs, filter-based samples, and reference monitors.

1.03.B–T03 Atmospheric Fine Particulate Matter (PM 2.5), Black Carbon, and Organic Carbon Levels in Oshakati, Namibia

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Ambient air pollution, particularly fine particulate matter ($PM_{2.5}$; aerodynamic diameter ≤2.5 µm), poses a growing public health concern, contributing to cardiovascular, respiratory, and metabolic diseases. In Africa, where over 1.1 million deaths were attributed to air pollution in 2019, monitoring efforts remain limited due to the lack of ground-based data and electronic health records. Namibia does not have an air quality act, meaning there is no legal requirement to track air pollution levels, potentially exposing the population to harmful pollutant concentrations. This study measured ambient $PM_{2.5}$ concentrations and selected chemical components—black carbon (BC) and organic carbon (OC) at an urban background site at the University of Namibia, Oshakati Campus (-17.78664, 15.69364). $PM_{2.5}$ was sampled every sixth day from July 2021 to February 2023 using personal air samplers equipped with PTFE membrane filters, operating at a flow rate of 4.0 L/min for 24-hour collection periods. A total of 72 samples were obtained. BC and organic carbon OC levels were determined via an OT21 optical transmitter, which analyzed light absorption at 370 nm to estimate biomass-burning contributions. Results showed $PM_{2.5}$ concentrations ranging from 0.5 to 47.7 µg/m³, with a mean of 10.6 µg/m³, exceeding the WHO's updated annual guideline of 5 µg/m³. The daily WHO limit of 15 µg/m³ was surpassed on 13 occasions. Average BC and OC concentrations were 0.8 µg/m³ and 0.9 µg/m³, respectively. Seasonal variations indicated the highest pollutant levels in winter, followed by spring, autumn, and summer. This study provides the first documented assessment of $PM_{2.5}$ and its carbonaceous components in Oshakati. Elevated pollutant levels, particularly in winter, suggest potential health risks for the local population, even at concentrations below established regulatory limits. Given the absence of national air quality monitoring regulations, these findings highlight the urgent need for systematic air pollution tracking and policy development in Namibia. Further research should include source apportionment studies and health risk assessments to better understand exposure impacts and inform mitigation strategies.

1.03.B–T04 Implications of Exposure to Ultraviolet and Infrared Lights on Brain Biomarkers and Cerebrocerebellar Cortex of Wistar Rats

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Light, as an environmental cue, is very important in facilitating sight and a host of other non-visually responses in animals physiologically including circadian rhythm regulation, metabolic levels and activity, and pathological changes. This study investigated the effect of exposure to near Ultraviolet (UV) and near Infrared (IR) lights on neurotransmitter biomarkers activity (Acetylcholinesterase (AChE), Monoamine Oxidase B (MAO-B) and Adenosine Deaminase (ADA)) and cerebrocerebellar cortex brain of male Wistar albino rats (Rattus norvegicus). Thirty weaned male Wistar rats (30.02 ± 5.82 g) were exposed to daylight (8 am – 6 pm) and 6 hours (8 pm – 2 am) of artificial lights of varying wavelengths (UVA – 365 nm,

UVA – 396 nm, IRA – 850 nm and IRA – 940 nm) at night for 90 days. The control groups were exposed to darkness (DRK) and ambient light (AML). Each light treatment and control had five replicates. Biomarkers of neurotransmission were determined using enzyme-linked immunosorbent assay (ELISA) kits. Brain tissues of rats were histologically processed, stained with Cresyl violet and examined using light microscopy. Photomicrographs of the stained tissues were done using AmScope microscope 3.0 camera™. Data obtained were subjected to Analysis of Variance and followed by Duncan's multiple range test at $p < 0.05$. Rats exposed to Darkness and IRA – 850 nm elicited significant ($p < 0.05$) reduction in the mean levels of AChE (0.1061 ± 0.004 U/L and 0.1164 ± 0.005 U/L), MAO-B (0.1072 ± 0 U/L and 0.1073 ± 0.000 U/L) and ADA (0.1731 ± 0.013 U/L and 0.1918 ± 0.015 U/L) respectively. Varying degrees of pathology of Purkinje cells with numerous pyknotic cells and necrosis were observed in the cerebellar cortex of the male Wistar rats exposed to darkness and infrared lights. This study showed that exposure to darkness and IRA – 850 nm possessed inhibitory properties by downregulating MAO-B, AChE and ADA in male Wistar rats. Additionally, darkness and IRA – 850 nm induced negative pathological changes observed in cerebellar cortex in male Wistar rats.

1.03.P - One Health Approach to Protect Human Health in a Changing Environment

1.03.P–TuWe21 Health risks of atmospheric fine particulate matter (PM2.5) and its trace elements in Mabopane, South Africa

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Atmospheric fine particulate matter (PM2.5) is a significant environmental health concern, contributing to approximately 4 million premature deaths worldwide each year. This study aimed to assess the health risks associated with PM2.5 and its trace elements in Mabopane, South Africa, a region with limited local data on air pollution impacts. To address this, PM2.5 samples were collected on a sixth-day cycle from 15 June 2022 to 28 February 2023 at the Mabopane Fire Station. Samples were gathered using a GilAir-5 sampler operating at 4.0 L/min, and health risk assessments were conducted following US EPA guidelines, WHO air quality limits, South African National Ambient Air Quality Standards (SANAAQS), and US EPA reference levels for trace elements. The mean PM2.5 concentration was 10 µg/m³ (range: 1.1–29 µg/m³), exceeding the WHO annual limit but remaining below SANAAQS. Health risks (hazard quotient > 1) were observed across all age groups. Among 18 measured trace elements, calcium, iron, potassium, sulfur, and silicon had the highest concentrations (110–240 ng/m³). The excess lifetime cancer risk from nickel was 1.2×10^{-6}. The study indicates that PM2.5 and associated trace elements pose significant health risks in Mabopane, necessitating improved air quality management. These findings highlight the importance of targeted interventions to mitigate pollution from dust and human activities, contributing to public health protection in Mabopane and similar urban environments.

1.03.P–TuWe23 Assessment of trace metals in Amaranthus spinosus harvested from mine-polluted soils treated with selected farmyard manures

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Trace metals polluted soils poses significant risks for farming activities and may affect food safety and human health. This study assessed trace metal concentrations and uptake in A. spinosus grown on mine-polluted soils amended with selected farmyard manures (chicken droppings and cow dung). Following cultivation, plant tissues (leaves, stems, and roots) and soils were analysed for Cr, Ni, Pb, Cu, Zn, Mn, Fe, and As concentrations using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Cow dung-amended soils showed an increase in Zn, Pb, Mn, and Ni levels from leaves (107.99 ± 2.02 µg/L), Pb (16.57 ± 0.00 µg/L), Mn (4.68 ± 0.06 µg/L), and Ni (4.35 ± 0.08 µg/L), while chicken droppings resulted in an increased Fe levels in stems. Transfer factors (TF) were less than one in cow dung treatments, except for Cr, Zn, and Pb, that showed values >1, indicating the possibility of translocation to edible plant portions. Health risk assessments were all below 1, indicating that no significant non-carcinogenic dangers associated with consuming the vegetable at this stage. The present study emphasized the need for controlled application of organic amendments in mine-polluted soils to reduce trace metal buildup in food crops and contribute valuable insight into sustainable soil remediation procedures and promotes the development of safe agricultural systems in mining-affected areas.

1.03.P–TuWe26 In Vitro Toxicity Assessment of the Potential Occupational Health Risks Caused by Ceramic Resins Used in Additive Manufacturing

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Additive manufacturing (AM) is the process of fabricating a physical object by depositing successive layers of feedstock material from a three-dimensional design model. Different feedstock materials are used depending on the type of AM process and application, including polymers, metals, concrete, or ceramic resins. Ceramic resins are considered feedstocks of the future because of their desirable material properties, such as high strength, corrosion resistance, thermal conductivity, and biocompatibility. However, since AM operators still perform many manual tasks during fabrication, there are concerns regarding potential occupational exposure to ceramic resins via dermal absorption, accidental ingestion, or inhalation. This study aimed to investigate the in vitro toxicity of three commercially used Lithoz® ceramic resin feedstocks, namely LithaBone HA 480 (hydroxyapatite; LBONE), LithaCon 3Y 210 (zirconia, LCON), and LithaLox 350 (aluminium oxide, LLOX). Feedstock dispersions (1 mg/mL) were prepared in deionised water and diluted in cell culture media to obtain exposure concentrations (1, 5, 10, 20, 50, 100, and 200 µg/mL). Cytotoxicity, oxidative stress, and DNA damage were assessed in human (RPMI-2650 nasal carcinoma, A549 lung carcinoma, and HuTu-80 intestinal adenocarcinoma) and rat (H4IIE-luc liver hepatoma) cell cultures using the real-time xCELLigence cell proliferation, 2',7'-dichlorodihydrofluorescein diacetate, and 8-hydroxydeoxyguanosine (8-OHdG) enzyme-linked immunosorbent assays, respectively. LBONE caused cytotoxicity in three of the four cell lines, namely RPMI-2650 (200 µg/mL), HuTu-80 (200 µg/mL), and H4IIE-luc (100–200 µg/mL), while LLOX was cytotoxic towards the A549 and H4IIE-luc cells at 100–200 µg/mL. LCON was non-cytotoxic. Both LBONE (5 µg/mL) and LCON (1–5 µg/mL) induced oxidative stress ($p \leq 0.05$) in the RPMI-2650 cells. The majority of the ceramic resins did not cause DNA damage, except in the A549 (5 µg/mL LBONE, $p \leq 0.05$) and H4IIE-luc (50 µg/mL LBONE, LCON and LLOX) cells, where exposure increased the concentration of 8-OHdG, indicating potential DNA damage. The findings of this study show that selected ceramic resin feedstock materials used in AM cause cytotoxicity, oxidative stress and/or DNA damage in human nasal, lung, intestinal, and rat liver cell cultures. Consequently, ceramic resin feedstocks may pose a potential occupational health risk to AM operators. However, this warrants further investigation.

1.03.P–TuWe22 Multiple Biological Effects in Albino Mice, Mus musculus and Public Health Risks of Occupational Exposure to Volatile Organic Compounds (VOCs) Emissions in a Printing Press

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Printing press operations have been identified as significant sources of volatile organic compounds (VOCs), posing potential health risks to printing press workers. This study assessed the biological effects (genotoxic, biochemical and histological) in albino mice, Mus musculus and public health risks of occupational exposure to VOCs at a printing press in Somolu Local Government Area of Lagos State, Nigeria. The mice were exposed to VOC emissions in a printing press for 8 hours daily to simulate human exposure to these compounds over a period of 28 days. The levels of Total Volatile Organic Compounds (TVOCs) in the printing press ranged from 1.51 to 2.01 mg/m3 exceeding the exposure limits of 0.5 mg/m3 recommended by the WHO. There was a duration-dependent significant increase in genotoxic indices (micronucleated, binucleated and notched nuclei cells) and MDA levels as well as significant decreases in the levels of antioxidant enzymes (CAT, SOD, GSH, GPx) (biochemical indices) in the male and female exposed mice compared to the control mice. There were duration-dependent lung histopathologies (haemorrhage and inflammation of the alveoli membrane – day 14; distention of alveoli wall vessels, capillaries congestion with many RBCs and edema – day 28) in the male and female exposed mice though more pronounced in the females compared to the controls. The public health risk evaluations revealed that most of the Printing press workers do not use PPEs during operations and are not trained about this. Symptoms like headache, chest pain, dizziness, eye and nose irritation which are associated with exposure to VOCs were reported by the workers. These results imply that long term exposure to VOCs may predispose workers especially females in the printing industry to adverse health risks necessitating urgent behavioural and technological interventions to promote good health and wellbeing (UN SDG 3).

1.03.P–TuWe24 Assessment of heavy metals contents in chicken organs purchased locally from a store, South Africa

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Food safety and security have been recognized to be major growing issues within the food supply chain, raising scientific and public health concerns globally. Nonetheless, chicken is susceptible to contaminant by environmental pollutants, particularly heavy metals, which can bioaccumulate and magnify, posing a risk to human health. This study determine the heavy metals concentrations in various chicken organs (kidney, liver, gizzard, heart, and muscle) and the potential human health risks associated with the consumption of these chicken organs. The heavy metal content of chicken samples was determined using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). A total of 100 samples of chicken organs, 25 each from the kidney, gizzard, heart, muscle, and liver, were randomly purchased from South African chicken butchers. The mean concentrations of metals in chicken organs, measured in mg/kg, ranged from 1.94 - 10.29 for Mg, 0.02 - 17.97 for Cr, 0.02 - 3.13 for Mn, 0.39 - 41.93 for Fe, 0.02 - 12.87 for Ni, 0.01 - 0.53 for Cu, 0.10 - 2.01 for Zn, 0.01 - 0.02 for As, ND for Cd, and 0.02 - 0.06 for Pb in the same samples, respectively. The results indicate that all samples showed high levels of all elements above WHO limit except for Pb, while Cd were undetectable in all of the samples. Moreover, the liver exhibited the largest concentrations of elements. To maintain compliance with safety recommendations, the indicated sources of these metals (soil, water, and food) must be frequently monitored.

1.03.P–TuWe25 Assessing the Occurrence and the Environmental Risk of a COVID-19 drug, Dexamethasone, in the Orange-Senqu River Basin

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The onset of Covid-19 has led to the widespread occurrence of pharmaceuticals in aquatic ecosystems in addition to the low removal efficiency of wastewater treatment plants for emerging contaminants. These contaminants pose environmental risks even at the trace concentrations which they are detected. The prevalence of dexamethasone, a repurposed Covid-19 drug, poses aquatic disruptions and persistent environmental risks in the Orange-Senqu River basin which remain unaddressed. The study, therefore, investigates the occurrence of dexamethasone in the Orange-Senqu River basin, assesses its environmental risk and how chemometric indices substantiate its concentrations in relation to river health. The liquid chromatography mass spectroscopy analysis detected 15.43µg/ml, 39.42µg/ml, and 12.28µg/ml of dexamethasone in water samples from sites 4, 5 and 8, respectively. The method detected 1.59µg/g, 18.21 µg/g, 8.10 µg/g and 18.44 µg/g, in sediment samples from sites 1, 5, 7 and 8, respectively. Other sampling stations had undetectable concentrations. Additionally, detection of dexamethasone in water and sediment samples from similar stations was inconsistent as traces were detected in water samples and sediments had no detectable traces. This demonstrates spatial variability of the samples. The chemometric indices indicated that the drug may have altered the water chemistry although they do not validate its presence. The calculated risk quotients demonstrated high risk levels for fish compared to daphnia with maximum values of 39.42 and 18.44 in water and sediments, respectively. The presence of dexamethasone was detected in both water and sediment samples despite its variability across different sampling sites and in samples from similar sites. The undetectable concentrations in other sites and samples are attributed to dexamethasone occurring at traces below the limit of detection of the analytical method. The high-risk levels of dexamethasone fish urge an immediate intervention of including pharmaceuticals in monitoring programs. The varying values of the chemometric indices – Larson Index and Ryznar Stability Index, in relation to the detected concentrations of dexamethasone do not show a relationship which validates its presence and river health. However, in addition to the indices, water quality trends indicate that river health is attributed to other non-point sources of pollution extending to land use/cover and urbanization. To this effect, the above findings indicate an urgent intervention to monitor pharmaceutical concentrations at areas with high concentration levels.

1.04 - The Application of Bioassays for Adverse Outcome Pathways for Water Quality and Safety Assessment

1.04–T01 Tracing Toxicants for Exposure Assessment: the Use of Effect-Directed Analysis for Identification of Chemicals

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In our modern, daily lives we are all exposed to a multitude of chemicals varying in their physico-chemical characteristics. We are exposed via inhalation, ingestion and through the skin, with some exposure routes being more important than the other. Ultimately, all the chemicals in our living environment may find their way into our bodies, where they may be capable of interfering with e.g. metabolic processes and possibly impact our health. The classical approach to assess exposure is by quantitative, targeted analysis of a set of defined chemicals. Due to the large number of chemicals in use, it is certain that we are overlooking a significant part of the chemical space by applying these targeted methods. With the advancement of high resolution mass spectrometry (HRMS), a complementary approach is explored and continuously further developed and finetuned: suspect and nontarget screening. In this approach, the accurate mass measurements in combination with other characteristics like retention time, hydrophobicity, etc are used to try and identify the chemical measured. A very dynamic scientific community is continously improving aspects of the data processing and evaluation workflow. In our lab, we have developed an experimental prioritization approach in which we use in vitro bioassays to direct the chemical analysis to those regions of the mass chromatogram where we observe a biological response. This is done by liquid chromatographic microfractionation using a FractioMate [1], into the well plate(s) used for the in vitro testing. Endpoints for these assays can vary, e.g. endocrine disruption, mutagencity and/or antibiotic activity. In this presentation, examples will be presented of the application of Effect-Directed Analysis for the identification of chemicals.

1.04–T02 A South African Perspective on The Application of Effect-Based Methods (EBM) for Water Quality and Safety

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Surface waters contain a wide range of chemical contaminants negatively affecting human and environmental health. Effect-based methods (EBM) using in vitro and in vivo bioassays are recommended for water quality assessment to complement chemical analysis. The assays can assess the biological activity of the complex mixture. The aim of the study was to use case studies to assess the feasibility of the different EBMs contained in the South African toolbox on different water sources and types. The results showed that use of in vitro and in vivo screening assays developed for the South African scenario can provide biologically relevant information and complement chemical analysis. The assay endpoints are in line with the Global Water Research Coalition's recommendations for water quality and safety. Based on the toolbox and the results of the case studies a decision-making tool for South African applications was developed.

1.04–T03 The Application of Biological Assays in Water Quality Monitoring: A South African Case Study

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There are mixtures of contaminants in potable or environmental water. Many are detrimental to human and animal health. These compounds are acutely toxic at high concentrations, causing death. At lower concentrations, they cause chronic health issues such as endocrine disruption and cancer. In a developing country like South Africa, water quality monitoring guidelines are limited to routine analysis of a small selection of chemical contaminants. Even if it were possible to chemically quantify the thousands of contaminants present at any one time, it is impossible to predict the biological effect of the mixture. In this study, we investigated various biological assays available in South Africa for their suitability to quantify and/or qualify the biological effect of the compound mixture in environmental waters, treated waste waters, and the potable water of a rural town in South Africa. Treated wastewater treatment plant (WWTP) effluent was also collected. Water was sampled twice, once in a low-flow and high-flow season. The in vivo assays use biota such as bacteria, micro-algae, aquatic plants, crustaceans and fish to represent different trophic levels. Hazard classes for the water samples were determined based on the percentage of mortalities (lethal) or inhibition (sub-lethal) effects the exposed biota exhibited. The in vitro assays are reporter gene assays,

using genetically modified yeast and mammalian cell lines. Between them, they detect ligands of the aryl hydrocarbon receptor (AhR), marker of xenobiotic metabolism; ligands of the following hormonal receptors: oestrogen (ER), androgen (AR), and thyroid (TR) and compounds eliciting oxidative stress. The hazard classes of the in vivo assays ranged from hazard score of II (slight acute hazard) in a dam to V (high acute hazard) in the middle of a wetland. The ER was activated in the samples from all the sites, and the agonist concentration ranged from 0.02±0.04 –108±31 ng/L oestradiol-equivalents (Eeq). The highest Eeq was at the outflow of the WWTP. The same site also had the highest androgen activity (159±31 ng/L) dihydrotestosterone-equivalents. None of the sample extracts elicited a response from the AhR and thyroid receptors. The cell line detecting oxidative stress reacted to every sample extract and ranged from 12.6–1 106 µg/L dichlorovos-equivalents. The highest oxidative response coincides with the highest hazard class of the in vivo battery of tests, which came from the middle of the wetland.

1.04–T04 Clade Matters: Ecotoxicological Comparison Between the European and the North Atlantic Lineages of Eurytemora affinis

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Several aquatic invertebrate taxa commonly employed in environmental risk assessment (ERA) exhibit cryptic diversity, which can potentially confound the interpretation of results. The copepod Eurytemora affinis serves as a model organism for ecotoxicological research in oligo- to mesohaline estuarine environments and holds promise for application in ERA. However, E. affinis is a cryptic species complex composed of at least six genetically distinct, yet morphologically similar clades. It is therefore essential to investigate how this cryptic diversity may influence sensitivity to contaminants. The present study aimed to assess the ecotoxicological response of genetically distinct E. affinis clades. Specifically, the sensitivity of the European (E) and the North Atlantic (NA) clades from the Seine (France) and the St. Lawrence estuaries (Canada), respectively, was compared. Both clades were exposed to lithium (Li) and benzo[a]pyrene (BaP) using a standardized semi-chronic larval bioassay in separate experiments. Nauplii were exposed for 96h to Li (0.40, 4.39, 35.36, and 80.83 mg·L-1) and BaP (0.54, 5.39, 15.85, and 61.95 µg·L-1). Each treatment was performed in six replicates with 10 nauplii per replicate. Endpoints assessed after 96h included naupliar survival, growth and development. Median lethal and effective concentrations (LC50 and EC50) were calculated for each condition. No difference in survival were observed between the E and NA clades following Li exposure. The E clade was more sensitive in terms of growth and development, with EC50 value of mg·L-1 compared to 41.45 mg·L-1 for the NA clade. In contrast, the E clade demonstrated higher sensitivity to BaP, with an LC50 value of 8.41 µg·L-1, approximately 2.5-fold lower than the NA clade (22.24 µg·L-1). Growth and development were also more adversely affected in the E clade after BaP exposure. These findings indicate that E. affinis cryptic species (clades) may exhibit differential sensitivity to toxicants, likely due to genetic divergence and potential local environmental adaptations. Despite the observed inter-clade variation, the magnitude remains within the acceptable range of environmental variability considered in ERA, especially if a conventional safety factor of 10 is applied. This study provides valuable insights into the implications of cryptic diversity for the use of E. affinis in ecotoxicological bioassays and supports its continued application within the ERA framework.

1.04–T05 Poster Spotlight: 1.04.P–TuWe29, 1.04.P–TuWe30, 1.04.P–TuWe31

1.04.P–TuWe29 - In-vitro Assessment of Endogenic, Androgenic, Dioxin-like, Photosystem II inhibition and Genotoxic Potency in the Vall Harts Irrigation Scheme, South Africa; 1.04.P–TuWe30 - Biological effects of chemicals in the sediment of South African ports; 1.04.P–TuWe31 - Application of Adverse Outcome Pathways as a Risk Assessment Tool of Metal-Based Nanomaterials

1.04.P - The Application of Bioassays for Adverse Outcome Pathways for Water Quality and Safety Assessment

1.04.P–TuWe32 Can The Geotaxis Behaviour Of Mosquito Larvae (Culicidae) Be A Reliable Predictor Of Water Quality?

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Geotaxis is the behavioural response of an organism under the influence of gravitational forces. Geotaxis can either be negative or positive. A negative geotaxis refers to when an organism moves away from the centre of the earth and a positive geotaxis refers to when an organism moves towards the centre of the earth. Mosquito larvae display negative geotaxis behaviour in aquatic environments as this is their survival mechanism. In this study we used manganese metal, pymetrozine insecticide and distilled water (control) to assess the mortality and geotaxis of the mosquito larvae after exposure to these chemicals. Cohorts of ten Culex.sp second instar larvae were exposed to varying concentrations of the solutions. Mortality assays were conducted in 100 ml glass beakers filled to capacity. Exposures were carried out in 4 replicates and incubated for 24 hours at 20 ± 2 °C in a Kelvinator incubator (K385 FF). After the exposure duration, the dead larvae (fully immobile or unresponsive to tactile stimuli) were counted. Geotaxis behaviour assays were carried out at a room temperature between (18-20ºC) and 15 individual Culex.sp second instar larvae were exposed and recorded for all treatments of pymetrozine, manganese and distilled water (control). During the exposure time of 10 minutes, the cumulative time the mosquito larvae spent breathing at the water surface, moving upward within the water column and downward below the water surface or resting at the bottom of the water column was evaluated. The results indicated that larval mortality increased with increasing concentrations of both manganese (LC50 =572.074 mg/L) and pymetrozine (LC50 =20.259 mg/L). At 20 mg/L pymetrozine concentration, negative geotaxis behaviour decreased thus indicating a possible link between geotaxis behaviour and mortality. Further research is needed to enhance these approaches and evaluate their applicability across different species and environmental backgrounds.

1.04.P–TuWe33 Adverse Outcome Pathways in Sediment Toxicity Testing: A Case Study for the Biocide DCOIT

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The adverse outcome pathway (AOP) is a framework that summarizes mechanistic data and toxicity knowledge seeking cause-effect relationships between molecular initiating events and adverse effects at higher levels of biological organization. One advantage of AOP is the potential for using molecular or biochemical biomarkers to predict apical responses in individuals and populations, as an important tool in regulatory toxicology and risk assessment. AOP applications in aquatic toxicology include in vitro and in vivo models of waterborne exposure, with limited information on benthic organisms owing to the complexity of sediment exposure in terms of chemical mixtures and species traits. In contrast, omics techniques such as transcriptomics have emerged to improve sediment toxicity evaluation by establishing molecular initiating events and biomarker identification. Thus, this study aimed to evaluate the sediment toxicity of toxicants with a focus on molecular and biochemical biomarkers, using an AOP approach. Dichlorooctyl isothiazolinone (DCOIT) is the active ingredient in Sea-Nine 211TM, which is widely used in antifouling systems. DCOIT is a pseudo-persistent contaminant in areas affected by shipping traffic, harbors, and marinas. Transcriptional profiling of the burrowing amphipod Tiburonella viscana was performed using RNA-seq following toxicity testing using samples spiked with DCOIT (100 and 1000 ng/g). Transcripts revealed inhibited expression of genes associated with protein refolding, cytoplasmic translation, assembly of ribosomal subunits and nucleosomes, and biosynthesis, thus characterizing a protein refolding response as a molecular-level response, with biomarker responses determined as key events. The results of AOP 206 from the AOP-Wiki knowledgebase were used, in which protein adduct formation caused by chemical stressors led to neurodegeneration. Thus, the DCOIT-induced responses supporting this process include an unfolded protein response, oxidative stress, and apoptosis. We hypothesized that this cascade might represent a mode of action of DCOIT in benthic organisms, potentially linked to mortality at higher biological levels.

1.04.P–TuWe29 In-vitro Assessment of Endogenic, Androgenic, Dioxin-like, Photosystem II inhibition and Genotoxic Potency in the Vall Harts Irrigation Scheme, South Africa

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Effect-based monitoring provides an integrative approach to identifying potential hazards, as it can detect adverse effects or potentials present in the sample or sampling point. A hazard identification gap for complex compounds can be filled by applying effect-based approaches to environmental pollution monitoring. This study intended to investigate the presence of contaminants in surface water samples using in vitro bioassays for water quality monitoring. Water samples were collected in the vicinity of the Vaalharts irrigation scheme in July 2024, where different sections were selected to help understand the impact of the irrigation scheme on water quality. In vitro assays were conducted as part of biological monitoring to screen for endocrine, dioxin-like, photosystem II inhibitors and genotoxic effects in the water. The following bioassays were performed: Yeast Androgen Screen (YAS), Yeast Anti-Androgen Screen (YAAS), Yeast Estrogenic Screen (YES), Yeast Anti-Estrogenic Screen (YAES), Yeast Dioxin-like Screen, AMES test, and Photosystem II Inhibition. The bioequivalent values (EQs) for each bioassay were estimated. None of the samples possessed YAS (T-EQ < 39.025 ng/l), YAAS (Flu-EQ < 7641 ug/l), and YAES (OHT-EQ < 85.901 µg/l) activity. Similarly, the tested samples had no mutagenic potential; TA98 and TA100 showed no mutagenicity. However, the YES bioassay revealed that samples from seven sampling sites were estrogenic (E2-EQ > 0.132 ng/l). Moreover, all samples exhibited significant photosystem II inhibition activity. Suggesting that the photosystem II inhibition assay is the most relevant test to assess the agricultural impact. Estrogenic activity and photosystem II inhibition could be associated with pesticide and herbicide use in the Vaalharts irrigation scheme, with the potential to impact aquatic life. Therefore, without any interventions, water quality will continue deteriorating and not be suitable for aquatic life. These findings can be used for efficient and good water management solutions and to implement more stringent management control measures into the design of more effective environmental protection strategies. Exploring different seasons for future studies will give more insight.

1.04.P–TuWe30 Biological effects of chemicals in the sediment of South African ports

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Persistent organic pollutants (POPs) adsorb to sediment in waterways due to their hydrophobic nature. These include herbicides and endocrine-disrupting compounds such as polychlorinated dibenzodioxins and -dibenzofurans, polycyclic aromatic hydrocarbons and polychlorinated biphenyls. They enter aquatic systems via wastewater treatment plants, industrial effluents, and agricultural and urban runoff. Due to their hydrophobicity, these pollutants accumulate in sediments and are transported to the marine environment through fluvial sediment transport. Marine ecosystems are particularly vulnerable to additional pollution from oil spills and shipping-related activities. While previous studies have identified the presence of pollutants in South African harbour sediments, there is a need to assess the changes in pollutant levels over recent years and determine the exact risks they pose. This is crucial as many pollutants biomagnify through the food chain, posing a threat to both human health and local biota. In 2024, sediment samples were collected from three large harbours in South Africa (Richards Bay, Cape Town, and Durban) for bioassay analyses. Testing focused on xenobiotic metabolism through activation of the aryl-hydrocarbon receptor (AhR), as well as endocrine disruption through activation of androgen and glucocorticoid receptors. Both cell lines used (the H4IIEluc cell line and the MDAkb2 cell lines) also evaluate cytotoxicity and oxidative stress caused by environmental pollutants. The hypothesis of this study is that sediment extracts from the harbours will cause biological effects upon exposure to the different cell lines. Upon obtaining results, comparisons with prior studies will be made, and the overall threat posed by contaminants in sediment in each harbour will be evaluated based on international guideline levels. Additionally, this study facilitates comparisons with other global sites and international environmental guidelines. It is anticipated that sediment samples will show significant biological activity due to the presence of POPs. Xenobiotic activation in the H4IIE-luc cell line is likely, particularly in areas with high industrial and shipping activity. Endocrine disruption is expected to be most pronounced in samples taken closer to depositional zones and inflow areas. Cytotoxicity and the H4IIEluc assay results are expected to correlate since many AhR ligands (like dioxins and PAHs) are also toxic at higher doses.

1.04.P–TuWe31 Application of Adverse Outcome Pathways as a Risk Assessment Tool of Metal-Based Nanomaterials

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The adverse outcomes pathway (AOP) is a conceptual framework that can be used to show the linkages between sub-cellular initiating events and adverse outcomes. It allows for the organization of available biological information to understand how the health of wildlife and humans may be disrupted due to chemical and non-chemical stressors. The AOP framework therefore integrates (eco)toxicological processes across levels of biological to be implemented in studies from understanding stressor mediated adverse effects to management to risk assessment (both ecological and human). The AOP is a modular framework that elucidates the causal relationships between sub cellular processes (Molecular Initiating Events; MIEs); cellular, organ level, organ system and organism-level processes (Key Events; KEs) and population and ecosystem community responses (Adverse Outcomes; AOs). One of the main critiques of the framework is that due to its bottom-up approach there is a very strong focus on the cellular and molecular mechanisms and the outcomes that are important for risk assessment, i.e. protection of populations is not well represented. The use of Bayesian Networks (EN) through the relative risk assessment (RRM) framework is a promising method to incorporate AOPs into quantitative risk assessment. The RRM framework allows for the development of quantitative AOP (qAOP) networks that could define the relationships underlying transition from one KE to the next sufficiently well to allow quantitative prediction of the probability or severity of the AO occurring for a given activation of the MIE. In this poster we demonstrate the application of the AOP concept using three different indicator organisms, i.e. Caenorhabditis elegans (nematode), Daphnia magna (freshwater crustacean) and Danio rerio (freshwater fish) that were exposed to nanogold. We further demonstrate the potential application of BN-RRMs and AOPs in the risk assessment of nanogold.

1.05 - The Triple Planetary Crisis: Climate Change, Biodiversity Loss, Pollution

1.05–T01 A 'Blueprint' Assessment Workflow for Linking Impacts from Chemical Pollution to Biodiversity Loss

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Together with climate change, chemical pollution and biodiversity loss constitute the main elements of the current triple planetary crisis. However, it is currently not well understood how chemical pollution contributes to biodiversity loss. A targeted workflow showcasing how and which types of data and models can be effectively integrated to connect chemical ecotoxicity information to various levels of biodiversity damage is hence urgently needed. We address this gap by developing a conceptual overview of how to link chemical pollution to damage on biodiversity at different levels, and how related data and models can be integrated. An illustrative case study with initial focus on freshwater ecosystems demonstrates the proposed workflow, with recommendations how to apply this workflow more broadly. Main results are a conceptual framework to build on and integrate various existing data streams and models to link chemical ecotoxicity to biodiversity loss, an aligned definition of biodiversity damage metrics ranging from damage on species richness, genetic diversity, functional diversity and ecosystem services, recommendations for how to scale up the proposed workflow and how to integrate the proposed metrics as complementary criteria for chemical prioritisation efforts, and a quantitative link between ecotoxicity data and biodiversity damage as new line of evidence for chemicals risk assessment and management. The proposed targeted workflow developed or a regional scale with available data will serve as a blueprint for conducting larger-scale analyses for various types of regions, ecosystems and stressors. With that, such a blueprint aims at creating critical knowledge for improving chemical risk assessment through the introduction of biodiversity-related lines of evidence, and clarifying the link between chemical pollution and biodiversity loss to inform policies, such as UNEP's Global Framework on Chemicals, to enable the evaluation of policy options and management strategies, and to inform the private and financial sectors to foster sustainable investment and production practices worldwide.

1.05–T02 Climate Warming Shifts Communities to be More Sensitive to Chemical Pollutants

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Climate change and pollution are major drivers of biodiversity loss, but they are not independent. Increased temperature has

been shown to enhance chemical toxicity but less is known about how climate-induced changes in biodiversity may alter the sensitivity of assemblages to chemical stress. Here we explore the potential consequences of future climate change on the composition and sensitivity of freshwater macroinvertebrate assemblages to chemical stressors using the UK as a case study. End of the century macroinvertebrate assemblages were predicted for 608 UK sites for four climate scenarios (mean temperature changes of 1.28 to 3.78°C) and sensitivity to 19 chemicals (metals and insecticides) assessed. All four future climate scenarios resulted in a shift in the taxonomic composition of assemblages, with many associated with changes in the percentage of species at risk from chemical exposure. Climate warming is predicted to result in changes in the use, environmental exposure and toxicity of chemicals. Here we show that, even in the absence of these climate-chemical interactions, shifts in species composition due to climate warming will increase chemical risk and that the impact of chemical pollution on freshwater macroinvertebrate biodiversity may double or quadruple by the end of the 21st century.

1.05–T03 South African PESEIS approach to the management of multiple stressors affecting vulnerable water resources on multiple spatial scales

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The Limpopo River Basin, located within the borders of Botswana, Mozambique, South Africa and Zimbabwe in southern Africa, is one of the region's most ecologically important biodiversity hotspot areas with >18million vulnerable Africans who also depend on the services of the system for their livelihoods. The water resources of the region maintain a high diversity of aquatic animals many of which are endemic to the region, and dynamic ecosystem processes that contribute to the high socio-ecological importance of these water resources. Major water users include sizable urban areas, mining, industry, power stations and irrigated farming but apart from these water users there is still a high level of poverty in many regions of the basin that are characterised by rural communities that rely on rainfed subsistence farming and natural products derived from the ecosystem. Water resource development for agriculture, the provision of water for urban centers, industrialization, mining development and growth in the population have all increased the pressure on the already limited water resources of the Limpopo River basin and water scarcity is considered to pose the greatest threat to the livelihoods, economies and ecosystems of the Limpopo River basin. The variability of the environment and multiple flow, water quality and habitat stressors associated with the regional development, affects the quality and availability of ecosystem services and habitat and productivity of the ecosystem. The aim of this study was to use regional socio-ecological information related to the structure, function, use and protection of water resources in the context of regional management targets, to carry out a holistic regional scale ecological risk assessment addressing flow and non-flow stressors using the PROBFLO method. The study area includes the transboundary Limpopo River Basin in southern Africa that originates in the highlands that separate South Africa from Zimbabwe and Botswana and enters the Indian Ocean in Mozambique. In this assessment the socio-ecological consequences of altered flows have been evaluated by assessing the risk of alterations in water flow, in the context of non-flow variability to a number of ecological and social endpoints using the regional scale ecological risk assessment method PROBFLO. The regional scale ecological risk assessment method was developed in 1997 to consider the real properties of ecological structures and all the stressors effecting it within the spatial areas relevant to managers to ensure that the interaction of all components are taken into account when decisions are made. The approach has been considered to be suitable to meet the requirements of good practice, holistic eflow assessment frameworks. In 2018 a method incorporating Bayesian Networks and the Relative Risk Method was incorporated into a regional scale holistic eflow assessment method called PROBFLO that was implemented in this study. A review of available water resources information from the study area and region was undertaken in this study and with stakeholders of the study area and real hydrological and hydraulic information, the ten procedural steps of PROBFLO were undertaken. The application of the PROBFLO method included the establishment of a vision (step 1) for the study area and three social endpoints and nine ecological endpoints to represent the socio-ecological ecosystem of concern. In step 2-4, available data and expert solicitations were used to represent our understanding of the ecosystem and source, develop stressor, receptor and endpoint relationships for the study in the context of present and future resource use and protection scenarios that resulted in the selection of risk regions for the study and a conceptual model to direct the rest of the assessment. A suitable ranking scheme (step 5) was established as a foundation for the assessment and in the risk calculation phase (step 6) a Bayesian Network tool was used to perform the risk assessment. Hypothesised risk to the social and ecological endpoints for present conditions were initially determined and the tool was then calibrated using modelled natural environmental conditions and worse case scenario conditions. The risk model was then used to determine eflow requirements for the rivers and wetland in the delta, and evaluate the relative socio-ecological consequences of alternative water resource use and protection scenarios. These outcomes were presented to stakeholders with associated uncertainty and recommendations to reduce uncertainty, mitigate risk and establish a sustainable balance between the use and protection of the water resources in the study area. This study was undertaken in response to the concerns that stakeholders of the water resources of the Limpopo River Basin have

that the existing and planned use is unsustainable and may have significant, unacceptable socio-ecological consequences. The relative risk outcomes for all of the development scenarios considered result in moderate to high risk probabilities for most social and ecological endpoints considered, demonstrating that the basin has already been unsustainably developed. Only three of the 27 risk regions/sub-basin areas including the Luvuvhu, middle Limpopo and lower Limpopo River areas are in a moderate, potentially sustainable risk state. The risk of multiple stressors associated with natural, present, eflows and a future drought scenario demonstrates a massive shift towards excessively used conditions today to sustainability if the eflow scenario is adopted. This scenario represents an acceptable balance between the use and protection of the water resource throughout the basin. This eflow scenario represents a considerable improvement across the basin but it may not meet biodiversity conservation requirements due to the moderate to hard working vision for the basin. The stressors that need to be managed to achieve the eflow scenario includes flows, water quality, habitat and barrier management and other disturbance to wildlife stressors. The eflows from the study are being considered for adoption on a trial basis towards sustainability by multiple stakeholders of the shared basin. The PROBFLO method was successfully applied to the Limpopo River Basin to contribute to the evaluation of risk of multiple stressors to multiple social and ecological endpoints in the context of holistic eflows management in this transboundary ecosystem. From these outcomes, stakeholders have, been able to consider sustainable social and ecological trade-offs between, to balance the use and protection of water resources in the study area. And we have provided the initial requirements for eflows to maintain the socio-ecological sustainability of the water resources in the region. Although the accuracy of the PROBFLO projections used to guide sustainable water resource use needs to be validated when developments in the study area takes place, the adaptability of the approach allows for the incorporation of new information rapidly which will inform adaptive management.

1.05–T04 Water Beetles as Indicators of Climate Change Vulnerability in Freshwater Ecosystems

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The rapidly changing climate is a global phenomenon that is expected to have severe impacts on our water resources in South Africa. However, specifics regarding the nature and extent of these effects on aquatic ecosystems have not been adequately investigated. This is mainly due to the lack of empirical studies testing biotic responses to the expected thermal changes resulting from climate change. Macroinvertebrates are one of the best-known indicators of environmental change in freshwater ecosystems, and within this group, water beetles show promise as indicators of thermal stress. There are a limited number of studies that focus on investigating the thermal tolerance of water beetles in Austral regions when compared with those available for the Northern Hemisphere. This study aims to compare the vulnerability of widespread Pan Ethiopian vs ancient Gondwanan fauna to climate change by assessing the relative thermal sensitivity of water beetle taxa inhabiting each faunal group. It also aims to compare this data with the available data from the Northern Hemisphere. The study utilizes both dynamic ('Critical Thermal Maximum/Minimum' – CTM) and static ('Incipient Lethal Temperature' – ILT) exposures to assess relative differences in thermal tolerance among the regions, habitats and taxa. It is broadly hypothesized that Pan Ethiopian water beetles will be more vulnerable to climate change than Gondwanan water beetles.

1.05–T05 Climate Change: Friend or Foe, the Tarebia granifera Story

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Aquatic ecosystems are increasingly threatened by multiple stressors such as climate change, pollution and invasive species. In Africa, and especially in South Africa, there is limited information on invasive freshwater invertebrates, including molluscs, despite growing concern over their ecological impacts as well as their interaction with climate change and pollution. Of the thirteen alien mollusc species recorded in South Africa, Tarebia granifera (Lamarck, 1816), commonly known as the Quilted Melania snail, is believed to pose the greatest risk to native freshwater biodiversity. This study aimed to assess the risk T. granifera poses to native freshwater fauna in South Africa, with a specific focus on how climate change may influence the future spread and ecological impact of the species. Climatic suitability models were used within the Risk Analysis for Alien Taxa (RAAT) framework to evaluate both current and future risks within South Africa. A multi-model species distribution modelling approach was used alongside the CSIRO-Mk3.6.0 RCP 4.5 climate scenario to project areas of potential suitability under climate change. Results show that T. granifera already poses a high risk under present climatic conditions, with large regions of South Africa identified as suitable for its establishment. Climate projections indicate a further increase in overall habitat suitability, suggesting a likely expansion of the species' range over time. These findings highlight the importance of climate change as a compounding factor in biological invasions. Understanding how climate change interacts with invasive species dynamics is essential for informing conservation efforts and developing proactive management strategies. This research advances current knowledge of multiple stressor assessment in South Africa, especially in the context of freshwater

biodiversity. The findings are relevant for conservation planning, risk assessments, and the development of targeted biosecurity measures in the face of climate change

1.05.P - The Triple Planetary Crisis: Climate Change, Biodiversity Loss, Pollution

1.05.P–ThFr01 Scoping Review of Multipollutant Data Analysis and Visualization Methods for Chemical Mixture Risk Assessment

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While in a real-world context, we are exposed to a mixture of pollutants simultaneously, ambient air quality targets and permitted emissions tend to be set based on single-pollutant assessments. Therefore, current policymaking can fail to capture the synergistic (health) effects of real-world exposures, which often disproportionately impact marginalized communities. Integrating chemical mixture attributes into risk assessment requires cumulative methods that effectively analyze and visualize multipollutant data. Many analysis techniques for multipollutant data sets (e.g. dimensionality reduction techniques, clustering, correlation, cumulative indicators, etc.) are effective in reducing the complexity of high-dimensional data sets and produce informative multivariate patterns. Yet, these methods often generate abstract, technical outputs, which are difficult to interpret, especially for non-experts. Condensing a complex multivariate system with intertwined pollutant dynamics resists linear approaches and simple characterization. As a result, we face the trade-off between preserving detailed information and maintaining interpretability in the data representation. Our work examines how existing methods either simplify or preserve the complexity of multipollutant data and how methodological choices shape the resulting patterns. We conducted a scoping review of approaches exploring spatiotemporal pollutant patterns, including meteorological factors, emission sources and affected population characteristics. As an illustration of strengths and trade-offs highlighted through this review, we applied Principal Component Analysis (PCA) and Self-Organizing Map (SOM) to a case study from a Vancouver neighbourhood. SOM applied to raw pollutant data revealed distinct pollutant profiles aligned with diurnal cycles. Given that the number of input variables is reasonably small, the resulting pollutant profiles are readily interpretable and understandable. We hypothesize that applying PCA before SOM can help reduce complexity in data sets with higher dimensions, though resulting patterns become more abstract and require careful interpretation. These findings contribute to ongoing efforts to refine analytical tools for multipollutant datasets, emphasizing methods that balance complexity with interpretability, aligning more closely with real-world exposure patterns.

1.05.P–ThFr02 Awareness, Understanding and Practices of Household Waste Recycling: A Comparative Study of Low-and-High-Income Communities in the North of Pretoria, South Africa

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Various environmental regulations on solid waste management have been implemented in South Africa during the past two decades but have not adequately emphasized waste reduction through household waste recycling. Recycling household waste is fundamental for reducing landfill waste, minimizing environmental pollution and encouraging sustainability. This study assessed the practices, awareness and understanding of household waste recycling in high-income and low-income communities in the North of Pretoria, South Africa. A structured questionnaire was administered through face-to-face interviews and a door-to-door survey. A purposive sampling involving 122 participants was carried out. Data was collected from September 2023 until April 2024 and analysed using descriptive statistics and the Pearson chi-square test. Communities used for the study were divided into four sites (A, B, C and D) based on income. At sites A, B and C (low-income communities), 81.6%, 81.4%, and 75.0 % of participants, respectively, did not separate waste, whereas at Site D (high-income community), 61.5% of the participants did not separate their household waste before disposal. Participants from all the communities knew about recycling in the following order, Site D (76.9%) >Site C (60.7%) >Site A (60.5%) >Site B (51.2%), However, actual recycling rates remained low, with only 30.7% of high-income and 15.8% to 20.1% of low-income participants partaking in recycling practices. Inadequate time and lack of infrastructure were given as the major obstacles to household waste recycling by participants. Recycling was only carried out where there was evidence that it may lead to financial gains. Despite their knowledge of recycling, most participants did not recycle their household waste. Awareness campaigns and incentives ought to be introduced to encourage recycling and boost community participation. The creation of local recycling centres could enhance engagement in recycling, resulting in employment opportunities.

1.06.A - Wildlife Ecotoxicology: Integrating Bottom-Up and Top-Down Effects of Stressors in a Changing World

1.06.A–T01 Effects of Environmentally Relevant Pollutant Mixtures on Common Frog (Rana Temporaria) Tadpoles

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Small freshwater bodies, such as ponds, are biodiversity hotspots that provide important ecosystem services and are susceptible to chemical contamination due to their small water volume and often close proximity to anthropogenic structures. We investigated the chronic effects of environmentally relevant mixtures of metals, pesticides, and pharmaceuticals on survival, development, and growth of the common frog (Rana temporaria). Tadpoles (n = 9 per tank, 6 replicates per treatment) were exposed to different treatments in controlled laboratory conditions (18°C, 16:8 light-dark cycle) from newly hatched tadpoles to completion of metamorphosis. The experimental treatments comprised: a control, a solvent control, base metals (144.852 µg/L) and base organics (65.49 ng/L). Mixtures were also applied: Mix A & B contained base metals and base organics at static concentrations, alongside a concentrations range of unique components (range: 0.0079-1160 ng/L). Mix C comprised a concentration range of the base organics (0.6549 – 6549 ng/L) alongside the static concentration of the base metals. Endpoints recorded were survival, developmental rate and tadpole body condition (SMI) - which was analysed across three developmental stages (early, mid, and late). Results revealed significant differences in survival among treatment groups, with exposure to the lowest concentrations (Mix A5, B5, and C5) resulting in higher mortality compared to controls. By the end of the experiment, 90.57% of controls reached Gosner stage 40 and a significant reduction was observed in response to Mix C1, with only 63% reaching stage 40 ($p < 0.03$). Lower SMI was recorded in response to treatments BO, Mix A1, A3, A4, Mix B1, B2, B4, and Mix C1, C3, C4, C5 at the early stage. No effects were observed at later time points in tadpoles, nor at completion of metamorphosis. In conclusion, the effects did not follow a typical dose-response pattern: lower concentrations had a greater impact on survival, while higher concentrations more strongly affected development and growth. Further analyses are ongoing to understand physiological responses to these mixtures, including gene expression in the liver, brain, and gonads.

1.06.A–T02 Soil ingestion and toxic elements: A framework for future biodiversity conservation monitoring

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Human activities have increased pollution and toxic element concentrations in soils across the Earth's surface. These activities could have profound implications for wildlife that directly or incidentally ingest soil during foraging, and for humans utilising animals as a primary source of protein. To date, little is known regarding how soil ingestion influences toxic element intake and assimilation in wildlife. Here, we quantify toxic element exposure in a community of 17 African herbivores to examine how species-specific foraging behaviour influences toxic element egestion in faeces and assimilation in fur. We found that soil ingestion was highest in grazing (warthog, blue wildebeest) and fossorial (porcupine) species that forage close to the ground. Chromium, cobalt, tin, lead, vanadium and arsenic concentrations positively correlate with soil ingestion in both faeces and fur, indicating that soil ingestion is a major contamination pathway for toxic element exposure and assimilation in wildlife. As soil ingestion levels align with ungulate species-level hypsodonty (height of the tooth crown), we demonstrate that hypsodonty can be used to predict species-specific vulnerability to toxic-elements at broad-scales. As global demands for minerals and rare earth elements increase to support net zero emission targets, human activities are likely to intensify, increasing toxic element contamination of soils and impacting biodiversity, environmental and human health worldwide. The non-invasive approach to risk assessment outlined here, provides a framework for future biodiversity conservation monitoring particularly for rewilding and restoration initiatives at previously mined and transformed sites that support wildlife communities in which grazing and fossorial species co-occur.

1.06.A–T03 Pharmaceuticals reduce resilience of European common frog (Rana temporaria) populations in UK ponds

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Small freshwater ponds are biodiversity hotspots but are particularly vulnerable to multiple environmental stressors due to their

limited volume and proximity to urban and agricultural land use. Environmental stressors, including pollutants, have the potential to impact amphibian populations. We investigated the effects of chemical and other environmental stressors on population resilience in the European common frog (Rana temporaria) in the UK (47 ponds in England/Scotland; 2 time points). Resilience was estimated using visual observation and eDNA based on the following criteria: 1. eDNA positive, no frogspawn observed; 2. frogspawn observed, no tadpoles; 3. frogspawn and tadpoles observed (early time point); 4. frogspawn and tadpoles observed (early and late time point). The potential effects of environmental stressors on resilience was analysed by creating pollutant group level intensity scores [76 pesticides, 74 pharmaceuticals, 28 metals, nutrients], pH, salinity, heatwave frequency/intensity, invasive crayfish Pacifastacus leniusculus presence) combined to generate a composite Combined Stressor Intensity Index [CSII]. There were no effects of CSII on RT score at either time point. However, in March, higher group-level intensities of pharmaceuticals and nutrients were associated with lower RT scores, while higher intensities of pesticides and metals were associated with higher RT scores. At the individual analyte level, higher concentrations of cyproconazole and propranolol concentrations were associated with lower RT score in March. In May, marginal associations included higher RT scores with zinc and diphenhydramine, and lower RT score with verapamil and risperidone. This study found that while the CSII captured regional variation in potential environmental pressures across UK ponds, it did not consistently predict R. temporaria population resilience. Instead, specific stressor groups were more strongly associated with reduced resilience during the breeding season. These results highlight the value of integrated indices alongside targeted, field-based assessments to better understand stressor impacts on amphibian populations.

1.06.A–T04 Indirect Effects Dominate Forest Ecosystem Responses to Herbicides

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Pesticides are used around the world to control and suppress undesirable species. In some cases the direct target and non target effects are well understood, characterized, and can be used to describe how components of ecosystems will respond. In addition to these direct effects, other species to are likely to respond to those changes, leading to indirect effects that can cascade through ecosystems. For example, glyphosate-based herbicides are applied in forestry to reduce the abundance of competitive vegetation, which could lead to changes in the abundance of indicator species such as bumblebees that rely on flowering plants. We conducted two observational experiments to study indirect effects. The first involved surveying both the vegetation and bumblebee communities in harvest blocks that were or were not treated with an herbicide. We found that the abundance of shrubs was lower, and the abundance of forb species was higher in herbicide treated blocks. The total abundance of bumblebees, was higher in herbicide treated blocks. Structural equation models demonstrate that herbicide application has a direct negative effect on the abundance and diversity of shrub species and a direct positive effect on the abundance and diversity of forb species. The diversity of forb species was positively related to species richness of the bumblebee community and shrub cover was negatively related to bumblebee abundance. In the second experiment we compared canopy cover, soil temperature, soil moisture, soil pH, and salamander abundance across unharvested reference stands and clear-cut harvest blocks treated and untreated with a glyphosate-based herbicide. Overall, reference stands exhibited highest canopy cover and soil moisture, and lowest soil temperature. Herbicide-treated blocks showed decreasing soil temperature and increasing moisture with time since harvest, whereas untreated blocks exhibited the opposite trend. Salamander abundance in reference stands was 4 and 18 times higher than in herbicide-treated and untreated blocks, respectively, and 3 times higher in herbicide-treated than untreated blocks. Combined, the two studies demonstrate that the direct effect of herbicide use in forestry is a reduction in the abundance of deciduous shrub species. Our results broadly demonstrate that this desired direct effect leads to changes in the abundance and community composition of other groups of organisms.

1.06.A–T05 FISHTRAC: real-time monitoring, evaluation and rapid response to multiple water quality, habitat and flow stressors in remote rivers

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Fish are good ecological indicators and have been used for over 100 years by scientists to understand how ecosystems respond to changes in environmental variability, including multiple water quality, flow and habitat stressors. The development of and use of water resources for agriculture, mining and industry and urban and peri-urban communities has affected the quality, flows and habitat of rivers. The FISTRAC tool has been developed in southern Africa through multiple case studies to allow stakeholders to use established fish behavioural monitoring technology in real-time to evaluate changes in river condition. The

approach includes the integration of radio telemetry tagging and tracking methods with real-time monitoring approaches into an online web-based system. The FISHTRAC tool monitors and establishes the “normal” behaviour of tagged fish. When this “normal” behaviour changes according to established response significance knowledge, on a population scale, the FISHTRAC tool engages a Bayesian Network risk model to evaluate and reports on the probable risk and consequences of multiple stressors aligned to the fish responses. The FISHTRAC tool then communicates in real time to stakeholders for rapid response and multiple stressor management. This application has been demonstrated in ecologically important, remote riverine ecosystems with limited human resources and monitoring to demonstrate the functionality of the approach. Case studies of the FISHTRAC approach using Tigerfish (Hydrocynus vittatus) and Yellowfish (Labeobarbus spp.) in the Olifants, Sabie, Crocodile and uMngeni Rivers in southern Africa demonstrate the effectivity of FISHTRAC to identify and direct management efforts to mitigate the impact of water quality stressors associated with reduced dilution and pollution events in these rivers. The approach also identified altered river flows resulting in inadequate habitats for tracked fish. The tool provides valuable information to conservationists and river managers who have been able to initiate established management measures faster and in more effective, targeted means compared to historical reactive approaches. FISHTRAC has the potential to improve sustainable water resource management, particularly the management of multiple stressors affecting water resources in developing regions of the world.

1.06.B - Wildlife Ecotoxicology: Integrating Bottom-Up and Top-Down Effects of Stressors in a Changing World

1.06.B–T01 Iron Stable Isotope Composition as an Indicator of Iron Metabolism in Vertebrates

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Stable isotope ratios of metals in animal tissues reflect metal behavior under different biological conditions, such as health status or species differences. Iron is an essential trace element, and its stable isotope ratio (δ56Fe) fractionates in response to metabolic regulatioin, making it a promising tracer of iron metabolism across species. Previous studies suggest δ56Fe reflects storage iron levels, primarily iron bound to ferritin. To assess interspecies variation in δ56Fe and its link to storage iron level, we analyzed 14 vertebrate species (8 mammals, 2 birds, 2 reptiles, and 2 fish) and multiple tissues from mice (Mus musculus, Slc:ddY, male, n = 5). Samples were sourced from Hokkaido University and the es-Bank at Ehime University. Iron speciation was determined using Fe K-edge X-ray absorption near edge structure (XANES) spectroscopy at the High Energy Accelerator Research Organization (KEK, Japan). Total iron and other elements were quantified by inductively coupled plasma mass spectrometry (ICP-MS; Agilent 7850). The δ56Fe values were measured using multicollector ICP-MS (MC-ICP-MS, Neptune Plus) after the addition of a double spike of 57Fe and 58Fe, with precision confirdmed using reference material (DOLT5, NRC Canada) and two in-house standards with known isotope ratios, with a maximum error of 0.2‰. In mice, δ56Fe varied depending on the tissue type. The highest values were observed in the liver and spleen (−1.52‰ to −0.80‰, and −1.58‰ to −1.12‰), followed by the muscle (−1.87‰ to −1.23‰), testis (−1.88‰ to −2.07‰), kidney (−2.22‰ to −2.03‰), and red blood cells (−2.20‰ to −2.63‰). The δ56Fe of the diet (iron citrate) was −0.18‰, and the δ56Fe values of the stomach and intestinal contents were nearly identical to the dietary value. XANES revealed high ferritin-bound iron in the spleen and testis (64-89%, and 65-79%, respectively), followed by the liver (18-54%), muscle (32-33%), kidney (14-19%), and red blood cells (0%). The δ56Fe values positively correlated with ferritin-bound iron within mouse tissues ($r = 0.55$, $p = 0.01$), supporting preferential uptakes of heavy isotopes by ferritin. Among species, liver δ56Fe was relatively high in mammals, intermediate in birds , and lower in reptiles. Diets or stomach contents among three domesticated animals (mouse, quail, and bovine) showed small δ56Fe variation (0.22 ± 0.89‰). Across species, liver δ56Fe value was negatively correlated with ferritin-bound iron ($r = -0.42$, $p = 0.01$), suggesting that higher storage iron may reflect selective uptake of lighter isotopes from diet due to lower iron absorption efficiency. These results indicate that δ56Fe values reflect interspecific difference in relation to iron uptake and storage. Further analyses may contribute to the development of a broad, non-invasive indicator of abnormal iron metabolism.

1.06.B–T02 Heavy Metal and Pesticide Exposure in African Elephants: A Study from Lower Zambezi, Zambia

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Heavy metal and pesticide contamination present significant environmental challenges, particularly in regions experiencing increased anthropogenic activity [1]. Elephants are highly susceptible to the bioaccumulation of such toxicants due to their diverse plant-based diet and wide-ranging migratory behavior. Lower Zambezi National Park in Zambia, which is home to African savanna elephants and a variety of endemic wildlife species, has faced severe environmental threats from copper mining activities initiated in 2021. Although the government revoked the mining license in 2023 [2], significant ecological damage had already occurred [3], prompting concerns about potential contamination from heavy metals and pesticides. Hence the current study was designed to investigate the level of heavy metals and pesticides in elephants found in the lower Zambezi. To assess heavy metal and pesticide exposure in elephants, we employed a non-invasive fecal sampling approach. Fecal samples were collected from two distinct zones of the park: 33 samples from the eastern zone in November 2022 and 74 samples from the western zone in September 2023, along with plant and soil samples for a different study were used for comparative analysis. The concentrations of essential and non-essential metals (Cr, Cd, Pb, As, Cu, Co, Ni, Zn) were quantified using inductively coupled plasma mass spectrometry (ICP-MS). Pesticide residues were analyzed via liquid chromatography–tandem mass spectrometry (LC-MS/MS) and gas chromatography–tandem mass spectrometry (GC-MS/MS). We observed notable spatial and temporal variation in heavy metal concentrations across fecal, soil, and plant samples. Concentrations of Pb, Co, Ni, and Cd showed statistically significant differences between 2022 and 2023, which 2022 sample showed the higher for Pb, Co and Cd. In 2023, fecal metal concentrations followed the descending order: Mn (122.8 mg/kg) > Zn (26.3) > Cu (9.1) > Ni (4.61) > Cr (3.77) > Co (0.82) > Pb (0.31) > As (0.30) > Cd (0.002). This order mirrored that found in plant samples but not soil, suggesting that plant ingestion (e.g., Acacia spp.) is the primary route of metal exposure. Fecal samples generally exhibited higher metal levels than plant samples, indicating bioaccumulation. In one 2023 fecal sample, exceptionally high levels of Cd, Pb, As, Cr, Co, and Cu were detected, implying possible localized exposure, possibly associated with tourism activity and seasonal differences. Hierarchical clustering analysis showed that ~70% of high-exposure individuals were female, suggesting sex-based differences in foraging or home-range behavior. However, these differences were not statistically significant. Low levels of pesticide residues were detected. Organophosphates and carbamate insecticides commonly used in Indoor Residual Spraying (IRS)—such as Propoxur [4]—were identified in plant (Acacia bark) and low level in some elephant feces samples, confirming exposure. Although the sampling sites were located far from human settlements, the detection of malaria-control pesticides indicates extensive environmental contamination. This dispersion likely resulted from atmospheric deposition or hydrological transport through the Zambezi River. Our findings highlight discrepancies in metal concentrations between feces, soil, and plant matrices. Elephant feces generally contained lower levels than soil but higher than plants. Most concentrations remained within permissible human exposure thresholds [5]. Considering that elephants consume 100–200 kg of vegetation daily, the absence of pesticide residues in most faecal samples likely reflects rapid metabolic elimination, primarily via urinary excretion, rather than a lack of exposure. Despite the discontinuation of mining operations, persistent detection of heavy metals and pesticide residues suggests continued environmental contamination. This study provides the first empirical evidence of xenobiotic metabolism capacity in large wild herbivores using fecal biomonitoring. Although fecal-based assessment offers a promising non-invasive approach, further research is required to establish its validity and sensitivity, particularly for pesticide exposure. Continued environmental monitoring in the Lower Zambezi National Park is essential for understanding long-term ecological risks and guiding effective wildlife conservation strategies.

1.06.B–T04 Behavioural Responses of common frog Rana temporaria Tadpoles to Varying Stressor Intensities in a Field-Based Experiment

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Field-based research is essential for understanding how environmental stressors, including pollution, may impact wildlife. In this study, we investigated the effects of environmental stressor intensity on the behaviour of tadpoles (Rana temporaria) using an in situ caged experimental design, alongside the capture of wild individuals. Our three pond sites comprised a pond on a country estate that was deemed to have low environmental pressures (our reference site), an agricultural pond (with medium stressor intensity) and a Sustainable Urban Drainage System (SuDS) pond (with high stressor intensity). Site-level stressor intensity was quantified via z-scored indices for pesticides (n=76), pharmaceuticals (n=74), metals (n=28), nutrients, pH, salinity, and heatwave frequency (≥4 days with daily min/max temperatures exceeding the average). Tadpole behaviour was analysed at two developmental stages (early: Gosner 26–27; and late: Gosner 37–41) in group open-field tests (5 tadpoles per

test). Due to cage failure at the reference site and an absence of wild-caught tadpoles at the farmland site, only the following analyses could be undertaken; reference wild-caught tadpoles versus SuDS pond wild-caught tadpoles; and farmland pond caged tadpoles versus SuDS pond caged tadpoles. No behavioural differences were observed in any tadpoles between ponds at the early developmental stage. However, at the later stage, tadpoles from the reference site travelled significantly further than those from the SuDS pond. Reduced locomotor performance of wild-caught tadpoles from the SuDS pond, relative to the reference site, is consistent with laboratory-based literature showing that pollutants and other environmental stressors can alter tadpole movement patterns. Caged farmland tadpoles moved faster than caged SuDS tadpoles, however the latter spent more time moving and displayed a higher level of exploration behaviour. Our results indicate that stressor intensity affects locomotory performance in common frog tadpoles, though lack of consistency in these responses across the three sites, and varying behavioural endpoints impacted make functional interpretations difficult. Notably, however, these behavioural differences only emerged at the later developmental stage. These findings indicate tadpole behaviour has the potential for use as a non-destructive indicator of pond health, but further work is needed to establish the consistency of locomotory responses.

1.06.P - Wildlife Ecotoxicology: Integrating Bottom-Up and Top-Down Effects of Stressors in a Changing World

1.06.P–ThFr03 Hidden Contaminants: Understanding the Impacts Lead (Pb) Contamination on Wildlife, the Environment, and Human Health in Namibia under the One Health Concept

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Namibia is a developing country in southern Africa, which has an abundance of wildlife and is rich in mineral resources. Even with the extensive mining activities taking place throughout the country and the considerable hunting of game; there are currently few studies on environmental contamination with lead (Pb) and other metals resulting from hunting and mining activities. As such, Namibia lacks the scientific backing from research to support remediation efforts and lacks regulatory standards. This study will evaluate risks to Pb exposure in Namibia through the consumption of game and livestock meat products. As well as determine the potential risk for environmental Pb exposure to wildlife and domestic livestock from historical mining activities. Furthermore, it will identify the risk factors associated with Pb exposure from hunting (ammunition and hunting techniques) and mining activities. The rationale lies in the limited information available on Pb contamination in Namibia and, more significantly, the lack of insight regarding its health impact on the population. Additionally, the study aims to assess the effectiveness of current hunting methods in minimizing Pb exposure, and whether there is a need to revise the current hunting techniques to safeguard the well-being of these communities. To investigate the potential health impacts of Pb-based ammunition, an online survey is being conducted to assess hunting and dietary habits within the Namibian community. Preliminary results indicate that all 24 respondents consume game meat, with 39% eating it 2-3 times per week. Eighty-three percent of respondents obtain game meat through hunting. As expected, most hunters reported using Pb-based ammunition. Among these, four respondents use both Pb-based and Pb-free ammunition, while only two use Pb-free ammunition exclusively. Subsequent phases will employ convenience sampling to collect game tissue and canine blood samples from local farms. Additionally, bovine kidney, liver and muscle samples have been collected from local abattoirs as part of the survey sampling process; these samples currently await laboratory processing. Metal extraction and analysis will be performed using ICP-MS at the Laboratory of Toxicology, Hokkaido University, Japan. Stable Pb isotope ratio analysis will follow to identify potential sources of contamination.

1.06.P–ThFr04 The Utility of Freshwater Molluscs as Biomonitoring Organisms to Assess Pollution Pressure on Wetland Ecosystems

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Wetlands (Ramsar Convention definition, which includes lakes and rivers) are amongst the most highly threatened and biodiverse ecosystems globally, contributing to a huge range of ecosystem services. However, wetland biomonitoring techniques for the assessment of water quality are not well established. Gastropod and bivalve molluscs have high potential as useful bioindicators due to their sedentary nature, high bioconcentration capacity, wide distribution, and known sensitivity to contaminants. Here, we reviewed the available data for field-based studies that examined changes to biochemical biomarkers in wild freshwater molluscs. We found a total of ten studies, and across these, the most common pollutants reported were

metals, organochlorines, untreated municipal wastewater, and other persistent chemicals (e.g., polycyclic aromatic hydrocarbons and polychlorinated biphenyls). Tissues assessed across these studies comprised the digestive gland, gills, and soft tissue (whole body excluding shell). Lipid peroxidation (LPO), antioxidant enzymes- catalase (CAT) and superoxide dismutase (SOD) were frequently elevated across multiple species in response to either measured or hypothesised (due to land use) pollutant profiles, compared to reference sites. This elevation suggests oxidative stress is occurring in these organisms in response to polluted environments. In contrast, glutathione (GSH) and the biotransformation enzyme Ethoxyresorufin-O-deethylase (EROD) levels were reduced, indicating depletion of these enzymes as a result of the associated detoxification. Regarding species sensitivity, the zebra mussel (Dreissena polymorpha) frequently showed significant changes in biomarkers in response to polluted sites, whereas the swollen river mussel (Unio tumidus) showed consistently low or non-significant responses, which may reflect pollutant tolerance or poor biomarker sensitivity in this species. In conclusion, despite significant data gaps – most notably, the relative lack of studies using gastropod molluscs - a review of the available literature suggests that freshwater molluscs have potential as useful bioindicators for wetland ecosystems. Further studies should seek to incorporate a wider range of species across the Mollusca, as well as investigations into the potential impacts of emerging contaminants; such as pharmaceuticals.

1.06.P–ThFr05 Species-Specific Variation in δ-ALAD Activity as an Indicator of Lead Sensitivity in Birds

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Although lead (Pb) poisoning in wild birds caused by Pb ammunition and fishing sinkers has been recognized as a significant global issue, it remains a concern, particularly for waterfowl and raptors. Understanding interspecies variation in Pb sensitivity among birds is essential for identifying and prioritizing conservation efforts for the most vulnerable species. δ-aminolevulinic acid dehydratase (ALAD), one of the key enzymes in the heme biosynthesis pathway, is widely used as a biomarker for Pb exposure due to its high sensitivity to Pb inhibition. Therefore, we conducted a comparative study on the sensitivity of δ-ALAD to in vitro Pb exposure. Whole blood samples were collected from eleven avian species and rats. To ensure that contamination by heavy metal, including Pb, was at sufficiently low levels, samples were analyzed using microwave digestion followed by inductively coupled plasma mass spectrometry (ICP-MS). The enzymatic activity of the blood samples mixed with various concentrations of Pb acetate was measured using a colorimetric assay. The activity of the blood sample without Pb addition served as the control. The IC50 (half-maximal inhibitory concentration) was calculated using the ratio of the absorbance values at each Pb concentration relative to the control. Phylogenetic analysis was also performed using δ-ALAD amino acid sequences obtained from the National Center for Biotechnology Information database. Red-crowned cranes showed the lowest IC50 value (5.41 μM) among the eleven species tested, followed by five Accipitriformes species (8.43 μM), two Strigiformes species (18.4 μM), Muscovy duck (32.5 μM) and chicken (35.3 μM), suggesting a genetically influenced variation in susceptibility. Phylogenetic trees showed that clade grouping were consisted with taxonomic classifications. Furthermore, the substrate-binding and zinc-binding sites and their surrounding amino acid sequences were conserved among the species analyzed, suggesting that interspecies differences in sensitivity are not determined by these regions. These findings demonstrate species-specific differences in δ-ALAD sensitivity to in vitro Pb exposure in birds. Further investigation of δ-ALAD and additional factors influencing Pb sensitivity is needed to identify and prioritize highly susceptible species for conservation.

1.06.P–ThFr06 Investigating the Detoxification Capacity in Elephants with a Focus on Enzymes Involved in Alcohol and Organophosphate Metabolism

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Elephants, the largest herbivorous mammals, can be exposed to naturally occurring chemicals and face an increasing risk of

exposure to anthropogenic chemical substances due to expanding human activities. This study investigates the metabolic capacity of elephants with a focus on alcohol and organophosphate pesticides. In Southern Africa, tales persist that wild elephants seem inebriated after eating fermented marula fruits. While one study suggested that the ethanol concentrations in these fruits were too low to affect elephants of large body size, another reported that elephants possessed a dysfunctional gene encoding a specific isoform of alcohol dehydrogenase (ADH), the enzyme responsible for metabolizing ethanol in the stomach. However, the liver is the dominant tissue for alcohol metabolism, and the function of other ADH isoforms expressed in the liver has not been clarified in elephants. In the case of organophosphates, suspected incidents of elephant deaths due to poisoning have risen in recent years, such as bags of organophosphate pesticides were found in the digestive tract of an elephant in India. The metabolism of organophosphates is mediated by paraoxonase (PON), but few studies have been reported on PON in elephants. This study aimed to evaluate the hepatic functions of ADH and PON in elephants. Liver, kidney, and small intestine samples were collected from four deceased Asian elephants in Thailand. Transcriptome analysis was performed to compare mRNA expression levels among different isoforms of ADH and PON. We conducted ethanol metabolism assays for ADH and paraoxon metabolism assays for PON in the liver of Asian elephants, using rats as a comparative model. The mRNA expression patterns of ADH isoforms indicated that ADH1-c was the primary isoform involved in alcohol metabolism in the Asian elephant liver. The ADH kinetic analysis indicated that elephants had a lower Km value than rats, suggesting potentially more efficient alcohol metabolism and a relatively high ethanol tolerance. The gene expression level of PON1 in elephants was relatively low. PON activity in elephants was observed at very low levels, suggesting a limited capacity of elephants to metabolize organophosphates. This study provides new insights into the unresolved question of elephants' susceptibility to alcohol and offers one factor in assessing the risk of organophosphate pesticide exposure in these animals.

1.06.P–ThFr07 Organochlorine Pesticide Exposure in Carnivores from the Kruger National Park, South Africa

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Legacy contaminants such as organochlorine pesticides (OCPs) remain an environmental concern due to the persistent nature. Many recent studies have reported consistent high levels in mainly aquatic ecosystems in Africa. Yet there remains a paucity of data on OCP levels in other organisms such as terrestrial mammals. A few studies have reported on the OCP exposure in apex predators from both conservation and agriculture regions. The aim of this study was to determine the OCP exposure to two predator species, Lion (Panthera leo) and the Spotted hyena (Crocuta crocuta) from the premier conservation area in South Africa, the Kruger National Park (KNP). The KNP is situated on the eastern border of South Africa, with large agriculture and urban areas on its western boundaries. Serum samples were collected from 23 lions and 17 Spotted hyenas from the central region of the KNP. OCPs were extracted using liquid-liquid solvent extraction and analysed using a GC coupled with a mass spectrometer (GC-MS). Of the 22 OCPs tested for, 12 were recorded above levels of quantification in more than 80% of the samples analysed. The highest OCP levels were the hexachloro-hexanes (750 pg.mL) with patterns of α-HCH, γ-HCH, and δ-HCH accumulation were similar. Higher levels were recorded in hyena compared to lions and for both species males generally had higher levels than females. Aldrin and dieldrin levels were very similar in both species (15-25 pg/mL) with aldrin being higher in females and dieldrin highest in males. The total DDT levels were once again higher in hyena than in lions with para-para isomer of all three forms occurring in all samples. Four hyenas did display o,p DDT, indicating that there are traces of recent use. Other notable OCPs were heptachlor that were highest in male lions, while oxy-chlordane were highest in hyena. Both trans- and cis- hept epoxide were higher in lion than hyena with no difference between the sexes. Overall females had lower OCP levels than males, indicating possible biodilution due to maternal transfer. The higher levels recorded in hyenas compared to lions may be attributed to the difference in feeding strategy and the ability of the two different carnivore families to metabolise the OCPs. The mere fact that legacy OCPs are still found in wildlife underlines the importance of managing the illegal use and correct management of obsolete pesticide stocks.

2.01 - Ecological and Public Health Risks of Systemic Insecticides

2.01–T01 Neonicotinoid Insecticides Induced Mitochondrial DNA Damage: A Validation Study in Earthworms

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Since their inception in the 1990s, neonicotinoids (neonics), have been widely used in the seed treatment application. However, recent studies have demonstrated that their biological half-lives could be much longer than previously known. Therefore, the ubiquity of neonics in the environment is expected, and subsequently, those residues could render the

unintended hazards to non-target but essential organisms in soil and watersheds. We aimed to explore and validate mitochondrial DNA (mtDNA) toxicity resulting from sub-lethal exposures to thiamethoxam (THIM), as well as co-exposure to difenoconazole (DIF), a commonly applied systemic fungicide in the seed treatment, in earthworms. Earthworms (Eisenia fetida) that were analyzed in this study were obtained from an ongoing study in which they were initially exposed to THIM and DIF/THIM mixture for 30 days, followed by 60 days of pesticide-free cultivation. We then randomly selected three earthworms from each treatment for the measurements of body weight, 8-hydroxydeoxyguanosine (8-OHdG), mtDNA copy number (mtDNAcn), and in vitro mitochondrial respiration (mtRespiration) capacity. The 8-OHdG levels, a matrix resembling reactive oxidative stress (ROS), measured in gDNA of earthworms were significantly higher (8.0±1.8 ng/mL) in earthworms exposed to THIM/DIF mixture than those of control (4.3±1.2 ng/mL) and THIM exposed (4.0±0.7 ng/mL) (ANOVA, $p<0.01$),indicating a higher and persistent oxidative stress resulting from THIM/DIF exposure. At the end of the 30-day exposure and 60-day pesticide-free cultivation, we found that mtDNAcn demonstrated a significant up-regulation in earthworm exposed to both THIM (207.9±15.4) and THIM/DIF(263.1±6.1) mixture, compared to control (146.3±3.1). In order to validate mtDNA damage, we have developed a novel analytical protocol to quantify mtRespiration by applying isolated mitochondria obtained from fresh earthworms. The results showed that the oxygen consumption rates (RCR) for earthworms in both THIM (4.9±0.2) and THIM/DIF (2.9 ± 0.04) exposed groups were significantly lower than those in the control group (5.9±0.4, ANOVA, $p<0.05$), in particular for those exposed to THIM/DIF mixture. In this study, we validated the mechanism for mtDNA damage by delineating a cascading event of which sub-lethal exposure to THIM and THIM/DIF mixture could generate significant amount of cellular oxidative stress that leads to significantly higher mtDNAcn. The persistent mtDNA damage would subsequently impair mtRespiration capacity in earthworms.

2.01–T02 Metabolic Profiling and Ecotoxicological Effects of Combined Sublethal Acetamiprid and Epoxiconazole Exposure on Apis mellifera Colonies in Field Conditions

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The use of neonicotinoid pesticides is a primary factor contributing to the decline of pollinators in agricultural ecosystems. Most laboratory studies on bee ecotoxicology currently focus on acute exposure to individual chemicals. However, under natural field conditions, bees are often exposed to a mixture of chemicals over prolonged periods, and the potential synergistic effects of these substances may lead to an underestimation of the toxicity of each compound. In this study, Apis mellifera was placed in a field condition where it was chronically exposed to a neonicotinoid pesticide commonly found in pollen, acetamiprid, and a triazole fungicide, epoxiconazole, for four months. We evaluated the reproductive capacity of Apis mellifera and the morphological parameters of newborn bees after exposure. The Apis mellifera in the co-exposed group exhibited earlier signs of head and wing atrophy in newborn bees, and the co-exposed group was more susceptible to mite infestations. To assess the impact of combined exposure on Apis mellifera at the gene level, differential metabolites and gene expression in energy metabolism were conducted. The results of the study showed that only the ACE and co-exposure groups exhibited distinct metabolites associated with oxidative stress, which may be caused by excessive reactive oxygen species (ROS) production due to mitochondrial depolarization induced by acetamiprid. Our results suggest that estimates of lethal effects from a single pesticide may underestimate the threat to bees under realistic conditions. Even chronic pesticide exposure at environmental concentrations can pose a significant threat to bee colonies, potentially leading to colony collapse.

2.01–T03 Effects of thiamethoxam on thyroid axis, muscle exercise capacity, and energy metabolism in Pelophylax nigromaculatus

Caihao Mou[1] (1)Zhejiang University of Technology

Thiamethoxam, a broad-spectrum systemic insecticide, has emerged as a critical subject in ecotoxicological research due to its potential endocrine-disrupting effects and impacts on energy metabolism in non-target organisms. This study investigates the dual mechanisms of this compound on thyroid axis function and skeletal muscle locomotor performance in the black-spotted frog (Pelophylax nigromaculatus), aiming to elucidate its disruptive effects on energy metabolic networks. Experimental results demonstrated that thiamethoxam exposure significantly induced hypothyroidism in P. nigromaculatus, characterized by reduced levels of free triiodothyronine (FT3) and free thyroxine (FT4), indicating its pronounced regulatory interference on the hypothalamic-pituitary-thyroid (HPT) axis. Further analysis revealed that thiamethoxam impaired mitochondrial health in the gastrocnemius muscle, leading to a dose-dependent decline in skeletal muscle contractility and locomotor endurance. The synergistic effects of thyroid hormone homeostasis disruption and skeletal muscle dysfunction ultimately perturbed systemic energy metabolism dynamics by modulating mitochondrial oxidative phosphorylation efficiency and the activity of key enzymes in the glycolytic pathway. This study provides critical experimental evidence for deciphering the sublethal ecotoxicological mechanisms of neonicotinoid insecticides.

2.01–T04 Efforts Toward the High-Sensitivity Detection of Brain Function Disruption Induced by Insecticides

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In classical toxicology, chemical substances were believed to exert harmful effects on the organism by directly acting on cells, proteins, or DNA. However, it is now known that some chemicals exert toxicity by acting on receptors and disturbing neurotransmitters and various hormones. These disruptions can lead to adverse effects that do not necessarily accompany pathological histological changes, highlighting the need for detecting novel phenotypes and biomarker-based diagnostics. Therefore, to more accurately assess toxicity and health effects, it is essential to establish simple and quantitative methods for detecting both phenotypic changes and biomarkers. On the other hand, for neurotoxic substances such as insecticides, there are limited methods for quantitatively and sensitively evaluating their toxic effects. To address this gap, we have developed various approaches for detecting brain function disruption with high sensitivity, including in vivo live imaging, identification of activated brain regions using transgenic mice, and non-targeted analysis using LC/Q-TOF/MS to explore biomarkers that reflect brain function disturbances. In this study, we present our investigation of a model case focusing on anxiety-like behavior induced by neonicotinoid (NNs) exposure. We aimed to elucidate the relationship between such behavior and monoamine levels in different brain regions. Mice were orally administered acetamiprid (ACE), a type of NN, at a dose of 20 mg/kg body weight. Thirty minutes post-administration, the Elevated Zero Maze (EZM) test was conducted. Following the EZM test, concentrations of monoamines (dopamine, 3-MT, serotonin, histamine) in the hippocampus and striatum were measured using liquid chromatography-tandem mass spectrometry (LC/MS/MS). In the ACE-exposed group, there was a tendency toward increased anxiety-like behavior in the EZM test, accompanied by significant increases in dopamine, 3-MT, and serotonin levels. Correlation analyses per individual mouse revealed significant associations between behavioral test results and serotonin concentration in the hippocampus, as well as dopamine concentration in the striatum in the ACE group. It is known that most serotonergic neurons projecting to the forebrain originate from the raphe nucleus (RN), and that the major dopaminergic pathways are regulated by serotonergic neurons in the RN. Therefore, we examined neuronal activity in the RN by staining with anti-serotonin antibodies and observed enhanced serotonergic activity. These findings suggest that ACE alters monoamine levels and that serotonergic signaling in the hippocampus and RN may play key roles in ACE-induced anxiety-like behavior.

2.01–T05 Pollinator safety of Neonicotinoids – Scientific Background of a Controversial Debate

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Neonicotinoids are a class of insecticides that selectively target insect nicotinic acetylcholine receptors and have been widely used since the 1990s due to their high efficacy against insect pests, systemic activity in plant tissues, and favorable human safety profile. However, their environmental safety, particularly regarding pollinators, has been the subject of ongoing research and debate. Regulatory ecotoxicological risk assessments use a tiered, hierarchical approach, starting with standardized laboratory studies to determine intrinsic toxicity, but these do not always reflect realistic field exposures. Higher-tier studies, including semi-field and field trials, provide more ecologically relevant data and are central to regulatory conclusions. For systemic seed treatment uses, which can result in trace residues in nectar and pollen, pollinator risk assessments are based on colony feeding studies, residue analyses, and field studies. Numerous higher-tier studies have demonstrated little or no adverse effects of neonicotinoid seed treatments on honey bee colonies exposed to treated crops under typical use conditions. In addition to assessing systemic residues, precautionary measures—such as improved seed treatment formulations and optimized planting machinery—have been implemented to minimize environmental contamination from dust during sowing. For foliar spray applications, risks to pollinators can be effectively mitigated by avoiding treatments during bloom and restricting applications shortly before flowering. A comprehensive review of bee safety data for neonicotinoids highlights the importance of interpreting individual studies in context, distinguishing between regulatory and fundamental research objectives. While the intrinsic toxicity of neonicotinoids to bees is well established, field-realistic data support the safety of these compounds when used according to current risk mitigation measures.

2.01.P - Ecological and Public Health Risks of Systemic Insecticides

2.01.P–TuWe34 Simultaneous Exposure to Avermectin Enhances the Toxicity of R-dinotefuran and Reduces the Toxicity of S-dinotefuran

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Due to the threats of neonicotinoids to honeybee health, the screening of chiral isomers of neonicotinoids that are less toxic to non-target organisms is a promising protective approach. However, it remained unclear whether these safer isomers could retain their safety when co-exposed with other agrochemicals. This study selected avermectin, a fungicide frequently detected in pollen, for simultaneous exposure with the chiral dinotefuran on Apis mellifera to assess the safety of the isomers under realistic scenario. The results revealed that the 24-hour LD50 for the combination of S-dinotefuran and avermectin exposure was 0.005 μg/bee, compared to 0.0215 μg/bee for R-dinotefuran. Notably, under the combined action of avermectin, the toxicity difference between R-dinotefuran, previously considered relatively safe, and S-dinotefuran was reduced from 19.75-fold to 4.3-fold. Using the combination index method, distinct interactions between avermectin and the enantiomers of dinotefuran were identified. Avermectin exhibited antagonistic effects with S-dinotefuran from LD50 to LD90, while it shows synergistic effect with R-dinotefuran over the same dosing range. Then molecular docking results showed that avermectin preempted S-dinotefuran binding site and occupied the ASP110 amino acid residue of the receptor protein. In contrast, avermectin promoted R-dinotefuran binding to the receptor protein. Molecular dynamics simulations also verified the reliability of these conclusions. The current findings suggest that actual environmental scenarios should be considered when evaluating the safety of chiral pesticides.

2.01.P–TuWe35 Neonicotinoid Residues in Free-grazing Ducks and Their Eggs Associated Human Health Risk

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In Thailand, laying ducks are commonly raised by a free-grazing system that could be exposed to several residues (e.g., neonicotinoids) in the fields, resulting in concern about the toxic effects on ducks and residues in eggs. The objectives of this study were (1) to determine the residues of neonicotinoids in biological samples (duck serum, albumin, and yolk) and environmental samples (water, soil, and feed) from 9 duck farms using LC/MS/MS and (2) to investigate the metabolite formations, and cytochrome P450 (CYP)-dependent avian metabolism of neonicotinoids using in vitro biotransformation assay. Our results revealed that imidacloprid had the highest median concentration and the highest detection frequency in the ducks' serum followed by acetamiprid, then clothianidin or thiamethoxam and dinotefuran. Neonicotinoid compounds selectively accumulated in the albumin of duck eggs. The consistent detection of neonicotinoids in the feed, soil and water samples validated that, the ducks were mainly exposed to neonicotinoids from the nearby agricultural activities. However, upon human health risk analysis, levels of neonicotinoids detected in duck eggs were not found to present any appreciable risks to the duck egg consumers of Thailand. In addition, in vitro biotransformation assays revealed that the greatest CYP activities in the metabolism of most neonicotinoid substrates, such as acetamiprid to dm-acetamiprid, imidacloprid to hydroxylated-imidacloprid and imidacloprid-olefin, clothianidin to dm-clothianidin, and thiamethoxam to clothianidin, were found in chicken. These results suggested that the CYPs in chicken may have a greater capacity for metabolism of neonicotinoids compared to other poultry. This study further revealed that the maximum intrinsic clearance of dn-imidacloprid and dn-clothianidin in ducks may be controlled by CYP-mediated nitro-reductions of imidacloprid and clothianidin. Further studies employing CYP recombinant enzymes may be required to elucidate the specific CYP isoforms that may be involved in neonicotinoid metabolism in duck and other avian species.

2.01.P–TuWe36 Investigating the Developmental Neurotoxicity of Insecticide Combinations in LUHMES Cell Line

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Insecticide residues are a significant environmental concern due to their diverse origins and environmental persistence. Their sources are direct and indirect, with indirect sources being challenging to control and potentially leading to widespread contamination. Vector control, such as indoor residual spraying (IRS) and insecticide-treated nets, involves high concentrations and long-lasting effects up to 6 months, raising the risk of long-term exposure. Studies have shown a link

between maternal insecticide exposure and behavioral and cognitive problems in children, as well as developmental neurotoxicity (DNT) in mice. However, the effects of newer insecticides and their combined effects are not yet well elucidated. This study aims to clarify the pathways disrupted in DNT following the combined insecticide exposure. An in vitro model, LUHMES cells (human dopaminergic neurons), were exposed to common IRS insecticides, including piperonyl butoxide (PBO), deltamethrin (DEL), cypermethrin (CYP), λ-cyhalothrin (CYH), chlorfenapyr (CHF), and clothianidin (CLO) at 0 – 100 μM, as well as the cocktails of combined insecticides (ALL) of equivalent concentration. Neurotoxicity was assessed via mitochondrial membrane potential (MMP) using JC-10 assay, reactive oxygen species (ROS) production using dichlorofluorescein (DCF) assay, and neurite areas per cell measured by fluorescent staining. The results showed that individually DEL, CYH, and CHF concentrations above 1 μM significantly reduced MMP and neurite area per cell ($p<0.01$). For the ALL cocktail, a reduction in MMP was observed at 10 μM. None of the exposure groups resulted in changes in ROS production. These suggest that mitochondrial depolarization may serve as an early and sensitive indicator of DNT induced by certain insecticides, even at concentrations as low as 1 μM. Our findings suggested that mitochondrial function could potentially contribute to the reduced neurite outgrowth. However, further studies including in vivo models are required to confirm a direct causal relationship. This study has limitations, including the use of an in vitro model, a limited number of compounds tested, and the lack of long-term exposure assessment. Specifically, results from LUHMES cells may not fully capture the complexity of DNT in vivo, where metabolic and compensatory mechanisms are more complex. Therefore, validation using animal models and a broader range of chemicals is essential for more generalizable conclusions.

2.01.P–TuWe37 Elucidating the Cause of a Mass Mortality Event in Japanese Squirrels ~Assessment of Insecticide Residues and Synergistic Neurotoxicity~

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In 2023, an unusual incident occurred at a Japanese zoo, where 31 Japanese squirrels (Sciurus lis) died within a week. The first death was observed just hours after dermal and environmental exposure to a combination of three pesticides—fipronil, flumethrin, and trichlorfon—used for parasite control. These compounds belong to the phenylpyrazole, pyrethroid, and organophosphate classes, respectively, all of which are known neurotoxicants in mammals. This study aimed to elucidate the cause of the mass mortality by investigating: (1) which of the three pesticides contributed most significantly to the lethal outcome, and (2) whether additive or synergistic toxic effects occurred from combined exposure. First, residue analysis was conducted on various organs collected from the deceased squirrels using LC-MS/MS (Agilent Ultivo). Fipronil and its metabolites were detected at the highest concentrations in the liver (14.5 μg/g), followed by the kidneys (8.97 μg/g) and lungs (7.21 μg/g). Notably, a liver sample from a squirrel that died one week after exposure still contained 14.4 μg/g of fipronil, suggesting its long-term persistence in this species. Flumethrin was most abundant in the kidneys (1.73 μg/g), while trichlorfon was moderately present in the stomach contents (1.81 μg/g), indicating possible oral uptake from the environment. To further clarify potential additive or synergistic neurotoxic effects, behavioral testing using mice is currently underway. The open field test is being employed to quantitatively assess changes in locomotor activity (e.g., distance traveled, movement speed) and anxiety-like behavior (e.g., time spent in the center zone) following single and combined pesticide exposures. This study is expected to provide critical insights into the toxicological consequences of combined pesticide exposure in managed captive animals and highlights the need for improved risk assessment protocols when applying multiple agents in zoological settings.

2.01.P–TuWe38 Biomarker Search for Neurotoxicity Assessment Following Acute Exposure to Neonicotinoid by Using Liquid Chromatography Quadrupole Time-of-Flight Mass Spectrometry

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Neonicotinoid (NN) pesticides are extensively used worldwide due to their high insect selectivity. However, increasing evidence indicates that NN exposure can induce neurotoxic effects, including depressive-like symptoms, in mammals and other non-target organisms. Current neurotoxicity assessment methods may lack the sensitivity and reproducibility required to detect such effects. Therefore, the development of more sensitive and reliable evaluation techniques is essential. The brain, a lipid-rich organ, relies on lipids for various functions, and disturbances in lipid homeostasis are linked to numerous diseases. In this study, we aimed to establish a novel approach for assessing NN-induced neurotoxicity using lipidomics analysis by using Liquid Chromatography Quadrupole Time-of-Flight Mass Spectrometry (LC/Q-TOF/MS) to detect changes in brain lipid profiles. Mice were orally administered acetamiprid (ACE), a NN pesticide, at doses of 65 and 130 mg/kg, and brains were collected 30 minutes post-exposure. The lowest observed adverse effect level was selected based on previously reported

toxicity test results. Notably, the high doses used in this study were intentionally selected to detect neurotoxic effects. ACE and its metabolite N-desmethyl-ACE were detected in the cerebral cortex 30 minutes after oral administration of ACE, with ACE present at notably high concentrations. Non-targeted lipidomics analysis of the cerebral cortex revealed 358 annotated lipids. Fifteen lipids showed a fold change greater than 2.0 and statistically significant differences between the control and high-dose groups as determined by the Steel test, with an area under the curve of ≥ 0.900 in receiver operating characteristic analysis. Increased levels of seven fatty acids (e.g., palmitic acid) and five Fatty Acyl Esters of Hydroxy Fatty Acids (e.g., FAHFA 22:6_22:5) were observed, suggesting roles in neurodegenerative diseases and inflammation. These findings provide new insights into lipid alterations associated with NN-induced neurotoxicity and support the use of lipidomics as a sensitive tool for neurotoxicity evaluation following acute pesticide exposure.

2.01.P–TuWe39 Chemicals of Concern in Aquatic Macroinvertebrates from a Subtropical River System Impacted by Intensive Agricultural Activities

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Aquatic macroinvertebrates are used worldwide and are considered effective bioindicators of ecosystem health due to their different sensitivities to habitat alteration and pollution, as well as low mobility to reflect stressors that are site specific. The Letaba River in South Africa, as several other river systems globally, is impacted by intensive agricultural activities that use metal(loid) based fertilisers, as well as various pesticides to improve crop-yield. However, once these pollutants are utilised on crops it can enter aquatic ecosystems through aerial deposition, leaching, surface runoff and wastewater disposal, where it can be accumulated in aquatic biota. Therefore, this study assessed the accumulated concentrations of metal(loid)s, organochlorine pesticides (OCPs) and neonicotinoids along the Letaba River in five different macroinvertebrate families. Macroinvertebrate samples were acid digested and metal(loid) concentrations were determined on an inductively coupled plasma mass spectrometer (ICP-MS), while pesticide concentrations were extracted using the QuEChERS method and analysed using gas chromatography-mass spectroscopy (GC-MS) for OCPs and liquid chromatography-mass spectroscopy (LC-MS) for neonicotinoids. From the results, it was evident that metal(loid) concentrations were more site specific rather than family specific, with the macroinvertebrates from the downstream site accumulating higher concentrations of Cd, Cr and Hg, while the family Cyrenidae (freshwater clams) accumulated higher concentrations of Cu, Pb and Zn, regardless of site. Elevated concentrations of p'p-DDT and its metabolites were recorded in Cyrenidae and Potamonautidae (freshwater crabs), while elevated concentrations of lindane and oxy-chlordane were recorded in sites closely associated with agricultural activities in proximity of the river. Elevated concentrations of clothianidin accumulated in Cyrenidae, while Coenagrionidae (damselfly nymphs) accumulated elevated concentrations of nitenpyram, regardless of sites. Despite the pollutant type, it was evident that the filter feeding, sediment associated Cyrenidae can be considered as a reliable accumulation bioindicator, especially in river systems impacted by agricultural activities. This study also highlights the need for monitoring programs to assess how these pollutants enter the aquatic environment, and the effects thereof.

3.01 - Contaminants in Urban Environments

3.01–T01 Incorporating Contaminants in the Urban Air Pollutant Mixture under SWAPIT (Study of Winter Air Pollution in Toronto)

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SWAPIT (Study of Winter Air Pollution in Toronto) is an integrated urban air pollution study that was designed to accelerate the paradigm shift necessary to move from a pollutant-by-pollutant approach to one that is fully integrated for the urban air pollutant mixture. By actively soliciting the participation of over 200 researchers and stakeholders from Canadian governments and universities, SWAPIT incorporated an unprecedented number of pollutants in its scope. These fall within several major pollutant classes including trace contaminants and air toxics with exposure pathways of inhalation and/or ecosystem uptake

after deposition. Several categories of scientific activities are being conducted as part of the study. In situ measurements describe the levels and spatiotemporal variability of SWAPIT pollutants, and they also serve to quantify sources and environmental transformations, to evaluate and improve relevant scientific and technical tools, and to link the presence of pollutants to adverse impacts. A key activity under SWAPIT was a field campaign that took place over six weeks in 2024 during the under-studied winter season. The campaign involved a variety of measurement techniques. These included continuous instruments for airborne pollutants that yielded data at high time resolution (e.g., 1 minute) as well as sampling methods for air and deposition that integrated pollutant collection over hours to weeks. Data from air, deposition, and/or surface water measurements are becoming available from multiple locations for an extensive suite of contaminants. These include but are not limited to toxic metals and their isotopes, polycyclic aromatic compounds, plastics and rubbers (including tire wear particles) and their additives, organophosphate esters, polyhalogenated carbazoles, and per- and polyfluoroalkyl substances (PFAS). Further results link ambient pollutant levels in air, precipitation, and surface water to adverse human and ecosystem health impacts. SWAPIT results demonstrate that trace contaminants are key components of the air pollution mixture in urban areas. Their spatiotemporal distributions vary among compounds and suggest local sources for many. Evidence from SWAPIT suggests that trace contaminants may be linked to observable impacts at the urban scale, and ongoing analysis strives to explain the role of contaminant exposure relative to other factors.

3.01–T02 Pharmaceutical Contamination in Urban Environments: Evidence from a Multimatrix Assessment of Landfill, Hospital, and Wastewater Treatment Plants in Ghana

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Pharmaceutical residues are an emerging threat to environmental integrity, with the potential to disrupt ecosystems and compromise human health. Yet, research on their prevalence and ecological risks in sub-Saharan Africa remains limited. This study assessed the occurrence, distribution, and environmental risks of five widely used pharmaceuticals – metronidazole, ciprofloxacin, paracetamol, ibuprofen, and diclofenac – in soils and waters across urban hotspots in the Greater Accra Region, Ghana. Samples were collected from a municipal landfill, a hospital, and two wastewater treatment plants. Solid-phase extraction and LC-MS/MS analysis revealed widespread contamination, with detection frequencies ranging from 50% to 100%. Ibuprofen recorded the highest concentrations in aqueous systems (up to 858.6 ng/mL) and soil (up to 269 ng/g) samples. Wastewater treatment plants demonstrated variable removal efficiencies (57%–100%), indicating incomplete elimination of pharmaceutical residues. Notably, ciprofloxacin levels in landfill leachates approached ecotoxicological thresholds, suggesting a potential high risk to primary producers such as algae. Risk quotient analysis identified wastewater effluents and landfill leachates as key point sources requiring urgent regulatory and technological attention. These findings underscore the critical need for systematic environmental monitoring, investment in advanced treatment technologies, and the development of integrated pharmaceutical waste management strategies to safeguard urban ecosystems in the region.

3.01–T03 Forensic Identification and quantification of pesticides in Alleged Animal Poisoning Incidents in Japan

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Pesticides are widely used in agriculture and public health, yet their residues pose serious risks to non-target species, including companion animals. In Japan, while anecdotal reports of pesticide poisoning in companion animals exist, systematic forensic documentation remains scarce. This study aimed to identify and quantify pesticide residues in the stomach contents of deceased animals submitted for forensic investigation following suspected poisoning. A total of 44 samples were analyzed, including cats (n=24), dogs (n=11), birds (n=6), a civet, a rabbit, and a guinea pig, sourced from various prefectures. Sample preparation was performed using the QuEChERS method. Non-target screening was performed using liquid chromatography–quadrupole time-of-flight mass spectrometry (LC-Q-TOF/MS) against a curated library of 411 pesticides. Quantification of methomyl, a highly toxic carbamate insecticide, was conducted using LC-MS/MS. Blank and quality control samples were processed in parallel. Non-target screening revealed multiple pesticide classes: carbamates (e.g., methomyl), herbicides (e.g., cyanazine), fungicides (e.g., metconazole), neonicotinoids (e.g., acetamiprid), rodenticides (e.g., warfarin). Methomyl was detected in 65.9% of cases and was the most frequent and intense signal observed. Targeted analysis revealed toxic concentrations, particularly in cats (up to 157 mg/kg), a civet (75 mg/kg), and a dog (30 mg/kg); values exceeding reported animal LD_{50} thresholds. Given methomyl's mechanism of cholinesterase inhibition and rapid neurotoxicity, these results strongly implicate methomyl as the primary toxicant in multiple deaths. Our findings affirm methomyl’s continued risk to domestic animals in Japan and highlight its role in suspected poisonings. The study underscores the urgent need for better

surveillance, stricter pesticide regulation, and improved veterinary diagnostic capacity to address intentional and accidental poisoning in domestic animals.

3.01–T04 Pharmaceuticals in the Coastal Waters of eThekwini: Prevalence and Potential Risks

anisha velayudan[1], Janine Adams[2] and Brent Newman[1] (1)CSIR, (2)Nelson Mandela University

The widespread presence of pharmaceutically active compounds (PhACs) in aquatic ecosystems is concerning. Continuous inputs from multiple sources, including wastewater discharges, have rendered these contaminants pseudo-persistent. PhACs are biologically active and potent at low doses, thus even trace concentrations can cause unforeseen effects on non-target organisms. While studies on PhACs in South African freshwater ecosystems have increased, their prevalence and potential risks in urban estuarine and coastal environments are less understood. This study investigated the prevalence and potential ecological risk of 58 PhACs in surface waters across 47 coastal sites in the eThekwini Metropolitan area, South Africa, which included 18 beaches, 17 estuaries, four rivers, and eight stormwater discharge points. Hazard Quotients (HQs) were calculated to estimate the ecological risk of PhACs and categorized hazards from negligible to high. PhACs were detected at all sampling sites along the eThekwini coastline (minimum three per site), with the highest numbers, 31 and 30, recorded in the aManzanamtoti and uMngeni Estuaries. Acetaminophen and salicylic acid were ubiquitous. Total PhAC concentrations ranged from 17.9 ng/L (at Warner Beach) to 70.6 ug/L (in aManzanamtoti Estuary). The concentrations of some PhACs such as acetaminophen (49.18 ug/L) and ibuprofen (7.06 ug/L) in aManzanamtoti Estuary were among the highest reported for estuarine and coastal waters globally. The highest numbers of compounds and concentrations were detected in urban estuaries and rivers impacted by wastewater discharges, and at stormwater discharge points. HQs exceeded 1 for several PhACs (medium hazard), and exceeded 10 for ibuprofen, azithromycin and ciprofloxacin (high hazard). The highest cumulative HQ was at aManzanamtoti Estuary. These findings attest to the widespread occurrence and potential ecological risks of PhACs in urban coastal environments. They also highlight the role of rivers and estuaries that are impacted by discharges from wastewater treatment plants, and stormwater as pathways for PhACs into eThekwini's coastal waters. The study underlines the need for eThekwini municipality to improve wastewater infrastructure and stormwater management to safeguard nearshore ecosystems. These priorities are especially critical in South Africa and other developing countries, where infrastructure development lags behind rapid urban growth, exacerbating environmental risks.

3.01–T05 Poster Spotlight: 3.01.P–TuWe52, 3.01.P–TuWe40

3.01.P–TuWe52 - Ecological Risk Assessment of Water Contaminants in an Urban River Basin in Ghana; 3.01.P–TuWe40 - Evaluation of the Effects of Street Trees on Heavy Metal Concentrations and Mobility in Soils and Sediments Along Shaded and Unshaded Streets

3.01.P - Contaminants in Urban Environments

3.01.P–TuWe41 What are the potentially toxic elements lurking in your garden? A citizen science approach to identifying potentially toxic metal contamination risks in urban gardens

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In collaboration with the Victoria Compost Education Centre, we have investigated heavy metal soil contamination in backyard and community gardens in the Greater Victoria area since 2016. The results are shared with individual gardeners and published anonymously in a publicly available online map. In previous years, a team of Royal Roads University students conducted the sampling and performed the analysis, however, in 2024 the program pivoted to a citizen science approach where gardeners collected the samples themselves and submitted them to the lab for analysis. Following promotions calling for participation, 27 homeowners submitted 78 samples. The samples were analyzed for potentially toxic elements (PTEs) by X-ray fluorescence. The mean concentrations of PTEs such as As (6.4 mg/kg), Ba (257 mg/kg), Cu (49 mg/kg), Cr (59 mg/kg), Ni (12 mg/kg), Pb (103 mg/kg), and Zn (122 mg/kg) were all below the Canadian Council of Ministers of the Environment (CCME) soil quality guidelines for residential land use. However, concentrations of As, Cr, Cu, Pb, and Zn in a few samples exceeded the CCME guidelines. Based on information submitted by the homeowners, potential sources of these PTEs included leaded paint, wood preservatives, and automotive repair. The calculated chemical daily intake (CDI) values were below the respective tolerable daily intake suggesting that the risk associated with incidental ingestion of metal contaminants by

gardeners were low for most of the gardens. The results along with recommendations for limiting PTEs exposure in these gardens were provided to the homeowners.

3.01.P–TuWe42 Biochar Amendment in Remediation of Heavy Metals in Paddy Soil: A Case Study in Nobewam, Ghana

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Biochar is a stabilised, carbon-rich material created when biomass is heated to temperatures usually between 450 and 550 ◦C, under low-oxygen concentrations. This study evaluated the effectiveness of sawdust, cocoa pod ash and rice husk biochars in remediating metal-contaminated paddy soil in Nobewam, Ghana. Biochar was applied 21 days before cultivating the rice for 120 days, followed by soil sampling and rice harvesting for metals and physicochemical analyses. Compared to the untreated soils, biochar treatments exhibited an enhancement in soil quality, characterised by an increase in pH of 1.01–1.20 units, an increase in available phosphorus (P) concentration of 6.76–13.05 mg/kg soil and an increase in soil total nitrogen (N), and organic carbon (OC) concentration, ranging from 0.02% to 0.12%. Variabilities in electrical conductivity and effective cation exchange capacity were observed among the treated soils. Concentrations of potentially toxic metals (arsenic, cadmium, copper, mercury, lead and zinc) in paddy soils and rice analysed by atomic absorption spectroscopy showed significant differences ($p < 0.05$) among the sampled soils. The concentrations of arsenic and lead in all soil samples exceeded the Canadian Council of Ministers of the Environment soil quality guideline for agricultural soils, with untreated soils having the highest levels among all the soils. Cadmium had a potential ecological risk index > 2000 and a geoaccumulation index above 5, indicating pollution in all samples. In contrast, arsenic and mercury contamination were only found in the untreated soils. Among the tested treatments, rice husk and its combinations, particularly with cocoa pod ash, showed significant efficacy in reducing metal concentrations in the soils. The potential non-carcinogenic human health risks associated with the consumption of rice grown in biochar-treated soils were lower for all the metals compared to the control samples. Future research should focus on long-term field studies to validate these findings and explore the underlying mechanisms governing metal immobilization in paddy fields

3.01.P–TuWe43 Bioaccessibility and Risk Assessment of Toxic Metals in Soils and Cocoa Beans: Human Health Implications

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The surge in mining operations in Ghana, particularly in cocoa-cultivating areas, has impacted cocoa production and led to heightened levels of potentially harmful metals in the soil, which can accumulate in cocoa beans. This study aimed to assess the potential contamination of toxic metals in cocoa farm soils and beans from Ghana's mining and non-mining regions. Metal concentrations were determined through X-ray fluorescence analysis, inductively coupled plasma–mass spectrometry and Zeeman mercury analyzer for mercury quantification. The farm soils exhibited acidity with pH ranging from 4.08 to 6.86, electrical conductivity between 29.16 and 870.50 µS/cm, and soil organic matter content of 4.78 to 7.38%. While metal concentrations in the soil were generally within recommended limits, variations were observed between the study areas. Cocoa beans exhibited elevated toxic metal concentration ranges for arsenic (1.20–1.33 mg/kg), cadmium (2.68–3.16 mg/kg), chromium (9.31–11.73 mg/kg), copper (59.69–70.88 mg/kg), mercury (0.008–0.017 mg/kg), manganese (18.90–23.68 mg/kg), nickel (10.19–11.76 mg/kg), lead (1.71–1.86 mg/kg), and zinc (80.20-87.34 mg/kg). The mean percentage of bioaccessible amounts ranged from 13.54 – 80.00. The total metal concentration in cocoa beans indicated that arsenic, cadmium, chromium, and copper showed a potential health risk, with the target hazard quotient (THQ) exceeding 1 (THQ>1) for both children and adults. However, the bioaccessible amount of these metals in cocoa beans showed no potential health risks to both age groups (THQ<1). The farm soils were found to be highly enriched with toxic metals, which further accumulated in cocoa beans at levels that can pose a potential non-carcinogenic risk to consumers. The elevated levels of toxic metals in cocoa beans highlight the need for regular monitoring to mitigate the accumulation of these harmful substances.

3.01.P–TuWe44 Speciation, contamination, and risk assessment of potentially toxic elements in soils from mining and non-mining areas in Ghana

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Using a sequential extraction scheme, this study investigated the fractions of metals, including As, Cd, Cr, Cu, Hg, Pb, and Zn, in soils from two mining areas (Amansie and Konongo) and a non-mining community (Mampong) in Ghana. The elements were fractionated into exchangeable, carbonate-bound, reducible, oxidizable, and residual forms to assess their mobility and bioavailability. The results showed that Cd, Hg, and Zn had the highest proportions in the mobile fractions (exchangeable and acid-soluble), with Cd in Amansie soil exhibiting 40.67% (2.92 mg/kg) in the exchangeable fraction and 48.97% (3.52 mg/kg) in the acid-soluble fraction, indicating high bioavailability. Enrichment factor analysis revealed moderate to significant enrichment of Pb, Cd, and Hg in the mining areas (EF > 5), while geo-accumulation index calculations indicated moderate contamination of Pb and Hg in Amansie and Konongo. Ecological risk assessment identified Amansie as posing the highest potential ecological risk (Risk Index = 215), with moderate risks in Konongo (Risk Index = 177) and Mampong (Risk Index = 129). Health risk analysis found low non-carcinogenic risks but a potential lifetime cancer risk for children due to Cr exposure. Positive Matrix Factorization identified mining, agriculture, vehicular emissions, and geogenic processes as key sources of soil contamination.

3.01.P–TuWe45 Radiological Health Risks of Natural Radionuclides in Classroom Dust: A Study in Ghana's Ashanti Region

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This research investigated the distribution and radiological health hazards linked with natural radionuclides in dust samples obtained from educational institutions in Ghana's Ashanti Region. Twenty dust samples were obtained from classrooms across four districts: Ejura, Jamasi, Mampong, and Nsuta in Ashanti Region of Ghana and the activity concentrations of 226Ra, 232Th, and 40K were quantified using high-purity germanium gamma spectrometry. The findings revealed significant variations in radionuclide concentrations across study locations. The mean activity concentrations of 226Ra and 40K were below the global average, while 232Th concentrations exceeded international benchmarks in certain schools. Notably, classrooms in Mampong and Nsuta recorded elevated levels of radionuclides compared to those in Ejura and Jamasi, indicating spatial variations in potential exposure risks. Radiological hazard indices such as the radium equivalent activity, annual effective dose rate, and the external (Hex) and internal (Hin) hazard indices were below the recommended safety threshold, indicating minimal immediate risk. However, the absorbed dose rate exceeded the recommended 55 nGy/h limit in some locations, raising concerns over localized exposure. Nonetheless, excess lifetime cancer risk values were higher in some schools, particularly in Mampong and Nsuta, suggesting the need for continuous monitoring.

3.01.P–TuWe46 Ecological and Human Health Risk of Potentially Toxic Elements and Naturally Occurring Radioactive Elements in Food Crops from Soils in Mampong, Ghana

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This study examines the levels, spatial distribution, and health risks of naturally occurring radioactive materials (NORMs) and potentially toxic elements in agricultural soils and food crops (cassava, yam, and cocoyam) in Mampong Municipality. The research focuses on uranium-238, thorium-232, potassium-40, and heavy metals such as cadmium, chromium, lead, and arsenic, which pose environmental and health risks. The study's findings reveal that the soils are mildly acidic (average pH ~ 6.25), a condition conducive to increased metal solubility and bioavailability, which enhances the transfer of metals to plants. Key physicochemical parameters, such as electrical conductivity and organic carbon content, indicate that soils have low ionic contamination but varying capacities for metal retention and mobility. Potentially toxic elements concentrations in soils exhibited a consistent trend (Mn > Zn > Cr > Ni > Cu > Pb > Cd > As), with manganese and zinc as the most abundant, though potentially harmful elements like cadmium, chromium, and lead exceeded permissible limits in several locations. Mn concentrations, although the highest among metals tested, generally remained within safe levels and posed lower risks to human health and the environment. Zn concentrations were notable but also largely within acceptable limits, indicating moderate environmental concerns. However, the comparison highlights the variability of these metals' risks depending on location and other soil factors such as pH and organic content. Radionuclide measurements identified moderate activity concentrations of uranium-238, thorium-232, and potassium-40, with calculated hazard indices generally within acceptable

limits but with specific areas showing elevated risks. The study found high metal transfer rates from soil to crops, particularly for manganese, chromium, zinc, and cadmium. Cocoyam showed the highest bioaccumulation, with cadmium and chromium posing non-carcinogenic risks to children. Lifetime cancer risk assessments suggest long-term exposure concerns. The research highlights the need for continuous environmental monitoring and regulatory interventions to mitigate contamination risks. Public awareness initiatives and stricter policies are recommended to protect food safety, human health, and the ecosystem.

3.01.P–TuWe47 Human And Ecological Risk Assessment Of Potentially Toxic Elements In Soils From Artisanal And Small-Scale Gold Mining Area

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Potentially toxic element pollution deteriorates soil, water bodies, the atmosphere, and food crops. A substantial portion of the world's gold production comes from the artisanal and small-scale gold mining sector, linked to the soil's release of potentially toxic elements, raising problems for the ecological environment and public health. A Niton XL3t GOLDD+ field portable X-ray fluorescence spectrometer was used to screen soils for their metal concentrations. The study found that all metals were below the Dutch Target and Intervention Values; 2000 (VROM) limit except for Cd, Cu, V, and Zn. Soil samples showed toxic metal concentrations of Pb, As, Zn, Cu, Ni, Co, Cr, Cd, Ti, and V with Mg having high contamination. The soils in the Gbani area have a moderate to high degree of pollution, which may be caused by anthropogenic activities, according to the geo-accumulation index that was determined to assess the extent of contamination. There is no risk to human health from exposure to these metals at the current concentrations, as indicated by HI and HQ values which are all below 1. Monitoring the soils for their concentrations is recommended to protect human health and ecology.

3.01.P–TuWe48 Exposure and Risk of Toxic Elements through Medicinal Hydrophytes

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Aquatic medicinal plants (hydrophytes) play a critical role in traditional healthcare systems across Ghana. However, their intimate contact with water and sediment makes them susceptible to the accumulation of potentially toxic elements (PTEs), posing risks to human health. This study assessed the concentrations of Pb, Cd, Cu, As, and Zn in 36 samples from 12 commonly used aquatic medicinal species collected from the Sumanpa and Kyeremfa Rivers in the Mampong Municipality, Ghana. Using atomic absorption spectrometry, concentrations were evaluated against the WHO permissible limits. Risk assessments, including estimated daily intake (EDI), hazard quotient (HQ), hazard index (HI), and carcinogenic risk (CR) were conducted following U.S. EPA guidelines. Results showed that most samples, particularly roots and leaves, contained Pb, Cd, and As concentrations that far exceeded WHO limits. Arsenic posed the highest health risk, with EDIs and HQs indicating significant non-carcinogenic and carcinogenic risks, especially in Botrychium virginianum, Alternanthera sessilis, and Lemna minor. Leaves, which are commonly used in decoctions and infusions, were the most toxicologically concerning plant parts. Findings underscore the urgent need for public health interventions and evidence-based harvesting guidelines to mitigate heavy metal exposure from aquatic herbal remedies in Ghana.

3.01.P–TuWe49 Mercury and Heavy Metal Pollution of the Birim River, Ghana

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Birim river is one of the main tributaries of the Pra River, which ranks among freshwater bodies of economic importance in Ghana. The Birim river serves as a source of water for domestic water supply, irrigation and commercial/industrial activities in south-eastern Ghana. Artisanal mining activities along river bodies promote continual introduction of wide range of contaminants into these water bodies, and their toxicity poses great threat to the environment and human beings. Concentrations of some potentially toxic metals in the sediment of Birim river has been measured using X-Ray Fluorescence spectrophotometer for the metals and Cold Vapour Atomic Absorption Spectrophotometer for Hg. The mean concentrations (mg/kg) recorded for the sediment samples taken at different locations on the river over a year were: Fe (42918.50) > Mn (427.55) > Cr (112.05) > Co (103.87) > Zn (62.52) > Cu (32.96) > Ni (25.80) > As (25.32) > Sb (6.86) > Cd (6.11) > Pb (6.00) > Sn (4.44) > Hg (0.07). The concentrations of some metals in the sediment samples were found to exceed recommended values in international environmental soil/sediment quality guidelines (mg/kg) of; As (12), Cd (10), Co (50), Cr (64), Cu (63), Ni (45), Pb (140), Hg (6.6) and Zn (200), indicating pollution of the sediment. Hazard indices were examined to assess the extent of pollution in the water body. The geo-accumulation index revealed that the area is moderately polluted with

Cd and Zn, and strongly polluted with As. The contamination factor indicates that the area is strongly contaminated with As and Zn, moderately contaminated with Cd and Mn, and uncontaminated with the remaining metals. The Enrichment Factor (EF) indicated human influence - artisanal mining activities on the sediment concentration of As, Cd and Zn for the river. The risk indices explored show that there is the need for continuous monitoring of metal contamination of the river as well as the basin, as they are used for domestic purposes, to avoid future disaster. For the water samples, metal concentrations measured were lower than the WHO standards, except for Fe. However, the mean discharge of the river is 74.2 m3/s, indicating a relatively swift flow of the river hence dissolved metals would not be localised.

3.01.P–TuWe50 Source Apportionment and Human Health Risk Assessment of Potentially Toxic Elements in Soils Impacted by Artisanal Small-Scale Mining.

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Industrialization and urbanization in developing nations have contributed to the pollution of the biota and the entire ecosystem with potentially toxic elements (PTEs). This study aims to do source apportionment, assess pollution levels, and evaluate the human health-risk of PTEs in soil affected by artisanal small-scale mining in the communities of Atwima Mponua District, Ghana. The concentrations of metals and metalloids in 78 soil samples were estimated using a Thermo Scientific field portable Niton X-ray fluorescence analyser. Statistical algorithms including positive matrix factorization (PMF), principal component analysis (PCA), and various pollution indices were utilized to apportion the sources, contributions, correlations, and spatial distribution of the PTEs. The mean levels of the PTEs in the soil-samples were as follows: [Hg (0.304), Cr (2.90), V (4.47), Pb (4.99), As (9.10), Cu (15.47), Ni (26.30), Zn (39.56), Ti (264), Co (121.16), Cd (204.22), and Mn (361.80)] mg/kg respectively. The study found high contamination factors (CF) for Cd (85.10), and Co (2.08). The results of potential ecological risk (PER) for Cd 2553.01, Co 10.27, and As 3.71 The enrichment factor (Erf) for Cd, Hg, and Co were all > 1.5, indicating significant enrichment in the area. The correlation coefficient analysis showed strong positive correlations between the majority of the PTEs suggesting common sources. PMF multivariate receptor modeling analysis identified five (5) dominants and sub-dominant source profiles. The results have apportioned source contributions 2,4, and 5 to anthropogenic sources mainly the artisanal small-scale mining and agricultural activities, and attributed factors 1,3 as both anthropogenic and geogenic sources in the study area. The investigation concludes that the soil in the Atwima Mponua District is at serious risk due to the high levels of PTEs, particularly Cd and Co which pose significant ecological and human health risks. Hence, policy interventions are necessary to mitigate pollution and protect public health.

3.01.P–TuWe51 Temporal Variations of Lead Concentrations in Soil Along a Major Highway in Cape Town, South Africa

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Lead contamination in cities can be a serious public health risk. Lead emissions have historically come mostly from leaded petrol, amongst other sources, which has led to soil pollution. The persistence of lead in the environment is one of the factors that makes it a metal of concern. There is significant evidence of lead toxicity and impact on the environmental and public health. Increased levels of lead in soil can have several effects, particularly for vulnerable groups such as children. The ecosystem can also be significantly impacted by lead pollution. These factors have led to the phase out lead-based petrol in countries around the world over several years. South Africa has followed the global trend and phased out leaded petrol in 2006. The objective of this investigation was to determine the temporal variations of lead in soil along a major highway in Cape Town by analysing soil samples collected before and after the banning of leaded petrol in South Africa. Soil samples were collected before the banning of leaded petrol (2005), five years after the banning of leaded petrol (2011), and sixteen years thereafter (2022). Soil samples were collected at six sampling sites on the inbound and outbound sides of a major highway, from the city centre of Cape Town to about 35 km away. Soil samples were acid digested and analysed for lead using Inductively Coupled Plasma Atomic Emission Spectrometry (in 2005) and Inductively Coupled Plasma Mass Spectrometry (in 2011 and 2022). Sigmaplot 12 was used to statistically analyse the data. Statistical analysis of lead concentrations measured in soil over the three sampling periods have shown that lead decreased significantly in certain cases from 2005 to 2011 and 2022. However, in other cases lead concentrations significantly increased from 2005 to 2011. This may be attributed to other sources of lead in the environment, together with its persistence in environmental compartments. At many of the sampling sites soil quality guidelines were exceeded, even several years after the banning of leaded petrol. Thus, although leaded petrol has been banned in South Africa for almost 20 years now, lead should not be disregarded as an environmental pollutant.

3.01.P–TuWe53 Wastewater and Environmental Surveillance for Biological Contaminants in the Soet River Catchment: Case Study of Nomzamo in Cape Town

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Wastewater and environmental surveillance (WES) is a valuable tool in public health. This study used WES to monitor pathogenic Escherichia coli (E. coli) strains in the Soet River, focusing on Nomzamo, an informal settlement characterized by high population density with limited sanitation infrastructure. The City of Cape Town's (CCT) routine water quality monitoring from 2020 to 2025 has consistently reported E. coli levels in Soet River exceeding acceptable thresholds, with only 9% of samples meeting the compliance target in March 2025 - far below the City's 60% target. However, localized data to identify specific contamination hotspots are lacking. This study aims to identify E. coli hotspots using WES and guide sanitary interventions in high-risk areas. A cross-sectional, quantitative approach will be used. Bi-weekly sampling will be conducted over both dry and wet seasons upstream, within, and downstream locations in Nomzamo. Sites include portable toilets & communal toilets, open canals, and impacted surface waters, using grab and torpedo sampling techniques. Anticipated outcomes include a spatial profile of E. coli contamination patterns. Results will complement existing data and support sanitary interventions in hotspot areas, ultimately contributing to improved water quality compliance and reduced health risks in vulnerable communities.

3.01.P–TuWe54 An Aquaponics System to Provide Perchlorate-free Vegetables and Proteins to Rural Communities

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Perchlorates are used as oxidisers in solid fuel for rockets and missiles. Perchlorate contamination is widespread due to the compound's stability and high mobility in aqueous solutions, being found in multiple water sources across the world. Perchlorate is readily taken up and stored within plant tissues, where it may bioaccumulate and become orders of magnitude higher than the surrounding environment. Perchlorate has adverse effects on human health due to its interference with iodine uptake in the thyroid. Conventional municipal and domestic methods for perchlorate removal involve ion-exchange, reverse osmosis and bioreactors, though these methods are costly and not routinely used to treat water supplies. We hypothesise that an aquaponic system will be able to grow perchlorate-free crops and purify water of perchlorate as an affordable and versatile alternative to the methods mentioned. Literature suggests that transpiration causes plants to accumulate perchlorate in the leaves. Areas of the plant that are not directly exposed to contaminated water and have low transpiration will have significantly lower levels of perchlorate. There is some evidence that plants can metabolise perchlorate to chlorate, rendering it harmless. Aquaponic systems in the shallow water culture design will be constructed of polyvinyl chloride pipes and vertical storage containers as water reservoirs; biofilters will be present in each reservoir. Ammonia solution will be added to the reservoirs daily to simulate ammonia excretion from fish, and additional nutrients will be added in the form of hydroponic fertiliser. Soil systems will be polyethylene plant pots filled with coco coir and perlite in a seven-to-three parts mixture, respectively. We will test the absorption, storage and potential metabolisation of perchlorates in various areas of pea plants (Pisum sativum) exposed to three concentrations of perchlorate. The results from the aquaponic and soil systems will be compared to test differences in the aforementioned parameters. The concentrations will be 10 µg/L, 2 mg/L, and 1 g/L. Roots, stems, leaves, pods, and pulse of the peas will be freeze-dried before extraction of perchlorate using accelerated solvent extraction (0.1 mole NaOH), followed by ion chromatography to determine perchlorate content in the plant tissues. Plant vitality will be evaluated using chlorophyll fluorescence.

3.01.P–TuWe40 Evaluation of the Effects of Street Trees on Heavy Metal Concentrations and Mobility in Soils and Sediments Along Shaded and Unshaded Streets

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Several studies on the occurrence of heavy metals and organic pollutants from vehicular emissions in soils, road dust, vegetation, and the atmosphere along roadsides have been undertaken. Results from these studies have highlighted the role of vehicular emission on soil contamination but studies on road characteristics such whether the road is paved or not, material used for paving, and whether the road has a shade or not have rarely been considered, yet these factors because they affect the temperature of the soils and sediments along the road may affect biological, chemical and physical processes dictating heavy metal fate in the soil. This research focuses on the effect that street trees in may have on the mobility of heavy metals in soils and sediments along streets with a view of understanding the impact that street trees may have on the load of heavy metals delivered to surface water through stormwater originating from these streets and also to identify areas that need attention as far as stormwater management is concerned. Soil samples were collected from both shaded and unshaded sections of streets

around Johannesburg (urban) and Thohoyandou (Rural) and analyzed for their particle size distribution, pH, cation exchange capacity, and organic matter content, organic matter structure and composition, mineralogical composition, major and trace element oxides, and heavy metal concentrations in the different biogeochemical fractions of the soil using standard techniques. Mobility of metals in the soils and sediments were determined using the metal mobility factor. Results indicate differences in mineralogical and geochemical concentrations of the soil. Major minerals identified included Quartz, Corundum, hematite, and escalate among others. These results were reflected in the major and trace element oxides concentrations which followed the order $SiO_2 > Al_2O_3 > Fe_2O_3 > K_2O$. Heavy metal concentrations and mobility showed differences between soils and sediments, from shaded and unshaded sections of the streets. These results highlight the need to pay more attention to stormwater as a source of heavy metals to surface waterbodies.

3.01.P–TuWe52 Ecological Risk Assessment of Water Contaminants in an Urban River Basin in Ghana

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Effective management of aquatic ecosystems, particularly in urban and ecologically stressed catchments like the Odaw River Basin in Ghana, require robust ecological risk assessments for planning restoration efforts. A comprehensive evaluation of water contaminants was carried out in the basin using samples collected from twelve sites; eight from surface waters and four from groundwater. Sampling was conducted during both wet and dry seasons to account for hydrological dynamics. Standard analytical methods were applied to a broad spectrum of contaminants grouped into three categories: (i) nutrients (ammonia, nitrate, nitrite, and phosphate), (ii) heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, and iron), and (iii) contaminants of emerging concern (CECs) including perfluorochemicals (PFAS), hormones, pharmaceuticals, and pesticides. Results revealed a spatial gradient, with the highest contaminant levels recorded downstream, followed by midstream and upstream areas. One downstream site consistently recorded cadmium concentrations orders of magnitude greater than WHO drinking water guidelines, likely due to nearby artisanal electronic waste recycling. Ammonia and phosphate concentrations at one site also exceeded WHO drinking water guidelines of 1.5 mg/L and 0.6 mg/L, respectively. Statistical analyses confirmed significant spatial differences ($P < 0.05$) for most contaminant types, while seasonal variations were not statistically significant, likely due to the continuous redistribution of pollutants via hydrological mixing. Principal Component Analysis (PCA) indicated that two-thirds of the variance in surface water contamination could be explained by the first two axes, underscoring the interconnected nature of contaminant sources and behaviours. Groundwater samples generally had lower concentrations of contaminants, except for elevated iron levels in upstream regions, likely influenced by geological conditions. Notably, PFAS were detected across all samples, indicating pervasive pollution, and hormones showed some of the highest concentrations observed in tropical surface waters. Industrial discharges and untreated municipal wastewater were identified as key contributors to contamination. The findings underscore the pressing need for an integrated ecological risk assessment framework to prioritise critical contaminants and inform effective remediation, policy development, and sustainable water resource management in the Odaw River Basin.

3.02.A - Emerging Contaminants in Water: Current Trends and Innovations in Developing Countries

3.02.A–T01 One Health and Contaminants of Emerging Concern in Africa: Cyanotoxins and Pharmaceuticals in Surface Waters of Cameroon

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Cyanotoxins and harmful algal blooms represent a classic One Health issue. Here we critically reviewed the prevalence of cyanotoxins in African surface waters used as drinking water sources, and then we investigated the occurrence of targeted contaminants of emerging concern in Cameroon. We initially reviewed pertinent literature from three databases and examined these results following the PRISMA-Sc guideline. 84 studies evaluating the occurrence of cyanotoxins in surface waters were identified, representing only 17 out of 54 African countries. Microcystins (MC), anatoxins and cylindrospermopsin were assessed in 100%, 13.1%, and 10.7% of selected studies, respectively, while nodularin and saxitoxin were both studied in 4.8% of the publications. Concentrations of MC higher than the WHO provisional guideline for human lifetime exposure via drinking water (1 μg/L) were identified in 11 of 14 countries with available data. We then selected Lake Maga (Cameroon) for

study given its use for potable source water, and agricultural and aquatic life uses. We analyzed surface water samples for cyanotoxins, pharmaceuticals and personal care products (PPCPs) using LC-MS/MS. In our study, which is the first assessing cyanotoxins in Central Africa, 8 of 11 targeted toxins were detected. Additionally, 16 out of 25 pharmaceuticals and personal care products (PPCPs) analyzed were found in at least one sample with psychiatric drugs, analgesics, and illicit drugs most frequently detected. We then performd probabilistic environmental health hazard assessment to evaluate these observations. Despite the generally low concentrations detected, long-term exposure to these contaminants may affect the vulnerable human population of Maga and their livestock that use Lake Maga as a drinking water source, in addition to wildlife and aquatic organisms that rely on the lake. This finding emphasizes that CECs could pose environment and health risks in Cameroon and demonstrates the need of further research to better understand these risks within a One Health context.

3.02.A–T02 Pharmaceutical Residues in Surface Water Bodies from Upper Orange- Sengu River Basin: Occurrence Within Two Seasons Using Liquid Chromatography Coupled With Mass Spectrometric Technique

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Residues of pharmaceutical compounds remain one of the contaminants of concern in the environment. These substances eventually find their way into various compartments of the ecosystem, such as water, soils, sediments, and biotic components. Consequently, pharmaceutical residues have since gained the attention of researchers, primarily because of the fatal impact they exert on living organisms upon their release into the environment. Among the numerous pharmaceutical compounds manufactured all over the world, the present study focused on prednisone (PRD), metabolite-prednisolone (m-PRD), dexamethasone (DEX), and azithromycin (AZI). In the present study, a solid phase extraction−liquid chromatography−mass spectrometry (SPE-LC-MS) method was used to quantify the analytes of interest in water and sediment samples collected from eight sampling sites within the Upper Orange-Sengu River Basin in Free State, South Africa. The detection frequencies of AZI, m-PRD, DEX, and PRD in the water samples obtained from the eight sampling sites were 87.5%, 12.5%, 37.5%, and 25.0%, while the detection frequencies of the analytes in sediments were 75.0%, 75.0%, 50.0%, and 75.0%, respectively. Among the pharmaceutical compound residues monitored, m-PRD had the highest concentration in water, while the DEX level was the highest in sediments. Since these pollutants were detected within the ecosystem, it is expedient for stakeholders to continually monitor their presence and, most importantly, embark on remediation strategies for their removal from the environment. It is therefore expedient that continuous research be conducted to track the presence of pharmaceutical residues in the South African water sources.

3.02.A–T03 Evaluating the ecotoxicological effects of pharmaceutical and personal care product pollutants on aquatic ecosystems in Bulawayo, Zimbabwe

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Aquatic ecosystems often serve as the final repositories for chemical pollutants derived from anthropogenic activities. These pollutants including pesticides, heavy metals, polycyclic aromatic hydrocarbons, pharmaceuticals, and personal care products (PPCPs) exhibit varying degrees of toxicity. Although the environmental effects of many of these substances are well-documented, numerous anthropogenic chemicals, collectively known as emerging pollutants, remain insufficiently studied in terms of their toxicological impacts. In Zimbabwe, there is a notable lack of data on pollution caused by emerging contaminants, particularly PPCPs posing a challenge to effective environmental management and conservation. This study assessed the effects of pharmaceutical and personal care product effluents on the health of aquatic organisms in freshwater reservoirs through three independent studies. In the first study, zebrafish (Danio rerio) were exposed to pharmaceutical effluent for 28 days to evaluate oxidative stress and endocrine disruption. Biomarkers analyzed included activities of superoxide dismutase (SOD), catalase (CAT), glutathione S-transferase (GST) and vitellogenin content. Results showed increased SOD, CAT and GST activity, along with a 2.5-fold elevation in vitellogenin levels compared to controls, indicating potential endocrine disruption. The second study focused on the freshwater snails Lymnaea natalensis, which were also exposed to pharmaceutical and PCP effluents for 14 days. Post-exposure analysis of antioxidant enzymes SOD and glutathione peroxidase (GPX) and malondialdehyde (MDA), a marker of lipid peroxidation, revealed significant increases in enzyme activity and MDA levels ($p < 0.05$), suggesting oxidative stress. In the third study, Xenopus laevis tadpoles were exposed for 14 days to either 0.01% v/v veterinary pharmaceutical effluent or a 25 µg/L mixture of oxyclozanide and oxfendazole. Oxidative stress

biomarkers showed that SOD and GPX activities were elevated by up to 14-fold and 7-fold, respectively, in exposed tadpoles. Malondialdehyde levels were significantly elevated by 40% compared to the control group ($p < 0.05$) Collectively, these findings demonstrate that PPCPs can cause substantial oxidative and endocrine stress in aquatic organisms. The results highlight the urgent need for systematic monitoring and regulatory measures to manage PPCP pollution in freshwater ecosystems and safeguard aquatic biodiversity and ecosystem health.

3.02.B - Emerging Contaminants in Water: Current Trends and Innovations in Developing Countries

3.02.B–T01 Assessment of Ecotoxicological Effects of Polycyclic Aromatic Hydrocarbons in Sediments and Water from Klip River, Johannesburg, South Africa

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Polycyclic aromatic hydrocarbons (PAHs) are a class of organic pollutants that are widespread and persistent in the environment. These compounds are categorised by the United States Environmental Protection Agency (US EPA) as carcinogenic, mutagenic and teratogenic towards organisms including humans. This study identified and quantified the levels of selected PAHs and assessed their spatiotemporal distribution, in water and sediment samples collected from the Klip River in Gauteng Province, South Africa. Water and sediment samples, collected during low and high flow seasons, were extracted by liquid-liquid extraction (LLE) and microwave-assisted extraction (MAE), respectively. The resulting extracts were analysed using gas chromatography-flame ionization detector (GC-FID). The efficiencies of the applied extraction methods were evaluated using spiked water samples for LLE, and certified reference material (CRM-104) of sediment for MAE. The ecotoxicological effects of samples were evaluated using zebrafish embryo development test (ZFET). The endpoints assessed included hatch rate, mortality, and malformations such as developmental retardations, spinal deformities, impaired blood circulation, somite formation defects, pigmentation, irregular heartbeats, tail non-detachment, and embryo coagulation. The obtained percentage recoveries for MAE ranged from 80.7 to 117.8%, while those for LLE varied between 78.3 to 117%. The total concentration of PAHs detected in sediment samples ranged from 1.46 to 7.41 mg/kg, significantly higher than the concentrations detected in water samples, which ranged from 0.000579 to 0.00502 mg/L. The conducted toxicity test using the ZFET revealed that sediment samples from the Klip River are highly contaminated compared to the water samples, resulting in low hatch rates, high mortality rates, and high malformations in zebrafish embryos exposed to them, suggesting that exposure to this polluted water system poses serious ecological risks and may have detrimental impacts on aquatic life and human health who depend on it.

3.02.B–T02 Use of insecticide treated bed nets for fishing in sub-Sharan Africa may cause toxicity to fish and invertebrates in aquatic ecosystems

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Insecticide treated mosquito nets (ITNs) have been distributed worldwide to reduce malaria infections and studies indicate these nets have led to a roughly 40% global reduction in the incidence of malaria cases. ITNs are typically treated with pyrethroid insecticides, which are highly effective at killing mosquitos, but can also be very toxic to off-target organisms, especially aquatic organisms. Widespread distribution of ITNs may now be reaching a saturation point as observational data and survey-based research suggests that excess nets are being repurposed for other uses including fishing. Alongside the reports of mosquito net fishing, there are reports of decreased fish quantity and quality. However, there are a lack of studies investigating the impact of ITN fishing on aquatic ecosystems. The objective of this study was to examine insecticide leaching and environmental fate from ITNs in water and subsequent toxicity to aquatic organisms. Results from these studies indicate that pyrethroid insecticides do leach from ITNs when submerged in water. Interestingly, higher masses of leaching was recorded from smaller net sizes, indicating a possible saturation point. Overt toxicity was observed for D. magna during simulated fishing exposure scenarios. In P. promelas following exposure to ITNs, there was less overt toxicity, however, there were statistically significant impacts on the expression in metabolism and oxidative stress genes. Investigating fate and transport improved understanding of the risk of ITN fishing to aquatic ecosystems. Alpha-cypermethrin was transported to sediment and bioaccumulation was observed within the juvenile P. promelas. Overall, results of this study confirm anecdotal evidence that suggests pyrethroids are leaching from ITNs and can negatively impacting aquatic ecosystems, though field studies are needed to confirm these findings. Results from this study also indicate the need for a bigger discussion surrounding the impact of ITN fishing and the subsequent risk of pyrethroid leaching on aquatic and human health.

3.02.B–T03 The Use of Yeast Bioassays to Determine the Potential Risk of Azithromycin, a COVID-19 Drug, on the Aquatic Ecosystem and Human Health in the Orange-Senqu River Basin

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Azithromycin is a widely used macrolide that is frequently detected in aquatic ecosystems. The investigation of therapeutic antibiotics in African aquatic environments is notably underrepresented, leaving the impact of pharmaceuticals, such as macrolides, on water quality and ecosystems poorly understood. The presence of azithromycin in surface waters raises concerns about its potential risk to aquatic organisms and human health. Information on ecotoxicological and human health hazards of antibiotics through environmental exposure routes remains insufficient. Hence, this study aimed to investigate endocrine-disrupting and dioxin-like activities of environmental water samples from a transboundary river basin using in vitro bioassays. The protocols applied were the Yeast Estrogen Screen (YES) and Yeast Anti-Androgen Screen (YAAS), which were used to assess estrogenic and anti-androgenic activities, respectively, while the Aryl Hydrocarbon Assay evaluated dioxin-like activities. Sampling was conducted during summer and winter to reflect seasonal variation. The results revealed detectable estrogenic and anti-androgenic activity at several sites, with Estradiol Equivalent (EEQ) concentrations ranging from less than the limit of detection (LOD) to 35 ng/L during the summer season and less than the LOD to 58 ng/L during winter. Flutamide equivalent (FEQ) concentrations, expressing anti-androgenic activity, ranged between less than the LOD and 40 µg/L in summer and less than the detection limit to 47 µg/L in winter. Dioxin-like activity, measured in β-Naphthoflavone Equivalent, ranged below the detection limit to 1050 ng/L in summer and below the LOD to 1130 ng/L in winter. These concentrations exceeded values that were reported in the literature, suggesting a potential risk of endocrine disruption in aquatic organisms and a possible health concern for humans through exposure. The findings highlight the need to adopt economically-viable and effective screening tools such as yeast bioassays in developing countries, as a complementary measure to other risk assessment methods such as chemical concentrations. Also, the study contributes to further research on the long-term effects of azithromycin and similar compounds in aquatic environments, which are lacking particularly in the context of African aquatic ecosystems. Lastly, the importance of better pharmaceutical management policies is also emphasised.

3.02.B–T04 Photodynamic activity of novel porphyrin conjugates against bacteria in water

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In recent times, South Africa is classed as "water short" and is on its way to being "water stressed" in global terms. This is because of various past socioeconomic and political imbalances that have had a negative impact on the distribution of vital basic needs, including clean and potable water, particularly among lower income households across the country. In many lower income households across South Africa, water sources are mostly from rivers, springs, communal standpipes, and boreholes. However, these water collection points are polluted by large volumes of wastewater, discharged from dysfunctional wastewater treatment works. Also, non-functional municipal sewage systems have created a sewage pollution crisis of varying degrees across the country. This introduces pathogenic bacteria into water sources resulting in the animal to human transmission of zoonotic diseases. To address these concerns, existing studies in the literature have examined how these microbial pathogens can be treated with conventional water disinfection methods like chlorination. However, these conventional methods appear to be ineffective due to the ability of microorganisms to form biofilms as a mechanism against disinfectants. This calls for new strategies that are effective, environmentally friendly, and inexpensive to fight against both developing biofilms and antimicrobial resistance. Against this backdrop, using experimental methods, this project focuses on developing innovative materials that can use Antimicrobial Photodynamic Inactivation (aPDI) as a strategy for disinfecting microorganisms in water without inducing resistance in South Africa.

3.02.C - Emerging Contaminants in Water: Current Trends and Innovations in Developing Countries

3.02.C–T01 Optimisation and Validation of a High – Performance Liquid Chromatography – Photo Diode Array Method for the Quantification of Selected Pharmaceuticals in Biological and

Environmental Matrices

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The increasing occurrence of pharmaceuticals in biological matrices and wastewater poses significant environmental and public health challenges. These compounds, which originate from various sources, can persist in the environment, leading to adverse effects on exposed ecosystems and humans. This research aims to develop and validate a high-performance liquid chromatography method coupled to photo diode array detector (HPLC-PDA) for the quantification of selected pharmaceuticals, including acetaminophen, albendazole, diclofenac, efavirenz, lamivudine, norethisterone, and sulfamethoxazole, in biological matrices (e.g., blood, urine) and wastewater samples. This study will be the first to investigate norethisterone in South Africa. This method involves the optimisation of sample preparation techniques, such as solid-phase extraction (SPE), to effectively isolate and concentrate the target pharmaceuticals from complex matrices. The HPLC-PDA system will be operated over a Shimadzu SHIM-PACK GIST C18; 5 micron, 4.6 x 150 mm column to achieve good separation, and tuned for maximum sensitivity and selectivity for accurate detection of the pharmaceuticals. The developed method will be rigorously validated according to standard analytical procedures, including assessments of linearity, limit of detection (LOD), limit of quantification (LOQ), precision, and accuracy. Preliminary results suggest that the method will provide high sensitivity with LODs and LOQs suitable for trace-level detection. The recovery rates from spiked samples are also to be evaluated to ensure method reliability across different sample types. The validated HPLC-PDA method will be applied to analyse pharmaceuticals in real biological and wastewater samples collected from residents and wastewater treatment plants (WWTPs) in Durban, South Africa, respectively. This study will not only provide essential data on the occurrence and concentrations of pharmaceuticals in various environments but will also contribute to the development of strategies for monitoring and mitigating pharmaceutical contamination. The outcomes of this research will have significant implications for environmental management and public health, offering a robust analytical tool for ongoing surveillance and risk assessment of pharmaceutical residues in the environment.

3.02.C–T02 Photodegradation Kinetics of Amoxicillin, Carbamazepine and Diclofenac Under Simulated Solar Light: Insights from Fluorescence EEMs Deconvolution

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Understanding how pharmaceuticals break down and their transformation under sunlight exposure in aquatic environments remains limited. This study explored the photodegradation behaviour of three widely used pharmaceuticals: amoxicillin (AMO), carbamazepine (CAR), and diclofenac (DIC), using a custom-designed photoirradiation system that simulates solar conditions. Each compound was investigated at a concentration of 1.00 mg/L, both in the absence and presence of 1.00 mg/L of Suwannee River natural organic matter (SRNOM), to assess the influence of natural components on degradation processes. Throughout the 8.1-hour exposure period, changes in the aqueous systems were monitored using fluorescence excitation-emission matrix (EEM) spectroscopy and UV-Vis absorbance at 18-minute intervals. To deconvolute complex fluorescence data, parallel factor analysis (PARAFAC) was employed. This approach allowed for the identification and tracking of both parent compounds and emerging photoproducts over time. The results demonstrated distinct degradation behaviours across the three compounds. Amoxicillin degraded more rapidly than diclofenac, while carbamazepine remained relatively persistent. Although carbamazepine is not inherently fluorescent, several of its transformation products were detected through their fluorescence signatures. The presence of natural organic matter had a variable effect on the photodegradation of the selected pharmaceuticals. The NOM inhibited the degradation of AMO and the fluorescent photoproducts of CAR, while accelerating the breakdown of DIC. These findings suggest that the excited states of NOM can significantly mediate photodegradation pathways. The detection of multiple fluorescent photoproducts, many with unknown toxicological profiles, underscores the potential environmental risks posed by pharmaceutical transformation in surface waters. This study highlights the value of combining spectroscopic techniques with multivariate analysis to examine degradation processes in complex water matrices. Such methods provide a powerful framework for understanding contaminant behaviour and informing future water quality monitoring and regulation efforts.

3.02.C–T03 Mitigating membrane fouling in abattoir wastewater treatment, integration of pre-treatment step with zwitterion modified graphene oxide-polyethersulfone composite membranes

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Discharging abattoir wastewater into the rivers can significantly reduce water quality and affect aquatic organisms because the water contains increased levels of metals such as copper, cadmium, chromium, iron, lead, and zinc. Consequently, the

treatment and reuse of this wastewater for routine equipment maintenance are paramount for environmental and water sustainability. The membrane technology has been extensively used in wastewater treatment due to advantages such as environmental friendliness, selective separation, continuous operation, and energy efficiency. In this study, N-aminoethyl piperazine propane sulfonate (AEPPS) zwitterion was grafted on GO and blended ono the PES support for application in abattoir wastewater treatment. In order to reach potable/non-potable effluent, activated carbon (AC) or coagulation and the UF membranes are combined for effective treatment. Preparation of graphene oxide (GO), N-aminoethyl piperazine propane sulfonate (AEPPS) zwitterion, and AEPPS@GO nanocomposites. Modified Hummers' method was utilised to prepare GO nanosheets. N-aminoethyl piperazine propane sulfonate (AEPPS) was synthesized via ring opening reaction of 1,3-PS with AEP and AEPPS@GO was synthesised using a free radical method. The membranes were fabricated using phase inversion method. The modified membranes showed improved surface characteristics such as surface hydrophilicity and smoothness. These characteristics enhanced the membrane performance, like PWF and fouling resistance. The membranes containing GO (GO/PES) and AEPPS@GO (AEPPS@GO/PES) presented higher PWF values relative to the pristine PES membrane under the same condition, which increased with trans-membrane pressure. The AEPPS@GO/PES membranes presented an FRR of between 73% and 93.3%, maintaining relatively good performance over the six fouling–washing cycles compared to the baseline membranes (PES (59.5%) and GO/PES (70.6%)). Furthermore, these membranes were integrated with either AC or coagulation pre-treatment for the removal of organic characteristics from abattoir wastewater, and the efficiency of the integrated systems was compared. The FEEM plots exhibited almost no fluorescence peaks after using the integrated systems, indicating the good properties of activated carbon and coagulation. The coagulation–UF systems presented better results relative to the AC–UF systems based on the quality of the final effluent, i.e., EC, turbidity, TDS, and salinity. On the other hand, the AC-UF filtration system showed better removal of organic characteristics as observed from the FEEM results, a result attributed to its known ability in the removal of organics. The treated abattoir water quality using both integrated systems was improved to comply with the minimal discharge requirements (SANS 241:2015) for discharge with regard to turbidity, pH, TDS, and EC. Thus, the integrated systems tested in this work have a potential for real application in abattoir industries. These integrated systems offer affordable and effective alternatives when compared to other treatment systems, such as NF and RO, based on costs.

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3.02.C–T04 Prioritization of Pharmaceutical Compounds for Safe Agricultural Water Reuse: A Case Study Within the NEWater Project

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The reuse of reclaimed water for agricultural irrigation is increasingly encouraged in water-scarce regions, particularly across the Mediterranean. However, the presence of pharmaceutical contaminants in treated wastewater poses potential risks to both environmental and human health. The NEWater project (Natural based and low Energy consumption unconventional solutions for the management of Water sources) aims to develop innovative and efficient water systems for representative EU and non-EU regions, based on energy- and cost-efficient hybrid biological, physical, and nature-based solutions (NBS), and, when feasible, interlinked technologies across partner institutions. To ensure replication and scalability, the NEWater system will be validated in four large-scale operational sites ("NEWater Labs") representing diverse scenarios. To focus monitoring efforts among the project partners, this study aims to define a harmonized list of priority pharmaceutical compounds (PhACs) for reclaimed water monitoring across different irrigation systems. An up-to-date literature review covering over 60 peer-reviewed studies from the past decade was conducted, encompassing the four participating countries. More than 150 pharmaceuticals and transformation products (TPs) were identified and compiled into a comprehensive database. Catalonia was selected as a representative region for compound prioritization due to its extensive dataset and acute water stress. A multi-criteria decision-making framework was applied to prioritize compounds, considering four core parameters: occurrence, persistence, bioaccumulation, and toxicity (OPBT). Scores were assigned and normalized based on established environmental thresholds. Additional selection factors included: (i) crop uptake potential (derived from molecular weight, $LogD_ow$, and pKa), (ii) experimental uptake data from previous studies by the research group, and (iii) alignment with current European legislation, specifically Directive 2024/3019 on Wastewater Reuse and EU Watch Lists 2022/1307 and 2025/439. The preliminary list of top-ranked compounds includes several psychiatric drugs such as venlafaxine and carbamazepine, frequently detected in wastewater, along with other widely used substances such as non-steroidal anti-inflammatory drugs (NSAIDs) and antibiotics. This harmonized list represents a critical step toward targeted contaminant monitoring and risk mitigation in agricultural water reuse, supporting the development of safer and more sustainable irrigation strategies across Mediterranean regions.

3.02.P - Emerging Contaminants in Water: Current Trends and Innovations in Developing Countries

3.02.P–ThFr09 Relationship between Physicochemical Parameters and Heterotrophic Bacteria in Drinking Water Treatment Plant in Four Seasons Unveiled through Correlation Analysis

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Good microbiological quality of drinking water is essential to minimise the occurrence of diseases associated with the consumption of improperly treated water. Given this, the stages of a drinking water treatment plant (DWTP) are designed to remove and prevent the proliferation of microbial contaminants, including heterotrophic bacteria (HB), which are detrimental to human health. Despite these preventive measures, the growth of HB in the different stages of DWTPs has yet to be completely controlled. The reason behind the growth of HB is not clear, but it could be due to the inherent physicochemical conditions and temporal changes within the stages that could promote their growth. The present study evaluates the relationship between the physicochemical parameters (PP) and the HB at different stages in four seasons using correlation analysis. Water samples/produced sludge were collected from DWTPs in Tshwane Metropolitan Municipality, Gauteng Province, South Africa. Physicochemical analysis was done at an ISO/IEC 17025-accredited Chemistry laboratory, and enumeration of HB was done using the pour-plate technique for four seasons. Correlation analysis between HB and PP at different seasons was done to show the relationship between them. All the PP measurements were with the SANS241-1:2015 standard. The treatment stages caused a reduction in the HB, especially the pre-chlorination and sedimentation stages. Temporally, the growth of HB was higher in summer and winter. Correlation analysis revealed that Zn, ammonia, temperature, pH, and turbidity showed strong positive correlation with HB, with variation in the different treatment stages/seasons, indicating their role in the growth of HB.

3.02.P–ThFr10 Development of a GC-MS Method for the Determination of Selected Polycyclic Aromatic Hydrocarbons in Environmental Samples

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Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous due to natural sources and human activities; hence, they are found everywhere, translocating from one medium to another e.g. air, soil, and water. They are generally resistant to the natural degradation process; therefore, they tend to bioaccumulate with ease and seed into sediment in aqueous media. They also accumulate in food at different levels of the food chain due to their hydrophobicity and form, which have the capacity to induce adverse effects that can affect the normal functioning and health of biota and abiotic systems. PAHs are known to cause health effects such as carcinogenic, mutagenic, immunosuppression, adverse developmental and reproductive effects, endocrine disruption, oxidative stress, cardiovascular problems, heart rate variability, lung cancer, lung function abnormality, and many more. These negative consequences depend on the structure, shape, and number of aromatic rings in the PAHs. Soil and sediments have a high concentration of PAHs due to the organic content, particle size, surface area, and hydrophobic nature. Soil, sediments, air, and water can also be secondary sources of PAHs. The challenge encountered in the analysis of PAHs is the poor resolution of their isomers and high column temperatures that commonly used columns cannot handle and causing them to bleed. This proposed study aims to separate and quantify polycyclic aromatic hydrocarbons (PAHs). To achieve this, a viable gas chromatography-mass spectrometry (GC-MS) method is be developed and validated for the detection and quantification of PAHs in soil, and surface water. The PAHs are extracted by the optimized solid phase extraction technique. PAHs were separated and detected by the GC-MS method developed. The method is sensitive for PAHs, given LOD (0.06-0.16), LOQ (0.17-0.47), R2 (0.9763-0.9967), and %RSD (0.008-0.8). Strata-X 33u polymeric reversed phase seems to perform better than C18-SPE, however, it is still difficult to extract Acenaphthylene (Ace). Same with Hexane it seems to be a better extracting solvent than DCM, even though it is poorly dissolving PAHs, and the %recoveries of Ace are inconsistent.

3.02.P–ThFr11 Quantification of textile dyes in KZN surface waters using HPLC, and their environmental toxicological effects [Review]

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The severity of the environmental pollution caused by synthetic dyes has raised a great concern owing to their toxic nature, unfavourable health effects and bioaccumulation potential; as they have been found to be major water pollutants globally. Over

the past couple of decades, studies have covered the increased use of reversed phase HPLC, coupled with UV-VIS or diode array detectors. This review explores recent advances in the quantification of textile dyes in surface water, with focus on the use of High Performance Liquid Chromatography (HPLC) as an analytical tool for the detection and quantification of dyes. Factors including compatibility, cost and efficiency towards chromatographic separations; sample preparation techniques such as liquid-liquid phase extraction (LLE), solid phase extraction (SPE) and membrane filtration were extensively swotted. In addition, interrelated techniques such as mass spectrometry, UV-VIS spectrometry and capillary electrophoresis were revised. Attention to method's selectivity and sensitivity, detection limits and compliance with the environmental regulations in parts of Africa, Asia and South Africa was reported. Furthermore, toxicological effects of textile dyes have been explored in this work, and the ecotoxicity data, in-vitro and in-vivo assays, and cytotoxicity have been discussed. The complexity of analytical chemistry with toxicological assessments in a critical approach for evaluating and contributing to environmental studies have been highlighted. Thus, by providing an overview of existing methodologies, gaps have been identified in some areas that require in-depth work, such as chronic toxicity, dye metabolites and green dye chemistry.

3.02.P–ThFr12 Assessing PFAS Contamination in River Water and its Diverted Use for Irrigation in Agricultural Farms of India

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Per- and Polyfluoroalkyl substances (PFAS) have emerged as a significant global concern due to its pervasive use in both consumer and industrial applications. These persistent anthropogenic ‘forever chemicals’ have gained recent scientific attention because of their far-reaching impacts on different environmental matrices. The occurrence of PFAS in the riverine environment has emerged due to decades of industrial discharge, urban runoff and wastewater mismanagement. Measured concentrations of PFAS in surface and groundwater often range from ng L^{-1} to µg L^{-1}, which is alarming since some PFAS induce adverse biological effects even in very low concentrations. While the health advisories and regulations have been in effect in most developed countries, awareness and scientific research remain limited in the developing countries. This study focuses on the PFAS contamination scenario in India—a fast-growing economy with lax environmental regulations, where studies around the current PFAS situation is still in its infancy. Being an agricultural country, India has an over-reliance on the contaminated river water to meet its crop irrigation demands and livestock production, which is worrisome. In agrarian states like Haryana, river water is routinely discharged into the agricultural farms, creating a direct pathway for PFAS to enter the soil-crop-livestock continuum. To investigate this environmental issue, we conducted a targeted PFAS analysis using TQ-LC-MS/MS (Agilent Ultivo) on river water collected from two districts of Haryana and one in Uttar Pradesh (3 sites), which were directly used for agriculture. Samples were extracted using a 150 mg Bond Elut PFAS SPE cartridge for potential assessment of a total of 29 legacy and Gen-X PFAS congeners. Preliminary results show the presence of both short-chain and long-chain PFASs like PFOS, PFOA, PFBA, PFHxS, FTS, etc., in these regions where river water is consistently diverted for agricultural use in India. This is concerning from the One Health perspective, as humans positioned at the top tier of several food chains may be at continued exposure risk to PFAS through the consumption of agricultural produce and livestock products.

3.02.P–ThFr13 Extraction and chromatographic determination of diazepam, alprazolam and clonezapam in wastewater samples

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Pharmaceutical pollutants entering the aquatic environment have become a growing environmental concern. These pharmaceuticals are unique pollutants because of their special characteristics and behaviour that cannot be simulated with other organic pollutants. The untreated wastewater effluent that contains pharmaceuticals poses considerable threat to the aquatic ecosystem because of the negative effects of non-target organisms in the water. Recent years have seen a growing concern about the benzodiazepines, as emerging pollutants, and their effects on the aquatic environment. These compounds are nowadays widely detected in sewage wastewater. It is important to increase the emphasis on the characteristics of the benzodiazepines in order to differentiate them from industrial chemical compounds. In this study various solid phase extraction

techniques have been employed focusing on isolation of benzodiazepines in wastewater matrices. Employing this methodology has shown improved detection and analysis of diazepam and clonezapam as benzodiazepines. Preliminary results have shown the diazepam concentrations to range between 1 to 9 ppm in seasonal wastewater samples analysed, with higher concentrations during the winter season. In the case of clonezapam and alprazolam, concentrations ranged between 0.4 to 2 ppm. Seasonal characteristics of the benzodiazepines are discussed along the trends observed for the water quality characteristics of the final treated wastewater.

3.02.P–ThFr14 Occurrence and Health Implications of Potentially Toxic Elements in Drinking Water in Africa: A Scoping Review Protocol

Nomfundo Mahlangeni[1], Renee Street[1], Hanyani Lebese[1], Sizwe Nkambule[1] and Yonela Mkunyana[1] (1)South African Medical Research Council

Drinking water sources are vulnerable to contamination by potentially toxic elements (PTEs), posing a significant risk to human health. This issue is most evident in low-and middle-income countries, where drinking water and sanitation infrastructure are inadequate. The proposed scoping review aims to systematically compile and evaluate the literature on arsenic, cadmium, mercury and lead in drinking water sources across Africa, and to explore the risks of exposure and health outcomes. The protocol has been developed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Protocols (PRISMA-P) guidelines. The scoping review will follow the methodological framework developed by Arksey and O'Malley. A comprehensive electronic search will be carried out across four databases - EBSCO GreenFILE, PubMed, Scopus and Web of Science - from inception until 22 May 2025. Studies published in English will be included. Two reviewers will independently assess the titles, abstracts, full-texts, extract data and appraise study quality using Critical Appraisal Skills Programme (CASP) tools. A standardized data extraction form will be used to record the study characteristics. The preliminary search string identified more than 1500 papers to be screened. A descriptive synthesis will outline the characteristics of the included studies and summarize key findings in text and tabular format. This scoping review will map existing research on the extent of PTE contamination in drinking water and its associated health effects. It will also provide insight into the intervention strategies and highlight critical research gaps related to the monitoring of drinking water quality

3.02.P–ThFr15 The detection and isolation of Klebsiella species in wastewater treatment plants and downstream monitoring borehole

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In the North -West Province (NWP) of South Africa, groundwater, surface water and treated wastewater are the main water sources. However, these sources are compromised by elevated physicochemical parameters and the presence of microbial contamination which affect water quality. Recent studies have reported the presence of Klebsiella species in water sources. However, there is a lack of available information about the species in NWP. Klebsiella species are known to cause nosocomial infections including septicemia, pneumonia, and gastrointestinal infections and render antibiotics ineffective. Thus, the study aimed to detect and isolate the Klebsiella species in the effluent-selected wastewater treatment plants and groundwater. Physicochemical parameters such as phosphates, nitrites, dissolved oxygen, total dissolved solids, and salinity were measured and mostly exceeded the water quality standards. Microorganisms were isolated and enumerated using membrane filtration technique. Antibiotic resistance patterns were determined using the Kirby-Bauer Disk Diffusion test. The results revealed a high prevalence of antibiotic resistance particularly to ampicillin, imipenem, cefotaxime, cefazolin, and ceftriaxone. Extracellular enzyme tests were done to determine pathogenicity of the isolates and indicated widespread production of virulence factors such as lipase, gelatinase and proteinase. A similar trend was observed in the current study where most bacteria produced lipase (WWTP 63%, monitoring borehole 96% and reference borehole 75%), followed by gelatinase (WWTP 59%., monitoring borehole 88% and reference borehole 50%) and proteinase (WWTP 56%., monitoring borehole 58% and reference borehole = 38%). It was of great concern to report a high number of bacteria that can break down red blood cell (alpha and beta haemolysis). The DNA of microorganisms was extracted and subjected to end-point PCR for sequencing. The identity of the most prevalent bacteria in water sources were Klebsiella (K. oxycota, K.grimontii, and K. michigenesnsis), Escherichia coli, Enterobacter (E. kobei), Pseudomonas baetica, Aeromonas (A.hydrophilla, A. media), Raoultella ornithinolytica, and Hauxibacter chinensis. The results of this study made it evident that the water quality of these sources was not great and could have implications for downstream use. The detection of virulent, antibiotic resistant Klebsiella species highlights the potential public health concerns posed by contaminated water and emphasizes the need for improved monitoring and treatment strategies to safeguard water quality and public health.

3.03 - Fate and Effects of Metals in the Environment: Ecological and Human Health Implications

3.03–T01 Pollutant Source Identification in a Platinum Belt Headwater Catchment: A Comparative Geospatial Assessment of Dissolved and Sediment-bound Metals

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Land-use stressors contribute to trace metal accumulation in aquatic ecosystems, yet South African river health assessments rely solely on dissolved metal monitoring, overlooking sediment analysis as a potential complement. This study compared water and sediment sampling approaches to track chromium (Cr) and zinc (Zn) pollution in the Gwathle River Catchment, South Africa, during wet and dry seasons. Using inductively coupled plasma mass spectrometry (ICP-MS) for water samples and energy dispersive X-ray fluorescence (EDXRF) for sediments, we evaluated each method's ability to identify pollution sources across multiple spatial scales. Seasonal analyses revealed significantly higher dissolved Cr in the dry season, while no significant differences were observed for dissolved Zn. In addition, there were no significant seasonal differences in either sediment-bound Cr or Zn. Statistical modelling revealed that dissolved and sediment-bound Cr concentrations were best predicted by cumulative scale mining impacts, while dissolved Zn correlated with sub-basin scale lithology and sediment Zn with combined urban and lithological factors. Spatial concordance analysis showed substantial agreement between water and sediment Cr signals along a land-use intensification gradient, indicating its conservative geochemistry enables effective multi-media source tracking. In contrast, Zn showed negligible phase concordance, suggesting dissimilar dissolved versus particulate behaviour. The strong performance of Cr across both media demonstrates that paired sampling comprehensively traces pollution along intensification gradients. As a complementary tool for monitoring trace metals in South African aquatic ecosystems, sediment analysis may offer a pragmatic screening approach for assessing metal contamination across catchments, particularly where capacity constraints exist. This approach enables rapid and cost-effective delineation of persistent catchment contamination rapid profiling of metal distribution patterns across large areas, providing valuable insights for water resource management.

3.03–T02 Phylogenetic and mechanistic underpinning of soil invertebrate sensitivities to metals

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Trace metals are some of the highest-risk environmental pollutants, because of their widespread occurrence, potential to transfer in food webs and inherent toxicity. Soil organisms are notably vulnerable to the impacts of metal contamination. Many anthropogenic activities release metals to soils, where they have long residence times leading to sustained exposures for below-ground species. The construction of species sensitivity distributions for soil invertebrates for different metals (e.g. Cu, Cd, Pb, Zn, Ag, Ni, Cr) has highlighted the extent to which soil organisms vary in metal sensitivity. Currently, however, the phylogenetic distribution and mechanistic causes of these differences are not well understood. In this presentation, we will show that soil invertebrate sensitivity to metal exposure is not randomly distributed among different species, but instead has a clear phylogenetic signature. This means that some species are more vulnerable to the effects of some metals than they are to others. We show how these differences in sensitivity can be linked to key metal-handling traits, including the range and types of metal-handling genes each possess; how active these are; and how they influence biological uptake, internal distribution and sequestration state. Focussing on a species-specific case study of differential sensitivity to a range of metals in two nematode species, we show how traits that are linked to the presence and extent of uptake and the physiological capacity of these two species to tolerate external exposure act as key driver of difference in sensitivity

3.03–T03 Poster Spotlight: 3.03.P–ThFr16, 3.03.P–ThFr17, 3.03.P–ThFr18

3.03.P–ThFr16 - Prolonged Effects of Flooding on Groundwater Quality in the Lower Volta River, Ghana; 3.03.P–ThFr17 - Exposure and Effects of Mercury to the Freshwater Calm Corbicula; 3.03.P–ThFr18 - Effects of Sludge Addition on the Partitioning and Mobility of Heavy Metals in Heat Affected Soil

3.03–T04 Poster Spotlight: 3.03.P–ThFr19, 3.03.P–ThFr20

3.03.P–ThFr19 - Tracking trace metal and nutrient pollution and their sources in surface water and sediments: A case study of selected rivers and streams in Johannesburg; 3.03.P–ThFr20 - The Application of Artificial, Transplanted and Resident Mussels in a Complimentary Approach to Monitor Metalloids and Elements in Marine Environments

3.03.P - Fate and Effects of Metals in the Environment: Ecological and Human Health Implications

3.03.P–ThFr16 Metal Pollution in Cape Town's Urban Rivers: Spotlight on the Salt River Catchment

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The Salt River is a major urban catchment in Cape Town, South Africa, with two main tributaries, the Liesbeek and Black Rivers, covering large sections of Cape Town's Southern suburbs. The Salt River enters the ocean at Table Bay. A multitude of pollution sources are found along the banks of these rivers, including industries, houses, sewage treatment plants, golf courses and informal settlements. This study investigated the spatial and temporal distribution of metals (Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn), in the Salt River catchment through comparison of recent data (2022) with previous unpublished data (2006), comparison of wet and dry seasons and comparison of selected sampling stations. Five replicates of water and sediment samples were collected at each of the selected sampling stations, during two sampling occasions (wet and dry seasons 2022). Sample preparation and metal analysis was done using nitric acid digestion and an ICP-MS. Results showed that sections of both the Liesbeek and Black Rivers, as well as the single Salt River station, are heavily polluted with metals. Metals in water samples that exceeded the acceptable target quality range and fell within the moderate, large and critical impact categories were Al, Cr, Cu, Fe and Mn they are the categories as set in the new South African Water. Al, Cu, Fe, Mn and Zn in sediments were above the permitted set of guidelines as recommended by Canadian interim sediment quality guidelines. Results also showed that metal levels have significantly increased since 2006 due to increases in land use. Metal concentrations were also generally higher during the dry season of 2006, most likely due to reduced water flow and slower currents, but conversely higher during the wet season of 2022, most likely due to increased waste runoff inflow. The Salt River itself has proven difficult to study as it is entirely canalized, which indicates that potentially high loads of polluted sediment are carried straight to the lagoon. This study will form an important basis for further studies on the impacts of aquatic pollution on freshwater, coastal and marine biota. This research identified the need for continual monitoring of metal pollution in urban rivers to mitigate environmental and public risks, particularly in the Salt River catchment.

3.03.P–ThFr17 Prolonged Effects of Flooding on Groundwater Quality in the Lower Volta River, Ghana

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Catastrophic natural events can exacerbate pseudo-persistent pollution from existing sources. However, distinguishing between pollutants from existing sources and contaminants mobilized by flooding through runoff can be difficult. In October 2023, spillage from the Bagare Dame in Burkina Faso and excessive rainfall in the Upper Volta River basin required the emergency release of water from the Akosombo Dam. Downstream communities were inundated with rising river water that lacked the contamination loads (based on pre-flood studies) typically associated with excessive precipitation and subsequent runoff. Once flood waters receded sufficiently to allow safe access, we monitored the Volta River, standing flood water, and ground water quality during five sampling events over three months, coinciding with the dry season and little precipitation. To ascertain contaminant sources, we analyzed a wide range of pollutants, including bacteria, heavy metals, nutrients, and contaminants of emerging concern. During the first month of sampling, stagnant flood water and ground water sampled from inundated wells showed high levels of nutrients, heavy metals, and bacterial counts above WHO drinking water standards, making the ground water unfit for consumption even after boiling. Once flood waters receded, heavy metal concentrations in ground water fell below WHO drinking water standards, as did nutrient concentrations, except phosphate (0.05-0.09 mg/L). Fecal coliform counts remained high in tested groundwater (1150-2250 cfu/mL) throughout the study. The inundated communities rely on gravity-fed septic tanks for wastewater disposal, and these tanks were some of the first to be flooded, thus inundating open wells with sewage-laden flood waters. The persistence of high fecal coliform counts and elevated phosphate concentrations

may be associated with nearby (<10 meters distance) aging septic tanks. High initial heavy metal concentrations, including chromium (0.02-0.04 mg/L) and cadmium (0.01-0.04 mg/L), suggest flooded electronic waste recycling businesses (observed during the first reconnaissance of the affected area) as a potential contaminant source that vanished with the receding flood waters. This study underscores the complexity of pollution sources and the potential for catastrophic natural disasters to exacerbate existing pollution.

3.03.P–ThFr18 Exposure and Effects of Mercury to the Freshwater Clam Corbicula

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Mercury (Hg) is considered a global toxic pollutant that can have adverse effects on human and environmental health. Mercury has the ability to accumulate and biomagnify in the food chain in freshwater species and have been reported to have a wide range of negative effects, including oxidative stress and damage, behavioural changes, reduced filtering rates, immunotoxicity, neurotoxicity, reproductive impairments and growth inhibition. This study assessed the bioaccumulation and biological effects following exposure to a range (1.45–50 µg/L) of Hg concentrations on the freshwater clam Corbicula sp. The Corbicula clams were exposed to Hg concentrations for four weeks, followed by a two-week depuration period. Mercury concentrations in the water and clam tissue were determined after each week. Additional tissue samples were flash frozen and stored at -80°C for biomarker analyses. Biomarkers, including metallothionein (MT), reduced glutathione (GSH), catalase (CAT), and malondialdehyde (MDA), were analysed in clam tissue. Results showed an increase in Hg bioaccumulation in clams over time, with a decline in Hg concentrations during the recovery period. Exposure period, rather that exposure concentrations influenced Hg bioaccumulation patterns. However, higher exposure concentration had more profound biomarker effects. Initial Hg exposure induced protective measures to reduce internal Hg exposure (as seen in MT increases) and oxidative stress, as shown by initial increases in GSH and CAT activities. Prolonged exposure led to the overburdening of these defences, particularly at higher Hg concentrations, resulting in oxidative damage evident by elevated MDA levels, which is an indication of cellular damage. The findings highlight the ecological risk of low levels of Hg and the potential for oxidative stress in clams under natural conditions. This is of particular concern as Hg levels in water and sediment continue to rise in South African freshwater ecosystems, due to continuous emissions from coal-fired power stations and an increase in artisanal and small-scale gold mining activities.

3.03.P–ThFr19 Effects of Sludge Addition on the Partitioning and Mobility of Heavy Metals in Heat Affected Soil

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The impact of high temperatures and sewage sludge application on soil heavy metal (HM) mobility was evaluated in an endeavor to understand whether increased soil temperatures may compromise the effectiveness of sewage sludge as a HM immobilizer. Both contaminated and uncontaminated soil samples were subjected to temperatures of 100°C, 200°C, 300°C and 400°C for 2, 4, and 6 hours, after which they were amended with stabilized sewage sludge at different sludge application rates. The soil samples were then characterized for various physicochemical properties and HM concentrations in the different soil geochemical fractions before heating, after heating, and after sewage sludge application. Up to 19% increase in soil pH was observed with OM and CEC decreasing by up to 100% and 80% respectively with increase in soil temperature. Segregation of heavy metals (HMs) into the different soil geochemical fractions before and after heating varied but increase in soil temperatures increased HMs concentrations in the non-residual fractions (F1, F2 and F3) and HM mobility. Applying sewage sludge to the heated and unheated soils reduced metal concentrations in the F1 fraction at the expense of the F3 and F4 fractions where increase in metal concentrations of up to 30% (As and Cu), 20% (Cd), 25% (Co), 60% (Cr and Ni), 50% (Pb) and 55% (Zn) were observed. Immobilization of the HMs in the heat affected soils were significant mostly in soils with high rates of sludge application. The findings of this study revealed that the occurrence of fires may increase the mobility of HMs in soils, sewage sludge could still be used as an immobilizer of these metals though at higher application rates than would be used in soils which have not experienced fire events.

3.03.P–ThFr20 Tracking trace metal and nutrient pollution and their sources in surface water and sediments: A case study of selected rivers and streams in Johannesburg

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Contamination of surface waters and sediments by trace metals and nutrients remains a significant global threat to biodiversity and human health. This environmental problem emanates from different sources, including agricultural runoff, industrial discharges, and improper disposal of waste, leading to the accumulation of toxic substances in aquatic environments. Johannesburg is one of the South African cities facing challenges with diverse industrial, commercial, and residential activities polluting the environmental waters. With these activities, the soil and water of the city have been contaminated with metals such as lead (Pb), chromium (Cr), thallium (Th), arsenic (As), among others, as well as nutrients such as nitrates and phosphates. This study focuses on tracing sources of trace metals and nutrients in selected streams and rivers around the City of Johannesburg, evaluating potential ecological risks of trace metals, and identifying pollutants that are prioritized by water quality indices. In addition, these potential pollution sources will be defined by multivariate statistical methods such as hierarchical clustering analysis (HCA) and principal component analysis (PCA) to identify patterns and relationships among these pollutants.

3.03.P–ThFr21 The Application of Artificial, Transplanted and Resident Mussels in a Complimentary Approach to Monitor Metalloids and Elements in Marine Environments

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Human activities and natural weathering processes are responsible for the input of elements into marine environments. Since the 1970s, mussels have been used world-wide as bioindicators of metal element exposure due to their wide distribution abundances and their sessile nature making them ideal to indicate local exposure conditions. However, they do not reflect true bioavailability of elements since they are able to take up both the dissolved as well as the particular matter element fractions. In addition, long-term exposure may result in localized adaptation to element exposure. and the plentiful, and stationary. The aim of this study was therefore to utilize artificial mussels (AMs), mussels transplanted from reference sites (TMs) and resident mussels (RMs) to provide an indication of metalloid and element exposure from tropical and cold temperate regions of the southern Africa coastline. Artificial sampling devices (AMs), together with brown mussels (Perna perna) and black mussels (Choromytilus meriolionalis) were deployed in Richards Bay and Durban harbours (representing tropical conditions) and Walvis Bay and Swakopmund harbours (representing cold temperate conditions) respectively. Following a deployment period of six weeks, the AMs and TMs together with RMs were retrieved. Metalloids and elements were extracted using acid digestion and concentrations were determined using ICP-MS techniques. Metalloids (As, Se and Hg) as well as elements (Al, Cd, Cu, Mn, Ni, Pb and Zn) were higher in all three monitoring tools from the tropical sampling sites. Distinct spatial differences in metal bioavailability between Richards Bay Harbour (higher Al, Cr and Mn) and Durban Harbour (higher Cd, Cu and Pb). The AMs from the temperate sites indicated very low bioavailability of elements, while Pb and Hg levels increased in the TMs and were higher than the levels in respective RMs at both sites, indicating local sources of these potentially toxic elements. Interestingly some metals such as Cr, Cd, Se decreased (i.e. depurated) in the TMs following deployment at some of the exposure sites, indicating lower environmental exposure than the “reference site” exposure. This is attributed to the contribution of natural processes such as coastal upwelling that increases particulate-bound elements. This complimentary approach to monitoring strategies allows for a more comprehensive assessment of metal exposure in marine environments.

3.04 - Integrative Framing for Environmental Assessment: Ecosystem Services, Sustainability, Lifecycle Assessment and Other Tools for Science-Informed Decision Making

3.04–T01 The ES Paradigm as a Bridge Between Science and Decisions

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Managing the environmental and social impacts that stressors, introduced as people seek to obtain selected ecosystem services (ES) from land- and waterscapes, pose to the sustainable delivery of these and other interconnected ES is a transdisciplinary challenge requiring new approaches to communication and collaboration. To achieve this, environmental scientists must ensure that the science they generate is relevant to and translated in terms of societal values and objectives, to facilitate its

incorporation into local, national, and international decision-making processes. Enhancing traditional Environmental Risk Assessment (ERA), comparative risk assessment (CRA) and Environmental Impact Assessment (EIA) by complementing standard toxicity and other endpoints to Ecosystem Services (ES) has been identified as one of the current priorities for future enhancements in the chemical/environmental regulatory, sustainable development and policy context. ES concepts provide the potential for a more holistic system-based approach (including regulation, monitoring, remediation, restoration and development projects and policies). Yet, the dynamics between biodiversity/ecosystem structure and the delivery of particular ES often remains unclear and context-dependent, as are the societal benefits/costs resulting from them, and who is bearing those costs and reaping those benefits. Hence there is a pressing need to deepen the understanding of such concepts towards seamless implementation and integration into the existing regulatory and decision frameworks. This paper describes "taxonomies" of various aspects of ESP applications, based upon their decision context, perspective and assessment approach. It then examines a range of current and emerging regulatory and management applications to which the ESP can be applied in light of this taxonomy. This paper will provide an overview of how such frameworks can be built and used to support trade-off evaluation, policy development and decision-making. A number of examples, developed to inform decisions such as habitat restoration, landscape regulation to protect soil/sediment balance, coastal protection, dredged material management and sustainable remediation strategies, will be used to illustrate such framework development and application.

3.04–T02 Relative risk assessment incorporating Bayesian Network probability models to integrate multiple stressors management in regional, transboundary water resource management in southern Africa

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The Limpopo River Basin, located within the borders of Botswana, Mozambique, South Africa and Zimbabwe in southern Africa, is one of the region's most ecologically important biodiversity hotspot areas with >18million vulnerable Africans who also depend on the services of the system for their livelihoods. The water resources of the region maintain a high diversity of aquatic animals many of which are endemic to the region, and dynamic ecosystem processes that contribute to the high socio-ecological importance of these water resources. Major water users include sizable urban areas, mining, industry, power stations and irrigated farming but apart from these water users there is still a high level of poverty in many regions of the basin that are characterised by rural communities that rely on rainfed subsistence farming and natural products derived from the ecosystem. Water resource development for agriculture, the provision of water for urban centers, industrialization, mining development and growth in the population have all increased the pressure on the already limited water resources of the Limpopo River basin and water scarcity is considered to pose the greatest threat to the livelihoods, economies and ecosystems of the Limpopo River basin.The variability of the environment and multiple flow, water quality and habitat stressors associated with the regional development, affects the quality and availability of ecosystem services and habitat and productivity of the ecosystem. The aim of this study was to use regional socio-ecological information related to the structure, function, use and protection of water resources in the context of regional management targets, to carry out a holistic regional scale ecological risk assessment addressing flow and non-flow stressors using the PROBFLO method. The study area includes the transboundary Limpopo River Basin in southern Africa that originates in the highlands that separate South Africa from Zimbabwe and Botswana and enters the Indian Ocean in Mozambique. In this assessment the socio-ecological consequences of altered flows have been evaluated by assessing the risk of alterations in water flow, in the context of non-flow variability to a number of ecological and social endpoints using the regional scale ecological risk assessment method PROBFLO. The regional scale ecological risk assessment method was developed in 1997 to consider the real properties of ecological structures and all the stressors effecting it within the spatial areas relevant to managers to ensure that the interaction of all components are taken into account when decisions are made.The approach has been considered to be suitable to meet the requirements of good practice, holistic eflow assessment frameworks. In 2018 a method incorporating Bayesian Networks and the Relative Risk Method was incorporated into a regional scale holistic eflow assessment method called PROBFLO that was implemented in this study. A review of available water resources information from the study area and region was undertaken in this study and with stakeholders of the study area and real hydrological and hydraulic information, the ten procedural steps of PROBFLO were undertaken. The application of the PROBFLO method included the establishment of a vision (step 1) for the study area and three social endpoints and nine ecological endpoints to represent the socio-ecological ecosystem of concern. In step 2-4, available data and expert solicitations were used to represent our understanding of the ecosystem and source, develop stressor, receptor and endpoint relationships for the study in the context of present and future resource use and protection scenarios that resulted in the selection of risk regions for the study and a conceptual model to direct the rest of the assessment. A suitable ranking scheme (step 5) was established as a foundation for the assessment and in the risk calculation phase (step 6) a Bayesian Network tool was used to perform the risk assessment. Hypothesised risk to the social and ecological endpoints for present

conditions were initially determined and the tool was then calibrated using modelled natural environmental conditions and worse case scenario conditions. The risk model was then used to determine eflow requirements for the rivers and wetland in the delta, and evaluate the relative socio-ecological consequences of alternative water resource use and protection scenarios. These outcomes were presented to stakeholders with associated uncertainty and recommendations to reduce uncertainty, mitigate risk and establish a sustainable balance between the use and protection of the water resources in the study area. This study was undertaken in response to the concerns that stakeholders of the water resources of the Limpopo River Basin have that the existing and planned use is unsustainable and may have significant, unacceptable socio-ecological consequences. The relative risk outcomes for all of the development scenarios considered result in moderate to high risk probabilities for most social and ecological endpoints considered, demonstrating that the basin has already been unsustainably developed. Only three of the 27 risk regions/sub-basin areas including the Luvuvhu, middle Limpopo and lower Limpopo River areas are in a moderate, potentially sustainable risk state. The risk of multiple stressors associated with natural, present, eflows and a future drought scenario demonstrates a massive shift towards excessively used conditions today to sustainability if the eflow scenario is adopted. This scenario represents an acceptable balance between the use and protection of the water resource throughout the basin. This eflow scenario represents a considerable improvement across the basin but it may not meet biodiversity conservation requirements due to the moderate to hard working vision for the basin. The stressors that need to be managed to achieve the eflow scenario includes flows, water quality, habitat and barrier management and other disturbance to wildlife stressors. The eflows from the study are being considered for adoption on a trial basis towards sustainability by multiple stakeholders of the shared basin. The PROBFLO method was successfully applied to the Limpopo River Basin to contribute to the evaluation of risk of multiple stressors to multiple social and ecological endpoints in the context of holistic eflows management in this transboundary ecosystem. From these outcomes, stakeholders have, been able to consider sustainable social and ecological trade-offs between, to balance the use and protection of water resources in the study area. And we have provided the initial requirements for eflows to maintain the socio-ecological sustainability of the water resources in the region. Although the accuracy of the PROBFLO projections used to guide sustainable water resource use needs to be validated when developments in the study area takes place, the adaptability of the approach allows for the incorporation of new information rapidly which will inform adaptive management.

3.04–T03 Utility, significance and caveats for the use of bioaccumulation in GHS classification of substances and their mixtures

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Bioaccumulation, which is a net consequence of uptake, biotransformation and elimination processes, has been included among parameters for classifying substances in the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). GHS, as a comprehensive system for sound management chemicals, provides specifications for the classification, management and communication of hazards to users using labels and Safety Data Sheets (SDS). This paper takes a closer look at bioaccumulation as one of the key parameters for classifying substances in GHS, since it indicates the possibility of long-term adverse effects. This is a narrative review that assesses relevant GHS documents and internationally accepted methods for assessing persistence and degradability. Bioaccumulation is often measured using the bioconcentration factor (BAF), biomagnification factor (BMF) and the octanol-water partition coefficient (Kow). The KOW is a surrogate for estimating the distribution of the chemical between water and lipids in organisms, with high KOWs indicating lipophilic (or hydrophobicity) and ability to bioaccumulate. Depending on the acute and chronic toxicity of a substance as measured using LC50, EC50 and NOEC, BCF≥ 500 or log KOW ≥ 4 can be used to locate substances in GHS category 1, 2, 3 or 4. Although KOW is a simple parameter, there are technical issues with its determination and applicability to certain classes of substances, such as hydrophilic substances and nanomaterials. Moreover, the use of BCF has also been questioned because of its reported dependence on bioaccumulation processes such as metabolism, bound residues and other factors. Therefore, we can show in this paper that the application of BCF and KOW are not as straightforward as GHS appears to indicate. The supporting evidence for the universal application of cut-off points BCF≥ 500 or log KOW ≥ 4 as well as the potential use of the biomagnification factor (BMF) have also been critically analysed. Although bioaccumulation has been used widely in risk assessment of chemicals, its application in GHS requires some caution and refinement to avoid misclassification.

3.04–T04 Enhancing Environmental Decision-Making: Developing Weighting Factors for African Life Cycle Assessments

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There is a widespread effort by companies, research institutes, and governments to reduce the environmental impacts of human activities globally through Life Cycle Assessment (LCA). To assist decision-makers in evaluating comparable product alternatives, environmental LCA results must be presented clearly to facilitate informed decision-making. Therefore, aggregating environmental impacts using weighting factors is essential. However, most of the life cycle impact assessment (LCIA) methods such as TRACI, ReCiPe, or IMPACT World+ established by developed countries are used for LCA studies in African countries. These methods have been developed using weighting factors based on the discussion with stakeholders in these countries using their region specific or world average values. Therefore, using any of these LCIA methods for LCA analysis in African countries will not give results that is a true representation of the environmental problems. Because no weighting factors have been developed specifically for African countries, LCA practitioners on the African continent are forced to adopt European-based factors. This reliance leads to a less transparent decision-making process. The absence of African-specific weighting factors is due to a lack of technical expertise and the resources required in these countries. One solution is to utilize available environmental emissions and resource use data, along with related policy goals, to develop appropriate weighting factors. The Swiss-based Distance-to-Target (DtT) Ecological Scarcity Method (ESM) is one such approach. The ESM can provide eco-factors that calculate the environmental effects of a product, service, or technology as a single score and reveals hotspots along a products value chain. Because it is country-specific and policy-derived, the ESM reflects a country's current environmental emissions, resource uses, and national policy targets. Additionally, it can inform policymakers, support more effective decision-making in companies, and promote life cycle thinking, for example, in implementing new strategies and regulations to prevent emissions. The method has the potential to assess a wide range of environmental interventions, consider the specific features and needs of the corresponding national environmental policy and support decision making in these countries. Therefore, the objective of this study is to adopt the ESM to develop weighting and eco-factors for Nigeria, South Africa, Morocco, Ghana, and Mauritius using pollutant emissions, resource use data, and the corresponding government-defined environmental quality targets from policy documents. The selection of these countries is based on: (i) the availability of environmental standards and pollution emission reduction targets; (ii) their current and future roles in Africa, particularly regarding resource production; and (iii) significant interest among stakeholders, scientists, and policymakers in reducing environmental pollution. Developing eco-factors grounded in each country's specific environmental conditions and policy framework ensures the traceability, accuracy, and consistency of life cycle impact assessment findings in these nations. In addition, it can serve as a basis for environmental policy enactment and reformulation.

3.04.P -Integrative Framing for Environmental Assessment: Ecosystem Services, Sustainability, Lifecycle Assessment and Other Tools for Science-Informed Decision Making

3.04.P–TuWe55 Integration of Ocean Modelling in 3-Dimensional Volumetric Classification Models to Define the Pelagic Ecosystems in the KwaZulu-Natal Bight, South Africa

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Developing regions often face significant barriers in environmental monitoring, particularly in offshore marine systems where infrastructure and in-situ data collection are limited. Addressing these challenges, the proposed study will explore a novel method for classifying pelagic ecosystems using high-resolution ocean model outputs. These outputs will be transformed into three-dimensional volumetric units (voxels) to visualise the pelagic environment using GIS and analysed through statistical clustering techniques based on physicochemical variables such as temperature, salinity, current velocity, and biogeochemical properties. The proposed method will group ocean regions with similar characteristics, such as temperature, salinity, current velocity, and biogeochemical properties, across depth zones from the epipelagic to the abyssopelagic. This will support a more detailed understanding of vertical ecosystem structure and enhance the classification and mapping of pelagic ecosystems in the open ocean. The study aims to align with the Ocean Accounting Framework by refining the delineation of ecosystem extents and improving the tracking of changes in ecosystem dynamics, particularly under multiple stressors. Ultimately, the work has the potential to inform marine spatial planning and provide valuable insights for managing economic activities that depend on pelagic environments, such as fisheries, and support sustainable ocean development goals.

3.05 - Understanding and Managing Environmental Pollutants in Developing Regions: Practical Tools, Risk Assessment, and Community-Driven Solutions

3.05–T01 Unveiling the Presence of Polybrominated Diphenyl Ethers in Firefighter Protective Clothing

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Flame retardants are groups of chemicals commonly added to different consumer products such as textiles, plastics, wood and electronics to impart flame retardancy and reduce the impact of fires. Brominated flame retardants, particularly polybrominated flame retardants (PBDEs), have been reported to be harmful to human and the environment. This study investigated the presence of brominated flame retardants, particularly PBDEs, in the protective garment. Firefighter protective garments were analysed for brominated flame retardants, particularly polybrominated diphenyl ethers. The samples were Soxhlet extracted and quantified for the flame retardants using the gas chromatography mass spectrometry for BDE-28, -47, -77, -99, -100, -153, -154, -183 ,209 and hexabromocyclododecane (HBCDD). PBDEs were detected in the firefighter protective garment with varying concentrations ranging from 261.61 to 729.06 (µg/g). The samples were further subjected to 5-8 kW/m2 radiant heat flux, using the cone calorimeter, to investigate the volatilization of the PBDE compounds. Volatilizing compounds that were targeted included BDE-28, -47, -99, -100, -154 and 209. Volatilizing compounds were detected with concentrations ranging from 0.59 to 1.25 ng/g. This study hs unveiled the presence of PBDEs in the firefighter protective garment. The unveiling of PBDE compounds in the firefighter garment increases the cancer exposure burdens for firefighters.

3.05–T02 Evaluation of Ascorbic Acid as an Intervention of Metal Toxicity in Dogs in Kabwe District

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Non-essential metals and metalloids mainly cause oxidative stress in exposed individuals' bodies. Treatment of toxicity caused by these metals and metalloids is mostly by chelation therapy, which has several side effects. The antioxidant, L-ascorbic acid (L-AA), which is readily accessible, is considered a promising nutritional supplement to alleviate metal toxicity. Dogs have been used as sentinels for metal toxicity, and their blood lead levels (BLL) are known to be comparable to those in humans. The main aim of this study was to investigate the use of L-AA in dogs living in a metal-contaminated Town, Kabwe. Kabwe was formerly a mining town where remediation of toxic metals and metalloids is still ongoing. L-AA was administered orally daily for 14 days to 10 female dogs and 12 male dogs, and blood was collected on days 1 and 14. In both males and females, blood plasma concentrations of malondialdehyde, cortisol, corticosterone, blood urea nitrogen, and creatinine were significantly reduced when levels were compared pre- and post-treatment. The activity of δ-aminolaevulinic acid dehydratase was also statistically significantly increased post-treatment. This indicated the efficacy of L-AA in alleviating metal and metalloid-induced oxidative stress without withdrawing exposure. The blood of the subject dogs generally reduced selected metals and metalloids. However, Pb levels were primarily reduced in dogs younger than 24 months. Interestingly, the reduction of Zn and Cu, often associated with the administration of L-AA, occurred only in male dogs. L-Ascorbic Acid might not only serve as an intervention to alleviate the effects of metals in the general population but may also assist young children during critical developmental stages. Ethical approval clearance was obtained from the University of Zambia Biomedical Research Ethics Committee (UNZABREC) under reference number 5310-2024.This study received clearance from the Zambian Ministry of Fisheries and Livestock and was carried out strictly per its regulations.

3.05–T03 An assessment of two selected veterinary antibiotics commonly found in veterinary waste and their toxicity on the freshwater snail Helisoma duryi

Terence Machingura[1], Joanna Change[1] and Norah Basopo[1] (1)National University of Science and Technology

The use of veterinary antibiotics has been steadily rising worldwide due to rapid population growth and the growing demand for animal feed. Although they are essential for controlling the health of animals, they frequently end up in the aquatic environment, where they have unanticipated effects on organisms that are not their intended targets. The impact of oxytetracycline, enrofloxacin, and livestock effluent on the activity of antioxidant enzymes, acetylcholinesterase, levels of lipid peroxidation and histopathological changes was investigated using the freshwater snail Helisoma duryi. Freshwater snail

Helisoma duryi was exposed to the two selected antibiotics for a 21 day period. The concentration of the selected antibiotics was also determined in the effluent with levels of enrofloxacin 10 times that of oxytetracycline at 498.654 ppm and 48.286ppm respectively. The inhibition of the glutathione peroxidase enzyme activity was observed for snails exposed to oxytetracycline and enrofloxacine. A decrease in lipid peroxidation was also observed for exposures of both antibiotics. In conclusion, there is a need for further research that will inform policy and will enable environmental management efforts to minimize the impact of veterinary waste on aquatic ecosystems.

3.06 - Methods for Deriving Protective Guidelines for Environmental Exposure

3.06–T01 Deriving protective guidelines in ecotoxicology – recent developments in statistical ecotoxicology and their adoption within the Australian and New Zealand Water Quality Guidelines

Rick Van Dam[1], Joe Thorley[2] and David Fox[3] (1)Water Quality Advice, (2)Poisson Consulting, (3)Environmetrics Australia

The primary concern of most environmental regulatory risk assessments is whether there is a level of toxicity that poses a risk to the ecosystem. Generally, in a protective-risk management framework, the goal is to determine the concentration at which there is an acceptable effect on the ecosystem. This talk will focus on the methods adopted within Australia and New Zealand for deriving safe water quality exposure guideline values. In Australia and New Zealand, the 2000 Australian and New Zealand Guidelines for Fresh and Marine Water Quality represented a major step forward in water quality assessment and monitoring. Key advances at that time included the adoption of a risk-based approach to water quality management, the notion of different levels of ecosystem condition/protection and a new method for deriving water quality guideline values (GVs) for toxicants based on species sensitivity distributions (SSDs). The GV derivation method has been subsequently updated in 2015, 2018 and 2025 to reflect recent developments in the science. Here, we focus on the most significant changes in the most recent revision of the method, related to the adoption of new statistical approaches. These include 1) model averaging of the SSD to allow for uncertainty in the choice of the underlying statistical distribution; 2) the inclusion of mixture distributions to accommodate bi-modality; and 3) the addition of a preferred toxicity metric, the NSEC (no-significant-effect-concentration) a generalisation of the NOEC (no-observed-effect-concentration) that is independent of the treatment concentrations. The new tools developed in support of the updated framework are being co-developed between Australia and Canada, with funding from DCCEEW and include the R package ssdtools (https://github.com/bcgov/ssdtools) along with an easy to use online interface (https://bcgov-env.shinyapps.io/ssdtools/). The use of the open-source software combined with the collaborative github platform is facilitating adoption of methodological improvements in real time and will hopefully provide a platform for greater harmonisation globally.

3.06–T02 South African Water Quality Guidelines for Aquatic Ecosystems (2024 Revised Version)

Neil Griffin[1] and Oghenekaro Nelson Odume[1] (1)Rhodes University

After 28 years, the 1996 South African Water Quality Guidelines for Aquatic Ecosystems have been revised to facilitate rapid decision-making in the management of the country's water resources. The revised guidelines are software-based and follow a three-tier approach. Tier 1 guidelines are generic, similar to the 1996 guidelines, but with references to the Ecological Categories A-F. This implies that guideline values are developed for each ecological category. Tier 2 guidelines are derived at the ecoregion level II to account for spatial variability within the country. By developing guidelines for each Level II ecoregion in the country, the revised guidelines take into account the spatial variability caused by factors such as climate, physiography, geology, soils, and elevation. In addition, the Tier 2 guidelines are developed for both physicochemical and biological responses. This accounts for the community-based effect of the ecosystem on water quality change. The Tier 3 guidelines are triggered when risk is suspected based on the results of Tiers 1 and 2. Tier 3 provides a means for a site-specific water quality risk assessment by collecting detailed site-specific information. The Tier 3 guidelines are event/scenario-based, which implies a focus on the event/scenario driving water quality change rather than on the symptoms. The revised guidelines are implemented within a software-based decision support system (DSS) flexible enough to allow for rapid decision-making regarding the risk posed by pollutants of concern. The DSS interface allows for easy navigation and takes DWS capacity and capability into account. As the guidelines are software-based, they are easily updatable and support educational and research purposes.

3.06–T03 Marine Ecotoxicology and Climate Change: Deriving Water Quality Benchmarks with Consideration of Influence of Multiple Stressors on Chemical Toxicity

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Over the past 25 years, my research has centred on developing environmental quality benchmarks—such as water and sediment quality guidelines—to regulate and manage chemical contaminants in both Europe and China. The primary objective has been to identify effect thresholds for chemicals of concern (commonly referred to as trigger values) and to ensure that environmental concentrations remain below these thresholds, thereby safeguarding aquatic ecosystems and their inhabitants. As my work in this field has progressed, I have encountered numerous unresolved challenges associated with the establishment of reliable effect thresholds. In this presentation, I will highlight some of the key obstacles in determining trigger values that effectively protect aquatic ecosystems from chemical pollution, particularly in the context of multiple stressors—environmental factors such as pH, salinity, and temperature—which are increasingly influenced by climate change. Finally, I will propose potential solutions and advocate for expanded research efforts aimed at enhancing the ecological realism of trigger value development. These improvements are essential for advancing more effective and adaptive environmental protection strategies. To investigate the influence of individual environmental stressors—specifically salinity, pH, and temperature—on the toxicity of chemicals to aquatic species, standard acute toxicity tests were conducted using selected metals and metal oxide nanoparticles. These tests involved a range of aquatic organisms, including microalgae, invertebrates, and fish, exposed along gradients of salinity, pH, or temperature. Toxicity endpoints, such as the median lethal concentration (LC50) and median effect concentration (EC50), were determined for each test. Taking temperature as an example, the relationship between the toxicity endpoints and temperature was established and modeled for each species. To further explore the effect of temperature on toxicity thresholds at the community level for the same metal, acute toxicity data for various aquatic organisms exposed to different temperatures were extracted from the U.S. Environmental Protection Agency's ECOTOX database and relevant open literature. Species sensitivity distributions (SSDs) were constructed for individual temperature conditions, and temperature-specific hazardous concentration for 10% of species (HC10) was estimated using appropriate regression analyses. The relationship between HC10 and temperature was then visualized and examined. Based on the relationship between HC10 and temperature, a novel model was developed to determine predicted no effect concentrations (PNECs) at different temperatures. A similar methodology was applied to investigate the relationship between HC10 and pH (or salinity) at the community level, providing deeper insights into how environmental stressors modulate chemical toxicity across aquatic ecosystems. Given that multiple environmental stressors can interact to influence the toxicity of chemicals to aquatic organisms, additional laboratory experiments were conducted to assess the combined effects of pH, salinity, and temperature on the toxicity of zinc oxide nanoparticles (ZnO-NPs) to representative aquatic species: diatoms, copepods, and mussels. The impact of these stressors on the physicochemical properties of ZnO-NPs was evaluated using standardized nanoparticle characterization methods. Typical toxicity endpoints were measured, and the expression of relevant stress response genes was analyzed to provide mechanistic insights. The interactive effects of the multiple stressors and ZnO-NP exposure were assessed using analysis of variance (ANOVA), allowing for the identification of the key stressor(s) that most significantly influenced chemical toxicity. Due to space limitations, only the results concerning temperature and copper toxicity are presented in this abstract. The relationship between LC50 and temperature exhibited either an inverse V-shape (Figure 1, Left)—indicating the lowest toxicity at the optimal temperature (Topt), with toxicity increasing as the temperature deviated above or below Topt—or a linear trend, where toxicity increased with rising temperature. At the community level, the relationship between HC10 and temperature also followed an inverse V-shape. This pattern was found to be consistent across other chemicals (data not shown) and may serve as a useful basis for predicting predicted no-effect concentrations (PNECs) of chemicals under varying temperature conditions. Similarly, relationships between salinity (or pH) and chemical toxicity at both species and community levels were also established. The results will be presented and discussed during the oral presentation. Among the three species studied, temperature emerged as the most influential factor affecting the toxicity of ZnO-NPs, followed by salinity, while pH had the least impact. In diatoms, the relationship between IC50 and temperature exhibited an inverse V-shape, and toxicity increased with decreasing salinity. For mussels and copepods, toxicity was more pronounced at higher temperatures, with salinity effects varying and showing interactive patterns with temperature. These findings reinforce the critical role of temperature in modulating chemical toxicity and highlight the importance of incorporating temperature effects when deriving PNECs. Temperature was identified as the most influential factor affecting chemical toxicity, followed by salinity and then pH. The results demonstrate the potential to predict temperature-dependent chemical toxicity. Moving forward, standard toxicity testing protocols should be expanded to include both optimal and critical maximum temperatures for test species. Furthermore, the observed relationships between HC10 and environmental variables such as temperature and salinity suggest that it is feasible to predict predicted PNECs across various environmental conditions using QSAR-SSD (Quantitative Structure–Activity Relationship–SSD) models. This study provides a foundation for refining current approaches to deriving environmental quality benchmarks and contributes to more ecologically relevant and effective protection of aquatic

ecosystems. Acknowledgements: The authors thank the Research Grants Council and the Innovation and Technology Commission, the Hong Kong SAR Government for providing the research funding, and thank his PhD students and postdocs for their contributions to this important series of research.

3.06–T04 How to Consider Additive Mixture Toxicology within Veterinary Pharmaceutical Legislation

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Conventional ecotoxicological assessments typically focus on single compounds and regulation is still ignoring and thus underestimating the effects of additive or synergistic mixture toxicology. Therefore, this study assesses how a Mixture Assessment Factor (MAF) might statistically be defined, considering the extensive variety of chemical mixtures possible, and what role single substance tests and measured environmental concentrations (MECs) can play in this process. The proposed approach includes publicly available databases, such as the Pharms-UBA (PU) for MECs and the European Medicines Agency's public assessment reports for effect data. Both were supplemented by internal data from the German Environment Agency, specifically from the Non-Target Screening portal for MECs and the Chemical Safety Information System for effect data. Three questions arose: (i) Based on theoretical additive effects, on what level the MAF should be set? (ii) Which mixtures are found in the environment, and in what range are the additive MECs? (iii) What are the PNECs of these mixtures and what MAFexact/min can be derived? The effect dataset contains 51 AS, which can theoretically form 2.25 x 10^15 mixtures. Thus, the most relevant mixtures need to be found. The PU MEC database shows that, only based on soil and veterinary pharmaceuticals, 35 different AS can be found with theoretical 33 x 10^6 mixtures possible. In reality, 219 different cases were identified where mixtures actually occurred in the environment. Mixture sizes ranged from 2 to 17 out of 35 substances with additive MECs from ng up to mg/kg soil. In summary, our analysis demonstrates the need to incorporate additional safety factors into the regulatory framework to account for the already elevated levels of mixture exposure. This study could serve as a first step in identifying relevant mixtures, their occurrence, their mixture concentrations and consequently, the necessary adaptations of regulatory guidance to align with environmental protection goals.

3.06–T05 Poster Spotlight: 3.06.P–ThFr21, 3.06.P–ThFr22

3.06.P–ThFr21 - Deriving of Predicted No Effect Concentration for Pharmaceuticals in Global Estuaries Monitoring Programme; 3.06.P–ThFr22 - Ecological Risk Assessment of Emerging PFAS in the Marine Environment

3.06.P - Methods for Deriving Protective Guidelines for Environmental Exposure

3.06.P–ThFr24 Development and Validation of LC-MS/MS Analysis Method for Biomonitoring of Glyphosate and its Metabolites in Human Serum

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The growing global population requires increased food production and pesticides play a key role in protecting crop yields. Glyphosate, the most widely used herbicide globally, is approved in >100 countries for its broad efficacy and low cost. Its widespread use, however, raises environmental and health concerns. Inadvertent exposure can be monitored by quantifying glyphosate and its metabolites, aminomethylphosphonic acid (AMPA) and methylphosphonic acid (MPA). However, due to its small size and highly polar nature, glyphosate typically requires derivatization, which complicates sample preparation and method development. This study presents the first validated LC-MS/MS method in Southern Africa for the simultaneous quantification, without derivatization, of glyphosate, AMPA, and MPA in human serum and its successful application to clinical samples from farming-intensive areas of the Western Cape for exposure monitoring. Calibration standards and quality controls were prepared by spiking working solutions into pesticide-free human serum, to final serum concentrations ranging from 15.0–760 ng/mL for glyphosate, 25.00–1600 ng/mL for AMPA, and 0.75–48 ng/mL for MPA. Sample preparation involved using Oasis MAX cartridges. Quantification was performed on a Sciex QTRAP 6500+ LC-MS/MS system using a Phenomex Luna C8 column with gradient elution. Method validation followed the SANTE/2021 guidelines, evaluating linearity, LOQ, selectivity, matrix effects, recovery, reproducibility, and autosampler stability. Deidentified serum samples (n

=261) from communities in the Western Cape with high pesticide usage were analysed for glyphosate and metabolite detection. The method had a quadratic regression with 1/x2 weighting. Precision across all STDs and QCs remained within the acceptable threshold of ≤20%. The method demonstrated high selectivity, with no detectable interference from endogenous compounds at analyte retention times. Matrix effects and recovery, evaluated using six independent serum sources, were within acceptable limits. A signal: noise threshold of ≥20 indicated detectable levels in 54/261 samples, with 3 samples showing quantifiable concentrations. A robust LC–MS/MS method was developed and validated for the simultaneous quantification of glyphosate, AMPA, and MPA in human serum. The method detected glyphosate and metabolites in 20.7% of patient samples from farming intensive regions of the Western Cape.

3.06.P–ThFr22 Deriving of Predicted No Effect Concentration for Pharmaceuticals in Global Estuaries Monitoring Programme

Chong Chen[1], Kenneth Leung[1], Qiang Ou[1] and Ruolan Jia[1] (1)City University of Hong Kong

Pharmaceuticals are regarded as an important type of contaminants of emerging concern (CECs), and the active pharmaceutical compounds with potential high toxicity can pose significant risks to aquatic life due to their high potency towards biological targets. The first phase of the Global Estuaries Monitoring (GEM) Programme involved collecting samples from more than 180 estuaries worldwide and conducting a thorough monitoring of 65 pharmaceutical residues in estuarine waters. To enhance the assessment of ecological risks posed by pharmaceuticals in global estuaries, the toxicity data on these 65 target substances were extensively reviewed. The analysis revealed that certain compounds still lack adequate toxicological data to facilitate a comprehensive ecological risk assessment. Consequently, the aim of this study is to address this knowledge gap. Ten pharmaceuticals with insufficient toxicological data were selected as the focal substances for this study. They include four antibiotic sulfonamides, two antihistamines, one antidepressant (amitriptyline, AMT), one anti-epileptic, one nonsteroidal anti-inflammatory drug, and one artificial sweetener. For this study, eight species were cultured in the laboratory as test organisms for saltwater conditions. These species are three microalgae (C. muelleri, I. galbana, and T. suecica), one copepod (T. japonicus), one brine shrimp (A. tiberiana), one rotifer (B. plicatilis), one jellyfish (Aurelia aurita), and one medaka fish (O. melastigma). Taking AMT as an example, the L(E)C50 values ranged from 0.03 to 5.48 mg/L for microalgae, copepods, and brine shrimps. Overall, the test models demonstrated a sensitivity sequence of algae > invertebrates > fish. However, the toxic potencies of pharmaceuticals exhibited significant variations among different organisms, underscoring the necessity of conducting toxicity evaluations using a range of species at diverse trophic levels within aquatic environments. Utilizing the gathered data, the HC5 values (representing the level for safeguarding 95% of species) of these 10 pharmaceuticals will be derived through the species sensitivity distribution model. Subsequently, the predicted no effect concentration will be calculated to establish a basis for formulating marine environmental criteria. This research aims to offer deeper insights into how marine organisms respond to CECs, thereby enhancing our understanding of their effects on marine ecosystems.

3.06.P–ThFr23 Ecological Risk Assessment of Emerging PFAS in the Marine Environment

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Per- and polyfluoroalkyl substances (PFAS) are persistent, bioaccumulative, and toxic chemicals widely used for decades, with emerging PFAS like 6:2 Cl-PFESA gaining recent attention due to improved analytical methods. This study analyzed PFAS concentrations in marine mammals, crustaceans, fish, and sediments from the South China Sea (SCS). Results showed that while certain PFAS, like PFHxS and PFOA, posed negligible risks, PFOS levels exceeded critical thresholds in some marine mammal samples, indicating potential adverse effects. Additionally, 6:2 Cl-PFESA concentrations in most dolphin and porpoise samples suggested significant toxicological risks. For humans, the hazard index (HI) for PFOS via seafood consumption approached critical levels, with combined dietary exposure to PFAS mixtures, particularly PFOS and PFDA, indicating high health risks. Ecological risk assessments revealed that while PFOA posed low risks, PFOS showed high risks historically, though these have declined post-regulation. However, ∑6:2 PFESAs consistently posed high ecological risks since the 1970s, highlighting their ongoing environmental threat. These findings emphasize the need for stringent regulatory measures to mitigate PFAS-related risks to both ecosystems and human health.

3.07.A - Plastics in Aquatic Environments: Occurrence, Effects, and Implications (Macro to Micro)

3.07.A–T01 The Microplastic Profile of Alpine Rivers in the Autonomous Province of Bolzano-South Tyrol, Italy

Heinrich Dahms[1], Daniele Ricaldone[2], Magdalena Vanek[2], Francesca Vallefuoco[2] and Roberta Bottarin[2] (1)EurAc Research, (2)Eurac Research

Remote and pristine environments are havens for organisms that are sensitive to pollutants and other anthropogenic activities. The Autonomous Province of Bolzano-South Tyrol in Northern Italy hosts remote environments where sensitive freshwater macroinvertebrates can flourish. However, microplastics, an emerging contaminant of great concern, has the ability to be transported through the atmosphere and become deposited in these environments. Microplastics are tiny plastic particles smaller than 5 mm and can range from a variety of polymers with each having distinct characteristics and additives that changes the properties of the particles. In this study, ten sites in the study area were investigated for microplastics. These sites included remote glacial streams, major river confluences, and impacted rivers with increased anthropogenic activity. At each site, nine replicates of sediment were collected which consisted of three bank, three instream at 5 cm depth, and three instream at 20 cm depth were collected. A further three replicates of benthic macroinvertebrates were collected which consisted of the entire community, to determine where the microplastics are distributing in the ecosystem. Microplastics were then separated through density separation with ZnCl2 and centrifugation. Biota were identified to the order level, placed into subsamples of five animals, digested in a 10% KOH solution, and plastic identified through stereomicroscopy. Plastics were then separated for polymer analysis through Raman spectroscopy. Microplastics were detected within glacial and impacted sites. In sediment, microplastics were detected in concentrations of 14.78 ± 3.23 items/kg-instream and 18.5 ± 8.5 items/kg-bank in glacial streams which were lower than those found in the impacted sites at 94.36 ± 23.43 items/kg-instream and 66.7 ± 23.67 items/kg-bank. The abundance of microplastics in biota had not showed a major increase downstream, however, the overall prevalence of the downstream sites was higher (38%) than the overall prevalence of all animals over the entire study area (18.8%). This could indicate that microplastics may become more easily bioavailable to more complex animals. The results of this study highlight how microplastics distribute in remote environments, which polymers may be most prevalent, and which organisms may be more greatly impacted. The data collected in this study will aid to close the gap on the impact of microplastics in remote areas.

3.07.A–T02 Influence of Rocha River Biofilm Development on PET Microplastics' Lead and Zinc Adsorption Capacity

Sofía Isabel Fuentes Zárate[1], Brenda Mariola Cruz Benavent[1] and Paul d'Abzac[1] (1)Universidad Católica Boliviana "San Pablo"

Microplastics (MP) are widely recognized as vectors for environmental pollution, particularly in aquatic ecosystems. Polyethylene terephthalate (PET) is one of the most common polymers detected in freshwater environments of Bolivia. The ability of MP to adsorb metals poses risks to living organisms and water quality. In polluted aquatic environments, these pollutant complexes increase the health risks for aquatic organisms. The Rocha River in Cochabamba, Bolivia, has significant levels of contamination by MPs and heavy metals such as lead (Pb) and zinc (Zn). This study aims to understand how native biofilm development on PET MP affects their adsorption capacity for lead (Pb) and zinc (Zn). To explore this phenomenon, first, the PET MP were characterized and then were exposed to river water from two locations, described by different contamination levels, to allow biofilm formation, generating two biofilm-MP complexes. The biofilms were characterized microbiologically. Finally, adsorption processes of PET MPs and complexes with lead (Pb) and zinc (Zn) were described. The PET MP are fragment-like shapes, typical of secondary MPs generated by mechanical degradation, with sizes ranged between 300 and 600 µm. The particles present carboxylic, acetone, and phenol functional groups. In the complexes, 18 bacterial strains were identified, mostly Gram-negative, including 12 pathogenic genera such as Escherichia coli, Shigella sp., and Acinetobacter calcoaceticus. Adsorption results show that the C2 complex exhibited the highest Pb and Zn adsorption capacity, outperforming both C1 and pristine PET. The influence of biofilm presence from C2 complex increases at higher levels the Pb adsorption, compared to Zn. Kinetic data indicate chemisorption as the dominant mechanism. Additional modeling confirmed heterogeneous multilayer adsorption and surface interactions, including electrostatic forces, pore-filling, and surface complexation. The results highlight that the capacity of the MPs-biofilm complex to adsorb lead and zinc depends on factors such as the density of the biofilm and the characteristics of each metal. These findings suggest that native biofilms play a critical role in modifying the adsorptive behavior of PET MPs, particularly for lead. The enhanced interaction between MPs

and metals due to biofilm presence highlights the importance of considering biotic factors in environmental risk assessments and future studies on pollutant transport via microplastics.

3.07.A–T03 Atmospheric Microplastics in a Coastal Urban Area of Lima, Peru

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Atmospheric microplastic pollution has become an emerging environmental concern due to its potential risks to both ecosystems and human health. Lima, as a coastal metropolis, faces increasing challenges regarding air quality and plastic pollution. However, research on airborne microplastic particles in this region remains scarce. This study aims to evaluate the presence, distribution, and characteristics of airborne microplastics in the district of Chorrillos, Lima, Peru. The research seeks to identify potential sources of contamination and assess the possible environmental and human health implications. Airborne particulate matter was collected from selected site within the district of Chorrillos using passive sampling techniques over a four-week period. The sampling point was located on the top floor (third floor) of the Chorrillos campus of the Peruvian University of Applied Sciences (UPC). Microplastics were identified and characterized based on their morphology using an optical fluorescence microscope. Statistical analysis was conducted to assess spatial distribution and variations in concentration. Preliminary findings indicate a significant presence of airborne microplastics in the collected samples. The microplastics were predominantly fibers, followed by fragments and films. The identified particles varied in size, between 2.5 and 216 µm. Color analysis revealed a prevalence of blue and green particles. The total number of microplastic particles identified was 1598. The concentration and characteristics of the microplastics suggested multiple potential sources of contamination. While specific sources could not be determined, the presence of different particle types and colors indicates contributions from diverse anthropogenic activities. Additionally, variations in microplastic abundance were observed over time, highlighting potential environmental and meteorological influences on their distribution. This study provides evidence of airborne microplastic pollution in Chorrillos, highlighting the urgent need for further research and policy action to mitigate potential environmental and public health risks. Raising awareness and implementing strategies to reduce plastic emissions is an essential step toward improving air quality and promoting sustainability in urban coastal environments.

3.07.A–T04 The fate of Microplastics as Emerging Contaminants in Daspoort Wastewater Treatment Plant and Their Effect on Bioavailability of Heavy Metals

Fundzani Asnath Melato[1] and Ntebogeng Sharon Mokgalaka-Fleischmann[1] (1)Supervisor

Wastewater treatment plants (WWTPs) serve as a key source of microplastics (MPs) pollution, facilitating the transfer of MPs from contamination sources into both aquatic and terrestrial ecosystems [1]. While wastewater reuse has been considered as an alternative to solve water scarcity problems in South Africa, there is still a wide knowledge gap on the potential impact of MPs on wastewater reuse. In this study, wastewater samples were collected during wet and dry seasons from influent, primary settling tank, secondary settling tank and effluent points at the Daspoort wastewater treatment plant (DWWTP) in Pretoria. The samples were sieved on-site for isolation of MPs (Figure 1) and the other batch collected in precleaned glass bottles were stored in a cooler box and transported to the laboratory for further analysis. Fresh sewage sludge samples were collected from a sludge tank. Total content of Cd, Co, Cr, Cu, Mn, Ni, Pb and Zn in was determined from acid digested wastewater and fresh sewage sludge samples using ICP-MS and ICP-OES. The amount, size and shape of the isolated MPs were characterized by FTIR and Raman spectroscopy. The total MPs extracted from the influent, primary settling tank, secondary settling tank, and effluent were 210, 178, 121, and 66 particles/L, for wet season. For dry season, the total MPs extracted from the influent, primary settling tank, secondary settling tank, and effluent were 196, 156, 110, and 102 particles/L, respectively. On the other hand, the mean concentrations of HMs induced by MPs from Daspoort WWTP were ranked as follows Zn (0.441 mg/L) > Cu (0.281 mg/L) > Cr (0.029 mg/L) > Pb (0.028 mg/L) >Ni (0.22 mg/L) > Co (0.009 mg/L), > Mn (0.002 mg/L) > Cd (0.001 mg/L), for dry season and Zn (1.642 mg/L) > Mn (1.076 mg/L) > Pb (0.884 mg/L) > Cr (0.695 mg/L) > Cu (0.624 mg/L) > Ni (0.499 mg/L) > Co (0.339 mg/L) > Cd (0.333 mg/L) for wet season. All the HMs concentrations detected during wet season exceeded maximum permissible limits set by SAWQ and WHO and thus highlight the concerns on human health and environmental risk. Overall, this study offers both a theoretical and conceptual framework for understanding the distribution of microplastics (MPs) and heavy metals (HMs) within Daspoort WWTP, as well as the potential interactions and leaching of HMs from MPs. In water-scarce countries such as South Africa, the reuse of treated wastewater has gained increasing significance, highlighting the crucial role WWTPs play in limiting the release of MPs into terrestrial and aquatic ecosystems. Despite this, the study's results indicate that MPs continue to be released into the environment through treated effluent and the disposal of sewage sludge.

3.07.A–T05 Independent Scientists Need to Contribute to Capacity Building in order to have an effective Global Plastics Treaty for Africa

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The impacts of plastics and plastic waste is a particular challenge in third world countries, particularly in Africa. Although Africa produces only 5% and consumes only 4% of global plastics, the effects of plastics may have much far-reaching consequences across the continent, given the high dependence of numerous African countries on economic activities, such as tourism. The Global Plastics Treaty is intended to be a legally binding instrument to be adopted by all United Nations member states. The Treaty comprises numerous proposed Articles, to which all countries are expected to agree to and comply with. Once the Plastics Treaty comes into effect, all member states are expected to comply with the resolutions made, including enhancing reliable data to inform science-to-policies. Collection and analysis of data requires highly skilled expertise, which may be lacking in many African countries. The aim of this network session is to foster engagements between all stakeholders (including scientists, civil society, business sector and policy-makers) at the SETAC World Congress to: 1. Identify the major skills needed to meet the requirements of the Plastics Treaty; 2. Discuss how capacity building related to the Plastics Treaty can be fostered by networking across Africa and internationally; 3. How skills development and capacity building can be incorporated in higher education (focusing on post graduate education) in Africa; and 4. Initiate and form a network of stakeholders across Africa (and internationally) to contribute to addressing the plastics pollution problem in Africa.

3.07.B - Plastics in Aquatic Environments: Occurrence, Effects, and Implications (Macro to Micro)

3.07.B–T01 Microplastic Contamination and Oxidative Stress Responses in Commercial Fish Species: Biomarker Evidence from Lagos Lagoon, Nigeria

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Microplastics (MPs) are emerging contaminants in aquatic environments and have been detected in water, sediments, and edible fish species from the Lagos Lagoon, Nigeria. However, limited information exists on their potential physiological effects on fish. This study investigates MP contamination and associated oxidative stress in the visceral organs (gill, stomach, liver) of four commercially important fish species: Oreochromis niloticus, Chrysichthys nigrodigitatus, Gymnarchus niloticus, and Clarias gariepinus (n = 16 each). The gill, stomach and liver of each species were examined for MPs by ultrafiltration and stereomicroscopic identification; oxidative stress biomarker activities were determined by standard biochemical analysis. Polymer identification was conducted by Fourier Transformed Infra-red spectroscopy. Microplastics were detected in all fish tissues, with fibers (64%) being the predominant form, followed by fragments (24%). FTIR analysis identified polymers such as polyethylene, polychloroprene, polypropylene, and polystyrene. Oxidative stress biomarkers showed significantly elevated antioxidant enzyme activities and lipid peroxidation levels ($p \leq 0.05$) in MP-contaminated tissues, indicating physiological stress responses. The findings highlight that microplastic ingestion may induce oxidative stress and potential health risks in commercially consumed fish. Further studies are recommended to fully understand the long-term impacts of MPs and associated pollutants on fish physiology and food safety.

3.07.B–T02 Environmental Concentrations and Characteristics of Microplastics in Water, Sediment and Mussels Along the Mwanza Gulf Shoreline of Lake Victoria, Tanzania

Farhan Khan[1], Bahati Mayoma[2] and Conrad Sparks[3] (1)Norwegian Research Centre (NORCE), (2)Cape Peninsula University of Technology and University of Dar es Salaam, (3)Cape Peninsula University of Technology

Microplastics (MPs: particles < 5 mm) accumulation in the environment and aquatic organisms has been widely reported globally, but the information about their presence in the transboundary African Great Lakes ecosystems remains scarce. The aim of this study was to determine the MP concentrations in water, sediment and mussels during the dry season (July to August 2024) at 8 sites along the Mwanza Gulf shoreline of Lake Victoria, Tanzania. Site selection was based on anthropogenic activities and land use. Water and sediments samples were collected from all 8 sites while freshwater mussels (Nitia sp) were collected only from 6 sites due to unavailability. MPs were extracted following Potassium Hydroxide digestion and Zinc Chloride floatation. The results show that water MP concentration was the highest at Bwiru Bay site (1.28 ± 0.15 standard error, particles L^{-1}) located in the northern part of the gulf. Similarly, Bwiru Bay displayed the highest MP concentration in sediment (303 ± 109.52, particles kg^{-1}), suggesting that fishing, wastewater treatment ponds, and settlement activities present in the area are contributing to high levels of MPs. Mussels sampled across sites exhibited MPs variation in both frequencies of

occurrence and concentration per individual. Kayenze Ndogo mussels recorded the highest MP concentrations per individual (9.4 ± 3.97 particles individual^{-1}), whereas the Kirumba Bay site had the highest MPs concentration per tissue weight (1.05 ± 0.27 particles g^{-1} wet tissue). Fibrous MPs were the dominant shape in water, sediment and mussels comprising 96.88, 68 and 86%, respectively. Blue MPs were the most prevalent overall in water, sediment and mussels comprising 50.22, 29.77 and 37.76% respectively. A higher concentration of microfibers across the investigated sites, including those in remote areas, highlights that most of the MPs come from secondary sources such as fishing and laundry which are common anthropogenic activities within Mwanza Gulf and the surrounding catchments. We propose further research to understand potential ecotoxicological effects of MPs found in mussels at environmentally relevant concentrations in order to determine the biological responses of freshwater mussels from Mwanza Gulf that are ingesting MPs.

3.07.B–T03 Abundance and Characteristics of Microplastics and Litter at an Impact and Non-Impact Site in Table Bay, Cape Town

Conrad Sparks[1] and Adetunji Awe[1] (1)Cape Peninsula University of Technology (CPUT)

This study assessed the abundance and characteristics of microplastics and litter at an impacted and non- impacted site in Table Bay, Cape Town an area vulnerable to marine pollution from urban runoff, sewage, and industrial activities. The aim was to compare microplastic concentrations and identify plastic polymer types in water, sediment, and mussels. Samples were collected from Lagoon Beach and analyzed using chemical digestion, density separation, filtration, microscopy, and FTIR spectroscopy. Litter was collected at both sites. Results showed that fibers were the dominant microplastic type, with black/grey being the most prevalent color across all matrices. Polyethylene (PE), polypropylene (PP), and polystyrene (PS) were the most common polymers. The impacted site exhibited higher microplastic and litter concentrations and diversity, with most branded litter originating from South African sources. These findings highlight the need for improved local waste management, policy enforcement, public education, and further research to address marine plastic pollution effectively.

3.07.B–T04 Review of best practices for sustainable plastics management in developing economies

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Plastics pose a significant environmental and human health challenge due to their persistence in the environment and their role in introducing pollutants over time. Among these, microplastics have garnered global attention, with nanoplastics and plastic-associated chemicals emerging as areas of growing concern. In response, policy-centered strategies are being developed to reduce plastic production and consumption, including efforts to establish legally binding international instruments. Historically, various national policies have addressed plastic use, waste management, and pollution. This review focuses on policy instruments from selected developing countries, evaluating their effectiveness in mitigating plastic pollution. While some countries show potential for successful implementation, enforcement remains inconsistent. China’s Green Fence policy effectively reduced pollution from imported waste, helping maintain environmental standards. However, domestic plastic waste management remains a challenge. In Costa Rica, policy enforcement is strong in eco-tourism hubs due to effective regulatory oversight, but implementation lags in other regions. In Africa, countries like Rwanda and Kenya have enforced strict plastic bans, but illicit trade resulting from lack of alternatives threatens these gains. These country-level policies were compared to the European Union’s (EU) approach, recognized globally for its advanced plastics management, zero-pollution targets, and environmental investment. The EU’s success is largely attributed to robust funding and support mechanisms, which are lacking in the reviewed developing countries. Additionally, there is minimal investment in research and public engagement to foster grassroots support. To enhance effectiveness, developing countries must address these gaps by strengthening policy enforcement, investing in infrastructure and citizen education, and integrating research-based strategies. Revisiting and refining existing policies is essential to reduce the plastic burden and associated environmental risks.

3.07.B–T05 Recommended approaches to regulating chemicals of concern in the global plastics treaty

Susanne Brander[1] (1)Oregon State University

Many of the chemicals used in plastics are demonstrated to be hazardous, and only a small number of the thousands of additives, fillers, dyes, and non-intentionally added substances used in plastic products are regulated and / or covered by existing multilateral environmental agreements. Due to these challenges, it is important that these chemicals of concern are fully considered and included in the global plastics treaty, including those in current use as well as potential replacements, in order to avoid regrettable substitutions. Via a brief introductory talk, this discussion-based platform presentation will introduce

six essential science-based recommendations for establishing a global regulatory framework for plastic-associated chemicals, and will ask the audience to form breakout groups around each of the suggested recommendations. Participants will discuss the benefits and drawbacks of suggested components such as plastic chemical reduction and simplification, safe and sustainable design, incentives for change and how these might work at a global scale, holistic approaches for alternatives (e.g. life cycle analysis), and also how these changes can be made in a just and equitable matter with human rights being given full consideration. Additional considerations during these breakout discussion include potential phase-outs of hazardous and redundant chemicals, strengthening transparency and the ability to track where chemicals end up, the potential dangers of over-reliance on recycling as a solution, and approaches for holding producers of plastic chemicals and products accountable for environmental damages. We will also consider the importance of traditional ecological knowledge and indigenous practices that will aid in reducing our reliance on plastics and thus reduce the use of the chemicals needed to make them functional. We aim to include multinational perspectives and input from individuals coming at the plastics challenge from many different angles and experiences, and will aim to put together an article for SETAC Globe with outcomes from group discussions, along with other presenters and participants from this sessioni. The ultimate goal of this organized activity will be to highlight diverse global voices as we near treaty implementation or another round of negotiations, depending on the outcome of INC 5.2 in Geneva this August.

3.07.C - Plastics in Aquatic Environments: Occurrence, Effects, and Implications (Macro to Micro)

3.07.C–T01 Environmental Concentrations, Characteristics and Risk Assessment of Microplastics in the Breede River (Western Cape, South Africa) Catchment, Estuary and Coastal Area

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Microplastic contamination is now increasingly being reported on in South African aquatic envrionments but none have been done within the context of catchment-to-coast. Therefore, the aim of this study was to determine the concentrations, characteristics and risk assessment of microplastics in the Breede River catchment, estuary and coastal area. Surface water and sediment were sampled along the catchment, estuary and coast of the Breede system during both the wet and the dry season. Microplastics were extracted and identified using microscopy and fourier transform infared spectroscopy (FTIR) analyses. Average microplastic abundances were 0.26 ± 0.02 particles/L in water and 43.65 ± 2.71 particles/kg in sediment samples. The catchment and coastal regions of the system are considered sinks for microplastic contamination in water and sediment, respectively, given the higher microplastic abundances recorded at these regions. Microplastics were mainly black/grey fibres, 500 – 1000 µm in size and polyethylene terephthalate (72%) was the most common polymer type recorded. Pollution load indices indicated that pollution was present throughout the different regions of the system during both the wet and the dry season for both water and sediment. Microplastic polymer risk indices ranged from low to high in the water and from low to moderate in sediment. Pollution risk indices were dangerous in water in the catchment (dry season) and the coast (wet & dry season) but generally low in the sediment (wet & dry season). Seasonally, pollution risk indices were dangerous in water during the wet season. The results from this study serves a baseline for future reaserch efforts and to inform policy makers that govern the protection of the Breede system so they may be able to develop and implement regular monitoring and the necessary mitigation measures to reduce contamination within the system. The Breede system is an ecological important system both for its unique biodiveristy and its high level of endemism. The results from the risk assessment does however indicate that the polymers in water during the wet season pose a threat to the overall health and functioning of the Breede system from catchment-to-coast. Thus, the regular monitoring of the system is crucial.

3.07.C–T02 Microplastic Contamination in a Closed Marine System: Insights from the Two Oceans Aquarium, Cape Town

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Urban harbours are recognised sinks for plastic contamination; however, limited research exists on how microplastics (MPs) are transported into and accumulate within closed marine systems that draw water directly from these environments. In closed systems, MPs pose potential risks to husbanded organisms through ingestion and exposure, especially in facilities that maintain semi-natural conditions for education, conservation, and display. This study aimed to evaluate the extent and characteristics of MP contamination across the Two Oceans Aquarium's water supply chain, from the harbour intake points to internal exhibit

tanks and biological samples, as a baseline for long-term risk assessment and resilience planning. Surface water, sediment, African Penguin (Spheniscus demersus) scat, and Sardine (Sardinops sagax) tissues were sampled from intake pumps, exhibit tanks, and the penguin habitat. Microplastics were extracted using density separation (for sediments and scat) and vacuum filtration (for water), while biological samples were digested using a 10% potassium hydroxide solution. Microplastics were characterised under a Zeiss Stemi-4 stereoscopic microscope at 20× magnification, and categorised by shape, size, and colour. Microplastics were detected in ~ 90% of water samples and in 74% of sediment and 94% of biological samples. Intake water contained an average of 10 ± 1.1 particles/L, while exhibit tanks reached up to 9.88 ± 1.78 MPs/L. Statistically significant differences were observed between intake and exhibit water ($U = 536$, $p = 0.04$). Fibres were the most common morphotype, followed by fragments, with blue and black the dominant colours. Preliminary detection of MPs in penguin scat and sardine samples suggests potential ingestion pathways, though further analysis is needed to confirm trophic transfer. This research establishes foundational data for understanding MP pathways and accumulation within a harbour-connected closed marine system. It underscores the need for ongoing monitoring and adaptive water management to minimise plastic exposure risks to husbanded marine life. The Two Oceans Aquarium serves as a model sentinel site for tracking MP dynamics, revealing spatial contamination patterns linked to stormwater inflows and visitor interaction zones. These findings support targeted mitigation, inform exhibit design, and reinforce the aquarium's role as a platform for translating marine plastic science into action and policy.

3.07.C–T03 Environmental Risk Assessments of Microplastics Around Stormwater Outlets of Cape Town, South Africa

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The Cape Peninsula of Cape Town is impacted by numerous stormwater drainage systems that discharge contaminated runoff into coastal waters. These stormwater systems are potential pathways for microplastics (MPs) to enter the marine environment of Cape Town. The aim of this study is to assess the potential risks that MPs from stormwater systems pose to the environment by using risk indices and condition indices as a guideline. The risk indices applied in this study were the contamination factor (CF), pollution load index (PLI), polymer risk index (H), and pollution risk index (PRI). The calculations were used to calculate the risk of MPs in water, sediment, and three different invertebrate feeding groups: mussels (filter feeders), sea urchins (grazers), and whelks (carnivores). The CF at impacted stormwater sites were rated as a high risk, (Category III). In contrast, the PLI indicated only a moderate risk, corresponding to Category II. Notably, both H and PRI at Camps Bay (impact site) were vulnerable, as it presented a high-level risk (Category III). The CI of biota revealed that mussels exposed to areas affected by stormwater, where elevated levels of MPs were found, had a significantly higher CI when compared to mussels from controlled areas . Due to MPs potentially having higher ecological risks at Camps Bay, Mouille Point, and Three Anchor Bay in water, sediment and three different feeding groups of invertebrates. it is imperative that waste management authorities (local, provincial or national government) implements precautions to reduce the number of MPs entering coastal waters via stormwater runoff in Cape Town, South Africa. Mitigation measures should be taken into account so that runoff is treated before entering the marine space or adding natural filters in problematic areas.

3.07.C–T04 Microplastics and Metals in Coastal Sediment and Mussels of the Western Cape, South Africa

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Microplastics and metals are contaminants that can potentially affect the health of coastal ecosystems. To date, very few studies have analysed these contaminants at the same time. The aim of the study was to a analyse spatial and temporal (wet and dry season) concentrations of metals and microplastics (MPs). Coastal sediment and mussels were collected at Strandfontein, Lagoon Beach and Saldanha Bay (Western Cape, South Africa) in 2021 and 2022. At total of 11 metals were analysed and MPs were characterized by shape, colour, size and polymer composition. Polymer ecological risks were evaluated using multiple risk indices (Contamination Factor (CF), Pollution Load Index (PLI), Polymer Risk Index (H), and Pollution Risk Index (PRI)). Metals in sediment were highest during the wet season and at Strandfontein. Metals in mussels varied based on season, with no clear trends based on either season or site. Mean MP concentrations in sediments and mussels were 48.89 ± 3.12 SE MPs/Kg and 0.67 ± 0.03 SE MPs/g wet weight, respectively, suggesting no bioaccumulation of MPs in mussels. MPs were detected in 76% of mussels, with 1.06 to 3.24 MPs per individual across sites. Most MPs were fibres (89%), dark in colour (65%, mainly black/blue), and between 0.5 and 2 mm in size (65%, primarily 0.5–1 mm). The majority of polymers identified were synthetic (85%), with polyethylene terephthalate (PET) being most prevalent (44%). Significant spatial variability was observed in both sediment ($H(3) = 12.343$, $p = 0.006$) and mussel ($H(3) = 33.386$, $p < 0.001$) samples, while no

temporal differences were found (sediment: U = 1092.000, p = 0.742; mussel: U = 14114.500, p = 0.315). There were no clear correlations between metals and MPs in mussels or sediment, but the statistical analyses were affected by inconsistent sampling effort of metals and MPs. Potential ecological risks of MPs varied across respective indices. The research provided a first attempt at analysing metals and MPs from the same sites in the Western Cape of South Africa. Given the ecological risks posed by metals and MPs, it is evident that more research on metals and MPs is needed in South Africa to provide scientific data to inform management decision of these contaminants in the future.

3.07.C–T05 Why independent local and Indigenous science-based evidence and expertise are crucial to ending plastic pollution

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Safe, sustainable, and equitable solutions to the global plastic pollution crisis will require contributions from a wide range of experts including independent scientists, citizen scientists, Indigenous peoples, waste pickers, and front line and fence line communities. These communities of knowledge could provide rigorous peer reviewed assessments and analyses, complex knowledge systems, and the lived experiences of those most effected and marginalized by plastic pollution across the full life cycle. Indigenous knowledge, for example, has developed in situ over many generations, and offers a holistic perspective, sustainable practices, and a deep understanding of the interconnectedness of ecosystems, all of which are essential for developing effective and equitable solutions. The science-policy interface (SPI) is the process by which scientific knowledge informs and shapes policy, primarily by facilitating knowledge exchanges between scientists and policymakers. Guidance from all plastics experts will be needed for an equitable evidence-based SPI for the global plastics treaty to drive material, product, technical, and systems innovations and a just transition toward a safer, more equitable, and more sustainable and transparent circular global economy. However, not all SPIs are alike. An informed and equitable SPI for an effective global plastics treaty will require that independent expert communities fully and meaningfully participate at all phases including problem, barrier, and driver identification, the operationalization of policies and plans and strategies, and the implementation of solutions. The success of the global plastics treaty will depend on the effectiveness of its SPI, and the success of its SPI will rest on its participatory, inclusivity, transparency, and conflict of interest mitigation policies and processes. Based on these principles and policies, the SPI could support the universal human rights to science (including enabling independent scientists' contribution to the science and public access science), the human right to access to information, the human right to a clean, healthy, and sustainable environment, and Indigenous rights including data sovereignty.

3.07.P - Plastics in Aquatic Environments: Occurrence, Effects, and Implications (Macro to Micro)

3.07.P–TuWe57 Effects of plastics-related chemicals on the aquatic environment: Tetrabromobisphelol A (TBBPA) as a pollutant of concern

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Tetrabromobisphenol A (TBBPA) is a well-known flame retardant that is still in use globally, despite its potential environmental risks. While primarily used for epoxy resin for printed circuit boards, TBBPA has also found wide application in the polymer industry as either a reactive chemical or an additive. As a result, the current production of TBBPA has reached 145000 metric tonnes/year, with an estimated annual increase of 4.8% from 2024 to 2032. Consequently, TBBA has become one of the environmental pollutants of concern, with leaching from common plastics evidenced. In the current research, the aquatic ecotoxicological effects were assessed using standard test systems. Briefly, Daphnia magna and S. vacuolatus were acutely exposed to TBBPA, with immobilization and growth inhibition assessed, respectively. In addition, a sublethal feeding inhibition effects were assessed in D. magna. The results showed significant effects of TBBPA in the D. magna (48-hour EC50=3.8 mg/L), with immobilization increasing in a concentration-dependent manner. Similar results were observed in S. vacuolatus, where the growth was inhibited in a concentration-dependent manner. Using sublethal TBBPA concentration, feeding inhibition in D. magna after acute exposure resulted in the increasing feeding inhibition. The effects of TBBPA to these two keystone aquatic species, that have a direct trophic relationship, evidences the potential adverse impact of TBBPA to the functioning of the aquatic ecosystem. Additionally, the effects on the microalgae as a primary producer further shows the potential of TBBPA to collapse the entire aquatic ecosystem; the unavailability of microalgae will have a ripple effect on the food chain. The sublethal effects in D. magna further show that TBBPA can affect the organisms' survival and ecosystem function even at lower concentrations. Given the increasing usage and disposal in the environment, TBBPA has the potential to

cause significant harm to the environment, as evidenced in the current research. In addition, ecotoxicity to other organisms and human health risks data have already been reported In conjunction with current measures to control pollution, control of TBBPA disposal and strict regulations are thus recommended.

3.07.P–TuWe58 Microplastic Shapes and Fish Health: Understanding the Link for Effective Environmental Policies

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Microplastic (MP) pollution has long been overlooked but recently recognized as a significant global environmental threat. These tiny particles, measuring less than 5mm, including fragments and fibers, have been detected in aquatic environments such as lakes, rivers, and oceans. Their presence in these ecosystems raises serious concerns due to their harmful effects on aquatic organisms. Given their small size, MPs can be easily (mistakenly) ingested by fish and other aquatic organisms. However, research on their specific impact on fish remains limited, and the role of different MP shapes in toxicity and bioaccumulation is not yet well understood. The study aimed to examine the gut response of Danio rerio when exposed to varying shapes of polyethylene terephthalate (PET) MPs, specifically micro-fibers (M.Fb.) and micro-fragments (M.Fg.), through dietary intake. A total of 114 adult fish were subjected to 6 particles of PET MPs per feed per day for 15 and 30 days. Physiological parameters have been assessed through mortality and growth as endpoints. Although no mortality was evidenced at the 6 MPs concentration supplemented for 30 days, a significant reduction in body weight was evidenced at the end of 15 and 30 days. Further histopathological analysis of the intestine showed considerable structural damage in fish exposed to 6 MPs per feed, including villi coalescence, epithelial layer detachment, epithelial and muscle layer degeneration, dysplasia, hypertrophy, hyperplasia, and necrosis. The histopathological alteration index (HAI) indicated severe intestinal damage in fish exposed to M.Fb. at 6 MPs per feed for 30 days compared to M.Fg., suggesting that the shape of MP plays a critical role in toxicity. Thus, the research outcomes enhance the understanding of MP interactions with fish, highlighting their potential impact on organisms and ecosystem health. The findings emphasize the need for further studies on the long-term effects of MP exposure and call for effective environmental policies to mitigate MP pollution and protect aquatic ecosystems.

3.07.P–TuWe59 Harnessing Citizen Science for Microplastic Monitoring in the Coastal Waters of the Western Cape

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Citizen science has emerged as an effective tool for engaging the public in plastic litter research, while simultaneously increasing environmental awareness and promoting more sustainable behaviour. While citizen science approaches to data collection, provides opportunities for sampling accessible sites to support long term monitoring, challenges still exist around data validation. This study assesses the efficacy of a citizen science approach for monitoring microplastics (MPs) in the False Bay region (Western Cape, South Africa), conducted through collaborations between the Centre for Sustainable Oceans (Cape Peninsula University of Technology) and the “Engaging the Public” citizen initiative at Cape RADD (Cape Research and Diver Development). MP Samples were collected from 2022 to 2024, volunteers conducted supervised sampling across 19 sites (n = 19), while MP experts sampled three sites (n = 3), yielding a total 2165 particles. Water samples were collected and filtered in-situ through 250 µm mesh filters and stored in 0 ml Falcon tubes). In a dedicated MP laboratory, all particles collected were characterised by shape, colour and polymer type. Quantitively, on average MP concentrations significantly higher ($p < 0.001$) in expert collect samples compared to volunteer collected samples. Filaments (~ 49%) were the most abundant MP type in volunteer samples; while fragments (~ 52%) followed by filaments (~ 47%) were dominant MP types found in expert collected samples. Transparent (~ 37%), followed by black (~ 35%) coloured MPs dominated in volunteer collected samples; while black (62.8%) and blue (~ 21.5%) coloured MPs dominated in expert collected samples. A subset of suspected microplastics (n = 629, ~ 30% of total) were analysed using an attenuated total reflectance Fourier-transform infrared (ATR-FTIR) spectrophotometer, confirming ~ 20 % of particles were MPs. These results demonstrate the value of citizen science in filling spatiotemporal knowledge gaps in marine MP monitoring, with implications for collaborative interventions and conservation efforts. Furthermore, this study validates the use of citizen science approaches to monitoring MP pollution as a crowd-sourced indicator for microplastic contamination.

3.07.P–TuWe60 Degradation and Ecotoxicological Effects of Poly(lactic acid) (PLA) / Polyhydroxybutyrate-co-hydroxyvalerate (PHBV) Blends on the Behavioural and Gravitactic Responses of Culicids

Patricks Voua Otomo[1], Nomasonto Portia Dlamini[1] and Julia Puseletso Mofokeng[1] (1)University of the Free State

An environmental challenge with a worldwide negative impact on ecosystems is plastic pollution. To address this global issue, biodegradable plastics are used to substitute petroleum-based plastics in disposable applications. In the present study, the biodegradation of neat 50/50 w/w PLA/PHBV and its nanocomposites with 1 and 5 wt.% Titania dioxide (TiO2) nanoparticles was assessed mimicking environmental conditions. The primary process by which these blends and nanocomposites were degraded in water and soil was biodegradation. Furthermore, the toxicity and effects of these samples on the swimming, breathing, resting, and gravitaxis behaviours of mosquito larvae (Culicidae) were also tested. For the ecotoxicological assessments, 1 x 1 cm of all the samples were immersed in 500ml distilled water and incubated for 10 days at 80°C to make aqueous solutions for these blends. Individual larvae were exposed to 210ml solutions of degraded polymers and the larval behaviours of interest were recorded for 600 seconds (10min). In both water and soil, the biodegradation rates of the neat PLA/PHBV were higher than those of the nanocomposites. However, no significant difference ($p > 0.05$) was observed between all the mass loss percentages of neat blends. The ecotoxicological results indicated that statistically, in the control, and treatments of the neat and TiO2-filled blends, breathing was the most prominent behaviour when compared to swimming and resting ($p < 0.05$). There was no difference between the swimming and resting rates in all the treatments and controls ($p > 0.05$). The geotaxis results showed that most culicids displayed a negative geotactic behaviour with the control displaying the least geo-negative behaviour ($p < 0.05$). This suggested that aqueous solutions of the neat and TiO2-filled blends caused the mosquito larvae to display more breathing behaviour than in the control. Because culicids normally spend most of their time breathing, these findings suggest that the solutions of degraded polymer blends were not harmful to the test organisms and that these polymers could potentially replace petroleum-based plastics/polymers without causing deleterious impacts on mosquitoes and similar organisms.

3.07.P–TuWe61 Microplastics as Emerging Contaminants in Urban Rivers: Assessment and Characterization in the Msimbazi River, Tanzania

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Microplastics (MPs) are plastic particles smaller than 5 mm, they are an increasingly recognized class of emerging contaminants in aquatic environments. Their persistence, potential for bioaccumulation, and role as vectors for toxic chemicals raise serious ecological and public health concerns. This study assessed the occurrence, distribution, and characteristics of MPs in the Msimbazi River, a heavily urbanised and industrialised river system in Dar es Salaam, Tanzania. To address this issue, water and sediment samples were collected from five sites; Pugu, Kinyerezi, Vingunguti, Buguruni and Magomeni representing gradients in urban development and pollution pressure. Microplastics were extracted using sieving, hydrogen peroxide digestion, density separation with zinc chloride, and vacuum filtration. Visual identification under a stereomicroscope was followed by polymer confirmation using Fourier Transform Infrared (FTIR) spectroscopy. Results revealed widespread contamination, with MPs ranging from 11 to 116 particles per liter in surface water and from 72 to 494 particles per kilogram in sediment, noticeably higher than some global reference values. Fibers were the most dominant type (67%), followed by fragments and films. The smallest particle size class (<500 μm) was most abundant in both media. Identified polymers included polypropylene, polyvinyl chloride, and polyamide, suggesting input from domestic waste, packaging and textile fibers. Magomeni and Buguruni were the most densely polluted sites characterised by industrial discharges and informal settlements. This study provides the first detailed evidence of Microplastic pollution in a Tanzanian urban river. The findings highlight the urgent need for regulatory controls on plastic waste disposal and wastewater treatment. They also establish a foundation for future risk assessment frameworks targeting microplastics and related emerging contaminants in African freshwater systems.

3.07.P–TuWe62 Contextualizing microplastic pollution in different river habitats through rapid habitat analysis

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Microplastic research in rivers has rapidly increased over the last decade. However, no clear or concise method exists for the sampling of microplastics in rivers, with researchers making use of plankton nets that have the ability to contaminate the sample or through various volumes of bulk water collected and filtered, with various replicates used. This leads to studies

where a single river system could have various levels of microplastics that can significantly change between sites. These changes have been related to the surrounding anthropogenic activities; however, the context of the environment may contribute to the concentrations found. The aim of this study was to determine microplastic abundances in water and sediment, with a critical evaluation of the site where sampling took place to determine which environmental factors would impact microplastic distribution. The results indicated that the use of a bulk water sample did not have significant differences in microplastic concentrations, however, the study determined that environmental factors such as velocity, river obstructions, and most importantly, discharge, can change the context of the microplastics at the site, and how it may impact niche specific organisms. The results of the study were used to produce a new measurement to provide a contextualized representation of microplastics at a site that could be used as a better indicator of microplastic pollution at the site and its impact on biota.

3.07.P–TuWe63 Risk of Microplastics in South African Freshwater: Case Study

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The high production and consumption of plastic products have led to significant microplastic (MPs; <5 mm) pollution in aquatic environments. These particles have emerged as contaminants of increasing concern due to their potential risks to aquatic ecosystems and human health. Due to their emergence, the contamination levels, pollution loads, hazard factors, and overall risks associated with their occurrence remain largely unknown, especially in South African freshwater. The study aimed to determine the potential risks of MPs along the Vaal River Basin at five sampling sites throughout the year. The risks were established using a suite of complementary in silico methods: contamination factor, pollution load index, hazard index, and ecological risk index. A suite of complementary methods indicates that MPs of different properties pose varying risks at different sites. The level of contamination and pollution load index across the different sites ranged from moderate to very high. Increased adverse effects emanated from MPs with fibrous shapes and PVC-based polymer types. MPs pollution in the water samples reached hazardous levels across all investigated samples, with severe ecological hazards. Seasonal variation significantly influenced contamination levels, with higher risks recorded in the dry season. Risk assessment models provide a standardized framework for determining risk levels, but their effectiveness is compromised by varying physicochemical properties of MPs used in the assessment. As a result, the derived data often lacks comparability. Irrespective of the method's limitations, the assessment highlights the MPs risk along the Vaal River, which necessitates ongoing monitoring, coupled with experimental studies on MP toxicity using aquatic organisms to support evidence-based environmental regulation and policy development in South Africa.

3.07.P–TuWe64 Addressing the Insufficiency of Marine Outfall Regulations in Mitigating Microplastic and AMR Pollution from Wastewater Treatment

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Microplastics are found in all marine compartments, ranging from sea ice to sediments, beaches, and the open ocean, with a significant portion originating from land-based wastewater treatment plants. Policy in the South African context permits responsible disposal of wastewater through a marine outfall provided that the raw wastewater undergoes treatment and does not cause any adverse effects to the receiving body. However, a desktop study focused on regulatory framework for marine outfalls in South African coastal cities shows that partially treated (primary or preliminary treated) wastewater could be deposited into oceans. Microplastics form a considerable proportion of the wastewater mixture but also Enterobacteriaceae. To demonstrate the relevance of the wastewater treatment plant (WWTP) bacteria in biofilms on microplastics, this study aimed at identifying and characterizing Enterobacteriaceae isolates from a simulated marine environment using microcosms. Experiments challenging the regulations were based on microbiology of the effluent that is discharged through an outfall. Microcosms were set up by spiking seawater with WWTP effluent and adding the sterilized collected plastic pieces. Scanning electron microscopy (SEM) was used to determine colonization on the microplastics. After 30 days of microcosm exposure, selective media and incubation conditions were used to isolate Enterobacteriaceae. Pure isolates were tested against 16 antibiotics normally used in human clinical settings. In the initial biofilms directly from microplastics from the WWTPs, several genera generally associated with wastewater treatment were isolated. Dominant species isolated and identified were Citrobacter sp., Escherichia sp., Enterobacter sp., Serratia sp., Klebsiella sp. and Pseudomonas sp.. Several isolates were resistant to carbapenems (doripenem and imipenem; 9% to 27%). Some isolates were resistant to up to ten of the antibiotics.

Bacterial infections caused by Carbapenem-resistant Enterobacteriaceae have become a global concern in the fight against bacterial infections. The results of the present project show that clinically relevant Enterobacteriaceae colonize microplastics and that these survive in biofilms on these microplastics surfaces. Such results suggest that more data is needed that will challenge the current policy regulating the release of sewage through marine outfalls as well as the notion that dilution of sewage is an answer to pollution.

3.07.P–TuWe65 Toward Standardized Microplastic Uptake Assessments in Bivalves: Experimental Trials in Exposure System Design and Particle Quantification

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In the face of growing global concerns over the ecological impacts of microplastics (MPs), the development of reliable and standardized laboratory exposure methods have become increasingly essential. This preliminary study aimed to optimize experimental conditions for MPs exposure by assessing quantification methods of lab-made MP particles, its uptake pathways in bivalves, and system retention efficiency. The experiments assessed different aeration systems to ensure adequate particle suspension and to maintain overall water quality. Aeration was tested by comparing the flow rate between air stones and pipettes, while water quality parameters were monitored over several days using a portable testing kit and a bench meter. Key parameters measured included temperature, salinity, pH, turbidity, nitrates, nitrites, ammonia, copper, and phosphates. These measurements were taken to safeguard the health and survival of the test organisms. Two MP quantification methods were investigated, namely, mass-based (g) and a volume-based method using Nile Red staining with Sedgewick Rafter chamber analysis. To investigate the dynamics of uptake, the exposure of MPs was examined in dead mussels to understand passive deposition. Additionally, the system retention of the MPs particles was monitored over time to account for the efficiency of exposure and to determine potential losses due to settling, adhesion, or clumping. The pipette method resulted in a higher retention rate of 93.33% as opposed to 84.17% of fragments from the air stone experiment. Retention experiments suggest that low flow bubbling via the pipette method maintained homogenous distribution of particles and system stability, while vigorous bubbling from the air stone disrupted stability and water quality. Comparison of quantification methods indicated that the mass-based method produced inconsistent weight measurements, while the volume-based analysis demonstrated greater sensitivity and consistency for detecting low plastic particle concentrations. Uptake pathways experiments using dead mussels revealed that dead mussels cannot actively uptake MP particles, but they may act as negative controls for assessing passive deposition. These findings will support protocol refinement for live mussel exposure experiments, enhance standardization across studies, and improve understanding of MP interactions with bivalves, supporting the development of environmental policy and regulation.

3.07.P–TuWe66 Abundance and Characteristics of Anthropogenic Litter Along the Tanzanian Shores of the African Great Lakes: Volunteer Involvement, Outreach and Stakeholder Engagement

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Environmental pollution due to mismanaged anthropogenic litter is one of the most pressing issues facing the world today. To reduce existing environmental burdens of litter, clean-up events have increased in popularity. Here, we report on the results of the Clean Shores, Great Lakes project, in which we conducted 69 volunteer-based clean-ups along the Tanzanian shorelines of the African Great Lakes (Victoria, Tanganyika, and Nyasa (also known as Lake Malawi)). A total of 5483 volunteers engaged with the project across all clean-up sites, collecting 431328 pieces (25981 kgs) of anthropogenic litter. Expressing the data as normalized to area (items m-2) or effort (items individual-1 hour-1) revealed that the interpretation of a polluted site varies with units. Litter abundance varied from 0.06 to 13.89 items m-2 and 5.2-706 items individual-1 hour-1. Plastics were the major litter type constituting 75% of all litter (mean = 74.2 ± 12.5 % across all sites), while clothing (10.9 ± 9.5 %) and fishing gear (3.7 ± 5.2%) were also prevalent. Two items constituted > 40 % of all collected litter, namely plastic beverage bottles (average 23.7 ± 17.1 %, range 0-72.9 %) and plastic bags (average 19.7 ± 13.2 %, range 1-50.3 %). Prioritizing intervention measures on these two items could reduce litter leakage significantly. Further, a holistic approach was undertaken through voluntary engagement, citizen science involvement, stakeholder dissemination and school visits to increase public awareness. Clean-up data when disseminated to relevant policymakers and stakeholders can motivate activity for the environmental management of anthropogenic litter and plastic pollution.

3.07.P–TuWe67 Microplastic Bioaccumulation in Polychaetes from the Ramsar-Designated Berg River Estuary, South Africa

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Estuaries are critical transitional ecosystems between rivers and oceans, delivering essential ecological services. Despite their importance, estuaries are highly susceptible to pollution due to their unique characteristics and landscape position. Plastic pollution, especially microplastics (MPs) (particles <5 mm), has become a significant concern with the advent of mass plastic production. Polychaetes represent a substantial portion of the estuarine benthic community and they have been shown to accumulate MP's, however, South African studies are lacking. The Berg River Estuary, on the West Coast of South Africa, is an ecologically significant system known for rich biodiversity and important ecosystem processes. This estuary was designated as a RAMSAR site in February 2022. Despite numerous sources of MP pollution from the Berg River catchment to the estuary mouth, no investigation has been done to date on MP's in this sensitive estuary. This study aimed to assess MP pollution by measuring contamination levels in water, sediment and polychaetes across four sites within the Berg River Estuary. Additionally, the study investigated the potential of polychaetes as biomonitors of MP contamination within this ecosystem. Sampling was conducted in May 2024, samples were digested and MPs identified using microscopy. FTIR analysis is in progress. The highest MP concentrations were recorded at sites 3 (5.48 ± 1.39 MPs/L) and 2 (3.39 ± 0.51MPs/L) for water, site 4 for sediment (31 ± 8.43 MPs/kg), site 1 for Capitellidae (4.1 ± 1.2 MPs/ind), and site 4 for Nereididae (4.33 ± 0.86 MPs/ind) and Spionidae (4.35 ± 0.48 MPs/ind). Dominant MP types included fibres and black and transparent MPs, with particles smaller than 2 mm being most prevalent. Three of the five sampled matrices showed higher MP concentrations in downstream urbanised and industrialised sites, indicating localised pollution sources. Using the bioaccumulation factor to assess MP accumulation from sediment and water to polychaetes, bioaccumulation was confirmed, with levels reaching 2835.45 ± 806.11 at site 1 between water and spionids. Our findings highlight the importance of site-specific environmental factors and varying polychaete feeding behaviour in influencing microplastic accumulation. We recommended expanding the spatial and temporal scale of the sampling to include the catchment and coast to better understand microplastic distribution and seasonal variation within this system.

3.07.P–TuWe68 The Effect Of Microplastics On The Enzymatic Treatment Of Seaweed

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Seaweeds are a promising source of bioactive compounds known to possess antioxidant, antiviral, antimicrobial, and anticoagulation properties, which makes seaweed an attractive source for biotechnological applications. Brown seaweed is particularly interesting – it is rich in fucoidan and alginate, both associated with numerous health benefits. When plastic waste enters the marine environment, microplastics (MPs) are formed due to biotic and abiotic processes. Many studies have detailed the severe effects of MPs on marine organisms. However, none of these studies have focused on the effect of MPs on seaweed degradation, a natural process that releases valuable nutrients into the marine environment. The aim of this study was therefore to determine the effect of MPs on the ability of carbohydrate-active enzymes (CAZymes) to degrade seaweed and the release of biotechnologically valuable bioactive compounds exhibiting antimicrobial and antioxidant activities. Brown, green, and red seaweed were collected along the Cape Town coastline, and were dried and ground, defatted, depigmented, and in the case of the brown seaweed, the fucoidan and alginate components were extracted. The CAZymes, fucoidanase (Wf GH168), cellulase from Trichoderma reesii, and the small laccase from Streptomyces coelicolor, were produced and purified for application in seaweed degradation. The release of reducing sugars was monitored, and the optimal combination of enzymes will be applied in future studies to determine whether MPs have an inhibitory effect on the efficacy of the CAZymes. The degradation products from these treatment experiments will then be assessed for antimicrobial activity, antioxidant activity, and cytotoxicity. Studies on MPs in the marine environment are usually focused on their impacts on marine organisms and environmental health. However, this first-of-a-kind study will provide insights into the potential interfering role of MPs in natural processes that occur in the marine environment and a bioprocess that plays a key role in accessing the biotechnological potential of seaweed, a resource that contributes to the global Oceans Economy.

3.07.P–TuWe69 Microplastics in economic fisheries from major fish landing sites in Lagos, Nigeria

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There is a growing environmental and public health concern regarding plastic pollution, particularly the accumulation of microplastics in marine ecosystems, which has significant implications for human consumers and aquatic organisms. This research examines the degree of microplastic pollution in fish species and benthic invertebrates at prominent fish landing sites in Lagos, Nigeria. Sampling occurred at 10 sites: Epe, Ikorodu, Lekki, Makoko, Lagos Island, Badagry, Ijegun, Ojo, Apapa, and Ajah. Benthic invertebrates including Blue Crabs (Callinectes sapidus) and Tiger Prawns (Penaeus monodon) were

examined alongside three economically important fish species: Tilapia (Oreochromis niloticus), Silver Catfish (Chrysichthys nigrodigitatus), and Red Snapper (Lutjanus campechanus). Morphometric examination indicated discrepancies in fish dimensions and mass, with Epe producing the most substantial specimens. Ingestion of microplastics was verified in the gastrointestinal tracts of all species, with microscopy and FTIR tests detecting several polymer types. Polyvinyl Alcohol (PVA) was the predominant polymer, comprising 42.9% of microplastics in fish and 52% in benthic invertebrates. Other significant polymer types included Ethylene Propylene Diene Monomer (EPDM). The predominant morphologies were fibers, with colour analysis revealing that black, brown, and Blue microplastics were prevalent in both fish and benthic invertebrates. Lagos Island demonstrated the largest concentration of microplastics, whilst Makoko displayed the lowest. Tiger prawns exhibited a greater average microplastic load (3.1 per individual) compared to Blue crabs (2.3 per individual). A survey of community stakeholders highlighted the prevalent utilization of Single-Use Plastics (SUPs), with Ikorodu and Badagry exhibiting the highest consumption rates. Although 74.5% of respondents endorse legislation aimed at mitigating microplastic contamination, detrimental waste disposal practices continue, with hardly 40% of the populace utilizing professional waste management services. This study emphasizes the widespread occurrence of microplastic contamination in the coastal waters of Lagos and stresses the immediate necessity for more public awareness, better waste management methods, and more robust regulatory interventions to address this growing environmental concern.

3.07.P–TuWe70 Microplastics in the Sediments of Rivers from Sites in Southern KwaZulu-Natal, South Africa

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Microplastic pollution has become an emerging concern worldwide, having the ability to persist in the environment and cause a wide variety of issues. Although the issue of microplastics is being increasingly recognised, the majority of research is focused on the marine environment, with terrestrial and freshwater environment research lacking. The focus of this study was to determine the presence of microplastics in the sediment from rivers at 28 sites in southern KwaZulu-Natal Province, South Africa during 2024. Approximately 2 kg of sediment was sampled from sites during routine river sampling. Microplastics were then separated from 50 g of sediment using density separation and zinc chloride. Microplastics were then analysed for abundance, shape, colour, and seasonal differences using standardised MERI protocol. Through the findings of this study microplastics were identified at all sites with a total difference of 358 microplastic particles between the high and low flow seasons. These identified microplastics, were predominantly white in colour and pellet shaped. The difference in microplastic abundance between April (high flow season) and August (low flow season) 2024 was not statistically significant. This study highlights the potential pollution sources that contribute to the microplastic contamination observed in sediments from these freshwater systems. These potential sources include agriculture, urbanisation, refuse, industrial activities, tourism and recreational activities such as angling. The findings of this study also emphasise the need for targeted mitigation and management strategies to address observed microplastic contamination across the various river systems in southern KwaZulu-Natal.

3.07.P–TuWe71 Microplastic Exposure Induces Hepatotoxicity Through Oxidative Stress: An Investigation Into the Molecular Mechanism

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Polystyrene microplastics (PSMP) are ubiquitous contaminants of the biosphere, this makes human exposure inevitable. Numerous studies have provided evidence that PSMP can bioaccumulate in human organs such as the liver. The liver is rich in mitochondria, facilitates first pass metabolism and detoxification of xenobiotics. These factors make the liver a target for PSMP toxicity. A unifying endpoint of PSMP toxicity has been linked to oxidative stress, however the molecular mechanisms involved in this is not elucidated in human liver cells. The production of reactive oxygen species (ROS) at complex I, II and III in the electron transport chain (ETC) occurs when electrons escape and interact with the abundant surrounding oxygen. In this way alterations in metabolic function directly leads to changes in ROS production. This study sets out to determine the molecular mechanism behind PSMP induced oxidative stress using luminometric, spectrophotometric, fluorometric and protein expression techniques. This study tested the toxic effects of three selected PSMP concentrations (5, 75, 200 µg/mL) to estimate the effect of low, intermediate and high exposure levels. Results showed that PSMP disrupted metabolic function and decreased ATP output while increasing intracellular ROS in a dose dependent manner. Data further indicates that oxidative stress and apoptosis was induced as indicated by the increase in MDA levels (biomarker for lipid peroxidation) and caspase 3 activation for all tested concentrations. The levels of GSH and GSSG supported the role of the antioxidant system in overcoming PSMP induced oxidative stress, however catalase activity was significantly decreased. This prompted further

investigation into the molecular mechanisms which revealed that PSMP treatment upregulated the expression of the mitochondrial SOD2 along with cytoplasmic SOD1 and catalase. The data showed upregulation of NRF, the master transcription factor of the antioxidant response. The project conclude that the upregulated antioxidant expression was not enough to detoxify the ROS and could not prevent oxidative stress. This study provides insight into the molecular mechanisms of PSMP induced hepatotoxicity and may aid in understanding and predicting the contamination risks of this neglected but ubiquitous toxin. This is of particular importance to developing countries where the risk of PSMP exposure is high due to the lack of infrastructure for dealing with the plastic burden.

3.07.P–TuWe72 Toxicity Identification Evaluation of Leachate from Selected Bioplastic Straws Using A Marine Copepod Species

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Whereas biomass-based and biodegradable plastics, called “bioplastics” as combined, are promoted as one of realistic solutions to the marine plastic pollution, their degradation products may pose adverse effects to aquatic organisms. This study evaluated the toxic effects of leachates from three commercially available bioplastic straws, made of 25% bio-polyethylene blended polypropylene, polylactic acid, and bio-polybutylene succinate on a cyanobacterium (Cyanobium sp.) and a copepod (Acartia sinjiensis) species, with and without UV irradiation. Straws were first cut, exposed to simulated sunlight, ground, and sieved to <1 mm, then stirred in artificial seawater and filtered to prepare leachates. No significant growth inhibition was detected for all the leachates for the cyanobacterium while significant effects on survival, hatching, and development were found for the copepod for leachates of all three bioplastic straws both with and without UV irradiation. Chemical analyses were performed using AIQS (Automated Identification and Quantification System)-GC-MS and ICP-MS for leachates, and Pyrolysis-GC-MS for the straws to identify major toxicants to contribute the observed toxicity in the leachates. Organic additives such as phthalic esters and metals such as copper and zinc were detected in the leachates. Some additives such as 2,4-di-tert-butylphenol were identified by Pyrolysis-GC-MS, suggesting their presence in both leachates and plastic materials. Zinc was considered as one of the major toxicants while copper and phthalates were not but further investigation is necessary to completely identify the other major contributors.

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3.07.P–TuWe73 Filaments in the Flow: Assessing Microplastic Distribution and Drivers in Gauteng’s Wetland Pans

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Microplastic contamination poses a growing threat to urban wetlands vulnerable to industrial effluent, land use change, and atmospheric deposition. Understanding the sources and distribution patterns of microplastics is essential for effective management of freshwater resources in rapidly urbanizing regions. This study investigated seasonal and spatial variation in microplastic distribution across four urban wetland pans, Bullfrog, Korsman, Sand, and Blaauw pans in South-Eastern Gauteng province, using a multidisciplinary approach. Water, sediment, and Chironomids were collected using standardised field protocols. Microplastics were isolated through KOH digestion, identified following MSFD guidelines, and characterised using ATR-FTIR. GIS-based hotspot and land use analyses were used to trace contamination sources and assess environmental drivers. Seasonal shifts in water quality were evident. pH, salinity, and conductivity increased during summer, while water clarity was highest in winter. Sediment composition varied across pans and seasons, with textures ranging from fine to coarse. Nutrient loading was elevated at specific sites, particularly in the Sand and Bullfrog pans, indicating localised pollution pressure. Microplastics in water were mostly filaments, followed by irregular particles. Sediment samples and chironomids microplastic loads were predominantly filaments. Blue and black filaments were most common, with some red and transparent filaments. Korsman pan showed peak microplastic levels in summer, while Bullfrog and Blaauw pan peaked in winter. These patterns indicate both seasonal and spatial variability in contamination. Multivariate analysis revealed links between microplastic abundance and abiotic variables such as water clarity, salinity, and temperature. Polymer analysis confirmed Polyethylene terephthalate, cotton, and nylon as the major sources, likely from textile waste and runoff. Long-term land cover trends (2014–2024) showed summer vegetation expansion and winter contraction, shrinking wetlands in dry years, and increased erosion in Sand and Blaauw pans, supporting the role of landscape dynamics in microplastic transport. Overall, the results highlight the chronic and complex nature of microplastic pollution in urban wetland systems, shaped by seasonal environmental shifts, site-specific factors, and anthropogenic pressures.

3.07.P–TuWe74 3D Printed Microplastic Particles as Potential Metal Vectors in the Freshwater Environment

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The use of additive manufacturing techniques, such as Fused Deposition Modelling (FDM) 3D printing, is becoming increasingly popular thanks to its ability to streamline supply chains. While polymer waste production is reduced, wastes of FDM origin are physically and chemically different to conventional polymers. Consequently, it is critical to explore the ways in which this new waste interacts with the environment. It is also important to assess the validity of current microplastic isolation techniques when applied to 3D printed polymers. This study therefore aimed to investigate the relative metal adsorption behavior of three common FDM 3D printing polymers, namely polylactic acid (PLA), acrylonitrile butadiene styrene (ABS), and polyethylene terephthalate glycol (PETG). The ability of these polymers to withstand a standard organic matter digestion protocol was also investigated. To do this, microplastic fragments of PLA, ABS and PETG were 3D printed and then exposed to water from the Tweelopiespruit in Krugersdorp, South Africa. Samples were drawn after 96-hour and 28-day exposure periods for heavy metal analysis. An additional group of microplastic fragments was exposed to 10% (w/w) KOH(aq) at 60 ˚C for 12 hours, as per a conventional digestion protocol. Surface morphology was analyzed with Scanning Electron Microscopy (SEM) after each exposure step. It was found that after a 28-day exposure period, each polymer carried a small quantity of all the analyzed metals. While adsorbate concentrations were low, 3D printed polymers do have a role to play in riverine metal transport. ABS carried significantly higher ($p<0.05$) concentrations of Co, Cr, Cu, Ti, U, and V than either PLA or PETG, potentially due to the more porous surface structure of this polymer. However, as multiple metals appear to have leached from the polymer particles into solution, it is perhaps the leaching of metal rich additives, rather than the polymer surface area, which explains this result. No differences in the adsorption performance of PLA and PETG were found. The digestion of organic matter in 10% (w/w) KOH(aq) at 60 ˚C for 12 hours caused the depolymerization of PLA and surface structure alterations of all three polymers. To preserve microplastic samples during pre-treatment steps, digestion methods which do not require heating should be investigated, as it is likely that the elevated temperature was responsible for polymer degradation.

3.07.P–TuWe75 Urban activities and wastewater effluents contribute to microplastic and metal load in the bottom sediment of the Apies River, South Africa

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Urbanisation and wastewater effluents are becoming serious threats to freshwater ecosystems due to their role in metal and microplastic pollution. Metals and microplastics are known to have a synergistic effect on aquatic biota. The present study was carried out to investigate the potential of urban activities and wastewater effluents on increasing metal and microplastic load in the Apies River. The bottom sediment samples were collected from ten (10) different sites along the longitudinal gradient of the 65 km stretch of the upper Apies River. For metal analysis, aqua regia was used for sample digestion, and inductively coupled plasma optical emission spectroscopy was used for metal analysis. Metal contamination indices and the potential ecological risk index (RI) were used to classify contamination status and the ecological risk of metal contamination in the river. Fenton's reagent and hydrogen peroxide were used for sediment digestion, whereas hypersaline solutions were used for density separation. Microplastic abundance was counted using a stereo microscope, and chemical characterization was performed using Raman spectroscopy. The water pH ranged from neutral to slightly alkaline across all sites. No definite trend was observed for metals across sites, however, Cr and Cu exhibited concerning concentrations for most sites. The contamination factor for Cr reached 4.6 at some sites, denoting considerable contamination. The pollution load index ranged from 1.95 to 4.78, whereas the degree of contamination was > 25 from Site 7 to Site 10. In contrast, Sites 4 to 6 showed the Cr geoaccumulation index of > 1, suggesting moderately contaminated. However, the RI was < 40 at all Sites, suggesting low risk based on the 5 metals assessed. Nevertheless, microplastic abundance showed an increasing trend from Site 1 to 6, then decreased from Site 7 to 10, with polyethylene, polystyrene, polyethylene co-vinyl, polyvinyl chloride, and polypropylene being among the polymers. Microplastic abundance showed significant positive relationships with Cr ($\rho = 0.6$), Fe ($\rho = 0.51$), and Zn ($\rho = 0.72$). The findings of the present study provide insight into the dynamics of metals and microplastics in rivers impacted by urban activities and wastewater effluents.

3.08 - Pollutants Without Borders: Tracking Environmental Pathways, Assessing Risks and Advancing Solutions

3.08–T01 Dissipation and Degradation of Benzobicyclon Herbicide (BUTTE®) and its Degradation Product in Rice Fields

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Benzobicyclon, (BZB) is the active ingredient in BUTTE® herbicide and has gained attention for resistance management strategies to control rice pests. The dissipation of BZB was monitored in rice fields spanning two rice growing seasons. BZB and the primary degradation product benzobicyclon hydrolysate (BH), partitioning favored sediment and water respectively with a slow partitioning of the metabolite into the water column as the parent degraded in sediment. Photochemically generated hydroxyl radical dissipation is an important mechanism for chemical degradation in aquatic systems but is rarely considered with other dissipation mechanisms in traditional pesticide registration packages. The hydroxyl radical rate constant was measured for BH and the influence of hydroxyl radical dissipation was modeled in a simulation using the regulatory exposure models PFAM and EXAMS2. A significant difference between dissipation with and without the rate constant was estimated with hydroxyl radical contributing up to 30% of the degraded BH. The photodegradation of BH was also found to be highly dependent upon the concentrations of trace elements in water as well as in seawater. This is important as rice field effluent often enters estuarine and marine ecosystems in many parts of the world. It was found that as salinity increased from 0 ppt to 35 ppt, the half-life of BH decreased exponentially from 84.1 ± 2.6 hours to 3.5 ± 0.07 hours. Additionally, it was found that, when isolated from other ions, magnesium ions most influenced this degradation. The half-life of BH in the presence of magnesium was 5.85 ± 0.12 hours. The half-lives in the presence of copper, iron, and zinc were 126.4 ± 2.24 hours, 146.5 ± 4.5 hours, and 87.23 ± 2.7 hours, respectively. The results of this investigation should provide information used for the more accurate assessment of risk to aquatic ecosystems.

3.08–T03 The Good, the Bad, and the Murky: Metal and Organochlorine Pesticide Bioaccumulation in Invertebrates and Fish from Ephemeral Pans in Southern Mozambique

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Temporary pans are vital yet understudied wetland ecosystems in southern Africa, supporting unique aquatic biota while being highly sensitive to surrounding land-use practices. These endorheic systems are susceptible to pollutant accumulation due to periodic filling and drying cycles. This study aimed to investigate the bioaccumulation of metals and organochlorine pesticides (OCPs) in selected invertebrate and fish species from ephemeral pans in and surrounding Karingani Game Reserve (KGR), southern Mozambique. Specifically, contaminant concentrations between conservation and pastoral landscapes were compared to assess potential exposure risks. Samples of water, sediment, invertebrates (Notonectidae, Dytiscidae, Nepidae), and killifish were collected from 17 pans inside and 11 pans outside KGR during the 2024 wet season. Metal concentrations in biota and sediments were determined using ICP-MS and FIMS techniques, while OCPs were quantified via GC-ECD. Bioaccumulation factors for sediments (BSAFs) were calculated for selected metals, and statistical analyses were conducted to compare concentrations across sites and species. Results showed significantly higher concentrations of As, Pb, Se and V in invertebrates from pans in the reserve, while Cd, Ni, and Zn were elevated in pans from pastoral regions outside the reserve. In killifish, significant differences in Hg, Mn, V and Zn concentrations were observed between pans inside the reserve. BSAF values revealed species-specific accumulation patterns, with Nepidae and Notonectidae consistently showing higher bioaccumulation of metals. Since there are no large industrial or urban areas in the vicinity of the sampling region, it is likely that metals such as As, Pb Se, V and Zn are of natural geogenic origin. The Hg however may be transported via atmospheric distribution as has been found in other studies conducted in near pristine conservation regions. Limited OCPs were recorded above the limit of quantification. Concentrations of aldrin and chlordane were notably elevated in invertebrates from pans outside the conservation area, indicating likely agricultural runoff or pesticide use in pastoral landscapes. Although generally lower, some inside pans still exhibited DDE and DDD levels, suggesting possible historical contamination or diffuse pathways from regions where DDT is still used for malaria vector control. This study provides the first baseline assessment of metal and OCP bioaccumulation in ephemeral pans in southern Mozambique. The findings highlight the influence of historical land use activities as well as larger scale pollutant distribution patterns that result in species-specific contaminant uptake. This study further makes a valuable contribution to baseline data for future ecotoxicological assessments and informing wetland management strategies in tropical conservation landscapes.

3.08–T04 Using risk assessments for birds to identify potentially high-risk agrochemicals and their potential role in decision-making

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Nearly half of global population growth between 2019 and 2050 will emanate from countries in sub-Saharan Africa, increasing the pressure on these nations to supply sufficient resources. An estimated 40% of South Africa's land surface is currently used for agriculture, and the industry continues to expand. As the largest agrochemical user in sub-Saharan Africa, shortfalls in its legislation governing agrochemical registration processes and use have been highlighted. For example, South Africa does not have a toxicity risk assessment scheme for product registration. Using the European Food Safety Authority (EFSA) risk assessment guidance for birds, we determined potential acute (short-term) and reproductive (long-term) toxicity risks from recommended wine agrochemical products. First-tier risk assessments were conducted, assuming birds were only exposed to agrochemical active ingredients through their diet. Insecticide products had the highest acute risks to all bird feeding guilds, but frugivores and insectivores were most affected. Fungicides posed the greatest reproductive risks to all bird feeding guilds, except frugivores, for which herbicides had more potential adverse effects. Many of the active ingredients used in wine agrochemical products in this study are banned elsewhere and recognised as highly hazardous. Results from this study could be used to make recommendations to sustainable farming certification schemes and be incorporated to strengthen environmentally friendly product grading programmes. This could improve pesticide use within the industry and inform effective and long-term mitigation strategies. A similar approach could be applied to other crops grown within South Africa. Ultimately, such risk assessment processes should be incorporated at the product registration stage to curb the continued use of harmful products in South Africa.

3.08–T05 Toxic Chemical Mixtures outside of the Safe Operating Space on a Global Scale

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The increasing number and amount of chemicals produced, used, and emitted into the environment results in the pollution of water resources with complex mixtures of chemicals all over the world. Based on harmonized LC-HRMS chemical target screening of about 500 organic micropollutants in surface water and wastewater at almost 1000 individual sites in regional to continental-scale case studies in Europe, western Kenya, Lahore/Pakistan, and central Chile we present a comparative mixture risk assessment based on Toxic Units (TU) and Risk Quotient (RQ) summation. The median sum of RQ values in all the case studies from four different continents exceeded the number of 1. PNECs are exceeded by median water concentrations and by maximum water concentrations by up to 2 and 5 orders of magnitude, respectively, in Lahore water bodies and European WWTP effluents. The most impacted group of organisms are invertebrates. The mixture risk assessment has revealed that in Europe, 75% of all investigated sites exceed chronic risk threshold levels and are thus outside the safe operating space for aquatic invertebrates. Percentages of water bodies at risk in Lahore water bodies and western Kenya were even higher. Pesticides such as organophosphate insecticide diazinon, the neonicotinoid imidacloprid and the phenylpyrazole insecticide fipronil are the main risk drivers. In Lahore water bodies extremely high concentrations of etofenprox used to control insect vectors of malaria and dengue are dominating the risks to crustaceans, fish and even algae with concentrations up to three orders of magnitude above EC50 values for crustaceans. However, herbicides, fungicides, pharmaceuticals, and biocidal surfactants also contribute substantially to impacts on aquatic ecosystems and on biodiversity. While the current study is the broadest investigation of toxic water pollution with respect to compounds and world regions considered, it is still based on snapshot investigations. More systematic, temporal and spacially resolved, and action-oriented monitoring, particularly in low- and middle income countries, is required as an important step towards safe water resources worldwide.

3.08.P - Pollutants Without Borders: Tracking Environmental Pathways, Assessing Risks and Advancing Solutions

3.08.P–TuWe76 Occurrence and Risk Assessment of Steroid Hormones: A Case Study of Selected Rivers in Western Kenya

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Endocrine disruption in aquatic ecosystems is typically dominated by natural and synthetic steroids, which are increasingly

monitored in high-income countries and across various environmental matrices. However, studies on the occurrence of endocrine disruptors in African water systems are limited. We aimed to bridge this knowledge gap by investigating the concentrations and toxicological risks of steroidal water pollutants from different classes in western Kenya rivers systems. The study was carried out in five rivers within Migori, Kisumu, Kericho, Homabay and Kisii counties during dry seasons (February and July) and wet seasons (May and October). Grab water samples (350 mL) were collected using Nalgene bottles, placed in a -18 ◦C and transported to the laboratory. Solid phase extraction was done and samples analyzed using Liquid Chromatography-High Resolution Mass Spectrometry (LC-HRMS) and Liquid Chromatography-tandem Mass Spectrometry (LCMS/MS). Estrogenic, androgenic, glucocorticogenic and progestagenic risks were calculated using Bioanalytical Equivalents based on chemical concentrations (BEQchem). A total of 35 steroid hormones were detected with detection frequencies ranging from 1 to 64% and median concentrations varying between 60 pg/L (17β -estradiol) and 9.2 ng/L (androsterone). Mometasone furoate exhibited the highest median concentration among the glucocorticoids at 4.5 ng/L while estrone was detected in 2% of the samples at median concentrations of 1 ng/L for estrogens. The hormone 17β -estradiol was the most frequently detected estrogen in the sampled rivers with 64% detection frequency and a median concentration of 0.06 ng/L. This high detection could be attributed to its excretion via human and animal urine and released into water sources. The median BEQchem values for estrogenicity in dry and wet seasons were very similar with 0.06 ngE2/L and 0.05 ngE2/L, respectively, and fall within the effect-based trigger values (EBT) range. In 16% and 2% of the cases, BEQchem exceeded the EBT range in dry and wet season, respectively, indicating likely estrogenic impacts on exposed organisms with 17β-estradiol and 17α-ethinylestradiol contributing to the predicted risk. This comprehensive study provides the first evidence-based data towards regulation and monitoring of steroid contamination in western Kenya Rivers.

3.08.P–TuWe77 Ameliorative Effects of Piroxicam on Anthracene-Induced Lung Damage in Female Rattus Norvegicus

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Anthracene is a component of polycyclic aromatic hydrocarbons (PAHs), present in cigarette smoke,steak meat fire, burning tyre, bone fire, some television and radiocasing fire and insome industrial emissions. It may cause tumor of lungs and other organs as well as alterations in haematological and biochemical parameters [1]. Hence, the study was carried out with an intent to discovering therapeutic potential of piroxicam against anthracene-induced lung damage. Randomized controlled trial was adopted for the study. Thirty-six female rats of seven weeks old that weighed 166.25±26.79 g divided into six groups of 6 each were used for the study. Each of the rats of group 1, 3, 4, 5 and 6 was administered100 mg/kg of oral anthracene for three weeks except group 2 administered 2.5 mg/kg of water. Thereafter, each of the members of groups 1and 2 was administered 2.5 mg/kg of water, group 3 (piroxicam 2.5mg/kg), group 4 (carboplatin 2.5 mg/kg/piroxicam 2.5 mg/kg), group 5 (piroxicam 5 mg/kg) and group 6 (carboplatin 2.5mg/kg) for a period of 3 weeks. Blood sample (2 ml) was collected pretreatment (day 0), 7, 21, 35 and42 for haematology and serum biochemistry. The experimental rats were sacrificed using 100 mg/kg of sodium pentobarbitone for harvesting of lungs, hearts, livers, kidneys and spleens for allometric scaling [2]. Two-way Analysis of variance (ANOVA) was used to analyze the data. Least significant difference was detected at 5% level [3]. Body weight, packed cell volume, erythrocytes, leucocytes and neutrophils counts, were significantly decreased ($p<0.05$), whereas lymphocytes, monocytes, basophils, eosinophils were significantly increased ($p<0.05$) in group 2, 3, 4, 5 and 6 on day 42, respectively [4]. Significantly decreased weight ($p<0.05$) was observed for lung, kidney, liver and heart. Urea, creatinine, aspartate aminotransferase, alanine aminotransferase, alkaline phosphate, carcinoembryonic antigen, total oxygen consumption [5], heart rate, ventilation rate, lung volume and tidal volume were significantly decreased ($p<0.05$) by anthracene (100 mg/kg). All the pathophysiological parameters were ameliorated by piroxicam (2.5 and 5mg/kg) and carboplatin (2.5mg/kg). Carboplatin cured micronodular lesions, whereas piroxicam (2.5 and 5.0 mg/kg) reduced micronodular lesions, respectively [6]. Hence carboplatin alone could be used for the treatment of anthracene-induced lung damage, whereas piroxicam could be used to ameliorate anthracene-induced lung damage. Three-week administration of carboplatin and piroxicam could be beneficial against obesity, polycythemia, immunostimulation, hyperuremia, hypercreatinaemia, hyperphosphataemia and transminitis. However co-administration of carboplatin and piroxicam could be beneficial in coasting disease, anaemia and immunoinhibition.

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3.09 - Nanomaterials and Advanced 2D Materials: Innovations, Transformations, and Ecotoxicological Implications

3.09–T01 Transformed Nanoparticles, Altered Outcomes: CuO and ZnO Toxicity in Model Species

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Engineered nanoparticles (ENPs) are increasingly used across various consumer and industrial sectors, with global production rising dramatically in recent decades. Their distinctive physicochemical features—such as nanoscale size, large surface area, and high reactivity—underpin their utility but also raise concerns regarding environmental release and potential toxicity. Among ENPs, copper oxide (CuO) and zinc oxide (ZnO) nanoparticles are of particular interest due to their application in agriculture, for instance as nanofertilizers. However, their behavior and toxicity in the environment are influenced by chemical and biological transformations they undergo post-release, which are often overlooked in standard toxicological assessments. This study evaluates how such transformations affect the toxicity of CuO and ZnO ENPs using two model organisms: Lepidium sativum (garden cress) and Daphnia magna (a freshwater crustacean). To replicate environmental aging, the nanoparticles were subjected to sulfidation (via exposure to sulfide ions), biotransformation (via interaction with bovine serum albumin to simulate protein corona formation), or a combination of both. Subsequent analyses focused on changes in particle morphology, chemical composition, aggregation behavior, and dissolution rates. Toxicological assessments were conducted following OECD test guidelines No. 202 and No. 208. Sulfidation transformed CuO into CuS and $CuSO_4$, significantly modifying particle shape and enhancing solubility fivefold. In contrast, ZnO exhibited partial sulfidation with reduced dissolution by 70%. Protein corona formation generally decreased solubility across both nanoparticle types. Toxicity outcomes varied: sulfidated CuO exhibited increased toxicity toward D. magna, whereas protein coating mitigated this effect. In plants, root growth inhibition by CuO was alleviated following both sulfidation and BSA exposure. ZnO toxicity was consistently reduced after transformation, particularly at higher concentrations. In summary, environmental transformations substantially influence the toxicity profile of CuO and ZnO ENPs, and their effects depend on both nanoparticle type and target organism. These findings underscore the necessity of including environmentally realistic transformation processes in ENP risk assessments, as metal ion release alone does not fully explain observed toxicological outcomes.

3.09–T02 How Engineered Nanoparticle Transformations Redefine Their Interactions with Plants

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Plants are increasingly subjected to engineered nanoparticles (ENPs) due to the targeted use of nano-enabled agrochemicals and the widespread presence of ENPs in the environment. Numerous studies have reported both advantageous and detrimental effects of ENPs on plant systems. Upon release into the environment, ENPs undergo a range of transformations - including physical, chemical, and biological processes - that modify their properties and behavior within plants. Considering the essential role of plants in agroecosystems and the potential for ENPs to accumulate within the food chain, it is crucial to thoroughly investigate plant responses to these materials. This study aimed to elucidate the fate of both pristine and transformed CuO ENPs within plant-related environments. Sulphided ENPs (sulph-CuO ENPs), protein-coated ENPs (BSA@CuO ENPs), and sulphided ENPs with a protein corona (BSA@sulph-CuO ENPs) were derived from pristine ENPs (p-ENPs) and employed in this investigation. Pristine ENPs, transformed ENPs, and Cu^{2+} were applied either to Hoagland nutrient solutions or to soil in order to simulate scenarios involving the deliberate application of ENPs and their occurrence in soil as by-products or contaminants. In the first experimental setup, p-ENPs, transformed ENPs, and ionic Cu were introduced at concentrations of 1, 10, and 100 mg Cu/L into Cu-deficient Hoagland solution, and the responses of barley (Hordeum vulgare L.), a species sensitive to Cu deficiency, were evaluated. The second setup examined the effects of soil-applied ENPs (at 20 and 200 mg Cu/kg) on edible plants cultivated in soil, specifically spinach (Spinacia oleracea L.) and lettuce (Lactuca sativa L.). Barley samples were analyzed for mineral composition, gene expression, and single particle characterization within both the growth medium and plant tissues. Spinach and lettuce were assessed for transition metal accumulation and biochemical parameters, including pigment content, malondialdehyde (MDA), and glutathione (GSH) levels. The results demonstrated that the transformation of ENPs influenced Cu accumulation in plants. Notably, treatment of Cu-deficient barley with ENPs revealed the most pronounced differences in Cu content between pristine and transformed CuO ENPs at the highest concentration applied, following the accumulation pattern: p-CuO ≈ BSA@CuO < BSA@sulph-CuO< sulph-CuO ENPs. However, Cu

concentrations in leaves of ENP-treated plants were approximately two orders of magnitude lower than in barley exposed to Cu^{2+} ions. The pattern of expression of genes associated with cellular Cu trafficking and homeostasis in treated plants did not mirror the Cu leaf content, which indicates different dynamics of Cu management and molecular response to alien particles. In soil-grown plants, the pattern of copper accumulation differed: Cu content in leaves was the highest in plants grown with soil treated with the pristine CuO. These findings suggest that the transformation state of ENPs has a significant impact on plant responses, including metal uptake and accumulation. Moreover, metal accumulation resulting from exposure to transformed ENPs may represent an increased risk to human health.

3.09–T04 2D Hexagonal Boron Nitride (h-BN) and 1D Boron Nitride Nanotubes (BNNT); Distinct Effects at the cellular level of these Structural Analogues to Graphene and Carbon Nanotubes

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Hexagonal boron nitride (h-BN) and boron nitride nanotubes (BNNTs) are emerging advanced nanomaterials with 2D and 1D structures analogous to graphene and carbon nanotubes, respectively. The market for these BN materials is expected to undergo rapid growth, driven by industry demand for high performance and 2D semiconductor materials. However, studies on safety are limited to date and there is a serious knowledge gap on the hazard (for environment and human health) and degradability/metabolism of these 2D materials (both in the environment, in organisms and at the cellular level). Thus, this study's aim was to first identify if multi-walled nanotubes of BN (BNNT) could produce a hazard profile similar to that evidenced already for multi-walled carbon nanotubes (MWCNTs) and secondly if the material when present in a 2D sheet-like structure (hexagonal BN, h-BN) increases or decreases the hazard profile. Using cell lines as an in vitro testing platform, investigations were performed to assess material-cellular interaction, effects on cell viability and reactive oxygen species (ROS) levels, as well as any induction of cellular detoxification activity (cytochrome P4501A, CYP1A) following 2D h-BN and BNNT exposure. Cells from rainbow trout (Oncorhynchus mykiss) liver and gill (RTL-W1 and RTgill-W1) and also a mammalian (brown rat, Rattus norvegicus) hepatoma cell line (H4IIE) were employed. Clear differences were evidenced in material uptake, leading to plasma membrane disruption and loss in metabolic activity for BNNTs at lower exposure concentrations compared to h-BN. Interestingly, only the BN material in nanotube form induced an increase in CYP1A dependent EROD activity, suggesting a possible involvement in its metabolism. Interference studies revealed potential auto-fluorescence, quenching, and adsorption, which must not be neglected when testing with dye-based assays, and assays that rely on optical read-outs. Therefore, while these investigations at the cellular level provide key information on potential events involved in materials processing, interference free assays and robust protocols are needed to ensure accurate and reliable dose response data for future hazard assessment of emerging advanced materials. Acknowledgement-This research was funded by Graphene Flagship Core 3 Project (grant agreement no. 881603) and a General Protocol of Action between MITECO and INIA, CSIC for carrying out Activities Related to Substances and Chemical Mixtures.

3.09–T05 Evaluating the Toxicological Impacts of Carbon Nanomaterial-Polyethersulfone Composite Membranes in Water Treatment Applications

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Carbon nanomaterials (CNMs) are being increasingly used in various fields due to their unique properties, including their high surface area, excellent electrical conductivity, and chemical stability. These materials can be used in membrane fabrication for water filtration membrane systems to make them more efficient. They have also been used for enhancing the photocatalytic efficiency of titanium dioxide (TiO2). Despite the beneficial implication of the nanoparticles in modifying water treatment membranes, they might not be stable enough in the membrane matrix, leading to leaching of the nanoparticles from the membranes during their use in water treatment. Although recently developed nanomaterials present potential uses as environmentally friendly photocatalysts, but may also present risks to human health and the environment. This study aims to assess the toxicity of CNMs and TiO2 used in water filtration membranes for wastewater treatment. Nanomaterials were synthesized using Hydrothermal, Sol-Gel and Hammer's Method. Membranes were fabricated using Nonsolvent-induced phase separation. The nanomaterials and membranes were characterized using SEM, RAMAN, XRD, and FTIR. Leaching studies were conducted during the filtration experiment, and samples were analysed using Inductively coupled plasma mass spectrometry (ICP-MS) and UV-Vis. The toxicity of the nanomaterials was tested using various tests such as the MTT assay, lactate dehydrogenase (LDH) release assay and the oxidative stress assay. It was noted that nanomaterials do leach, and the uniformity in membrane microvoids was lost due to nanoparticle leaching and possible degradation of the membrane polymer. The toxicity results revealed that the toxicity of the nanocomposites was concentration dependent. At lower concentrations, the

nanocomposites did not exhibit any significant toxicity, and the cells remained viable. However, at higher concentrations, the nanocomposites showed toxic effects, leading to a decrease in cell viability. Understanding the toxicity of nanomaterials helps determine the potential risks associated with their use. It is also crucial for developing regulations and guidelines for their safe use in wastewater treatment, and for researchers and engineers to develop safer and more effective methods for using them in wastewater treatment.

3.09.P - Nanomaterials and Advanced 2D Materials: Innovations, Transformations, and Ecotoxicological Implications

3.09.P–ThFr25 Insight into Factors Influencing the Purchase, Use and Disposal of Rapid Antigen Test Kits: Potential Environmental Impact of the Generated Nano-waste

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The widespread use of rapid antigen test kits (RATs), particularly during the COVID-19 pandemic, has raised significant concerns about their environmental impact due to the presence of engineered nanomaterials. RATs are widely used for the detection of various conditions (including pregnancy, HIV, malaria, and COVID-19) owing to their affordability, speed, and convenience. Many of these kits incorporate gold nanoparticles (AuNPs) on conjugated strips to enable visual detection of target antigens. Although individual kits contain recyclable quantities of plastic and paper, the smaller proportion of AuNPs, coupled with large-scale consumption, presents a potential environmental risk. This study investigated the factors influencing consumer behavior related to the purchase, use, and disposal of RATs and assessed the potential environmental implications of the resulting nano-waste. Six (6) boxes of a commercially available COVID-19 RATs brand were analyzed to estimate waste generation and characterize AuNPs. The packaging components were weighed to determine solid waste (g), and analytical techniques including Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy coupled with Energy Dispersive X-ray Spectroscopy (SEM-EDS) were used to measure particle size and identify nanoparticle coatings on test strips. Paper constituted the highest approximate amount of RATs waste (67.7%), followed by plastic (26.96%), and nano-enabled strip only making up 0.42% of waste. Additionally, a three-month online survey (n=204) assessed public perceptions toward RAT usage and disposal. Results revealed that 66.5% of respondents were female, and factors such as cost, result accuracy, and personal health monitoring influenced purchase decisions in over 60% of responses. Notably, more than 60% reported disposing of used kits in general household waste, though 91% expressed interest in improved disposal practices, and 81.3% were open to environmentally friendly alternatives. These findings highlight the urgent need for improved product design, clearer disposal instructions, and increased public awareness to mitigate the environmental risks associated with RAT-related nano-waste.

3.09.P–ThFr26 A Comparative Toxicological Assessment of Gold Nanoparticles (nAu) from Rapid Diagnostic Test Kits in Aquatic Ecosystems

Tarryn Botha[1], Rorisang Malatsi[1] and Amina Nel[1] (1)University of Johannesburg

The increasing use of gold nanoparticles (nAu) in medical diagnostic kits, such as SARS-CoV-2 rapid test kits, has raised concerns about their potential environmental toxicity. Upon disposal, these kits may release nAu into aquatic ecosystems, where their long-term effects remain largely unknown. This study aimed to assess the toxicity, bioaccumulation, and ecological effects of nAu leachate from these diagnostic kits in aquatic ecosystems. The research characterized the physicochemical properties of nAu leachate through Fourier Transform Infrared Spectroscopy (FTIR) and Dynamic Light Scattering (DLS). Acute toxicity tests were conducted across different environmental conditions, including variations in pH of the water medium, while toxicity comparisons will be made between unused whole leachate and used whole leachate. The study extended across multiple trophic levels by assessing toxicity in aquatic plants (Raphidocelis subcapitata), invertebrates (Brachionus calyciflorus, Daphnia pulex and Daphnia magna), and vertebrates (Danio rerio). Bioaccumulation of the nAu was analyzed using CytoViva dark-field hyperspectral microscopy to confirm nanoparticle uptake and tissue localization. Statistical analysis, including LC50 and RQ calculations and one-way ANOVA, will determine the significance of toxicity variations across experimental conditions. The findings will provide critical insights into the environmental risks associated with nAu-containing diagnostic tools and inform regulatory policies for their safe disposal.

3.09.P–ThFr27 Immune and Stress Responses in Zebrafish Exposed to Pregnancy Rapid Test Kit Leachate

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Nanogold (nAu) is the most researched advanced material in biomedicine due to its unique physicochemical properties, modifiability, and perceived biocompatibility. Colloidal gold rapid test kits, such as pregnancy test kits and SARS CoV-2 test kits, are one of the most common applications of nAu due to their sensitivity and ease of use. However, as the use of such test kits and other sources of advanced materials increase, so does the prevalence of these materials in the environment, which could potentially threaten aquatic and human health. Despite this, there exists a large knowledge gap regarding the bioaccumulation, potential immunotoxicity, and stress-related effects of leached nAu. This study aims to assess the bioaccumulation, biodistribution, and physiological impact of nAu leached from pregnancy test kits in zebrafish (Danio rerio) using a fish embryo acute toxicity test according to OECD guidelines. Samples will be collected every 24 hours for analysis. Fourier-transform infrared spectroscopy (FTIR), dynamic light scattering (DLS), and inductively-coupled plasma mass spectroscopy (ICP-MS) is used to characterize the leached nAu. The activity of the embryos, heart rate, and blood flow is assessed using video recordings. Findings from this research will strengthen our understanding of the potential risks associated with advanced materials and nanomedicine safety.

3.09.P–ThFr28 Comparative Surface Characterization of Nano-Enabled Rapid Antigen Test Kits

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As single use nano-enabled rapid antigen diagnostic test kits become widely employed for domestic medical diagnostics, understanding their chemical makeup and transformation potential after use becomes increasingly important. These test kits are built on a lateral flow assay (LFA) principle and consist of several key components, a nitrocellulose membrane, a sample pad, a conjugate pad, an absorption pad, and plastic housing. The use of these disposable test kits has raised concerns about their environmental impact and safe disposal of generated nano-waste as they have also been shown to leach into the environment upon improper disposal. By comparing a range of commercially available test kits, this study seeks to identify potential toxicants and contaminants that may arise from these products pre- and post-use, aiming to incorporate various characterization techniques. Fourier transform infrared (FTIR) spectroscopy was applied based on transmittance and absorbance of infrared light through the sample. Attenuated total reflectance (ATR) was used as a variant of this technique, employing a high refractive index crystal to reflect infrared light onto the sample. Scanning electron microscopy (SEM) was used to assess surface adhesion, coupled with energy dispersive X-ray spectroscopy (EDX) to scan for metal composition, and transmission electron microscopy (TEM) to determine primary nanomaterial size ranges. The study found surface properties of the range of these nano-enabled rapid antigen test kits to have surface coated nanogold or nanosilver with size ranges between 3-20 nm. Surface adhesion patterns observed from SEM visually changed between used and unused test kits. FTIR analysis revealed distinct material compositions of test strips and surface chemistries across the range, including variations in polymer matrices and functional group signatures, which may influence environmental interactions and degradation potential. These results highlight the risks across the range of test kits and how surface compositions and nanomaterial concentration influence their ability to leach into the environment.

3.09.P–ThFr29 Automated Synthesis of Silica-Supported Metal Nanoparticles for Enhanced Catalytic Transfer Hydrogenation of Cinnamaldehyde

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In chemical synthesis, there is an increase in the demand and interest for sustainable and green reactions that are effective and cheap. They catalytic transfer hydrogenation reaction is an example of this green chemistry reaction, much safer than the traditional methods. The challenge lies in developing efficient catalysts that maximize yield while minimizing environmental impact. This study aims automate the synthesis of nanoparticles supported on silica for catalytic transfer hydrogenation (CTH) of cinnamaldehyde. Nanoparticles have significant catalytic activity due to their high surface to volume ratio and properties that can be tuned. With automation, we propose better control on the size, distribution and morphology. This research leverages advanced characterization techniques, including transmission electron microscopy (TEM) and X-ray diffraction (XRD), to evaluate the structural integrity and dispersion of synthesized nanoparticles on silica supports. The performance of the synthesized materials was assessed in the selective hydrogenation of cinnamaldehyde to produce cinnamyl alcohol. This is used a valuable intermediate in perfumery and pharmaceuticals. The results showed that including metal nanoparticles into silica drastically increased the kinetics and selectivity of the reaction. The supported catalysts also had better stability as compared to the unsupported adding onto sustainability. This aligns with the objectives of the SETAC World Congress in

promoting responsible environmental practices and innovative research collaborations. This paves way for future investigations and incorporations of more modules to increase functions automated reaction setups. This could increase efficiency in the environmental and industrial contexts.

3.09.P–ThFr30 Hazard Assessment of Graphene Family Materials (GFMs) Using the Aquatic Invertebrate Daphnia magna As Indicator Organism

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Graphene family materials (GFMs), such as graphene (GR) and graphene oxide (GO), are rapidly increasing in both industrial and environmental applications due to their unique physical and chemical properties, such as their thermal stability, large surface area, and high reactivity. While these characteristics make GFMs extremely valuable to their various applications, they also create potential environmental threats, with their ability to persist in aquatic environments. The chemical structure of GR allows it to bind to biological molecules with ease, which facilitates its absorption by organisms. Similarly, GO can easily infiltrate organs, tissues, and cells, seriously impairing their critical biological processes. The small water flea, Daphnia magna, is a widely used model in ecotoxicological studies, however, there remains a significant knowledge gap concerning D. magna and the exposure to GFMs. This study addresses this critical research gap by investigating graphite material (which was used as a reference material), four different GO materials, and five functionalised GR materials to determine the acute effects on D. magna following OECD standard toxicity testing guidelines in a controlled laboratory environment. Of the materials tested, graphite showed little to no acute toxicity to D. magna, with a 48 h LC_{10} of 37.7 mg/L and LC_{50} higher than 100 mg/L . The four GO treatments (based on different synthesis techniques) did not show any acute toxicity (i.e. LC50 > 100 mg/L). In contrast, the functionalised GR materials demonstrated significantly higher toxicity, with the most toxic being GR-N with an LC_{50} value of 3.3 mg/L. This is followed by GR-COOH (LC50 = 33.6 mg/L). The increased toxicity is likely due to the presences of additional elements such as nitrogen and fluorine within the functionalised GR samples, supporting the hypothesis that GFMs can act as "Trojan horses", enhancing the bioavailability of the graphene and its toxicity. By examining the acute response of this invertebrate species, this study provides a toxicological perspective and highlights the potential ecological risks associated with the increasing use of GFMs. The results contribute to a better understanding of the cumulative effects of GFMs in aquatic environments and may inform future environmental safety by design regulations.

3.09.P–ThFr31 Assessing the Acute Toxicity of Graphene Related 2D Materials (GR2Ms) to Fish using OECD Test Guideline (TG) No. 203; Potential Adaptations to Facilitate Testing

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Specific tests and guidance documents are available to support toxicity testing for hazard assessment and classification of chemicals to meet regulatory needs. For instance, Organisation for Economic Co-operation and Development (OECD) Test Guideline (TG) 203 serves for assessing acute toxicity in fish. However, being originally developed for soluble chemicals, the application of this TG to graphene related 2D materials (GR2Ms) requires additional adaptations due to these materials low solubility in water and the difficulties in generating stable suspensions. In this study, we investigated the applicability of TG 203 to GR2M and proposed adaptations for maintaining test material concentration and stability in suspension. An industrial graphene oxide (GO, GRAnPH®) provided by Grupo Antolín, S.A. served as test material. Rainbow trout (Oncorhynchus mykiss) fingerlings were used in the assays. Under standardized test conditions, an important GO precipitation was observed. The use of turbines permitted increasing stability at the highest concentration (100 mg/L) of the assay. The addition of humic acid (HA) proved to be effective for maintaining suspensions stability at all exposure concentrations (4-100 mg/L). HA, however, induced cytochrome P450 1A (CYP1A) and CYP3A detoxification activities in fish at 50 and 100 mg/L. Therefore, depending on the cases, HA could mitigate or increase toxicity, so that when performing acute toxicity tests its use should be avoided. Taking this into account, using only turbines to maintain material stability, OECD TG 203 was applied to test GRAnPH®. There were no acute lethal effects after 96h exposure to concentrations as high as 88.5 mg/L and no visible abnormalities were detected either in control or treated groups. Increases in CYP1A and CYP3A detoxification activities were measured in GRAnPH® exposed fish, which points to specific disturbances that warrant testing over a longer term chronic duration, but that may not have been accurately reflected if the test had been applied using HA as a dispersion aid. In conclusion, preliminary tests prior to use of OECD TG No. 203 can serve to identify appropriate adaptations to meet test validity criteria (e.g. concentration maintenance). This information is essential to ensure that future assessments generate meaningful data fulfilling regulatory requirements. Acknowledgements: This research was funded by Graphene Flagship Core 3 Project (grant agreement no. 881603).

3.10 - Soil Ecotoxicology – Impact, Ecotoxicity Tests, Monitoring and Risk Assessment

3.1–T05 Poster Spotlight: 3.10.P–TuWe79 & 3.10.P–TuWe80

3.10.P–TuWe79 - Temperature and Moisture Modulate Aflatoxin's Ecotoxicological Impact on Soil Health: Insights from Earthworm Studies; 3.10.P–TuWe80 - Ecotoxicological Insights for Sustainable Agriculture on the Moon and Mars;

3.10–T01 Environmental Risk Assessment for Low-Concern Active Substances

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Potential Low-Concern Active Substances (LCAS) comprise a heterogeneous group of substances with different modes-of-action. These substances are still only slowly obtaining approval on the market. While the term “low-risk” is only applied to substances after risk assessment has been completed, it is more appropriate to determine the potential of low risk of natural or nature-like substances with other modes-of-action at an earlier stage in order to make this risk assessment more fit-for-purpose. Such an approach, based on a Problem Formulation Approach scheme, was developed within the EFSA project GP/EFSA/PLANTS/2023/04 Fit-for-purpose and innovative risk assessment for LCAS and uses. The substances included in this project comprise botanicals (plant extracts); microbial metabolites; natural organic substances including e.g. salt/minerals; semio-chemicals (i.e. substances that are excreted by an organism and influence the behavior of the same or other organisms); peptides; and dsRNA. The Problem Formulation Approach as developed within this project uses Pathways to Breach the Protection Goal (PBPGs) for each combination of hazard and protection goal. The project delivers general PBPGs and guidelines how to apply these pathways. The different steps in the pathway are linked to steps in the analysis plans. These steps are intended to collect information. The Problem Formulation Approach facilitates the integration of all information (hazard, e-fate and effects) and is fit for purpose for both a qualitative and quantitative evaluation of LCAS with other hazards beyond just toxicity. The approach is flexible and transparent to facilitate communication, it integrates the most recent scientific progress in the analyses plans and it follows a harmonized scheme for all hazards and protection goals. The developed approach is explicitly not intended to serve as an end in itself, nor to increase the requirements or workload involved in the assessment. The approach was discussed with stakeholders and member states in a workshop in January 2025 in Thessaloniki, Greece and the consortium received positive feedback. Currently the consortium is working on the final report. This research is performed for EFSA Food Safety Authority under contract GP/EFSA/PLANTS/2023/04.

3.10–T02 Assessing Pesticide Residues in Agricultural Soils: Implications for Soil Health and Sustainability

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Soil residue analysis is crucial for detecting pesticide contamination, preserving soil health, ensuring food safety, and promoting sustainable agricultural practices. Pesticide residues in soil contribute to environmental contamination, affecting crop quality, disrupting essential soil microorganisms, weakening nutrient cycling, and plant growth. Regular soil monitoring ensures pesticide residues remain within safe limits, preventing long-term contamination. Seventy topsoil samples from Ghana's Vea and Weija irrigation schemes, collected in rainy (35) and dry (35) seasons, were analyzed for pesticide residues. In addition, farmers were interviewed on their knowledge of handling these insecticides. The pesticide residues in the soil samples were extracted using accelerated solvent extraction (ASE) and analyzed using a gas chromatograph triple quad mass spectrometer (GC-MS/MS) for quantification. Questionnaires were used to collect data, and precautions taken when applying these pesticides. Out of 20 insecticide residues analysed, 6 were detected in the dry season, and 10 in the rainy season. Chlorpyrifos (organophosphate) and cypermethrin (synthetic pyrethroid) were the most detected pesticides. Chlorpyrifos at Vea showed the highest concentrations, 315 ng/g in the rainy season, and 583 ng/g in the dry season. Statistical analysis revealed significantly higher chlorpyrifos residues at Vea ($p = 0.030$) compared to Weija, and a seasonal variation in insecticide concentrations ($p = 0.001$) in the two schemes. Although farmers from both schemes knew the advantages of using

personal protective equipment (PPE), only 27% of Weija and 25% of Vea irrigation scheme farmers used PPE during pesticide application due to cost and non-availability of the materials. This study provides baseline data to help farmers refine pesticide use, prevent over-application, while ensuring effective pest control for sustainable agriculture. Governments should provide regular training to increase farmers' awareness of exposure risks while ensuring PPE is both accessible and affordable, to encourage its use.

3.10–T03 Geotaxis as an endpoint in behavioural ecotoxicology: current testing limitations and perspectives

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Behavioural responses are recognized as sensitive indicators of chemical toxicity in ecotoxicology. This study introduces novel, gravity-oriented behavioural assays to assess the effects of imidacloprid on the geotactic behaviour of mosquito larvae (Culex sp.) and Argentine ants (Linepithema humile). In mosquito larvae, exposure to imidacloprid (0, 1, 2 mg/L) caused a significant shift from negative to positive geotaxis 5 min into the exposure, indicating impaired breathing behaviour. In Argentine ants, while avoidance of contaminated soil was evident on flat surfaces, geotactic responses on a 45° incline revealed that ants consistently moved downhill, even when the contaminant was positioned downslope, suggesting an override of the ants' avoidance behaviour by innate positive gravitaxis. These findings highlight a critical limitation of conventional flat-surface assays and demonstrate the ecological relevance of incorporating gravitational orientation into toxicity testing. This framework may enhance our understanding of contaminant avoidance in heterogeneous surfaces which are more reflective of natural environments.

3.10–T04 Temperature-Dependent Efficacy and Ecotoxicity of Tween 80 for Remediation of Petroleum-Contaminated Podzolic Soils

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Petroleum hydrocarbon contamination is a persistent environmental issue in cold-climate oil-producing regions such as the Khanty-Mansi Autonomous Okrug–Yugra (Western Siberia). Podzolic soils prevalent in this region are acidic, low in organic matter, and poorly buffered, making them particularly vulnerable to degradation from diesel spills. This study evaluated the remediation potential and environmental safety of Tween 80, a non-ionic surfactant, in diesel-contaminated podzolic soils under simulated cold-climate conditions. Soil samples were artificially contaminated with diesel fuel (50 mg/kg) and treated with Tween 80 at two concentrations (1.5×10^{-4} and 3.0×10^{-4} mol/dm³). The samples were incubated for 90 days under ambient (22–24°C) and refrigerated (2–3°C) conditions. Total petroleum hydrocarbon (TPH) concentrations and soil pH were monitored throughout. Environmental safety was assessed using bioluminescent Ecolum bacteria and the freshwater crustacean Ceriodaphnia affinis. TPH reductions of up to 20.8% at room temperature and 17.0% under cold conditions were observed, with the lower surfactant concentration proving more effective. Soil pH increased from ~5.3 to near-neutral values (~6.7), especially in refrigerated samples, suggesting improved buffering capacity. These effects indicate enhanced contaminant mobility and improved conditions for microbial recovery. Ecotoxicological assays revealed no significant toxicity at Tween 80 concentrations ≤0.5 mg/dm³. Adverse effects were detected from 2.0 mg/dm³ and above, with 100% mortality in C. affinis at 20 mg/dm³. Since field-application concentrations remained below 0.3 mg/dm³, Tween 80 can be considered environmentally safe under the tested conditions. The study demonstrates that Tween 80 effectively mobilizes diesel hydrocarbons and improves soil pH in cold, acidic environments without causing acute toxicity at relevant concentrations. These findings support the use of Tween 80 in surfactant-assisted remediation strategies for petroleum-contaminated soils in boreal and subarctic regions. Future research should focus on scaling the approach to field conditions and exploring synergies with biostimulation or temperature-enhancing techniques to improve treatment efficiency in low-activity soils.

3.10.P - Soil Ecotoxicology – Impact, Ecotoxicity Tests, Monitoring and Risk Assessment

3.10.P–TuWe81 Sulfamethoxazole-Trimethoprim: impact on plant microbiome and resistomes

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Sulfamethoxazole-Trimethoprim (SMX-TMP) is a widely used antibiotic combination in medicine and it has been detected in agricultural environment due to wastewater irrigation and manure. These residues persists in soil and interact with plant root

zones, potentially altering microbial community structure and promoting the spread of antibiotic resistance genes, posing risk to plant and soil health. These antibiotics can disrupt the delicate balance of the plant microbiome, which is essential for nutrient cycling, plant growth and disease resistance. Their presence can exert selective pressure, leading to an increasing in antibiotic resistance gene. This not only threatens plant health and agricultural productivity but also poses risk to human health through potential transfer of antibiotic resistant genes via the food chain. This study will help to explore the ecological consequences of antibiotic contamination in soil, focusing on plant microbiome health and the spread of resistance genes. The findings will guide the sustainable agricultural practices and contribute to the global fight against antimicrobial resistance. The aim was to understand the uptake of SMX-TMP antibiotics by plants and their effect on plant microbiomes and antibiotic resistance genes. In this experiment, a variety of techniques were utilized. The DNA of rhizosphere and bulk soil was extracted using DNeasy® PowerSoil Pro Kit and plant samples was extracted using QIAGEN DNeasy® Plant Pro kit. The quantity of the extracted DNA was measured using a nanodrop spectrophotometer ranging from 24ng/µl to 293.8ng/µl. The 16S ribosomal RNA gene, a universal bacterial gene marker, was amplified using the polymerase chain reaction with, 1492R, and 27F as primers. Real-time qPCR was performed to determine the prevalence of SMX-TMP Resistance genes of the microbial communities in the rhizosphere and endosphere of different treatment lettuce plants. Amplicons were purified using AMPure® XP (Beckman Coulter) and quantified by a NanoDrop® 1000. The prepared DNA library was loaded onto the R9.4 flow cell (FLO-MIN106; Oxford Nanopore Technologies) and sequenced on the MinION™ Mk1B. MINKNOW software ver. 1.11.5 (Oxford Nanopore Technologies) and was used for data acquisition. Guppy was used for basecalling the MinION™ sequencing data (FAST5 files) to generate pass reads (FASTQ format) with a mean quality score > 7. The FASTq files were analyzed using a custom script. Taxa were determined based on the silva 168 database. The downstream analysis was carried out using phyloseq and vegan packages in R. Amplification efficiencies of standard curves ranged between 95% and 103%. The coefficient of determination (R2) standard curves exceeded 0.98, with a slope range of between -3.46 and -3.24 for all real-time PCR reactions. The experiment revealed significant variations in bacterial composition across plant compartments and treatments at the phylum and genus levels, with the application of antibiotics playing as the main distinct in clustering of bacterial communities in the endosphere and bulk soil. The phyla Proteobacteria dominated the bacterial community in all compartments. Phylum Bacteroidota showed high abundance in Sulfamethoxazole treatment on the endosphere compartment while Acidobacteriota was more prevalent in bulk soil, and Trimethoprim treatment.

3.10.P–TuWe82 Effects of Different Climatic Conditions on the Ecotoxicity of Soils from Waste Disposal Sites

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This research examines the ecotoxicological effects of soils derived from both legal and illegal waste disposal sites, under different climatic conditions, utilizing Eisenia andrei earthworms as bioindicators. The study evaluates the physicochemical properties of the soil, the bioavailability of pollutants, and the combined influences of temperature and soil moisture on ecotoxicological outcomes. Soil samples were tested for heavy metal levels, and standardized OECD and ISO bioassays were performed to assess sub-lethal impacts on earthworm survival, growth, reproduction (28-day growth test and 28-day OECD reproduction test), and avoidance behaviour (2-day ISO test). The experiments explored various combinations of air temperatures (20°C, 22°C, 25°C) and soil moisture levels (30%, 50%, 60% of water-holding capacity) to replicate climatic fluctuations. The results reveal that soils from legal disposal locations demonstrated greater bioavailability of heavy metals in comparison to those from illegal sites, which corresponded with notable declines in earthworm growth (assessed through weight variation) and reproductive outcomes (including cocoon production and juvenile hatching). Increased temperatures (25°C) and lower moisture levels (30%) intensified metal toxicity, leading to decreased earthworm survival and heightened avoidance responses. In contrast, elevated moisture conditions (50–60%) alleviated certain negative impacts, indicating that climatic factors play a crucial role in influencing pollutant bioavailability. This research emphasizes the environmental hazards associated with poorly managed waste disposal sites and stresses the necessity of incorporating climatic variables into ecotoxicological evaluations. The findings highlight the urgent requirement for adaptive waste management strategies to respond to climate-induced changes in contaminant behaviour. Employing standardized bioassays and E. andrei as a responsive bioindicator offers substantial support for regulatory measures designed to alleviate the effects of soil contamination.

3.10.P–TuWe79 Temperature and Moisture Modulate Aflatoxin's Ecotoxicological Impact on Soil Health: Insights from Earthworm Studies

Mark Maboeta[1] and Tanya Fouché[2] (1)North-West University, (2)University of South Africa

Aflatoxins are well-known fungal toxins produced by specific soil fungi (Aspergillus sp.). Due to its toxic and carcinogenic nature, extensive research has been done on the impact of post-harvest aflatoxin contamination, with less attention given to pre-harvest stages. Aflatoxin contamination in the production and food industry remains a challenge, with recent studies suggesting that aflatoxin contamination might become a bigger problem in the future. Given the short half-life of aflatoxins in soil, regulations recommend disposing of contaminated crops and food products into the soil for natural degradation. However, the fate and consequences of aflatoxin in soil and their effects on soil organisms providing essential ecological services remain unclear, potentially posing risks to soil health and productivity. Protecting soil biodiversity and ecosystem services is essential for the success of the United Nations Decade on Ecosystem Restoration. This study investigated the toxicological consequences of aflatoxin contamination to soil organisms that contribute to important ecosystem services, under varying temperatures and soil moisture conditions. Laboratory toxicity tests were conducted at different combinations of air temperature (21 and 26 °C) and soil moisture (30 and 50% water-holding capacity). A standardised soil medium was used in which adult earthworms (Eisenia andrei) were exposed to two environmentally relevant soil concentrations of aflatoxin (10 µg/kg and 100 µg/kg). Established biomarkers included growth, reproductive success and genotoxicity. Results indicated an insignificant effect on the survival, growth and reproduction at aflatoxin concentrations between 10 and 100 µg/kg but showed a concentration-dependent increase in DNA damage at standard testing conditions. However, the interaction of aflatoxin with different environmental conditions altered the exposure effect outcomes in soil. Drought conditions (30% WHC) resulted in significantly reduced reproduction rates and increased DNA damage in earthworms. This study highlights the potential risk of environmentally relevant aflatoxin levels to the functional ability of important soil organisms. It underscores the influence of temperature and moisture on the exposure effect outcomes of aflatoxin in soil, emphasising the need to review standard toxicity protocols for laboratory studies to include broader environmental conditions during ecotoxicology studies.

3.10.P–TuWe80 Ecotoxicological Insights for Sustainable Agriculture on the Moon and Mars

Mark Maboeta[1], Hindrik Bouwman[1] and Vickey-Luanne Harris[1] (1)North-West University

Humanity has had its sights set on establishing sustainable life on the Moon and on Mars for many years. However, sustainable extraterrestrial agriculture presents a unique set of challenges. To overcome these closed-loop ecosystems have been tested and used to produce food in space. However, these systems typically depend on significant terrestrial input, making long-term missions costly and resource-intensive. As a result, there is growing interest in utilising in situ resources, specifically the native regolith. Due to the absence of organic matter, however, Lunar and Martian regolith are not suitable for supporting life. Therefore, this study aims to use well-established ecotoxicological models to understand the toxic challenges of using in situ regolith and finding pathways to transform the regolith into sustainable life-supporting substrates using minimal terrestrial input. All organisms were exposed to Lunar Highlands (LHS-1) and Martian Global (MGS-1) regolith simulants at varying concentrations, alongside a terrestrial soil control, to simulate different levels of terrestrial input. A series of bioassays were performed to assess the acute toxicity of the regolith simulants. With regolith used as a sedimentary substrate, Daphnia magna, Heterocypris incongruens and Pseudokirchneriella subcapitata were used to assess mortality and growth inhibition. With regolith as soil, a Phytotox assay was conducted using Sinapis alba, Lepidium sativum, and Sorghum saccharatum to evaluate germination success and root development. Finally, Eisenia andrei were used to assess reproduction, growth, mortality and avoidance. Preliminary results indicate that MGS-1 is highly toxic at 80% concentration and higher, while LHS-1 is comparatively lower, such as in the case of root development. However, notable toxic effects are evident in other assays such as Eisenia andrei growth, reproduction, mortality and avoidance. While different organisms have demonstrated varying sensitivities to the substrates, based on current findings, it is hypothesised that the safe upper limit for using LHS-1 will be considerably higher than that for MGS-1, however, neither will be able to be used without terrestrial input. Further investigation is ongoing to refine these thresholds. Determining these thresholds gives practical insight into how regolith can be transformed into a life-supporting substrate that can be used for sustained life in space.

4.01 - Navigating the Science-Policy-Society Interface for Evidence-Informed Environmental Management

4.01–T01 Science-Informed (Regulatory) Decision Making: Translating Science

Sabine Apitz[1] (1)SEA Environmental Decisions Ltd

Managing or preventing the environmental, economic and social impacts of stressors on ecosystems is the focus of environmental regulatory decision-making. Seeking to achieve this raises a number of questions: What attributes or conditions does a decision aim to sustain or restore? Who benefits from such actions? For what period will such actions convey benefits? At what cost (to whom?) and Who provides answers to these questions? [1] These are normative questions, rooted in societal values. To address them requires engagement with stakeholders of all types, including underrepresented sectors of the community that may not have a strong voice. Consensus-based environmental decision making (CBED), which promotes the empowerment of stakeholders to guide the decision process [2], calls for frameworks and indicators to evaluate the range of potential effects to the environment associated with decision making. To achieve this, environmental scientists must ensure that the science they generate is relevant to and translated in terms of societal values and objectives, to facilitate its incorporation into local, national, and international decision-making processes. When such decisions are framed within a regulatory program, then those societal objectives are framed within regulatory objectives, standards and criteria. While fundamental environmental research can be purely objective, its application in policy and decision making is a normative process combining science, trans-science and policy [3]; the distinctions between these are not always made clear. Although science should be kept objective, translating scientific outcomes in terms of societal decision criteria can support decision making. This paper presents a conceptual review of case studies to discuss the need for and approaches to linking sound scientific measures to stakeholder (including regulator) decision criteria in order to support broad, science-informed decision making. This paper will describe and illustrate how such frameworks can be built and used to support trade-off evaluation, policy development and decision-making. A number of examples will be used to illustrate how scientifically defined metrics can be linked to regulatory objectives.

4.01–T02 Toward Product Safety and Circularity: Understanding the Information Structure of Global Databases on Chemicals in Products and Articles

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Access to information about chemicals in products and articles is critical for supporting enforcement of chemical regulations, assessing human and environmental risks from chemicals, allowing informed consumer choices, and enabling product circularity. In this work, we identified and evaluated available databases (DBs) on chemicals in products and articles from the literature using a defined protocol and from European national market surveillance authorities, nongovernmental agencies, and industrial sector groups using questionnaires. This is the first comprehensive review of DBs that provide information about chemicals in products and articles. A majority of these DBs are heterogeneous in terms of scope, ontologies, and data structures. Among the 57 identified DBs, 49 identified specific substances and only 30 reported their concentration in their products. In addition, 35 DBs included hazard information and 27 DBs provided safety information about products or chemicals. The analysis highlights the lack of comprehensive or accessible data on chemicals in products and articles for most categories of products/articles and jurisdictions. The limitations of existing DBs were attributed to scattered regulatory information requirements, a lack of data for unregulated substances, the complexity of supply chain communication, and confidentiality issues. In response to these challenges, we identified opportunities for improving existing information transfer structures and exploring alternative data sources to promote product and article safety and circularity.

4.01–T03 Science-Policy-Society Engagement in Drinking Water Quality Assessment and Co-Creation of Water Security Solutions and Climate Change Adaptation in an Urban Slum in Lagos, Nigeria

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Water insecurity which includes challenges with potable water access and quality has been exacerbated by climate change among other stressors. Rural and coastal communities, often with limited access to urban infrastructures for improved water

access and quality, are some of the most impacted. This study aimed to use participatory action research and citizen science approaches to investigate climate change-related water vulnerabilities, and co-create context-specific solutions and adaptation plans in an urban slum community in Lagos, Nigeria. The study area was divided into 11 map plot areas where community mapping of drinking water infrastructure, and water security challenges as well as solutions were co-created through Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) with pre-mapped community stakeholders. Scientific (geophysical, microbiological, geochemical and parasitological) evaluations of the prevailing drinking water sources in the community were conducted following referenced methods. Further, 20 community assistants randomly selected across community were recruited and trained as Citizen Scientists to test the prevailing community drinking water sources using rapid drinking water test kits. The results showed that ~50% of the community mapped drinking water infrastructure were variously contaminated while other were not based on the FGDs and KIIs. The Eastern part of the study area (close to the Lagos Lagoon) have poor groundwater potential (GWP) (depth to aquifer >70 m). Some boreholes had high pathogenic bacterial counts, indicating potential health risks. The citizen science-led rapid drinking water tests should significantly high levels of Cu, Fl, Fe, Pb, Zn, Total hardness across some borehole water compared to WHO standards. Elevated levels (> WHO and NSDWQ standards) of Pb and As observed in some borehole water samples. The study results highlight the importance of integrating science, policy and society stakeholders in environmental risk evaluations for evidence-informed policy- or decision-making as well as co-creation and uptake of solutions. The study showed that the citizen science water tests aligned with two (2) of the laboratory-tested water parameters as well as the observations of the community members.

4.01–T04 From Air Quality Data to Actions for Clean Air - Method for Engaging School Children to Lower Hindrances for Air Pollution Mitigation

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Perceptions of and attitudes towards air pollution are critical components for implementation of action for clean air. Implementation of abatement strategies can be hindered by lack of voice among residents to approach their leader and demand action. Here, low levels of education and public awareness towards air pollution processes and air quality health effects in African countries can be a major hindrance for implementation of abatement strategies. To lower the hinderance for implementation air pollution measures, researchers from global south and global north have co- developed a method for dialog and knowledge exchange to transform air pollution data to information that can advance knowledge-based achievement of the SDGs. The method described builds on experiences from previous and ongoing projects in Kenya, South Africa and Sweden. Specifically aiming at utilizing information about levels and sources of air pollution and their relative importance as well as health effects of air pollution exposure to create awareness among residents and their children on the effects of air pollution. The school projects focus on children within the age 13-15 years. The method is generalized to be able to be used in different settings and can be linked to specific countries addressing their main issues of concern and takes benefit of local platforms for outreach. In April 2025 initial school projects were done in Sweden and in South Africa. In Sweden we applied the first version of our method on two school classes with 20-25 children in each. In South Africa the method was extended and utilizes in two school reaching over 1000 pupils. Based on the outcome of these activities recommendations for the next stage is to be developed and a refined version of the school program will be implemented in Kenya later this year. Generally, the approach was highly appreciated by the teachers and the children. Although the countries are very different, the challenges are similar. The key to success is to link the activity to fit the local requirements and make it relevant to the teacher by a concise link to their practical work and the curriculum. Collaborating across the Global South and Global North has enriched our work by bringing together diverse perspectives and experiences. This exchange has significantly strengthened the development of school program as a tool to achieve awareness beyond standardized curriculums and allowing us to learn from the various settings to create a more impactful approaches as a step towards efficient data driven actions for clean air.

4.01–T05 Development of Evidence-Informed Pan-Sectoral Air Quality Management Recommendations for Lagos, Nigeria

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Air quality is an important environmental index as it is capable of adversely impacting human health quite rapidly making its management rather cumbersome if compromised. Metropolitan cities across the world are often harbingers of poor air quality due to various carbon emitting sources among others thereby predisposing people to potential ill health. This study aimed to

develop evidence-informed air quality management recommendations for Lagos state, Nigeria through evidence synthesis and pan-sectoral stakeholders' consultation within the CLEAN Air project. We applied a rigorous systematic process to curate the evidence base with the evidence synthesis addressing questions focused on sources and emissions, air quality monitoring and modeling, environmental, health and climate impacts, policy and regulatory frameworks, public awareness and perception, technological and infrastructure solutions as well as economic and social costs. Targeted and tested keywords as well as search strings specific for Lagos were developed and searched in academic (PubMed, Scopus, ScienceDirect, PubMed, Google Scholar, and African Journals Online) and grey literature sources (government and environmental organizations, including WHO, UNEP, and local agencies like the Lagos State Environmental Protection Agency (LASEPA)). A total of 18305 records were retrieved from the databases with 108 studies included in the synthesis following removals based on the exclusion criteria at screening and eligibility stages. Thereafter, each full text was screened to retrieve air quality management recommendations bringing the total number of studies to 48. Following this, a pan-sectoral wide stakeholders' consultation was held for review and validation of the synthesized recommendations as well as categorization based on Political, Environmental, Social, Technological, Legal or Legislative and Economic (PESTLE) framework for policy recommendations. Our findings show that co-creation of air quality management recommendations should not be based on scientific research alone. There is need for consultation and inputs from various target pan-sectoral stakeholders and validation in order to achieve uptake.

4.01.P - Navigating the Science-Policy-Society Interface for Evidence-Informed Environmental Management

4.01.P–TuWe83 Are Equity and Fairness Quantifiable? Adapting Criteria Scoring to Support Decision-Making

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Ethical and equity considerations in decision-making encompass a broad range of issues, including social justice, equality, the polluter pays principle, distributional issues, demographic, temporal and spatial equity and business and other ethical concerns; many of these have proved difficult to quantify. All active management, including that for product development, results in (desirable and undesirable) environmental, economic and social impacts. Balancing trade-offs through sustainability, lifecycle assessment (or other) assessment poses normative questions–not just objective and science-based, but those rooted in societal values, requiring engagement and a careful consideration of diverse stakeholders' priorities. Risks, benefits and costs of land- and water-scape management, remediation and restoration alternatives are not borne equally in terms of time, space or demographics; nor are the values and priorities of different stakeholders the same. Embedding equity considerations within assessment and decision frameworks in a quantitative and transparent manner remains challenging. Though the focus of these will be the evaluation of alternative sustainability, the objective is to trigger discussion on how these approaches might be used in social LCA. A range of issues, such as transparency, community engagement and communication of uncertainty, address the fairness of the overall decision process, rather than the relative fairness of individual alternatives. These can be evaluated and enhanced in a number of ways. On the other hand, the relative importance of various impacts to different individuals or stakeholder groups can, to some extent, be addressed with stakeholder outreach, and weighting based upon preferences. However, every impact may differ in time (e.g., duration of impacts, or delay in benefits), space (e.g., greater impacts on some neighbourhoods or regions); or demographics (e.g., unequal access or profit from benefits; impacts of gentrification or development). Such distributional effects can be addressed in a narrative manner; highlighting best management practices to address them, or they may be addressed using weighting schemes, similar to "exposure" filters, in scoring systems. A series of thought experiments and case studies (using real and hypothetical data) will explore these differing approaches, and examine their strengths, weaknesses, data needs, and feasibility.

4.01.P–TuWe84 Working the Interface of Science and Regulatory Policy: The Critical Importance of Research Centers to Regulatory Science

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Regulatory science is a field critical to the responsible advancement of agricultural-use technologies including pesticides from concept, through research and development, to commercialization, and throughout a technology's life. Currently there is a lack of university programs in regulatory science specifically related to agriculture. Such programs are needed to 1) provide undergraduate, graduate and continuing education opportunities in regulatory science to develop the next generation of scientists, 2) provide a forum for the advancement of regulatory science in agriculture through engagement of regulators,

regulated entities and external stakeholders and 3) conduct research in regulatory science to establish sound policy decisions and communicating the risks and benefits of new technologies. The Center of Excellence for Regulatory Science in Agriculture (CERSA) was created with these needs in mind within North Carolina State University's (NC State) College of Agriculture and Life Sciences in 2018, establishing a cooperative partnership with Louisiana State University in 2019. The overarching purpose of this center is to be a national and international resource furthering excellence in regulatory science disciplines in agriculture. CERSA collaborates domestically and internationally with state and federal agencies, private industry, commodity groups, growers and producers, non-governmental organizations (NGOs) and academics to advance regulatory science through education, research and engagement. CERSA has developed workshops of thought leaders on various emerging issues associated with advancing scientific knowledge, federal and state regulatory transparency, and gaining public acceptance and understanding of policy decisions. Students participating in internships and other educational programs through the Center benefit from opportunities to participate in research projects at the forefront of regulatory science, making graduates attractive candidates for both regulatory agencies and companies.

5.01.B - Innovative Approaches for Sustainable Management, Remediation and Restoration of Environmental Matrices

5.01.A–T02 Bacterial Community Response to Different Nutrient Supplements During Bioremediation of Total Petroleum Hydrocarbon

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Despite the breadth of existing studies, a critical knowledge gap remains regarding how bacterial communities respond to different nutrient amendments over time in the same soil environment during bioremediation. The specific effects of fertilizers and various nutrient inputs on soil microbial diversity are still poorly understood. Given that biodiversity is a major driver of ecosystem function and a central concept in community ecology, understanding how nutrient regimes influence soil microbial diversity is crucial for both theoretical and practical applications . To address this gap, the current study investigates the dynamics of soil bacterial diversity in response to various nutrient supplements during petroleum hydrocarbon bioremediation. It specifically examines taxonomic dominance at different contamination levels, tracks changes in bacterial diversity across monitoring intervals, and compares outcomes with unamended control conditions. The study investigated the effectiveness of different nutrient amendments on bioremediation of petroleum hydrocarbon-contaminated soil from an aged oil spill site in Nigeria. The nutrient amendments used included osmocote slow-release fertilizer, inorganic fertilizer NPK, organic manure (cow dung), and natural-based slow-release fertilizers (casmes and cocodust). The soil was distributed into six microcosms, each representing a distinct treatment regimen, and maintained in a greenhouse for 5 weeks. Bioremediation progression was monitored through physicochemical, microbiological, and molecular analyses. Residual TPH was quantified using GC-FID analysis, and hydrocarbon-degrading bacteria were isolated and identified through 16S rRNA gene sequencing periodically. Statistical analysis was performed using first-order kinetic model, agglomerative cluster analysis, ANOVA, and heatmap analysis to evaluate treatment effectiveness. The bioremediation of crude oil-contaminated soil is a complex process that relies heavily on the interactions between microorganisms, nutrients, and contaminants. This study aimed to elucidate the impact of different nutrient supplements on bacterial community dynamics and total petroleum hydrocarbon (TPH) attenuation during a 35-day bioremediation process. Our results revealed significant shifts in microbial diversity, population, and hydrocarbon degradation rates across different treatment options. The bioremediation treatments revealed a notable variation in the rate of biodegradation and percentage degradation of TPHs among the different nutrient amendments. While all nutrients supported petroleum hydrocarbon degradation, CM+CD exhibited the highest level of degradation, closely followed by NPK. The order of percentage degradation, from lowest to highest, was: control < Casmes < Osmocote < Cocodust < NPK < CM+CD. Notably, CM+CD achieved the highest degradation percentage at the sixth week. The presence of cow dung in CM+CD microcosm likely contributed to the enhanced biodegradation efficiency due to its richness in micro and macro nutrients, bulking properties, and ability to increase soil porosity . Organic-based fertilizers are known to provide a sustainable and environmentally friendly approach to bioremediation, with slow-release properties and high nutrient-use efficiency . In contrast, NPK fertilizers have been widely studied for their role in biostimulation, with research showing improved nutrient availability and microbial activity that accelerates petroleum hydrocarbon degradation. However, prolonged use of mineral fertilizers alters soil physicochemical properties, affecting the soil microbiome's composition and function. This study observed that while the NPK-treated pots initially showed the highest biostimulation efficiency and biodegradation rates, microbial activity and TPH degradation declined thereafter due to diminishing nutrient availability. Slow-release fertilizers significantly enhanced microbial metabolic activity, achieving over 70% degradation of petroleum hydrocarbons (Ehis-Eriakha et al., 2025). These fertilizers provide sustained nutrient delivery while minimizing environmental impact . Field-scale

applications further validate their effectiveness (Ehis-Eriakha et al., 2025; Wang et al., 2019). Statistical analysis confirmed the critical role of nutrient supplementation in facilitating microbial-mediated PH degradation. The first-order kinetic model showed that CM+CD had the highest degradation rate and lowest half-life time, indicating that this treatment is the most effective in degrading TPH This study revealed a notable shift in bacterial community structure across all pots, irrespective of amendment. Taxonomical analysis showed that bacterial communities responded differently to various treatments over time, with significant variations in composition across pots and sampling days. These findings underscore the dynamic nature of bacterial responses to nutrient amendments and bioattenuation processes. The percentage distribution of bacterial communities and diversity, degradation percentage, and degradation rate across microcosms during bioremediation at different sampling days further demonstrated bacterial responses to different amendments and bioattenuation. The bacterial community response was evident at the class, phylum, and genera levels. Phylogenetic analysis of 16S rRNA sequences revealed that bacterial communities from all microcosms belonged to two phyla (Proteobacteria and Firmicutes), three classes (Bacilli, Gammaproteobacteria, and Betaproteobacteria), and eleven genera (Bacillus, Staphylococcus, Klebsiella, Burkholderia, Acinetobacter, Enterobacter, Cupriavidus, Stenotrophomonas, Achromobacter, Comamonas, and Pseudomonas). Notably, Proteobacteria and Gammaproteobacteria were the dominant phylum and class, respectively, consistent with previous findings. Bacterial diversity analysis showed that CM+CD, NPK, OSM, and CTRL had higher diversity than CM and CCD, although with varying percentage occurrences per sampling day for each genus. This result highlights the impact of nutrient amendment on bacterial communities and bioattenuation. Nutrient amendment is a powerful tool in bioremediation, as it stimulates and regulates microbial communities to carry out their metabolic activities. While microbial diversity is not directly proportional to degradation rate, a more diverse microbial community is likely to break down hydrocarbon pollutants faster due to the genetic diversity across the microbial group targeting different hydrocarbon components. This study underscores the crucial role of nutrient amendments in enhancing bioremediation of crude oil-contaminated soil. The findings reveal that bacterial communities respond dynamically to different nutrient amendments, with significant variations in diversity, population, and hydrocarbon degradation rates. Notably, the CM+CD treatment achieved the highest degradation efficiency, highlighting its potential as an effective bioremediation strategy. The bacterial community response to different nutrient amendments was characterized by the dominance of Proteobacteria and Gammaproteobacteria, with key genera such as Pseudomonas, Bacillus, and Stenotrophomonas playing important roles in TPH degradation. Overall, this study demonstrates that careful selection and application of nutrient amendments can optimize microbial community function and contaminant degradation, contributing to the development of effective bioremediation strategies for crude oil-contaminated soil

5.01.B–T01 Biodegradation Studies from Lab to Field: Reality Bites

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Biodegradation is an essential component of both natural attenuation and managed remediation of contamination in the environment, ideally reducing risks in soils, water and sediment. However, field-contaminated systems are complex, mostly with a mix of contaminants, weathered and aged on matrices made up of varied mineral and organic surfaces. Thus, teasing out order from this complexity is challenging. On the other hand, laboratory studies are by necessity simiplified, often using micobial isolates, single or a few contaminants, and controlled systems. While these simplified systems may provide insights into what biodegradation is possible, they may or may not reflect what will actually happen in real systems. The focus of this paper is to use the results of a series of experiments to illustrate the challenges and complexity posed by both top-down and bottom-up studies on PAH biodegradation in marine sediments, and, more broadly, in complex field systems. Rather than discussing each experiment in detail, this high-level review seeks to look at patterns and differences in PAH degradation results, as a result of experimental design, to illustrate the beautiful complexity that can be hidden in biodegradation experiments. PAH degradation rates in San Diego Bay sediments are high in test systems, but PAHs are still buried in sediments. As a side observation, long-term collection and study suggest that PAH degradation rates (aerobic and anaerobic) have dropped as dissolved inputs into the bay have been reduced. Still, it has also been argued that the high concentration of PAH degraders in contaminated surface sediments at some sites provide a “biofilter” helping to clean surface waters, a capacity which may drop as pollution levels are controlled. The degradative capacity of sediment microbial communities is an important component of the resilience not just of the benthos but also to the resilience of water bodies. These are ciritical ecosystem services that must be considered and balanced along with others for overall management of land and aquatic systems. PAHs are relatively simple and well-studied compounds, but it is still difficult to predict how they will degrade in real systems. Finding the right balance between control and realism in experimental studies is challenging, and thus studies should be carefully designed, and interpreted with caution. What a microbial community “can” do in the lab, and what it “will” do in the field are not always the same.

5.01.B–T03 Grafting and Application of Maize Tassel Derived Adsorbent for the Removal of short chain chlorinated paraffin and polychlorinated naphthalene from Aqueous Solution

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Persistent organic pollutants (POPs) are a group of toxic chemicals that adversely affect human health and the environment. Most POPs are halogenated and due to the strong carbon-halogen bond, they are resistant to degradation and can bioaccumulate in the environment. Therefore, their removal from the environment is very important. Among the various sources of removal of POPs, the conventional wastewater treatments have been shown to be effective to some extent but lacks the capacity to remove these completely. As regulatory limits for POPs are becoming increasingly stringent, innovative, sustainable and cost-effective water treatment technologies are urgently needed for efficient POPs removal. Technologies such as photodegradation, electrochemical approaches, and reverse osmosis have been shown to remove POPs from aqueous solutions. However, these technologies still present significant limitations such as extended treatment times, generation of secondary pollutant, high energy costs and generation of large volumes of waste that require further treatment. Because of the limitations of the aforementioned technologies, adsorption using bio-adsorbents are gaining attention due to their cost-effectiveness and efficiency. Maize tassel, an agricultural waste, has shown its potential to remove POPs such as PFAS when physically and chemically activated. However, maize tassel treated with nanoparticles such as ZnO and Ag for the removal of emerging POPs such as short chain chlorinated paraffins (SCCPs) and polychlorinated naphthalene (PCN) are yet to be explored. This knowledge gap needs to be attended to in order to give a holistic potential of maize tassel to remove a wide range of POP chemicals in aqueous medium.

5.01.B–T04 Mycofilters and the Effectiveness of Mycofiltration in the Removal of Contaminants in Water - A Systematic Review

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Mycofiltration is a low-cost environmentally friendly remediation tool which employs the use of saprophytic fungi immobilised on dead organic matter, to treat contaminated water. The purpose of this review was to collate literature on mycofiltration, identifying the water sources subjected to mycofiltration, types of fungi employed, the design and set-up of mycofilters, contaminants removed, and contaminant removal efficiencies (R%). Articles, reports and theses written in English between 1990 and 2023 were collected from academic databases, websites, and social and research networking sources. Article screening based on the inclusion criteria was conducted. Studies meeting the inclusion criteria were critically appraised. Metadata was extracted, and a narrative synthesis was done. Twenty-nine articles representing 136 studies (n) passed appraisal. These studies were published between 2010 and 2023, with n = 98 from journal articles, n = 22 from theses and n = 16 from reports. All studies were laboratory-based. A range of water sources were mycofiltered. Synthetic stormwater and real wastewater were the most frequently mycofiltered. Fungi of the Pleurotus genus were predominantly used in creating mycofilters. Regarding mycofilter design, perforated bowls, columns, sacks, jars and specialised bioreactors were used. The majority of the studies (n = 91) employed the continuous flow set-up for the mycofiltration procedure. A range of organic, inorganic and microbial contaminants were removed by mycofiltration. Organic and microbial contaminants were the most studied (n = 40 and n = 47 respectively). Organic contaminants included pharmaceuticals, pesticides, dyes and humic acids with removal efficiencies ranging between 60-100%. Regarding microbial contaminants, E. coli was the most studied contaminant, and removal efficiencies of 30%, 60% and 90% were reported. Inorganic contaminants removed were mostly metals with removal efficiencies above 60%. Overall, the review found that contaminant removal by mycofiltration varied, but the technology remained a promising cost effective and eco-friendly tool. The review observed research gaps including a lack of standardised methods for mycofilter preparation and design, and little to no assessment of mycofilter saturation. Addressing these gaps could aid in increasing mycofilter efficiency, and reliable upscaling of mycofiltration for implementation in the real world.

5.01.B–T05 Valorization of Tigernut Agro-Waste for Sustainable Bioethanol Production: A Green Remediation Approach Using Microbial Fermentation

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Agro-waste accumulation presents a significant environmental challenge, particularly in regions lacking sustainable waste management strategies. This study explores the remediation potential of tigernut (Cyperus esculentus) processing waste through its conversion into bioethanol, integrating waste reduction with renewable energy generation. A novel Aspergillus niger isolate (HEFAPhR) and Saccharomyces cerevisiae were employed in fermentation processes, following enzymatic

pretreatment with cellulase to release fermentable sugars. Using a Box-Behnken design to optimize parameters—substrate weight, pH, inoculum size, temperature, and fermentation time—bioethanol yields were maximized under controlled conditions. Notably, A. niger HEFAPhR produced 0.7718 ml ethanol from tigernut waste under optimal conditions (pH 6.0, 30°C, 5% inoculum, 10g substrate, 96h), outperforming S. cerevisiae (0.2467 ml). This approach exemplifies a low-cost, biologically driven remediation strategy that not only mitigates agro-waste pollution but also contributes to green energy development. The integration of microbial biotechnology and environmental engineering offers a viable path for restoring ecological integrity while supporting circular bioeconomy initiatives.

5.01.C - Innovative Approaches for Sustainable Management, Remediation and Restoration of Environmental Matrices

5.01.C–T01 Valorisation of Discarded Paper Waste for Bioethanol Production at Kwame Nkrumah University of Science and Technology, Ghana

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The growing volume of paper waste in urban environments poses significant challenges to waste management systems and contributes to landfill overuse. At the same time, bioethanol production from waste materials offers a promising avenue for sustainable energy generation. This study explores the feasibility of producing bioethanol from discarded paper waste at Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ghana. The main objective was to assess the bioethanol production potential from different types of paper waste commonly discarded on campus, including A4 sheets, brown envelopes, and mixed paper sheets. The results revealed that pretreated A4 sheets produced the highest ethanol yield (130.1 L/ton DM), followed by pretreated mixed sheets (85.5 L/ton DM) and pretreated brown sheets (65.4 L/ton DM). In contrast, untreated brown sheets yielded the lowest amount of ethanol (3.1 L/ton DM). A cost-benefit analysis showed that pretreated A4 sheets had the highest estimated sale value (GH₵ 1,410.06 per ton), while untreated brown sheets resulted in the lowest value (GH₵ 33.63 per ton). These findings demonstrate the technical and economic feasibility of utilizing campus paper waste as a feedstock for bioethanol production, highlighting the potential for waste valorization and renewable energy generation. The study suggests that converting paper waste into bioethanol can offer a sustainable alternative to fossil fuels while significantly contributing to waste reduction on university campuses and beyond.

5.01.C–T02 Briquetting: A Sustainable Innovative Technology for Gaseous Emission Reduction in Developing Countries

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Industrialization with its associated pressure for increased energy demand had resulted in high dependency on wood fuel due to increasing price of kerosene, electricity and cooking gas, especially amongst the rural populace in the developing countries. The resultant effect being the emission of greenhouse gases; carbon monoxide, black carbon (soot), particulate matter and volatile organic compounds (VOCs) into the atmosphere and contributing to global warming and climate change. Briquette technology, a waste to energy technology provides a sustainable alternative source of renewable energy thereby alleviating the aforementioned challenges. Briquette technology involves the densification of biomass waste/ agricultural waste (rice husk, sawdust, groundnut shell and sawdust, coconut shell e.t.c) to produce rich and low carbon emission (smokeless solid). This study presents the production of three (3) variants of briquettes from different agro waste/residues: coconut shell, sawdust and rice husk. The materials used were collected thus: the rice husk was gotten from Idodo community, Enugu state, Sawdust from SEDI Enugu wood workshop and coconut shell from coconut sellers in Ogbete market, all in Enugu State. Cassava flour was used as the binder while water was added to form slurry. Other processes of production are carbonization, pulverization, weighing, mixing and finally, briquetting using a manual press briquette machine followed by drying; sun drying for 3 hours and oven drying for 3 hours at 120^{o}C temperature. The briquettes were tested through the following tests: The ignition test, combustion test analysis, ash content test and calorific value test. The rice husk briquette had the highest ignition time; the combustion test showed that coconut shell briquette lasts longer while the rice briquette also had the highest ash content. All the briquette variants burnt clean (smokeless) and thus, released no gaseous pollutant to the environment. Therefore, this study showcased briquette technology as a sustainable alternative to wood fuel and conventional charcoal, thus an innovative approach to gaseous emission reduction.

5.01.C–T03 The Effects of Different Bio-ozone Treated Effluents on the Structure and Functioning of Freshwater Ecosystems

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Advanced wastewater treatment technologies, such as biologically activated carbon (Schwarz et al.) filtration and ozonation, are increasingly employed to remove micropollutants (MPs) from effluents. However, their ecological impacts remain insufficiently understood. In this study, we assessed the chemical and ecological effects of six treatment scenarios, BAC, ozonation (0.2 and 0.4g ozone/g TOC), and their combinations, using outdoor freshwater microcosms over a 42-day period. Endpoints across multiple trophic levels, including primary producers, zooplankton, macroinvertebrates, and microbial communities, were systematically evaluated. HPLC-MS/MS analysis revealed high environmental persistence of MPs in untreated effluents, with concentrations of 3165 ng/L and 3016 ng/L on days 14 and 42, respectively. The combined BAC and high ozone treatment (ED group) achieved the greatest removal efficiency, reducing MPs to 40% of untreated levels by day 14, and also exhibited the lowest predicted mixture toxicity. All treated groups showed further reductions in MPs concentrations by day 42. In addition, ozonated effluents significantly inhibited algal growth, likely due to transformation products and reduced phosphorus availability. While overall zooplankton and macroinvertebrate community structures were not strongly affected, certain zooplankton species (e.g., Chydorus sphaericus, Daphnia pulex, Simocephalus sp.) increased in abundance in most treatments except ED group. Redundancy analysis showed the zooplankton community in this group remained most similar to that of the untreated control. Macroinvertebrate diversity and abundance were highest in the untreated group, potentially due to low toxicity and greater algal food supply. Treated effluents significantly altered microbial communities in the water column. Functional prediction indicated that key microbial taxa related to pollutant degradation, nitrogen fixation, and denitrification were substantially reduced under high ozone conditions. Among all treatments, BAC combined with low-dose ozone (0.2 g/g TOC) achieved a favourable balance between removal efficiency and ecological compatibility. To further minimize potential risks from transformation byproducts, additional post-treatment polishing could be considered where necessary.

5.01.C–T04 Phytoremediation Potential of Phragmites australis and Zostera capensis for Removing Organophosphate Pesticides from Polluted Watersheds

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Organophosphate pesticides (OPPs) are persistent in the environment, but little information is available on their bioaccumulation in plant species. In this study, seagrass – Zostera capensis and common reed - Phragmites australis were collected from two estuaries in South Africa to investigate the bioaccumulation of OPPs from contaminated sediments and the water column. These plants were chosen because they grow abundantly in specific estuaries' intertidal zone, making them a viable phytoremediator in the urban environment. The extraction of OPPs in plant tissues was performed by QuEChERS method, followed by GC-MS analysis. The mean concentration of ∑OPPs ranged from 0.01 to 0.03 µg/L for surface water, 6.20 to 13.35 µg/kg dw for deep-rooted sediments, 18.79 to 37.75 µg/kg dw for leaf tissues, and 12.14 to 39.80 µg/kg dw for root tissues of Z. capensis from Swartkops Estuary. While the highest concentration of OPPs was found in leaves of P. australis (16.41 – 31.39 µg kg-1 dw), followed by roots (13.92 – 30.88 µg kg-1 dw), and sediments (3.30 – 8.07 µg kg-1 dw) from Sunday's Estuary. The biota sediment accumulation factor (BSAF) values of pyraclofos, quinalphos, fenitrothion, phosalone, EPN, diazinon, chlorpyrifos, pyrazophos, and isazophos were higher than one, implying that P. australis and Z. capensis possess the ability to bioaccumulate these compounds. The root-leaf translocation factors (TFr-l) of these pesticides were higher than 1, suggesting that both plant species possess the capacity to move these pesticides from roots to leaves. The insignificant correlation observed between log BSAF and log Kow and log TFr-l and log Kow implies that OPPs uptake was not dependent on log Kow. Our study demonstrates that P. australis and Z. capensis possess the potential to effectively remove OPPs from contaminated marine environment.

5.01.C–T05 Organobentonite-supported TiO2 Composite for the Simultaneous Adsorption and Photocatalytic Reduction of Cr(VI) from Water and Bacterial Disinfection

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Hexavalent chromium, Cr(VI), is a carcinogenic chemical species of chromium that is widely present in various water systems. This study focused on the development of novel hybrid TiO2-Ag/hexadecyltrimethylammonium(HDTMA)-bentonite(Bt) with intrinsic-hole scavenging capacities for the simultaneous adsorption-reduction of Cr(VI) from water and bacterial disinfection.

The modifier HDTMA imparts a positive charge to the inherently negatively charged bentonite, enhancing its interaction with anionic Cr complexes. The catalyst, TiO_2, facilitates the reduction of Cr(VI) to the less toxic Cr(III), while Ag acts as an antimicrobial agent for effective bacterial disinfection. The characterization of the composite revealed the successful incorporation of TiO2 onto Ag/HDTMA-Bt, resulting in a material possessing high adsorption and reduction efficiencies, making it advantageous over conventional adsorption materials. Over 98% of Cr(VI) ion removal was achieved from simulated wastewater in 1 hour using a composite dosage of 100 mg by the hybrid TiO2-Ag/HDTMA-Bt, while Ag/HDTMA-Bt removed 74% Cr(VI) ions in 2 hours using 200 mg of the adsorbent. The factors that affect the adsorption and reduction processes, namely composite dosage, TiO2 content, temperature, contact time, ionic strength, and pH, were also investigated. Adsorption isotherms and kinetic studies revealed that the adsorption of Cr(VI) onto Ag/HDTMA-Bt followed the Freundlich adsorption isotherm and the intraparticle diffusion kinetic model. The reactions were determined to be spontaneous at high temperatures using thermodynamic studies. Application to real water samples showed 91% Cr(VI) removal via the hybrid process, compared to 60% via adsorption alone. The material also retained high removal efficiency over multiple reuse cycles (up to eight), demonstrating its sustainability and cost-effectiveness. Furthermore, the composite exhibited strong antibacterial activity against E. coli even at a low dosage of 0.16 mg/mL, broadening its environmental applicability. These results highlight the TiO_2-Ag/HDTMA-Bt composite as a promising multifunctional material for sustainable water remediation, targeting both chemical and microbial contaminants.

5.01.P - Innovative Technologies for Sustainable Remediation and Restoration of Polluted Environment

5.01.P–ThFr33 Metagenomic analysis of microbial communities and their functions in crude oil polluted soils

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This study investigated the effects of petroleum hydrocarbon pollution on impacted soils of the Niger Delta. Petroleum pollution of the soil negatively impacts the microbial population, biodiversity, and activities within the area. The resistance of the indigenous microbial population to the toxicity of hydrocarbons is based on their energetic strategies and metabolic versatility in using the pollutant as carbon and energy source. In this study, shotgun metagenomics was used to analyze microbial diversity. Metabolic capability and functional profile of two petroleum hydrocarbon polluted sites in Bodo (N4.620134,7.282998E) and Tombia (N04o47.714, E0006o51) communities, both in Rivers State Nigeria were8/ investigated. Predominant phyla across all samples are the Proteobacteria. Other oleophilic phyla previously reported in oligotrophic environments like Acidiplilum, Actinobacteria, Verrucomicrobia, and Acidobacteria were found in the polluted soil. Stress response genes (cold shock, heat shock, starvation, osmotic stress, pH and oxidant detoxification) were well expressed in all samples analyzed. Genes for DNA repairs and de novo biosynthesis were also well expressed in addition to hydrocarbon degradation hydrogenases. Functional pathways include those for fermentation, respiration, de novo biosynthesis, and element cycling. These findings provide insight into the microbial activities and functional capabilities of indigenous microflora in petroleum hydrocarbon polluted soil.

5.01.P–ThFr34 Bioremediation and metal tolerance potentials of organisms isolated from crude oil-polluted environment

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Bioremediation, a sustainable approach to environmental restoration, harnesses the metabolic capabilities of microbes to degrade and detoxify pollutants. This study investigated the bioremediation and metal tolerance potentials of organisms isolated from a crude oil-polluted environment. Samples were collected from oil-contaminated soil, and isolates were characterized for their ability to degrade hydrocarbons and withstand heavy metal stress. Physicochemical analyses revealed higher pH (6.41), electrical conductivity (121 µS/cm), organic matter (3.64%), and total organic carbon (2.97%) in polluted soil than in the control sample. Microbial analyses showed less bacterial activity in polluted soil, with total heterotrophic bacterial counts of $3.3\times10^{\wedge5}$ colony forming units per gram of soil (cfu/g) compared to $2.5\times10^{\wedge6}$ cfu/g in unpolluted soil. Pseudomonas sp., Bacillus sp., Tatumella sp., Rhodococcus sp., Mycobacterium sp., and Proteus sp. were isolated from the polluted soil sample. Hydrocarbon-utilizing bacterial (HUB) counts of microbial consortium when subjected to 1% crude oil in

mineral salt broth increased from 1.02 × 10^⁶ cfu/g on day 0 to 2.98 × 10^6 cfu/g on Day 28. Gas chromatography analysis revealed a 24% reduction in total petroleum hydrocarbons (TPH), with concentrations declining from 615.37 ppm on Day 0 to 468.68 ppm on Day 28. This significant reduction underscores the consortium's efficiency in degrading hydrocarbons, particularly heavier fractions (C8–C40). When subjected to incremental concentrations of CuSO4 and CoCl2, bacterial tolerance was assessed by plate counts, revealing that at lower concentrations (0.1g/L), Pseudomonas aeruginosa demonstrated a CFU count of 1.2×10^3 in CuSO4 and 1.5 × 10^3 in CoCl2, indicating enhanced resistance to cobalt chloride. Similarly, Bacillus subtilis showed CFU counts of 1.4×10^3 in CuSO4 and 1.6×10^3 in CoCl2, further underscoring cobalt tolerance. These outcomes suggest that both Pseudomonas aeruginosa and Bacillus subtilis possess considerable resistance to heavy metals, making them promising candidates for bioremediation applications in co-contaminated environments.

5.01.P–ThFr36 Integrated Characterization and plastic Bioremediation Applications of Novel microorganisms from Different Ecological Niches

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The escalating global plastic pollution crisis necessitates innovative bioremediation strategies to mitigate environmental impacts. This study explores the plastic-degrading capabilities of novel microbial communities isolated from diverse ecological niches, including marine, sediments, terrestrial landfill soils, cow dung, and wastewater treatment systems. Through an integrated approach combining shotgun metagenomic sequencing, enzymatic profiling, and high-throughput biodegradation assays, we characterize the metabolic pathways and degradation efficiencies of these communities against prevalent plastics such as polyethylene terephthalate (PET), polyethylene (PE), and polyurethane (PU). The morphological and chemical biodegradation of plastics were verified by scanning electron microscopy (SEM) and Fourier transform-infrared spectroscopy (FT-IR), respectively, validating plastic biodegradation. Our results revealed distinct microbial consortia with robust degradative potential, driven by synergistic interactions and specialized enzymes. Notably, niche-specific adaptations enhanced degradation rates, with marine-derived communities excelling in PET breakdown and cow dung as well as landfill soil-derived consortia showing promise for PE. These findings inform the development of tailored bioremediation applications, demonstrating the feasibility of deploying ecologically adapted microbial communities in bioreactor systems and environmental settings. This research underscores the transformative potential of leveraging microbial diversity for sustainable plastic waste management, paving the way for scalable bioremediation solutions.

5.01.P–ThFr37 Soil Microbiome Response to Nature-Based Solutions and Amendments for Sustainable Agriculture

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The soil microbiome plays a very important role in maintaining ecosystem functions by influencing soil health, nutrient cycling, and plant productivity. Nature-based solutions (NbS) and soil amendments have emerged as promising strategies to enhance agricultural sustainability by harnessing and restoring soil microbial functions. This study explored the use of organic amendments (ecochar – formulation of biochar and organic matter) to promote beneficial microbiome response in soil for agricultural sustainability. Soil samples from farms in Port Harcourt, Nigeria and Evora, Portugal were amended with ecochar to determine the influence of this nutrient formulation on soil microbial community composition. The results of the physicochemical/microbiological analyses showed that the amendment increased concentrations of nitrogen, phosphorus and potassium in both the Nigerian and Portuguese soil samples respectively and also the growth of beneficial soil organisms. In unamended Nigerian soil, the microbial plate count was 3.6x10E5 colony forming units/gram of soil (CFU/g) while the amended Nigerian soil had a count of 7.3x10E5 CFU/g. Unamended Portuguese soil had 6.4x10E5 CFU/g while the amended soil had of 9.4x10E5 CFU/g. The bacterial isolates found in both soils were Bacillus spp., Klebsiella spp., Listeria spp., Proteus spp., Psudomonas spp., Lactococcus spp., Enterococcus spp., Enterobacter spp., Staphylococcus spp., Achromobacter spp., Moraxella spp., Leuconostoc spp., Serratia spp., Shigella spp., Clostridium spp., and Micrococcus spp., while fungal isolates were identified as Aspergillus flavus, Aspergillus oryzae, Mdicopsis romeroi, Aspergillus niger, Aspergillus fumigatus, Trichoderma spp., Penicillium spp., Fusarium spp. and Rhizopus spp. These microbial species have all been previously associated with plant growth promoting potentials widely and as such would be playing very beneficial roles in enhanced crop productivity. By using ecochar as an amendment, farmers can foster a more resilient soil microbiome for eco-friendly and sustainable farming. This integrated approach would not only enhance crop yields but also contribute to climate mitigation by sequestering carbon and reducing greenhouse gas emissions, positioning soil health as central to a sustainable future.

5.01.P–ThFr38 Evaluating the Impact of Crude Oil Pollution on Soil Health in the Niger Delta: A Baseline for Smart Sensor Development

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Crude oil contamination presents significant environmental and public health risks in Nigeria's Niger Delta region. This study provides an integrated physicochemical and microbiological assessment of oil-polluted soils from K-Dere, Gokana Local Government Area (GPS: 4.6451°N, 7.2379°E), with the goal of informing the development of a sensor-based algorithm for real-time pollutant detection. Soil samples were collected from 2 depths (0-15cm; 15-30cm) with control/unpolluted samples taken 250 meters from the contaminated site. The physicochemical analyses revealed elevated levels of Total Petroleum Hydrocarbons (TPH) in polluted soils (83.38 mg/kg) compared to the control (11.15 mg/kg), surpassing the Nigerian Upstream Petroleum Regulatory Commission (NUPRC) intervention limit of 50 mg/kg for TPH. Other pollutants, including nickel (0.052 mg/kg), iron (3.5 mg/kg), copper (0.03 mg/kg), and zinc (0.021 mg/kg), were also elevated, while lead levels remained constant (0.0026 mg/kg). The pH of the polluted soils was more alkaline (7.98) compared to the control (5.52), accompanied by visible soil alterations. Microbiological profiling revealed higher abundance of hydrocarbon-utilizing bacteria (HUB) in the polluted soils than the unpolluted control, indicating microbial adaptation. Isolated species included Proteus spp., Klebsiella spp., Enterobacter spp., and Pseudomonas spp. This integrated analysis serves as a baseline for data gathering to develop a sensor-based platform capable of early detection, monitoring, and intervention in oil-polluted wetland environments, an urgent need for sustainable environmental management in the Niger Delta.

5.01.P–ThFr39 Bioremediation Efficiency and Microbial Adaptation in Hydrocarbon-Polluted Soils in Ogoni, Niger Delta, Nigeria

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Hydrocarbon pollution has always posed a serious threat to soil health and ecosystem stability in oil-producing regions such as Ogoni in Rivers State, Nigeria. Bioremediation offers a sustainable method for mitigating such contamination, yet its effectiveness in complex field conditions remains a challenge. This study investigated the efficacy of treatment using organic nutrient addition and soil mixing on hydrocarbon-contaminated soil by evaluating microbial dynamics, physicochemical properties, total petroleum hydrocarbons (TPH), and heavy metal content. Soil samples were collected from a bioremediated site and a non-treated control site to address these challenges. Microbial enumeration and identification, along with chemical analyses, were conducted to compare soil health indicators between two sites undergoing bioremediation. The results showed that while total heterotrophic bacterial (THB) counts expressed as colony forming units/gram of soil (CFU/g) remained similar before and after bioremediation (2.31 × 10^5 CFU/g), hydrocarbon-utilizing bacteria (HUB) increased from 2.71 × 10^4 CFU/g before bioremediation to 7.92 × 10^4 CFU/g after treatment. Hydrocarbon-utilizing fungi (HUF) also rose from 1.2 x 10^1CFU/g to 2.1 x 10^1CFU/g, suggesting enhanced microbial activity due to bioremediation. Identified microbial genera included Pseudomonas, Bacillus, Proteus, and Fusarium. The treated soil exhibited improved moisture content (20.2%) and slightly lower pH (5.25) compared to the control (8.84% and 5.52, respectively). Nutrient elements such as potassium, phosphorus, iron, and aluminum were more concentrated in the treated soil. However, TPH levels in the treated soil remained elevated (21.7 mg/kg vs. 9.84 mg/kg in the control), indicating residual contamination. Heavy metals like lead and nickel were within permissible limits, and cadmium was undetected. In conclusion, bioremediation promoted microbial diversity and nutrient enrichment, facilitating partial hydrocarbon breakdown. Nevertheless, the persistence of TPH highlights the need for additional interventions for pollutant attenuation to regulatory standard. These findings underscore the potential and limitations of bioremediation in field conditions and contribute valuable insights for designing more effective remediation strategies in oil-impacted environments.

5.01.P–ThFr40 Characterisation of Magnetic Biochar Nanocomposites and Their Application for Treatment of Water Contaminated with Potentially Toxic Elements

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The contamination of water bodies by potentially toxic elements (PTEs) has increased significantly in recent decades due to anthropogenic activities such as mining, industrial discharge, agricultural and improper waste disposal. One of the challenges is the lack of effective, affordable and efficient methods for removing PTEs from wastewater systems. The study aims to

develop and evaluate cost-effective, locally available agricultural waste-based materials, specifically sugarcane bagasse (SCB) and corn stalk (CS) as bio-sorbents for water treatment. The as-prepared biochar was modified using magnetite (Fe3O4) to enhance their sorption properties. Despite progress toward the United Nations Sustainable Development Goals (SDGs), billions of people still lack access to safe drinking water and sanitation. The circular economy approach (CEA) offers a framework for transforming agricultural waste into valuable resources, reducing environmental impact and reliance on non-renewable materials. This study aligns with these sustainable efforts by repurposing agricultural waste for environmental remediation. Magnetic-biochar composites were synthesised via co-precipitation to incorporate magnetic nanoparticles. The resulting materials were characterised using Fourier transform infrared (FTIR) spectroscopy, scanning electron microscopy (SEM), powder x-ray diffraction (PXRD), zetasizer and Brunauer-Emmet-Teller (BET). Response surface methodology (RSM) was applied to help with the optimisation of experimental parameters, which include solution pH, contact time, adsorbent dosage, initial concentration and adsorption temperature on the removal of selected PTEs from simulated and real water samples. The application of response surface methodology (RSM) allows a minimal number of tests and the software incorporates mathematical and statistical tools used to analyse interactions between parameters. These results will contribute to understanding how agricultural waste can be repurposed for environmental applications. This research promotes the circular economy by recycling agricultural waste and reducing dependency on conventional, high-cost treatment materials. The findings may inform policy decisions and practical applications in managing PTEs contamination in water sources, particularly in regions with limited resources.

5.01.P–ThFr41 Recovery Of Valuable Resources From Acid Mine Drainage Using A Selective Precipitation And Removal Of Residual Chemical Species By Phytoremediation

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South Africa's limited freshwater resources face severe contamination from acid mine drainage (AMD), characterized by low pH and elevated toxic metals. This study addresses the challenge of developing cost-effective AMD treatment while recovering valuable metals through an integrated approach combining selective precipitation and phytoremediation. Magnesite was used for stepwise pH adjustment to selectively precipitate metals, followed by constructed wetland treatment using Chrysopogon zizanioides. Raw AMD showed severe contamination with pH 2.93, sulphate 3840 mg/L, and metals including aluminium (16.0 mg/L), iron (7.42 mg/L), manganese (35.2 mg/L), and uranium (14.2 mg/L), all exceeding regulatory guidelines. Characterization of the sludges at varying pH levels and the plant material employed scanning electron microscopy-energy dispersive X-ray spectroscopy (SEM-EDS), powder X-ray diffraction (PXRD), Fourier transform infrared (FTIR) spectroscopy, and inductively coupled plasma-optical emission spectrometry (ICP-OES) analyses. Selective precipitation achieved varying removal efficiencies: Fe complete removal at pH 4, Zn >90% at pH 6 to 7, Al > 88% at pH 10, and Co and Ni complete removal at pH 10. Manganese required pH 10 for 98% removal, while U showed <6% removal. Sulphate decreased to 1500-1600 mg/L through gypsum formation. Optimal conditions were pH 8-9 for balanced metal recovery. Phytoremediation provided limited additional treatment, with minor reductions of Al and Co concentrations but unchanged concentrations for other metals. The integrated approach successfully recovered most metals through chemical precipitation, with pH 8-9 identified as optimal for comprehensive treatment while maintaining economic viability. However, specialized treatments remain necessary for recalcitrant contaminants like uranium. This research advances sustainable AMD management by demonstrating metal valorisation potential, transforming environmental waste into recoverable resources aligned with circular economy principles, though complete regulatory compliance requires further optimization for persistent contaminants.

5.01.P–ThFr42 Fabrication of Maize Tassel Waste-Derived Novel Adsorbent for Efficient Per and Polyfluorinated alkyl Substances (PFAS) Removal from Water: Enhancing Circular Economy Solutions

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As regulations on per and polyfluorinated alkyl (PFAS) are becoming increasingly more stringent, cost-effective treatment methods are urgently needed to remove them from the environment. This study investigates PFAS adsorption onto maize tassel (MT) and chemically activated maize tassel (CAMT) focusing on the effects of adsorbent dosage, adsorbate concentrations, stirring speed, temperature, kinetics, isotherms, and adsorption capacities. CAMT exhibited higher removal efficiency for

short- and long-chain PFAS, while MT showed greater efficiency for long-chain PFAS. Electrostatic attraction and hydrophobic interactions most likely influenced adsorption of PFAS, alongside perfluorocarbon chain length, functional groups, molecular weight, and solubility. The Freundlich model best described the adsorption, indicating a multilayer process. Low ΔG^0 and ΔH^0 values suggest physical adsorption. Despite physicochemical interactions, adsorption followed a kinetically controlled process. These findings highlight the potential of maize tassel, an agro-based waste suitability to remove multiple PFAS from aqueous solutions.

5.01.P–ThFr43 Assessment of Heavy Metals, TPH and THC in Soils Samples From Two Automobile Mechanic Workshops in Southern Nigeria

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Pollution of soils in various automobile workshops across the country has occurred as a result of anthropogenic activities and improper disposal of spent oil in these workshops. This has led to increased concentration of some pollutants in the soil. In this study, two cities from the southern region of Nigeria were chosen for comparative assessment of the levels of total petroleum hydrocarbon (TPH), total hydrocarbon content (THC), and some potentially toxic elements (Ni and Pb). Soil samples were collected in triplicate at three different points within the vicinity of the automobile workshops in Port Harcourt and Ikot Akpaden. Soxhlet extraction was used for the extraction of the total petroleum hydrocarbons and total hydrocarbon content. Oxidizing-acidic mixture was used for the acid digestion of the samples for the potentially toxic elements. The Total petroleum hydrocarbons and total hydrocarbon content were analysed using Gas Chromatography (GC-FID), while the potentially toxic elements were analysed using graphite furnace atomic absorption spectroscopy (GF-AAS). The concentration of the metals was assessed using the contamination factor, degree of contamination, pollution load index, ecological risk factor, and geo-accumulation index. The results obtained for the metals from the three sampling points showed that their levels were low, and this was further confirmed by the negative values from the geo-accumulation index. However, the concentration of total petroleum hydrocarbons (TPH) and total hydrocarbon content (THC) was higher than that allowed by the Department of Petroleum Resources (DPR). There was a significant difference in the concentration of total hydrocarbon content. The study revealed that the soils were polluted as a result of the indiscriminate disposal of waste petroleum products (used engine oil, petrol, diesel, and other lubricants) directly on the soil. The innovative approach to the remediation of these automobile workshop sites using engineering solutions and green remediation practices is discussed.

6.01 - Chemical Pollution Across the Environment-Food-Human Continuum: Sources, Effects and Solutions

6.01–T01 Investigating the Presence and Levels of Pharmaceuticals in Spinacia oleracea Harvested from Soil Treated with Human Urine

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Human urine is a freely available and valuable organic fertilizer that has been considered as a potential alternative of chemical fertilizers for food production. However, it could also be a major route for the excretion of pollutants, metabolites and active pharmaceutical substances. Hence, the study investigated the levels of pharmaceuticals present in Spinacia oleracea harvested from the soil treated with human urine of patients taking pharmaceuticals after a treatment period of three months. The urine of male patients on pharmaceuticals was collected from patients at the HIV and AIDS clinic at an academic hospital while control urine samples were collected from male students who were not on any medication after consent was sought. The presence and levels of pharmaceuticals in all the urine samples before and after three months of storage were determined. Different volumes (150 mL, 350 mL, and 550 mL) of urine samples were used to treat the soil samples for the cultivation of S. oleracea. At harvest, S. oleracea plants were, oven dried, separated into stems, leaves, and roots before being ground into powder. Solid phase extraction was done on the urine samples before and after storage as well as in all the plant samples using Strata-X-C polymeric strong cation cartridges under vacuum. Residues of pharmaceuticals were determined in urine and plant samples using a Liquid Chromatograph coupled to Photodiode Array Detector and Mass spectrometer. Several pharmaceuticals were reported in the results of both urine and plant samples. The highest levels of pharmaceuticals reported in urine before storage was 1186.25 µg L-1 for metformin whereas it was 1343.71 µg L-1 for vancomycin in the urine that was stored for three months. Upon comparison of values before and after storage, pharmaceuticals such as metformin decreased from 1186.25 µg L-1 to 806.68 µg L-1 with no significant differences. Plant analysis results showed that pharmaceuticals were present in all plant parts of S. oleracea with leaves showing the highest level of pharmaceuticals. Metformin was the most concentrated

pharmaceutical and ranged between 32.15 µg L-1 and 849.55 µg L-1. It can be concluded that storage of urine for three months is not sufficient for pharmaceuticals to be completely disintegrated or volatilized in the urine used as a fertilizer and plants such as S. oleracea can uptake pharmaceuticals from soil that was treated with stored human urine containing pharmaceuticals.

6.01–T02 Wide-scope Target Screening for Emerging Organic Contaminants in Calçots: Unveiling Chemical Pollution in a Catalan Culinary Icon

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The reuse of reclaimed water in agriculture is increasingly promoted in water-scarce regions, particularly across the Mediterranean. However, the presence of emerging organic contaminants (EOCs) poses potential risks to the environment and food safety. This study aims to assess the occurrence of EOCs in calçots (green onions), a culturally significant crop in Catalonia (NE Spain), irrigated with various water sources, including reclaimed water. A widescope target method using high-resolution mass spectrometry (HRMS) was applied to provide a comprehensive chemical profile. Samples were collected during the 2024–2025 harvest season from nine farms in Girona and Lleida provinces, representing diverse irrigation practices. Each sample was separated into roots, bulbs, and leaves, freeze-dried, and extracted using bead beating with acetonitrile. Extracts were analyzed using two platforms: a Vanquish UHPLC system coupled to an Orbitrap Exploris 120 HRMS for wide-scope screening, and a Waters Acquity UHPLC coupled to a QTRAP 5500 for conventional target analysis. Target LC-MS/MS analysis enabled the quantification of 82 pharmaceuticals across more than 12 therapeutic classes and 16 plastic-related compounds, including bisphenols and tire wear derivatives like 6PPD-quinone. Notably, atenolol and caffeine were detected in the bulb—calçot's main edible part—at 6.0 and 254.3 ng/g dw, respectively. Tris(2-chloroethyl) phosphate (TCEP) reached 7.5 ng/g dw, and BPA was found in roots, bulbs, and leaves at 32.5, 1.9, and 0.7 ng/g dw, respectively. These results highlight the potential for contaminant translocation into edible plant tissues. Data from the wide-scope method, currently under evaluation, will enable comparison of both analytical approaches in terms of sensitivity, recovery, and overall performance. Additionally, contaminants found predominantly in reclaimed-water-irrigated sites will be identified as possible indicators of water-source-specific pollution. This study contributes to improved monitoring strategies for water reuse in agriculture, supporting food safety and environmental protection in regions affected by climate-induced water stress.

6.01–T03 Chemiresistive Reduced Graphene Oxide–Ion Imprinted Polymer Sensor for Ultra-Trace Cadmium Detection in Water

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Cadmium (Cd) contamination of water poses serious risks to ecosystems, food safety and human health, yet conventional laboratory methods for Cd quantification lack the portability and speed needed for on-site monitoring. To address this gap, we have developed a chemiresistive sensor that combines electrochemically reduced graphene oxide (rGO) with an ion-imprinted polymer (IIP) tailored for ultra-trace Cd(II) detection. Graphene oxide was first converted to a highly conductive rGO film, onto which a methacrylic-acid-based IIP was polymerised around Cd(II) templates; acid leaching then formed selective binding cavities. By optimising the IIP:rGO ratio to 1:3, we achieved a device that responds in under 60 s, with a 0.070 µg/L detection limit and a linear range up to 400 µg /L ($R^2 = 0.996$). Over two months of storage, the sensor's signal drift remained below 10%, and spiked recoveries in river and borehole samples ranged from 95.9 % to 103 %. Reproducibility (RSD = 2 %) and minimal interference from co-occurring metal ions (Zn^{2+}, Pb^{2+}, Cu^{2+}, Ni^{2+}, and Hg^{2+}) confirm its robustness. These results demonstrate that integrating rGO's superior electron-transport properties with IIP's molecular recognition yields a scalable, cost-effective platform for real-time monitoring of cadmium pollution across the water environment continuum, supporting sustainable management of water quality in changing environmental conditions.

6.01–T04 Screening Of Human Health Impacts From Exposure To Endocrine Disrupting Substances

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Endocrine disrupting chemicals (EDCs) are associated with various human health effects, presenting a major public health concern. However, the scale of global health impacts associated with the wide range of EDCs found across daily consumer goods remains unknown. To address this gap, we propose a framework for estimating health impacts from exposure to EDCs

in consumer products, with the specific aims to (a) identify a list of chemicals with known or suspected endocrine disrupting properties, (b) quantify EDC weight fractions in a set of consumer products, and (c) estimate population-level health impacts of EDC exposure from these products. We screened international regulatory and non-regulatory chemical lists to identify known and suspected EDCs. Through targeted and systematic literature searches and contact with experts, we identified four databases detailing chemical compositions of products, from which we curated a harmonised dataset of EDCs in consumer products. We applied the USEtox model to calculate aggregated human population lifetime burden for cancer, reproductive/developmental and general non-cancer toxicity effects associated with EDC exposure from these products, expressed in disability-adjusted life years (DALY), and scaled health impacts to reflect product use in the U.S. as an example region. We modelled the fate, exposure and health impacts associated with 213 EDCs identified in 342 products. We identified >50 unique EDCs in children's toys and food packaging, >70 in personal care products and >100 in cleaning products and building materials. Weight fractions ranged over 14 orders of magnitude, indicating EDC presence as functional ingredients (typically >0.01%) and as contaminants or residuals (<0.01%). EDC exposure was associated with a total 21 days of lifetime loss per billion capita, and per day of combined use of the 42 products contributing most to overall health impacts (top 5%). Ten EDCs were responsible for 95% of this health burden, particularly due to reproductive and developmental effects. We are concurrently exposed to many EDCs across household products, some at levels presenting immediate health concerns, compounded by potentially underestimated mixture effects. Building on our framework to expand the range of included EDCs and products, facilitated by regulation ensuring access to product composition data, can inform priorities for reducing EDC exposure and support systemic management of EDCs from local to global scale.

6.01.P - Chemical Pollution Across the Environment-Food-Human Continuum: Sources, Effects and Solutions

6.01.P–TuWe85 Design A 3D-Printed Flow Device For Selective Droplet-Based Liquid-Liquid Extraction Of Saturated And Aromatics: Potential Application For The Quality Control Of Mineral Oil Contamination In Food

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Mineral oil comprises a complex mixture of mineral oil-saturated hydrocarbons (MOSH) and mineral oil aromatic hydrocarbons (MOAH), used by the food industry in food-contact materials and packaging. During these processes, MOSH and MOAH have been shown to migrate into foodstuffs. This is of concern since MOSH is known to accumulate in the liver, spleen, and other organs, while MOAH is suspected to be carcinogenic. There is thus a need for the development of effective analytical techniques for the detection and quantification of MOSH and MOAH, to safeguard human health. Currently, solid-phase extraction (SPE), liquid chromatography (LC), and high-performance liquid chromatography (HPLC) are used to separate MOSH and MOAH fractions, while gas chromatography (GC-FID) is used for quantification. Using these approaches is either costly, requires a large solvent volume, or is time-consuming. This study proposes an alternative method of designing and fabricating a 3D-printed flow device that uses microfluidic principles to perform droplet-based liquid-liquid extraction (DLLE) for the fractionation of MOSH and MOAH compounds. The printed flow device is a standard T-junction with 2 inlets and 1 outlet, designed with Fusion360, printed with polypropylene using a Prusa 3Mk+ 3D printer. A deep eutectic solvent silver-based trifluorometthanesulfonate was used as the acceptor phase, and an in-line phase separator was incorporated into the flow system to improve automation. Parameters such as flow rate, extraction time, and mineral oil hydrocarbon (MOH) concentration were optimized using a central composite design. This flow system has potential applications in quality control processes in the food industry, due to its cost-effectiveness, ease of use, and scalability potential. This approach is envisioned to address the regulatory challenges associated with mineral oil contamination in food products and packaging in South Africa for improved safety and quality assurance in food industries. Future work will focus on validating the device's performance in real mineral oil samples and exploring its integration into existing quality control frameworks.

6.01.P–TuWe86 Development of Three-Dimensional Printed Silver Polymer Nanocomposite-Based Sorbents for the Extraction of Aromatic Hydrocarbons from Food and Environmental Samples

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Mineral oil hydrocarbons (MOHs) are complex mixtures of saturated (MOSH) and aromatic (MOAH) compounds derived from petroleum. In food-related applications, their migration from packaging materials may result in food contamination and potential adverse effects in humans, including bioaccumulation and genotoxicity, as well as carcinogenic effects. On the other

hand, they tend to persist in the environment where they have the same effect, so it is important to develop a method that can preconcentrate them properly and separate the two fractions from each other. MOSH and MOAH clearly have different health effects which justifies the need to separate and quantify these compound classes. However, developing countries, like South Africa, lack regulations for monitoring MOH contamination. Argentation chromatography is often employed for the selective extraction of aromatic hydrocarbons, where silica gel is impregnated with silver (Ag) ions, as they can selectively interact with pi-bonds. This study proposed the development of 3D printed Ag polymer nanocomposite-based sorbents to replace traditional solid phase extraction (SPE) which are solvent-intensive and time-consuming. The nanocomposite material was prepared in-house by combining melt blending and in situ reduction of Ag+ within the polymer matrix. The sorbent was 3D printed using fused deposition modelling (FDM), and the resulting nanocomposite material was characterised using scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy and thermogravimetric analysis (TGA). The 3D printed fabricated sorbents were used for the SPE process, where the solvents and compounds were optimised. The initial proof-of-concept testing with model MOH compounds revealed challenges in extraction efficiency as these compounds were not being effectively separated from each other. This meant that there was a need to improve the separation and extraction efficiency by expanding the compound selection. This study aimed to develop and evaluate 3D-printed sorbent technology for the extraction of aromatic hydrocarbons from environmental and food matrices. This innovative approach demonstrates significant potential as a cost-effective analytical tool for developing countries, paving the way for improved environmental and food safety monitoring.

6.01.P–TuWe87 Evaluation of the Rate of Uptake and Depuration of a short chain PFAS, Perfluorohexanoic Acid (PFHxA), in Eastern Oysters (Crassostrea virginica)

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Per- and polyfluoroalkyl substances (PFAS) are a large group of anthropogenic chemicals with over 9,000 substances classified under its umbrella. Due to their chemical properties, they are used heavily in commercial goods. However, these same properties that make them highly favorable for manufacturing make them extremely mobile, persistent, and resistant to breakdown in the aquatic environment. Due to their persistence, PFAS is ubiquitous in the aquatic environment, leading to its detection in remote locations. Historically, research has focused on perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS), ultimately leading a substantial gap in understanding the toxicity profile of short-chain PFAS in exposed aquatic organisms. In addition to a focus on “legacy” PFAS, research has focused largely on the effects of PFAS in model organisms. Non-model, commercially, and environmentally important aquatic organisms are vital to assess potential PFAS toxicity to best protect these vulnerable populations. In addition to protecting ecological health, human consumption of seafood has been shown to be a dominant route of PFAS exposure. PFAS has been shown to cause adverse effects in humans, and thus it is vital to assess the potential risk of PFAS exposure via seafood consumption to best protect human health. To address these data gaps, the current study aims to evaluate the bioaccumulation and depuration in eastern oysters (Crassostrea virginica) following exposure to environmentally relevant concentrations of Perfluorohexanoic acid (PFHxA). Oysters will be exposed to 2 ng/l, 20 ng/l, 200 ng/l, and 2000 ng/L of PFHxA via waterborne exposure for 28 days followed by a 28-day depuration period where no PFHxA will be present. The entire soft tissue portion of the oysters will be used for extraction as oysters are consumed whole allowing for assessment of potential human risk. Following spiking with isotope labeled internal standards, PFHxA will be extracted from the oyster tissue using the most efficient extraction method, which will be determined based on preliminary extraction efficiency data. PFHxA concentrations will be quantified using ultra high-performance liquid chromatography (UHPLC) coupled to a triple quadrupole mass spectrometer. The exposure is ongoing; however, it is projected that oysters will accumulate high concentrations of PFHxA with both depuration and accumulation increasing with PFHxA concentration. The findings in the study will help in predicting potential human health risk associated with consuming PFHxA-exposed oysters as well as potential ecological health risk to the oysters themselves. As PFAS is ubiquitous, it is essential to understand the accumulation and depuration of the contaminant within vulnerable aquatic populations to best protect ecosystem and human health.

6.01.P–TuWe88 Seasonal Dynamics and Environmental Risks of Glyphosate Contamination in Thathe Vondo Forest Plantation, Limpopo, South Africa

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Vegetation control in commercial forest plantations typically uses glyphosate-based herbicides. Nonetheless, they raise

concern with respect to maintaining ecological integrity due to the potential transport and long-term contamination of adjacent water bodies and surrounding soils. This study investigates the concentration levels and seasonal variability of glyphosate residues and its metabolites (AMPA) in surface waters and their surrounding soils within the Thathe Vondo Forest Plantation, Limpopo, South Africa. Samples collections were conducted during wet and dry seasons across 16 water bodies, consisting of rivers, streams, and dams, with surrounding soil samples at each water body. Water samples were taken in pre-cleaned polyethylene bottles and the surrounding soil samples were collected at distances of 0m, 50m, 100m, and 150m away from the water sources. Glyphosate residues were extracted using solid-phase extraction (SPE) and derivatized before analysis using Gas Chromatography-Mass Spectrometry (GC-MS). Descriptive statistics were calculated along with PCA and correlation analysis to study glyphosate relations with pH, temperature, total dissolved solids (TDS), electric conductivity (EC), salinity and turbidity. Results demonstrate that glyphosate concentration in surface water ranged from 1.55 to 1.99 µg/L. Soil residue concentrations ranged from 2.22 to 3.94 µg/g and were noted to be higher near water bodies. Seasonal trends indicated during the wet phase dispersion and solubility were more pronounced, thus the mobilization within the hydrological cycle. The absence of AMPA in all samples suggests limited degradation, indicating the recent application of glyphosate. Strong correlations between glyphosates and EC, TDS, and salinity were substantiated in PCA graphical outcomes, while correlation analyses confirmed a marked dependence on glyphosate and turbidity pictures in both periods. The findings reveal that the amount of glyphosate detected poses a danger to the surface water and soil, suggesting contamination levels change seasonally due to water movement. It is understood from this that there should be restrictions which dictate the periods of herbicide application to avoid amplifying ecological and public health hazards while demanding efficient buffer zones constructed around water bodies and deploying improved monitoring systems toward better sustainable management of the plantations.

7.02.P - Late-Breaking Science Poster Session

7.02.P–ThFr45 Chronicles of Clearwater – Where the Water Wonders Live: A Children's Book Series Bridging Science, Sustainability, and Storytelling

Amina Nel[1], Lourelle Neethling[1], Tarryn Botha[2], Katherine Holt[1], Amanda Thwala[1], Rorisang Malatsi[1], Christene Goldman[1], Fanelesibonge Vilakazi[1], Lutfiyya Latief[2], Quinton Dos Santos[1], Jacobus van Dyk[1] and Ntando Khumalo[1] (1)Department of Zoology, University of Johannesburg, (2)University of Johannesburg

Engaging children with environmental science is essential to fostering early awareness and long-term stewardship of our planet's most vital resources [1] .This presentation introduces a curated series of children's science storybooks that explore the world of water—from raindrops to rivers, wetlands to wastewater, and the creatures who call it home. Each book blends factual accuracy with creative storytelling, anthropomorphizing key aquatic characters (such as a zebra fish embryo, a droplet named Dewey, and a microplastic detective) to tackle real-world topics like water pollution, the water cycle, aquatic biodiversity, and ecotoxicology [2, 3]. Rooted in contemporary research and aligned with global environmental education goals, the collection serves both as a classroom resource and an outreach tool. The books simplify complex concepts like endocrine disruption, eutrophication, and microplastic contamination without compromising scientific integrity. Early feedback from educators and learners highlights their potential to spark curiosity and inspire questions among children aged 3–7.

7.02.P–ThFr47 Temporal Shifts In Field Margin Structure And Lepidopteran Larval Use: Towards A Likelihood Of Exposure Framework

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Butterflies and moths are in decline in farmland habitats. Pollution, including from chemicals and waste, has been attributed as a major driver of biodiversity loss. As vital components of agricultural landscapes, field margins offer habitats that support biodiversity, while buffering agrochemical displacement into the wider environment. This study investigates how seasonal variation in plant cover and height across three pollen and nectar margins influence the abundance and diversity of Lepidopteran larvae, and their likelihood of exposure to pesticide spray drift. Using plant cover, plant height, distance from the crop edge and species abundance, weighted species risk of exposure scores were calculated for the species collected within each margin. These data quantified the contribution of field margin vegetation structure in attenuating spray drift exposure in non-target lepidopteran species and provide evidence that may help design field margins that maximise both habitat quality (for beneficial species) and protection against pesticide spray drift.

7.02.P–ThFr48 The Effects of Ethanolic Extract of Boophone Disticha on the Development of Zebrafish (Danio Rerio) Embryos

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Women in South Africa are at a higher risk of depression compared to those in other countries, especially during pregnancy and after childbirth (Mulondo et al., 2024). Fluoxetine, a selective serotonin reuptake inhibitor (SSRI), is most commonly prescribed to manage depression in pregnant women (Bairy et al., 2007). However, the inadequate release of maternal serotonin resultant from reuptake inhibition has been reported to be associated with abnormal cardiovascular and neural development during early embryonic life (Nebigil, 2001, Vitalis and Parnavelas, 2003). The above could be due to the role played by serotonin during development (Correia et al., 2022). The high prevalence of depression in pregnancy and the side effects of the SSRIs have led to an increase in the use of herbal alternative medication. Boophone disticha is the most common member of the Amaryllidaceae plant kingdom, a South African medicinal plant used traditionally by several indigenous groups to treat depression (Nair and Van Staden, 2014, Lekoma et al.; 2022). This study will investigate the developmental effects caused by Boophone disticha extract on zebrafish embryos using the OECD Fish Embryo Toxicity test. Fish will be exposed to 5 concentrations of the hyderoethanolic extract ranging from 10 -50 µg/ml. Controls will include untreated, ethanol, herbal extract and fluoxetine groups. Survival, heart, breathing rates, blood flow and morphological changes will be assessed using Nodus Danioscope after 24, 48 and 72 hours post exposure. Results will be analysed and compared using the ANOVA test in SPSS software. The plant extract is expected to cause less developmental effects on embryos compared to conventional medication fluoxetine.

7.02.P–ThFr49 Effects of Ethanolic Extracts of Crinum Moorei and Crinum Macowanii on Behaviour and Histomorphometry of the Liver and Kidneys of Zebrafish Social Defeat Stress Model

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Depression affects over 322 million people worldwide, causing emotional and physical impairments. Fluoxetine, a selective serotonin reuptake inhibitor (SSRI) drug is a commonly used antidepressant. While SSRIS are considered safe, they have side effects that sometimes lead to treatment discontinuation. The above has resulted in the increase in use of herbal medication that include Crinum moorei (CMo) and Crinum macowanii (CMa), commonly known as the River lily and Cape coast lily respectively. The plants are believed to have affinity for serotonin transporter site. Scientific validation of their safety and efficacy is however lacking. Liver and kidneys are the organs most vulnerable to damage by ingested toxic substances. We aim to investigate the effects of ethanolic extracts of CMo and CMa on bahavior and histomorphometry of the liver and kidneys of zebrafish model of stress. 100 fish will be used. Twenty will be a control group and eighty will be exposed to social defeat stress and divided into ethanol, fluoxetine, CMo and CMa groups and treated for 21 days with behavioural tests using a zebrafish multivariate concentric square field (days 0, 7, 14, 21) will be videorecorded and analysed with ViewPoint software. Post trials, fish will be euthanised and stored in 10% buffered formalin. Histological analysis of liver and kidneys will include whole-mount and staining with Masson's Trichrome, haematoxylin and eosin to analyse connective tissue area fraction and histomorphometric tissue changes. We expect CMo and CMa extracts to alleviate the effects of stress without toxic effects in liver and kidneys, assessed primarily through behaviour and tissue analysis.

7.02.P–ThFr52 Evaluation of Cytotoxicity, Bioactivity Potentials of Phytochemicals Derived in Bioassay-guided Fractionation of Cannabis sativa Leaves

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Medicinal plants consist of a reservoir of phytochemicals possessing an array of biological activities that are useful in the treatment of several diseases. The plant of interest in this study is Cannabis sativa, used in the management of diseases such as neurodegenerative diseases, obesity, diabetes, cancer, etc. This study, therefore, investigates the cytotoxicity and bioactivity potential of bioactive compounds derived from Cannabis sativa leaves in bioassay-guided fractionation of the leaves. Crude extracts obtained via ethyl acetate, ethanol, and aqueous solvents will be fractionated using column chromatography and subjected to GC-MS and NMR for phytochemical profiling. The biological activities of these fractions will be evaluated using

in vitro antioxidants 2,2-diphenyl-1-picrylhydrazyl (DPPH), Ferric Reducing Antioxidant Power (FRAP), and 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid (ABTS, anti-inflammatory (RBC membrane stabilization, protein denaturation), antidiabetic (α-glucosidase and α-amylase inhibition), and antimicrobial assays. Molecular docking studies will be conducted to predict potential mechanisms of action and identify molecular targets. The cytotoxicity of the fractions will be evaluated using zebrafish (Danio rerio) embryos. The outcomes are expected to identify stage-specific cannabis-derived compounds with therapeutic potential and their cytotoxic effects in different fractions. This research offers a scientific basis for further drug development, focusing on its under-utilized phytochemical constituents.

7.02.P–ThFr53 Sentinel potential of Klebsiella pneumoniae for environmental AMR: RT-PCR surveillance of wastewater over an annual cycle

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South Africa's water sector faces growing challenges in effectively managing antimicrobial resistance (AMR) in wastewater treatment systems. Despite initiatives like the Green Drop programme, multidrug-resistant organisms such as Klebsiella pneumoniae and plasmid-mediated AmpC (pAmpC) β-lactamase genes remain absent from routine water quality monitoring frameworks. This study assessed the potential of K. pneumoniae and pAmpC genes as environmental indicators for AMR dissemination within a wastewater treatment plant (WWTP) and its receiving environment. A 12-month surveillance study was conducted, combining physicochemical water quality analysis with real-time PCR quantification of K. pneumoniae and six pAmpC genes (blaACC, blaCIT, blaDHA, blaECB, blaFOX, blaMOX) in influent and effluent samples. Positive correlations were found among certain physicochemical parameters and pAmpC genes, with blaMOX and blaFOX being most prevalent. K. pneumoniae and pAmpC genes were detected throughout the study period, with notable spikes in specific months. Removal efficiencies ranged from 6–98% for K. pneumoniae and 80–99% for pAmpC genes, although residual traces remained in treated effluent. Comparison with clinical AMR data revealed ongoing K. pneumoniae and resistance cases at a hospital serviced by the WWTP, suggesting healthcare facilities contribute to environmental AMR burdens. These findings support the inclusion of K. pneumoniae and pAmpC gene monitoring in national water quality and AMR surveillance programmes to improve early detection, inform mitigation strategies, and protect public health.

7.02.P–ThFr54 Toxicological Effects of Environmentally Relevant Concentrations of Selected Endocrine Disrupting Chemicals on a Mouse Sertoli Cell Line (TM4): Implications for Male Reproductive Health

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Increasing environmental pollution and developments in the chemical industry have contributed to declining reproductive health. Many environmental pollutants may possess (anti-)estrogenic and (anti-)androgenic properties and are referred to as endocrine disrupting chemicals (EDCs), exerting their effects by interfering with normal hormonal homeostasis, thus playing a major role in male reproductive system dysfunction. Mouse Sertoli cells, which are targets for various environmental contaminants, exhibit similarities to human Sertoli cells, and therefore serve as an ideal model for male reproductive toxicological studies. Sertoli cells (TM4) were exposed to environmentally relevant concentrations of selected EDCs, including cypermethrin, deltamethrin, rac-trans permethrinic acid, 3- phenoxybenzoic acid and para-nonylphenol (p-NP) for 24 hours in vitro. Cells were assessed for toxicity using the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay, oxidative stress using an intracellular total reactive oxygen species activity assay kit and for aberrant morphological changes using haematoxylin & eosin (H&E) staining technique. Following the 24 hours of in vitro exposure to the pesticides, the MTT assay data showed a moderate decline (approximately 20% cell death) in mouse Sertoli cell viability. Statistical analysis of reactive oxygen species (ROS) production revealed significant differences for the pesticide mixtures compared to the negative control. While the effect sizes were relatively small, practical significance was confirmed through Cohen's d-value analysis. Aberrant morphological alterations including membrane elongation, cytoplasmic vesicle formation and cell density reduction were observed, particularly in cells exposed to nonylphenol. This study provides evidence that exposure to pyrethroids and nonylphenol may potentially induce significant toxicity in mouse Sertoli cells. Future studies should be aimed at exploring the effects of prolonged in vitro exposure with environmental concentrations found in SA. Implementation of regular monitoring of the concentration levels of these compounds and exploration of safer alternatives to mitigate the potential detrimental consequences associated with prolonged exposure is recommended.

7.02.P–ThFr55 Wastewater-Based Surveillance of Viral Pathogens and Resistomes as Indicators of Public Health and Pollution in Sub-Saharan African Urban Environments

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Effective public health surveillance and environmental monitoring are critical challenges in rapidly urbanizing regions of Sub-Saharan Africa (SSA), where infectious diseases and antimicrobial resistance (AMR) pose significant threats. Wastewater-based surveillance (WBS) has emerged as a powerful, non-invasive approach to capture community-level health data, offering timely insights into pathogen circulation and pollution dynamics. This study explores the integration of viral pathogen detection with comprehensive resistome profiling, the collective repertoire of antibiotic resistance genes (ARGs), mobile genetic elements (MGEs) and plasmids, in urban wastewater systems across SSA. Utilizing advanced shotgun metagenomic sequencing and bioinformatic analyses, we characterize the diversity and abundance of viral communities alongside resistomes within wastewater samples from multiple urban centers. Our findings reveal distinct viral signatures reflective of prevailing infectious disease burdens, while resistome data uncover hotspots of antibiotic resistance dissemination linked to wastewater pollution and anthropogenic activities. The co-occurrence patterns of viral pathogens and ARGs provide a holistic picture of public health risks and environmental contamination, underscoring the interconnectedness of microbial threats in urban ecosystems. We discuss the practical implications of deploying WBS as an early warning system to detect emerging outbreaks and monitor AMR trends, particularly in settings with limited clinical surveillance infrastructure. Furthermore, we address region-specific challenges such as infrastructural constraints, data interpretation complexities, and the need for capacity building in genomics and informatics. This integrative surveillance framework offers a scalable, cost-effective strategy to inform public health interventions, guide wastewater management policies, and ultimately enhance disease prevention efforts in Sub-Saharan African urban environments.

7.02.P–ThFr56 Sustainable Management of E-Waste from Renewable Energy: An Institutional Framework and Policy Gap Analysis in Mozambique

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The global shift towards renewable energy is transforming energy systems and redefining environmental responsibility, especially in developing countries. As nations strive to decarbonise their economies and increase energy access, renewable technologies such as solar photovoltaic (PV) systems are being deployed on an unprecedented scale. In Mozambique, where nearly 40% of the population still lack access to electricity, renewable energy has become a key element of national electrification efforts through the adoption of off-grid solar systems and mini-grids in rural and underserved communities. However, this is also accompanied by the rapid growth of renewable energy electronic waste (RE-e-waste), which is hazardous waste. Moreover, due to limited infrastructure and regulatory oversight, countries like Mozambique face increased environmental and human health risks from improper disposal, contamination, and health hazards. This study maps and clarifies the existing institutional framework and policy gaps for RE-waste management in Mozambique. It also examines sustainable management options and proposes a comprehensive roadmap based on the concept of the circular economy. The work was carried out through analysis of national policies and institutions, stakeholder inputs, and international and context-relevant case studies. The findings emphasise the absence of a robust e-waste management framework, significant regulatory gaps, and limited recycling infrastructure as major barriers to sustainable RE-waste management. It also underscores the lack of reliable datasets that can support accurate qualitative and quantitative characterisation of the situation and impact assessment, both now and in the future. Therefore, the adoption of Extended Producer Responsibility (EPR), stakeholder coordination, and public-private partnerships is a key recommendation to reduce environmental and human health risks and to unlock a genuinely sustainable renewable energy expansion and circular economy opportunities in Mozambique and similar countries.

7.02.P–ThFr57 Fuel Fraud, Emissions, and Economic Loss: Combating Fuel Adulteration in South Africa through Biomarker Detection

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A significant portion of fuel stations in South Africa are illegally blending both petrol and diesel with paraffin, compromising fuel quality, increasing harmful vehicle emissions, and causing lasting damage to engines. According to recent findings by the Department of Mineral Resources and Energy (DMRE), 70 out of 1,000 service stations tested were found to dilute petrol and diesel with paraffin-a practice driven by the desire to reduce costs and evade fuel levies. Paraffin, not subject to the fuel tax,

offers a way for stations to boost profits while undermining environmental and economic regulations. This growing issue is exacerbated by declining domestic refinery capacity since 2020, leading to greater reliance on imported refined fuels. By 2026, it is projected that 53% of refined fuel products (amounting to 604,000 barrels per day) will be imported into South Africa. The consequences include increased input costs, reduced fuel security, and job losses due to refinery closures. To address this challenge, this research aims to develop and apply chemical biomarkers for detecting fuel-paraffin adulteration in both imported fuels and retail petrol station tanks. Biomarkers are hydrocarbon compounds that exhibit unique chemical "fingerprints" depending on their geological origin and refining process. They are resistant to environmental degradation and detectable at low concentrations using Gas Chromatography-Mass Spectrometry (GC/MS). This study will advance the development, characterization, and quantification of such biomarkers, alongside the application of multivariate statistical analysis to improve fuel fingerprinting and contamination assessment. The project also supports environmental protection by enabling the detection of excessive paraffin in diesel, which contributes to toxic exhaust emissions and air pollution. Furthermore, it seeks to inform policy enforcement by introducing a chemical marker into illuminating paraffin sold in South Africa, thereby preventing revenue loss and promoting fuel integrity. Ultimately, this work contributes to mitigating chemical pollution across environmental, economic, and human health systems offering a science-based solution to fuel adulteration in a developing country context.

7.02.P–ThFr58 C1q stimulates polarization and enhances mitochondrial respiration in M2 macrophages thereby promoting malignant progression of gastric cancer

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The tumour microenvironment (TME) profoundly affects cancer progression and overall patient survival. However, the complexity of tumour cell-TME interactions and their molecular basis in gastric cancer (GC) remain to be systematically elucidated. Single-cell sequencing revealed that C1Q+TAMs were enriched in gastric cancer tissues and had M2-type tumour-promoting features. We found that high abundance of C1Q+TAMs was associated with poor prognosis of gastric cancer patients by general transcriptome sequencing, and developed a machine-learning-based prediction model to evaluate the prognostic significance of C1Q+TAM-related gene expression profiles. Macrophage M2 polarisation was induced in vitro using interleukin 4 (IL-4) stimulation. RNA sequencing, real-time quantitative PCR, flow cytometry, immunoblotting, and immunofluorescence staining were used to determine macrophage phenotype. Exogenous and endogenous FAO, FA uptake and lipid content assays were used to analyse macrophage metabolism. Scanning electron microscopy was used to observe macrophage mitochondrial structure. The role of C1q in gastric cancer invasion and migration was investigated using co-culture experiments of M2 macrophages and gastric cancer cells. $C1Q^+$ High expression of immunosuppressive molecules by TAMs and their high infiltration are associated with poor prognosis in gastric cancer. We found that IL-4 and tumour-conditioned medium upregulate C1q expression in macrophages and promote the activation and proliferation of immunosuppressive M2 macrophages, and that C1q deletion hinders macrophage cellular metabolism and mitochondrial respiration, which reduces the production of NAD+/NADH and ATP, which are essential for immunosuppressive macrophages. Mechanistically, C1q enhances FABP5-mediated fatty acid metabolism, which activates the transcription factor peroxisome proliferator-activated receptor-γ (PPAR-γ). In conclusion, C1q stimulates M2 macrophage polarisation and modulates its mitochondrial respiratory capacity, which in turn maintains the immunosuppressive capacity of M2 macrophages to promote gastric cancer progression.

7.02.P–ThFr59 Metabolic Perturbations in Mice Following Acute Exposure to Naphthalene Using Untargeted Metabolite Profiling Technique

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Naphthalene is a polycyclic aromatic hydrocarbon (PAH) found in tobacco smoke and is partly responsible for air pollution. Excessive naphthalene exposure can cause a range of adverse health effects, including but not limited to hemolytic anemia, jaundice, headache, confusion, nausea, vomiting, cataracts, and respiratory toxicity. The present study evaluated the effect of acute naphthalene exposure on metabolic profiles in mice using a GC/MS-based metabolite profiling approach. Naphthalene was fed intraperitoneally (in corn oil (CO) at 200 mg/kg body weight for 6 and 24 hours, respectively. The animals were necropsied, and the lungs were harvested for metabolomics. The differences observed between the control group and the treated group were validated using a heat map, principal components analysis (PCA), and variable importance in projection (VIP) scores. Carbohydrate and amino acid metabolism were altered in naphthalene(NA)-treated male and female mice. For mice fed CO and NA at a 24-hour time point, glyceric acid, glucose-1-phosphate, succinic acid, and glucose were generated in female mice, whereas threonic acid, glucose-6-phosphate, levoglucosan, 2-ketoglucose, dimethylacetal, and sucrose were

generated in male mice. Alanine, tryptophan, and ornithine were generated in female mice and depleted in male mice. Pathway enrichment analysis reveals that lactose synthesis, carnitine synthesis, glycolysis, purine metabolism, and gluconeogenesis show strong levels of statistical significance ($p < 0.05$) in CO female mice. Galactose metabolism followed by phenylalanine and tyrosine shows the highest statistical significance (p-values < 0.05) in NA-treated female mice. Purine metabolism, Warburg effect, and urea cycle are top on most significantly enriched pathways ($p<0.05$) whereas Beta-alanine metabolism and glycine and serine metabolism are less important in NA treated male mice. The data not only demonstrated that an untargeted metabolomics approach could provide useful information on the cellular dynamics underlying the toxicological responses due to naphthalene toxicity in mice but also altered metabolites of sugars, amino acids, and lipids in a manner suggestive of cellular toxicity. This study complied with ARRIVE 2 and PREPARE guidelines and were approved by the Animal Care and Use Committee Landmark University, Omu-Aran, Kwara State (LUAC/2021/0019A).

7.02.P–ThFr60 Sewage sludge time scale physical and chemical data for AI applications (Pilot Study)

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Sewage sludge is a by-product generated during the treatment of wastewater in wastewater treatment plants. It results from the treatment of domestic and industrial wastewater. After primary and secondary treatment processes, solids settle out and form sludge. It consists of the residual, semi-solid material left from industrial wastewater or sewage treatment process. Managing it effectively is vital for ensuring environmental safety and improving treatment efficiency. This study aimed to investigate sewage sludge time scale physical and chemical data for AI applications. This study used activated sludge as an indicator to monitor the treatment process and the physicochemical data to monitor water quality in the wastewater treatment plant in Northwest. Samples of influent, effluent and activated sludge were collected across the period of three months using 1 litre sterile glass bottles. All samples were kept on ice in sealed cooler box and chemical analysis were done within 4 hours of sampling. Physical analysis for parameters such as temperature, pH, TDS, dissolved oxygen was measured on site using a calibrated Oakton PCStestr™ 35 waterproof field multimeter probe (Thermo FisherScientific, US). Sludge volume index was measured in the NWU Laboratory Potchefstroom campus. A sample of activated sludge was transferred into sterile glass cylinder and allowed to settle for 30 minutes to perform settleability test, this was done to monitor the quality of the sludge. Chemical analysis for parameters such as nitrite, phosphates, turbidity, heavy metals, and TSS were measured at NWU laboratory Potchefstroom campus. Nitrite and phosphates concentrations were measured using the Hach machine DR 2800. Turbidity was measured using Hach turbidity meter. Heavy metals were measured using ICP-MS Machine 7900 spectrophotometer (Agilent Technologies). All this data that was measured and recorded in triplicates. This data was recorded and analyzed in an excel software in a spreadsheet and this was done to investigate trends. The observed trends, particularly in nitrite and phosphate levels, could be used to train AI models to predict and mitigate spikes in contaminants and improve the performance of the wastewater treatment plant. The objectives of this study were met. The data collected from this study provides a rich foundation for future AI-driven predictions and process optimization. Further research is needed to establish reasonable methods for constructing AI models.

7.02.P–ThFr61 Out of Sight – An Evaluation of the Current Phase I Action Limit for Assessing Environmental Impact of Veterinary Pharmaceuticals

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The VICH GL 6 guideline outlines a tiered assessment scheme that is mandatory for all active substances (AS) used in veterinary medicines before they enter the market. As the first step, the predicted environmental concentration of the AS in question is compared to a so-called “action limit” of 100 µg/kg for soil. If this action limit is exceeded, an extended environmental risk assessment is required. This limit is currently based on data that were recorded between 1973 and 1997 in the USA. Since then, new active ingredients with higher efficacy (and, therefore, potential environmental impacts at lower concentrations) have been developed and put on the market. This consequently elevates the probability of environmental and organismic impact, which in turn affects biodiversity and, ultimately, the natural functioning of ecosystems. A critical evaluation of the action limit is therefore necessary. Does it still serve its purpose as a precautionary decision criterion on whether an experimental Phase II risk assessment must be conducted? To assess the protectiveness of the soil action limit of 100 µg/kg, we evaluated 82 tests (34 plant and 48 earthworm tests) for 18 parasiticides, 28 antibiotic and 5 other AS, using data from European Medicines Agencies Public Assessment Reports, supplemented by internal data of the German Environment Agency. We included parasiticides in the data evaluation, although the action limit does not apply here, as their environmental hazard is determined by their toxicity to insects. Tests between model predictions reveal no difference between models with and without parasiticides (with parasiticides n = 51, without parasiticides n = 33). For each AS, we included the

lowest available NOEC/EC10 and fitted a sigmoidal non-linear least squares model in the range of [0,1]. 17±6 % of the NOECs/EC10 values are below 100 µg/kg soil. This reduces to 17±8 % if only non- parasiticides are included in the data analysis. A total of 11 substances are below or equal to the action limit, 7 antibiotics and 4 parasiticides. In order to ensure that the action limit covers approximately 95 % of AS currently on the market, a reduction from 100 to 10 µg/kg would be necessary. The analysis shows that the current action limit is insufficient to protect organisms and ecosystems. In future revisions of the guideline, it will be necessary to adapt the action limit to current scientific standards.

7.02.P–ThFr62 Effect of In Vitro Exposure of First-Line Antiretrovirals on Human Sperm Motility Parameters

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This was a pilot study, investigating possible fertility implications of contemporary antiretroviral (ARV) medications used by millions of men worldwide. No data exists for contemporary first-line Human Immunodeficiency Virus (HIV) targeting ARVs. This study hypothesizes that in vitro exposure to the selected ARVs will show that sperm kinematic and motility parameters are negatively affected. The study was conducted at the Andrology clinic at the Department of Urology of Steve Biko Academic Hospital. This was a laboratory-based experimental study. The study analysed sperm motility and kinematics after exposure to the ARVs; Dolutegravir, Tenofovir and Emtricitabine, both individually and in combination. The Microptic SCA® Computer Assisted Sperm Analysis (CASA) system was used to generate standardized quantitative data on sperm motility and kinematics with high precision in a reproducible manner. To correct for confounding variables, an in vitro method was used, and only healthy sperm entered the experimental arm of the study after a rigorous donor selection, basic sperm analysis, and sperm preparation procedure. Additionally, the study design made sure that the exposed sperm were compared to the unexposed control sperm from the same study participant. Semen from 23 volunteers successfully passed all stages of the study including questionnaire screening, basic semen analysis, the sperm preparation procedure and the exposure to the ARVs out of the 30 recruited. On analyzing the data, no significant changes in curvilinear velocity (VCL) nor average path velocity (VAP) were found at any time during the study. Straight-line velocity (VSL) of the non-progressive sperm showed a significant decrease in the Tenofovir arm at 0 minutes and in all the ARV arms at 60 minutes post-exposure compared to the control arm. The straightness index (STR) and Linearity Index (LIN) of the non-progressive sperm showed a significant decrease at 0 minutes, 60 minutes and 90 minutes post-exposure in all ARV arms, while the Oscillation index (WOB) of the same non-progressive sperm sub population flagged a significant decrease in the Tenofovir arm and the combination ARV arm at 0- and 90-minutes post-exposure. Beat cross frequency (BCF) of the type b medium velocity progressive sperm population showed a significant increase at 90 minutes post-exposure in the Tenofovir arm, and a corresponding significant decrease in the proportion of type b medium velocity progressive sperm was also recorded at 90 minutes in all the antiretroviral arms. The study results show a decrease in sperm parameters like VSL, STR, LIN and WOB and an increase in BCF consistently in the Tenofovir arm, pointing to possible hyperactivation of sperm. This is consistent with previous studies documenting changes in sperm motility and kinematics with Tenofovir. Hyperactive sperm are more likely to get exhausted from travelling in circular paths and thereby unable to advance toward the ovum. The results also note an increasing pattern of sperm motility impairment with time from exposure, with type c non-progressive sperm showing abnormal behaviour at 0, 60- and 90-minutes post-exposure and type b medium progressive sperm starting to show changes at 90 minutes post-exposure. This is the first study to document sperm motility changes in the newer Dolutegravir ARV arm and the combination ARV arm. This pilot study concludes that the current first-line ARVs used by HIV patients and HIV-negative patients on Pre-exposure prophylaxis (PrEP) can negatively alter sperm motility and kinematics and that further research is warranted to quantify its impact on human fertility. The cost and logistical limitation of this pilot study limited the study duration to 90 minutes post-exposure, with parameters like Reactive Oxygen Species (ROS), Mitochondrial Membrane potential, Acrosome reaction and sperm DNA fragmentation not assessed. The pilot study recommends that these limitations are addressed in future studies before a comprehensive conclusion of the effects of ARVs on human male fertility can be drawn.

7.02.P–ThFr63 Unravelling the Nexus: Gender, Poverty, and Pollution in the Triple Planetary Crisis

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As you read this abstract, approximately 700 million people, or 8.5% of the global population, live in extreme poverty, subsisting on less than US$2.15 per day. Worse, is that progress on addressing this issue has stalled. A 2023 UN report showed global ambition to end extreme poverty by 2030 is falling woefully short. It forecasts that over 600 million people will remain in extreme poverty and 665 million people will be undernourished by 2030, the deadline for the UN’s Sustainable

Development Goals. With this lack of progress, the need for effective poverty alleviation programmes is greater than ever. The determinants of the triple planetary crisis have extensively focused on the interplay or nexus between climate change, biodiversity loss and environmental pollution. It has failed, to comprehensively incorporate the importance of poverty and inequality and their significance within the nexus. The nexus of poverty-inequality-environment is in line with the UNs' Sustainable Development Goals yet evidencing the ways to reduce poverty coupled with environmental protection has increasingly become a complex and challenging socio-political issue for the developed and particularly developing economies. Additionally, ecological disruption will create an additional 68 million people falling into poverty by 2030. Further consideration of the wider "nexus" (referred to as a point or area of interconnection where different aspects of the environment and human activities interact) inclusive of poverty and gender into future work programmes is essential. The term nexus is often used to describe the relationships between water, energy, and food systems, recognising that these resources are interconnected and that changes in one area can directly or indirectly impact another. The nexus approach emphasizes the need for integrated management of these resources to address this complex challenge and achieve sustainable development. The "Nexus" approach to environmental resources management examines the interrelatedness and interdependencies of environmental resources and their transitions and fluxes across spatial scales and between compartments. Instead of just looking at individual components, the functioning, productivity, and management of a complex system are taken into consideration. The term "Nexus" in Latin describes the act of tying together or something which binds. In connection with environmental resource management, the term nexus was introduced for the first time during the 1980s. Such a systems approach can result in improved water, energy, and food security by integrating "management and governance across sectors and scales", reducing trade-offs, and building synergies, overall promoting sustainability and a transition to a green economy. While a basic understanding of the concept exists and is widely used in research and practice, the concept is hardly operationalised. This hinders the analysis of the conditions (e.g., participation, governance) and effects (e.g., sustainability) of implementing a Nexus Approach to the sustainable management of environmental pollution, biodiversity and resources. With the additional need to consider the role of poverty and gender within this nexus, we recommend better future integration of the concept of the resource nexus in policy design and implementation. Driving the consideration of the development of a community of practice that cuts across academia, policy, practice, and civil society, on the sustainable management of environmental resources, is critical to better mitigate the impacts of climate change on pollution, biodiversity and people, while considering gender. Addressing the complex issues of poverty eradication and environmental conservation puts added pressure on the sustainable development goals; however, growth-oriented policies put pressure on ecological systems (i.e. the intensification of crop production etc.), making links between poverty and environmental change complicated. In developing countries, economic growth is often prioritised, compromising environmental preservation. Managing poverty as part of the nexus requires encouraging growth-oriented policies that align with environmental protection. Implicitly economic growth and related economic activities increase the demand for natural resource extraction and use through agriculture, deforestation, mining, and industrialisation which are associated with negative biodiversity challenges. Some studies, however, suggest that economic growth alleviates pressure on biodiversity as an increase in economic growth escalates the real income of communities and their affordability and willingness to pay for environmental amenities. Irrefutably the connection between poverty and the environment is rather complex. In this milieu, untangling the poverty-environment-biodiversity and gender nexus remains a key concern. A 4-year programme of work recently completed in South Africa (Environmental Pollution Programme; EPP) delivered a series of co-developed community led pilot projects proving nature-based solutions for the mitigation of pollution into rivers in three rural communities in the uMkhomazi catchment area of KwaZulu-Natal. Throughout the programme consideration was given on how to successfully design interventions to reduce exposure to environmental chemicals, and in order to do this it was important to understand the factors that influence an individual's exposure. Investigating variations of individual exposure to pollutants of concern by gender, age, household characteristics and household roles, provided the opportunity to drive future interventions and design measures to reduce exposure to chemicals. This programme whilst not explicitly seeking to understand chemical exposure by gender, and by default the consideration of the impacts of income inequality, gender and poverty on environmental pollution; demonstrated that our empirical outcomes showed that income inequality and poverty were significant determinants of environmental pollution. Hence, efforts to abate environmental degradation should give adequate attention to poverty and gender inequality in order to attain environmental sustainability. The continued debate on poverty and the environment nexus offers two competing approaches. First, the trade-off approach suggests poverty reduction and environmental degradation go together. The key argument is that the economically disadvantaged make use of natural resources for their survival and livelihood. The unsustainable use of natural resources degrades the environment and breeds the poverty exploit. Second, that poverty reduction and environmental conservation can be managed simultaneously. The available empirical literature on the poverty and environment nexus provides conflicting results. By consideration of the role of indigenous peoples (IPs) the results become further complicated. Whilst, the impacts of environmental pollution for IPs go beyond human health impacts. For example, most IP communities are dependent on a healthy ecosystem as essential for sociocultural well-being, the presence of pollution in wildlife or water (food commodities) has forced many individuals to shift away from traditional lifestyles. Moreover, many IPs have managed

their local environment in a sustainable manner. What is clear is, the literature suggests endogeneity between poverty and the environment, particularly as its consideration is frequently overlooked in studies. Moving to another layer of granularity, beyond IPs and delving into the complex relationship between pollution and gender, research has consistently highlighted the disproportionate effects on women and marginalised communities (IPs). The connection between environmental degradation and social inequality (poverty) is multifaceted, with far-reaching consequences for the health, wellbeing, and socioeconomic status of women and girls worldwide. The relationship between gender and pollution is deeply intertwined with socioeconomic factors, cultural norms, and environmental conditions. Women and girls are disproportionately affected due to a variety of factors, including their social roles, economic status, and biological susceptibility. As such women in poorer communities often bear the brunt of environmental degradation due to their traditional roles in managing household resources, such as water and fuel. This exposure is compounded by socioeconomic factors, including limited access to education, healthcare, and economic opportunities. For instance, in many developing countries, women are responsible for collecting firewood, which exposes them to indoor air pollution from burning biomass fuels. Poverty, and specifically lack of access to education and healthcare, and limited economic opportunities exacerbate these negative impacts further. To mitigate this disproportionate impact on women and girls, it is essential to integrate gender analysis into environmental policy-making. This involves understanding the different ways in which women and men are affected by environmental issues and developing policies that address these disparities. Future pollution programmes must address the role of gender analysis in environmental policy-making assessing how different environmental policies and interventions affect men and women differently. This will help identify potential gender-based disparities and inform the development of more equitable policies. Some key steps in integrating gender analysis include: • Conducting gender-disaggregated data collection and analysis • Assessing the different impacts of environmental policies on men and women • Engaging with both men and women in the policy-making process • Developing policies that address the specific needs and concerns of women and girls. Furthermore, the participation of women in decision-making processes is crucial for developing effective and equitable environmental policies. Policies that address the specific needs of women and girls in polluted environments are critical for reducing the disproportionate impact of pollution on these groups. We recognise that the impact of pollution on gender equality is a complex issue that requires a comprehensive and multifaceted approach. By understanding the intersectionality of gender and pollution, within the wider nexus, we can begin to understand and address the health and wellbeing impacts on women, promoting gender-sensitive environmental policies, that work towards reducing the disproportionate effects of pollution on women and indigenous peoples. The UK government have been clear that mainstreaming gender equality is important, but this only works alongside, not as an alternative to, standalone programming. The UK government is maintaining the commitment for 80% of their R&D programmes to have gender equality as a significant or principal aim and commits to influencing this across the HMG ODA R&D portfolio, to mitigate against the impacts of wider R&D cuts on women, girls and the most marginalised groups. The UKs International Climate Financing (ICF) ambitious approach on Gender, Equalities, Disability and Social Inclusion (GEDSI), states that all new ICF programmes where possible will have gender equality as a significant, if not principal, aim, and be “GEDSI empowering” to have a greater focus on climate adaptation which would mitigate the impacts of reductions by redirecting spend to the world’s poorest people and places. The UK government is developing an implementation plan for a strengthened approach to mainstreaming gender and equalities across programmes, policy and diplomatic engagement. So, in summary the nexus is complicated and complex, and to focus on how we can enhance gender responsiveness going forward is to understand how we can elicit changes to behaviour in delivery countries through early partnerships with in-country specialist GEDSI experts at the planning stages of programme development. Gender equality and the empowerment of women and girls are fundamental human rights, that are essential for sustainable development that leaves no one behind and for economic growth. We recognise that ODA policies and the JNCC EPP programme have an impact on gender equality – whether positive or harmful, intended or not – and recognise that future programmes must be designed to promote and facilitate transformative change. In order to achieve this, we need to consider the role of poverty, marginalised groups and gender in our assessments; we need better social and ecological assessments of decision-making over natural resources, to paint a clear picture of who benefits and who bears the costs of environmental decisions. Trade-offs and any potential human costs must be understood and explicitly addressed through open, just and democratic processes.

7.02.P–ThFr64 About 1.55 trillion Microplastics Flowing Through Protected Areas: Evidence from Kruger National Park Rivers, South Africa

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Plastic pollution is a global environmental challenge. It occurs everywhere, including freshwater systems, in the form of microplastics. As a result, it has become an ecological and environmental hazard. We investigated the spatial distribution and concentration of microplastics in sediment, water, and macroinvertebrates from catchment-independent but adjacent Olifants and Sabie rivers of the Kruger National Park. We further conducted a microplastic risk assessment for the respective river

water and macroinvertebrates. We subsequently derived microplastic particle estimates for the five major Kruger National Park (KNP) rivers (Olifants, Sabie, Crocodile, Letaba, Luvhuvhu). The microplastic profiles (size, polymer, morphotype, and colour) differed significantly between rivers. Riverbed sediment microplastic concentrations ranged between 2022 to 9971 n/kg dm, and 2237 to 27 259 n/kg dm, for the Olifants and Sabie rivers, respectively. Microplastic concentrations in river water ranged between 11 to 50 n/L in the Olifants River, and 4.0 n/L to 41 n/L in the Sabie River. We counted 369 MPs in 376 organisms (1.0 n/organism) with a mean of 8.8 n/organism, 8.5 n/organism, and 0.16 n/organism in filter feeders, predators, and grazers, respectively. Microplastic risk assessment was done based on five risk categories (level I – V). The Olifants River water was categorized at a dangerous level of risk (level V) and the Sabie River water was at very high risk (level IV). However, macroinvertebrates were not at high ecological risk (level I to III). Microplastic particle flux estimates were calculated using the association between microplastic concentration and river runoff. The Olifants River had the highest estimated microplastic particle flux (1.55 x 1012 n/month) compared to the other major rivers. Of the twelve observed plastic polymers, polyethyleneterephthalate was prevalent in sediment (39%) and water (32%). Concentrations varied along both river stretches, but the expected concentration decrease downstream was not observed. For macroinvertebrates, of the six polymer types observed, butyl (34%) and Chlorobutyl (20%) dominated. Microplastic-contaminated water could be toxic to aquatic life and/or have long-lasting effects. Finally, rivers need management from their headwater into the sea. The KNP rivers require local and international interventions.

7.02.P–ThFr65 Environmental and Health Risks of Polybrominated Diphenyl Ethers (PBDEs) at Informal Electronic Waste Recycling Sites in Nigeria

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Concerns about the adverse public health consequences of informal electronic waste (e-waste) recycling are increasing. This is because e-waste contains some hazardous substances such as polybrominated diphenyl ethers (PBDEs) which is used as flame retardants in electronics. There is dearth of information on the concentrations of PBDEs, the pattern of its distribution at the various e-waste recycling sites, and the health risks associated with exposure to PBDEs among informal e-waste workers in Nigeria. This study therefore adopted a cross-sectional study design to gain insights into these issues. The concentrations of 13 PBDE congeners were measured in top soils (0–10 cm) and in various dust samples from different e-waste recycling sites (burning, dismantling, repair) and the corresponding control sites. PBDE concentrations at e-waste sites were compared with the concentrations in samples from corresponding control sites in three study locations in Nigeria (Lagos, Ibadan, and Aba). Adverse health risks (cancer and non-cancer risks) among informal e-waste workers were calculated using the EPA model developed by the Environmental Protection Agency of the United States. The health risks exposure via three main routes (Dermal contact, ingestion, and inhalation) were estimated. There were significant differences in the level of PBDEs congeners between each of the e-waste recycling sites and the corresponding control sites. The levels of PBDEs at the e-waste recycling sites exceeded the levels at the control sites by a factor of 100s to 1000s. In general, the concentrations of PBDEs and the health risks at the e-waste sites increased as the intensity of the e-waste recycling activities increased: control sites < repair sites < dismantling sites < burning sites. A two-way ANOVA also confirmed a significant difference in all the PBDE concentrations between the activity sites, with the burning sites having the highest concentrations, followed by dismantling sites, then control sites. Dermal contact was the main route of exposure while exposure via inhalation was negligible for both carcinogenic and non-carcinogenic risks. Cumulative health risks via all routes of exposure (inhalation, ingestion, and dermal contact) exceeded the acceptable limits of both non-cancer effects and cancer risk at all e-waste sites. Our results suggest that informal e-waste recycling has negative impacts on the environment and adverse health effects on the e-waste workers. Therefore, the importance of occupational safety programs and management regulations for e-waste workers cannot be over emphasized.

7.02.P–ThFr66 Impacts of HHPs as key emitters of GHG's influencing climate change adaptation strategies globally

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Highly Hazardous Pesticides (HHPs) are recognized for their significant acute and chronic risks to human health and the environment, as defined by international classification systems such as the World Health Organization (WHO) and the Globally Harmonized System of Classification and Labelling of Chemicals (GHS), or through their inclusion in binding international agreements. Classified based on the eight criteria established by the Food and Agriculture Organization (FAO) and WHO Joint Meeting on Pesticide Management (JMPM), South Africa's HHP list identifies 216 registered HHPs, of which 26 are fully banned and 83 are classified as carcinogenic, mutagenic, or reproductive and developmental toxicants (CMRs).

The production, transportation, storage, and application of HHPs contribute to greenhouse gas (GHG) emissions, exacerbating climate change. In 2022, South Africa's GHG emissions reached 508.38 million tonnes of CO2 equivalent, accounting for 1.06% of global emissions. Projections indicate that, without intervention, emissions could range between 350 and 420 megatons of CO2 equivalent by 2030, undermining Paris Agreement targets. Agriculture, a major contributor to GHG emissions after the energy sector, is significantly impacted by HHP use, which intensifies emissions and contributes to potential global temperature increases. This paper examines the global context of HHPs, analyzing historical data and future projections to assess the potential environmental consequences if HHPs are not phased out or banned. It evaluates current climate change adaptation strategies, highlighting the need for transformative measures, including transitioning to renewable energy, enhancing energy efficiency, adopting regenerative agricultural practices, and protecting critical ecosystems. Additionally, the paper explores how multilateral agreements can support efforts to mitigate climate change and biodiversity loss while addressing risk management challenges associated with fossil fuel dependency.

7.02.P–ThFr67 Highly Hazardous Pesticides: Impacts on Aquatic Ecosystems and Human Health

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Highly Hazardous Pesticides (HHPs) are extensively registered and utilized in South African agriculture, despite global efforts through frameworks like the Global Framework on Chemicals to ban, phase out, or restrict their use. The Globally Harmonized System of Classification and Labelling of Chemicals (GHS) categorizes pesticides based on ten hazard criteria, encompassing international obligations under Multilateral Environmental Agreements (MEAs), acute toxicity to mammals and birds, chronic health effects, environmental toxicity, and risks associated with dioxins and heavy metals. This study focuses on hazard criteria 7 and 8, as defined by the Food and Agriculture Organization (FAO) and World Health Organization (WHO) Joint Meeting on Pesticide Management (JMPM), which address environmental toxicity and exposure, particularly their impacts on aquatic ecosystems and ecosystem services. Of the 202 registered HHPs in South Africa affecting aquatic ecosystems and wetlands, 48 are identified as groundwater pollutants (e.g., Atrazine) and 80 as surface water pollutants (e.g., Simazine). This paper evaluates the detrimental effects of these pesticides on aquatic life and ecosystem functionality. It also examines human health risks, including direct exposure (e.g., operator-related diseases) and indirect impacts, such as compromised drinking water quality from pesticides like Acephate and Oxadiazon, and bioaccumulation in aquatic food webs, as observed with Abamectin, leading to fish contamination. The study proposes recommendations for phasing out HHPs, emphasizing alternatives grounded in the Hierarchy of Control and Precautionary Principles. By integrating these strategies, the paper aims to mitigate environmental degradation and health risks while supporting sustainable agricultural practices.

7.02.P–ThFr68 Multi-Criteria Ranking Tool for Antiretroviral Drugs: A Guide to Water Quality Monitoring Priorities

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Antiretroviral drugs (ARVDs), extensively used in the treatment of HIV/AIDS (human immunodeficiency virus/acquired immunodeficiency syndrome), are increasingly detected in aquatic environments raising concerns about their potential human and ecological health risks. Designed to be pharmacologically potent and persistent, many ARVDs evade complete removal during conventional wastewater treatment, resulting in their continuous introduction in surface and drinking water systems. The present study developed and applied a specific multi-criteria decision analysis (MCDA) model to prioritise clinically relevant ARVDs commonly used in South Africa, based on environmental occurrence, toxicity, and exposure data. A systematic analysis of 24 peer-reviewed studies published between 2015 and 2024 identified 19 ARVDs across various South African waters. Toxicological endpoints and health-based reference doses were compiled from peer-reviewed databases and regulatory documents. All relevant risk and index metrics used in this MCDA were derived from data obtained by the systematic analysis. Six weighted and normalised indicators were integrated to compute a final priority score for each compound: hazard quotient score, hazard index, drinking water contribution, ecological risk score, priority index, and reliability function. Among the evaluated ARVDs, abacavir, lopinavir, emtricitabine, efavirenz, and nevirapine emerged as highest-priority, with abacavir demonstrating the greatest overall hazard potential across both human health and ecological risk metrics. The results emphasise the urgent requirement for targeted environmental monitoring and regulatory attention to specific ARVDs, especially in regions with high pharmaceutical usage and circumscribed water quality management. This integrative model supports evidence-based prioritisation in water quality management, advancing both eco-pharmacovigilance efforts and public health protection strategies in regions burdened by high pharmaceutical use, not just South Africa, but elsewhere as well. The model is adaptable, can include many more compounds and may serve as a decision-support tool for policymakers and environmental authorities globally.

7.02.P–ThFr69 Does Environmental Noise Mask Microplastic Signals? An Assessment of the Microplastic Discharge Unit on Wastewater Treatment Plants in Alpine Rivers

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The presence of microplastics in freshwater environments has been well documented. Unfortunately, the way microplastics are reported in terms of abundance, concentration, levels, and presence has varied across studies. This includes the measurement units commonly used in freshwater studies, such as particle per litre, particles per square metre, or per cubic metre. These units are often applied regardless of the water body type, sampling method or volume filtered or netted respectively. These differences limit the comparability of studies and the contextualisation of microplastics distribution in rivers. The Microplastic Discharge Unit (MDU) is a unit developed to not only report the concentration of microplastics but contextualise it by reducing environmental noise, such as the volume of water, stream characteristics, and other aspects that may influence how microplastics are reported. The unit achieves this by reporting the microplastics as a unit of particles moving through a river habitat every second, which can drastically change the context of the total number of microplastics in a river system. The present study aimed to assess the MDU and how significantly it can be used to reduce environmental noise and detect sources of microplastics entering a river system. This was tested by sampling above and below a wastewater treatment plant undergoing a new microplastic filtration system. A Before-During-After-control-impact sampling approach was conducted using the MDU sampling method to determine whether the method was effective in detecting the reduction of microplastics by minimising environmental variation, and whether the filter system showed any immediate reduction of microplastics in the river. It was hypothesised that (i) There will be a sharp decrease of microplastics below the wastewater treatment plants compared to upstream during filtering (ii) The discharge between sites will impact the concentration of microplastics reported through traditional units (iii) The MDU calculation will be effective at reducing environmental noise by detecting the changes of microplastic abundances in water during filter use. This poster reports the preliminary results on the efficacy of the MDU and filtration system employed in this study, which could both prove to have a significant impact on microplastic pollution and research.

7.02.P–ThFr70 Environmental Sustainability and Alternative Practices in the Western Highland of Cameroon

Divine Tarla[1] and Beltha Tanlaka[2] (1)North Dakota State University, (2)University of Buea

Market gardening in Cameroon's Western Highlands plays a central role in food supply, yet its sustainability is threatened by the overreliance on agrochemicals. This research assessed the environmental impacts of current phytosanitary practices by analyzing heavy metal residues in tomatoes, irrigation water, and soils from the Foumbot Production Basin. While laboratory results showed contamination levels surpassing safe thresholds for several metals, the study emphasizes that these challenges are not insurmountable. It recommends a transition toward safer pest control approaches, notably Integrated Pest Management (IPM), alongside phytoremediation strategies to restore soil and water quality. Adoption of these practices would not only reduce chemical dependency but also safeguard ecological integrity, enabling the region to maintain its status as a key food basket for Cameroon and its neighbors. The findings underline the need for proactive policies that encourage sustainable farming techniques and continuous environmental monitoring to balance productivity with ecological health.

7.02.P–ThFr71 Agrochemical Use and Human Health Risks in the Western Highlands of Cameroon

Divine Tarla[1] and Tanlaka Wilson Berinyuy[2] (1)University of North Dakota, (2)No Affiliation

The expansion of vegetable farming in the Foumbot Production Basin of Cameroon has intensified the use of agrochemicals for pest and disease management. This study investigated the relationship between farmers' pesticide practices and the accumulation of heavy metals in soils, irrigation water, and tomato fruits. Data was gathered through structured questionnaires administered to 393 vegetable growers and laboratory analyses conducted using Atomic Absorption Spectrophotometry. Results revealed dangerously high levels of cadmium, manganese, and iron in soils and irrigation water, with zinc and copper concentrations in tomato fruits frequently exceeding international maximum residue limits. These findings suggest severe risks to human health, particularly through dietary exposure, and raise concerns about long-term soil and water safety. The study concludes that unsafe pesticide application practices are a critical driver of contamination. It calls for urgent farmer training programs, stricter monitoring of pesticide use, and improved water management systems to protect public health and ensure sustainable vegetable production in the region.

7.02.P–ThFr72 Are There Micro-Sized Plastics Pollutants In South African Municipal Wastewater And Drinking Water Treatment Plants?

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The high production and consumption of plastic products have led to significant microplastic (MPs; <5 mm) pollution in aquatic environments. These particles have emerged as contaminants of increasing concern due to their potential risks to aquatic ecosystems and human health. The presence and behavior of microplastics in African aquatic environments remain poorly understood, especially within drinking water treatment plants, which is a crucial barrier to prevent MPs from entering potable water intended for human consumption. To improve the status knowledge of MPs in South Africa, the study aimed to investigate the presence of MPs across the water value chain. Samples were collected at different sites along wastewater (influent to effluent discharge point) and drinking water (dam to treated finished water) treatment plants. MPs were extracted using the Fenton reagents and characterized using a suite of complementary methods. The presence of micro-sized plastics pollutants were confirmed in all samples with varying properties and exposure extent. Different size class ranges (< 5 to > 1000 µm) were sized, with the size class of<5 µm being predominant. Mid-sized particles (10 – 100 µm) appear less dominant, whereas fragments surpassing 100 µm are limited. Similar to size, the number of particles detected varied, with a wide particle detection range (1 to 3612 particles/L). The detected microplastics (MPs) exhibited various shapes, including near-spherical, irregular, and fragmented forms. The confirmed presence of MPs in analyzed samples is concerning since it highlights the widespread MPs contamination and indicates both human and environmental exposure potential. This highlights the urgent need for further investigations into comprehensive hazard characteristics, sources, pathways, potential health implications, and mitigation strategies.

7.02.P–ThFr73 Control Fish Populations in the Era of Pharmaceutical Pollution in South African Aquatic Environments

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The integrity of aquatic toxicology research using fish as test organisms relies on the availability of reliable control fish populations unexposed to pollutants. However, the ubiquity of emerging contaminants such as pharmaceuticals in aquatic environments is changing this foundational assumption of perfect control organisms. Recent studies have shown that pharmaceuticals are present in all water sources, including rivers and groundwater in South Africa. This study shows the challenges of maintaining control fish populations while facing widespread pharmaceutical pollution in aquatic environments. Seventy adult fish, Oreochromis mossambicus (red strain) were exposed to the anti-retroviral drug, efavirenz (10.3 and 20.6 ng/L), in environmental controlled conditions for 28 days using a static-renewal system. The aim was to study the effects of efavirenz on the fish health; investigated biomarkers included, histological responses in the liver, kidney and gonads, and the bioaccumulation of efavirenz in the liver. The results showed varied histological changes in the liver, kidney and gonads in both control and exposed fish. Some of the observed histological changes including steatosis, fibrosis (in the liver), infiltration, vacuolation, renal cysts (in the kidney), atresia, infiltration (in the ovaries), Leydig cells hyperplasia and intersex (in the testes) were prevalent in the exposed fish. However, no significant differences were observed in both blood parameters and somatic indices for the liver and gonads between groups. Efavirenz bioaccumulated in the liver of both control and exposed fish but with statistically significant differences between the groups ($p < 0.001$). The highest efavirenz concentrations were observed in the livers of fish exposed to 20.6 ng/L efavirenz. Water analysis revealed the presence of efavirenz in all the control media (3.6 - 6.5 ng/L) and in the extra water samples collected directly from different municipality water taps (5.1 - 18.8 ng/L). From these findings, we argue that with the widespread pharmaceutical pollution in South African aquatic environments, contaminant-free environments are becoming scarce and baseline guidelines for fish toxicology studies should include reality-sensitive approaches in designing control groups. These results should also inform public health and environmental policies to include pharmaceutical screening of wastewater treatment plants' effluents in routine water quality monitoring.

7.02.P–ThFr74 Microplastics as Contaminants of Emerging Concern: Characterisation, Occurrence and Impacts

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The Orange-Senqu River Basin, an important transboundary water resource, is particularly vulnerable to diverse pollution pressures emanating from domestic, industrial, and agricultural activities. Amongst these, contaminants of emerging concern (CECs), including microplastics (MPs), are increasingly recognised for their persistence and potential ecological risks in freshwater systems. However, reliable data on their occurrence and quantities remain limited due to methodological

challenges, including a lack of standardised methods, limitations of detection techniques, and complex environmental matrices. This study focuses on the development and optimisation of a multi-step protocol for MPs detection in both water and sediment samples. Pristine plastic particles representing commonly used polymers (polyethylene terephthalate, high-density polyethylene, low-density polyethylene, polypropylene, polystyrene, and polycarbonate) were prepared individually and in mixtures to assess extraction efficiency and validate recovery methods. Samples were shredded and further fragmented using a grinder and size fractionated by sieving (2mm and 100 µm) before characterisation. Method validation with spiked samples (1 g polymer per 20 g sediment for individual tests; 1 g polymer mixture per 20 g sediment for mixture tests) demonstrated recovery efficiencies above 90% for HDPE and 80% for LDPE, while other polymers yielded lower recoveries. This contrast underscores matrix effects and the necessity for protocol refinement to improve recovery across polymer types. Preliminary findings demonstrate successful identification of target polymers using Fourier-transform infrared (FTIR) and Raman spectroscopy, with reproducible peak patterns for all polymers. The scanning electron microscope (SEM) analysis revealed irregular MPs morphologies, while the transmission electron microscope (TEM) provided nanoscale particles and confirmed sub-micron size fractions. Gas chromatography-mass spectrometry (GC-MS) detected characteristic hydrocarbon and additive compounds leaching from selected polymers, strengthening chemical confirmation of polymer identity and pointing to potential ecotoxicological relevance. By integrating vibrational spectroscopy, electron microscopy, and chromatography, this work contributes towards advancing characterisation frameworks that support MP monitoring assessments in African water systems. These findings highlight the importance of prioritising integrated datasets that combine physical (morphological, size) and chemical (polymer identity, leachates) characterisation of MPs to strengthen environmental risk assessments.

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